From Algorithms to Arctic Ice:

AI's Role in Climate Adaptation from Ottawa to Oslo

by

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Abstract

This study contributes uniquely to the understanding of artificial intelligence (AI) policy development in smaller economies, with a focus on Canada and Norway. It examines the ethical, economic, and environmental aspects of AI regulation and presents insights into how these nations navigate AI policies in the context of global AI superpowers. Positioned adjacent to larger economies—the United States and the European Union (EU) for Canada and Norway, respectively—these countries provide a specialized perspective on the intersection of national AI strategies, international influences, and climate change imperatives. The comparative analysis uncovers key differences and similarities, leading to actionable policy recommendations. Qualitative research methods are employed to critically evaluate policy documents, expert commentaries and case studies, explaining the objectives, strategies, and approaches of the two nations. The findings indicate that both have made progress in applying AI to climate action, yet they encounter challenges such as policy coherence, rapid technological changes, and the influence of larger geopolitical forces. Recent innovations like OpenAI's ChatGPT are examined for their potential impact on forthcoming regulatory frameworks. Although rapid policy and technological shifts may soon date some aspects of this study, it lays a foundational groundwork for future research aimed at bridging the gaps between technology, policy, ethics, and global environmental imperatives.

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List of Abbreviations

Abbreviation	Definition
AIDA	Artificial Intelligence and Data Act
AIA	Artificial Intelligence Act
AI	Artificial Intelligence
CCP	Chinese Communist Party
CCI	Council of Canadian Innovators
CIFAR	Canadian Institute for Advanced Research
EAIB	European Artificial Intelligence Board
EEA	European Economic Area
EFTA	European Free Trade Association
EU	European Union
GDPR	General Data Protection Regulation
GHG	Greenhouse Gas
GPAI	Global Partnership on Artificial Intelligence
GPT	Generative pre-trained transformer
ICT	Information and communication technology
LLM	Large language model
ML	Machine learning
NAIL	Norwegian Open Artificial Intelligence Lab
NAINE	Norwegian Artificial Intelligence Network
NDCs	Nationally Determined Contributions
NorwAI	Norwegian Research Center for AI Innovation
NORA	Norwegian Artificial Intelligence Research Consortium
NTNU	Norwegian University of Science and Technology
OECD	Organisation for Economic Co-operation and Development
RAISE	Responsible AI Strategy for the Environment
SDG	Sustainable Development Goals

1. Introduction

On July 7, 2023, the world recorded its highest average global temperature in history (Spring, 2023). This event, combined with the alarming news that the world is currently on track to surpass the Paris Agreement's 1.5 °C temperature limitation target, underscores the urgent need to address the growing threat of climate change. António Guterres, the Secretary-General of the United Nations, pronounced that the world currently exists in the "era of global boiling," as July 2023 was tracking to become the hottest month ever recorded (Hottest July Ever Signals 'Era of Global Boiling Has Arrived' says UN Chief, 2023). Numerous strategies and international agreements combatting climate change exist and continue to be developed; however, most of the world is arguably still predominantly preoccupied with post-pandemic socioeconomic recovery, as well as with wars, tensions among superpowers, and other geopolitical crises. During the initial shock from the COVID-19 crisis, the world witnessed a significant shift toward a virtual reality as an increasing number of individuals embraced online platforms for work, education, and daily activities. Many of the same cyber strategies still exist today. Yet the preoccupation with economic recovery from the pandemic has delayed actions taken to combat climate change. This combination of interconnecting factors has intensified the pressing need for immediate and concerted worldwide efforts to address the escalating climate crisis.

Artificial Intelligence (AI) has played a critical role in supporting the cyber climate-change mitigation and adaptation strategies through different measures such as renewable energy optimization, climate modeling, smart grid management, climate-change risk assessment, and natural resource management. The common applications of AI in everyday life include language translation, image recognition, credit scoring, e-commerce personalization, recommendation systems, speech recognition, autonomous vehicles, and automated decision-making processes. The uses of AI are a transformative technology that has a broad range of applications spanning multiple sectors. The integration of AI technologies is now dominating worldwide headlines as a trending topic mainly influenced by the emergence of OpenAI's generative pre-trained transformer (GPT), large-language model (LLM) chatbot, known as ChatGPT. The news coverage and government responses surrounding this chatbot can be attributed to the anticipation and/or apprehension regarding the rapid evolution of AI.

The escalating concerns about the impacts of both AI and climate change have accelerated the search for innovative, technology-driven solutions that can facilitate a sustainable societal shift. As countries aim to develop comprehensive policies and regulations that harness the benefits of AI while mitigating the diverse range of its effects, it is important to examine the strategies and approaches that different nations implement. While much attention has been devoted to the AI policies and strategies of leading AI nations, there is a sparsity of research on how smaller economies navigate this complex landscape.

Currently, the main academic focus throughout the world is on the AI development trajectories of major AI players, often overlooking the unique challenges and opportunities faced by smaller

economies. In this context, the term 'smaller economies' refers specifically to nations like Canada and Norway which, while advanced and robust in their own right, are considered smaller in comparison to AI superpowers such as China, the USA, and the EU. There exists a knowledge gap in understanding how these smaller nations form their AI policies and strategies when they must contend with the influence and competition from these worldwide AI heavyweights.

To address this knowledge gap, this study will investigate a central question:

How do smaller economies navigate the major global AI powers when developing their national AI policies?

For this research, Canada and Norway are selected as case studies to investigate the dynamics of smaller economies in the face of major AI powers. Canada presents a unique model of a smaller economy that has established itself as a global leader in AI, particularly in the area regarding ethical AI frameworks. Norway's strategic integration of AI demonstrates how a smaller, affluent economy can innovatively apply technology to advance its sustainable development and climate change goals.

To offer a thorough analysis of the primary research question, this study will explore four sub-questions that target specific aspects of AI policy and other factors:

1. **How do ethical considerations shape the development and application of AI policies in Canada and Norway?**

2. **What economic strategies are being implemented by Canada and Norway to accelerate or regulate AI technologies?**

3. **How do Canada and Norway differ in their AI policies aimed specifically at climate change mitigation and adaptation?**

4. **How can insights from the comparison between Canada and Norway inform an analysis of global commitments such as the Sustainable Development Goals (SDGs) and fulfilling the obligations of the Paris Agreement?**

To answer these questions there are three main research objectives of this study. First, the ethical frameworks that guide AI policies in smaller economies will be analyzed and then compared with the AI regulations in the major AI powers. By examining the ethical principles and considerations that influence policy decisions, this objective will be met by examining the values and priorities that inform AI development and implementation in different geopolitical contexts. Second, the study evaluates the economic instruments that small and large economies employ for the acceleration and regulation of AI technologies. This study rigorously analyzes financial incentives, subsidies, and other economic mechanisms that are explicitly designed to advance AI innovation and ensure its responsible development. Finally, and most

important, an examination of (or investigation into) the impact of AI policies and technologies on climate change mitigation and adaptation efforts in both smaller and major AI economies will be undertaken.

In the global AI landscape, major powers like the United States, China, and the EU command significant attention due to their considerable investments and technological advancements. In contrast, Canada and Norway stand as examples of smaller economies compelled to independently formulate policies addressing both the ethical considerations and environmental implications of AI, while at the same time being attentive to developments among the major powers. By focusing on these nations, this thesis presents a multi-layered perspective on how smaller economies navigate the complex terrain of AI policy formulation. It examines the balance between technological innovation, ethical integrity, and environmental responsibility.

This study's comparative analysis of Canada and Norway will offer an in-depth understanding of how these nations regulate AI technologies, considering the ethical, economic, and environmental dimensions that shape their policy frameworks. Specific attention will be devoted to ethical considerations that guide policy formulation, the economic strategies deployed to stimulate or regulate AI technologies, and the realistic outcomes of these policies in mitigating and adapting to the climate crisis. While AI has a broad range of applications, this study focuses particularly on its role in climate adaptation strategies employed by Canada and Norway. This research will serve as a resource for policymakers, academics, and other stakeholders interested in forming effective strategies to address the complex challenges of promoting ethical AI technologies that support the fight against the changing climate as well as a growing economy.

1.1.AI & Policy: Establishing Terms

With the intention to compare the effects of policies that regulate the impacts of AI, this study must first define what ‘intelligence’ is. Human intelligence, according to *Britannica*, refers to an individual's ability to engage in abstract thinking, acquire knowledge, apply logical reasoning, exhibit creativity, and demonstrate effective decision-making skills (Sternberg, 2022). This definition describes a capacity to reason, learn, solve problems, adapt to new situations, and comprehend complex information. Throughout history, the concept of intelligence has continually faced criticism, scrutiny, adaptation, updates, and improvement; however, we remain far from achieving a unanimous and definitive consensus on the term. In recent times, the unmistakable evidence of this non-existent universal definition becomes apparent when analyzing the ongoing debates surrounding 'artificial intelligence'.

To conduct an accurate comparison between Canada and Norway, this study will adopt the definition of artificial intelligence provided by the Organisation for Economic Co-operation and Development (OECD), as both countries are members of this organization. According to the OECD (2019), AI is “a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual

environments.” The definitions of both ‘intelligence’ and ‘artificial intelligence’ are quite broad and open to a wide and ever-increasing range of interpretations. Because of this, it is easy to see why these definitions continue to be widely debated by policymakers around the world, and why, in the absence of accepted definitions, it is difficult for countries to accurately promote and regulate AI technologies. But by adhering to the OECD's definition of artificial intelligence, at least, this study ensures a consistent analytical framework for evaluating AI policies in Canada and Norway.

The extensive scope of AI poses challenges for governmental regulation. First, the policies implemented need to be sufficiently broad to address the diverse range of areas that AI covers. Consequently, this necessitates more general strategies, rules, and regulations, and it can be more challenging for governments to effectively implement such because they impact so many overlapping sectors. A vague regulatory framework often fails to capture the intricate and specific impacts of AI, potentially resulting in overlooked consequences. These considerations emphasize the importance of examining various governmental strategies and frameworks, given the rapidly evolving impact of AI technologies. It is imperative for all nations to promptly respond to the potential transformative power and far-reaching influence of AI technologies. Moreover, the rapid expansion of AI technologies also requires enormous amounts of energy and therefore contributes to the production of greenhouse gases (GHG), another important factor for nations to be aware of. In addition, heightened levels of societal interconnectivity sparked by AI can give rise to a negative externality known as the ‘rebound effect,’ which involves a potential increase in consumption and emissions despite the initial gains in efficiency.

Moore's Law, outlined by Schaller (1997), is a concept introduced in 1965 by the co-founder of Intel; it states that the number of transistors on a microchip double approximately every two years, while the cost of computers is halved. This implies that every two years computers become twice as powerful and half as expensive. Throughout history, our technological development has consistently followed the trajectory predicted by Moore's Law. However, ongoing discussions persist regarding the expected longevity of Moore’s technological trajectory. The physical limitations of microchip size are evident, as hardware development approaches the atomic scale. As computational technologies advance into the quantum realm and become increasingly constrained by physical limitations, their progression now heavily depends on software developments, which are mainly driven and maintained by AI. Despite being non-physical, these advancements directly impact the environment. Increased computational demands drive emissions higher, lead to more data centers, and escalate the use of energy-intensive computing devices, especially those reliant on non-renewable energy sources.

This rapid pace of development presents a dual role for AI, as it has the potential either to reduce emissions through infrastructure upgrades, smart grid technologies, and advanced predictive capabilities, or increase emissions because of its increased energy consumption from

unsustainable sources to produce and operate the technologies. For example, Dhar (2020) found that the largest data center in the world, located in Virginia, USA, sources only 1% of its electricity from renewable energy sources, with the remaining 99% coming from non-renewable sources. This dilemma will need to be addressed by nations around the world, and this study will compare the specific goals and strategies that Canada and Norway have that specifically target, enable, and promote sustainable societal adaption and climate change mitigation using AI technologies.

This comparative investigation of Canada and Norway will inspect the AI policies, regulations, and initiatives aimed at mitigating and adapting to the environmental consequences of climate change. Within this scope, this study will assess governmental strategies that not only offer a high likelihood of enabling successful AI implementations but also minimize adverse outcomes, such as increased carbon emissions and inequitable wealth distribution. Special attention will be given to ethical dimensions, including considerations like privacy and accountability, that influence AI policy formulation and execution at both national and international levels. Economic incentives and disincentives guiding corporate and public-sector behavior in AI development will also be assessed, with particular attention to their success in steering AI toward sustainable practices. Though the study broadly covers elements of ethical guidelines and economic incentives, the primary focus will lie at the intersection of AI and climate change. This research will also explore potential unintended rebound consequences, such as spikes in carbon emissions, that could arise from rapid advancements in AI, often driven by capitalist incentives or national defense considerations. By addressing these issues, the study aims to provide a comprehensive understanding of how AI can be responsibly used for ethical economic growth, while cautioning against the hazards that could exacerbate climate-related challenges.

Additionally, this research assesses how external pressures from major economies, including the USA, the EU, and China, shape AI developments in smaller nations such as Canada and Norway. By conducting an in-depth analysis of how Canada and Norway construct their comprehensive AI policies and frameworks in the face of these external pressures—with a distinct focus on ethical, economic, and environmental considerations—this study aims to generate valuable analytical insights applicable to countries and regions with similar demographic, geographical, or economic characteristics.

The increased level of attention to AI by governments and the mainstream media has generated intense debates and hypothesizing on the evolution of AI systems. Such recent developments have seemingly overshadowed much of the more necessary and pressing coverage of the global climate crisis. It is evident that countries have dissimilar strategies and lack a unified goal when it comes to the efforts required for mitigating climate change. This dilemma is even more pronounced when it comes to the development and implementation of strategies and policies among nations regarding AI. While this study primarily examines Canada and Norway, it will also incorporate broader international perspectives on AI and climate change policy to showcase the current fragmentation in global approaches. This detailed

comparative analysis between Canada and Norway centers on understanding how smaller economies construct AI policies under the influence of major global powers. This comparison of the individual strategies, rules, and regulations of the two nations, in the context of AI and climate change, aims to uncover the fundamental reasons and motivations that underlie their respective policies. These factors impact both the similarities and divergences in their policy frameworks.

1.2.Overview of the Thesis Structure

The study will begin with a literature review, which will integrate the theoretical framework into the examination of the current state of AI technologies, rules, regulations, and policies in Canada, Norway, and other relevant and pivotal global economic entities. Within the scope of this review, specific attention will be dedicated to the role of AI in climate change mitigation and adaptation, as well as how ethical considerations and economic factors shape policy and technological development. The theoretical framework will serve as a conceptual lens through which these complex aspects are analyzed, offering a structured approach to explore the connections among AI, ethics, economics, and climate change.

Following the literature review, a separate chapter on the methodology and methods of this study will describe the research design and approach for this comparative analysis. This chapter will detail the use of case-based qualitative and mixed-method techniques, elaborating on data collection methods, sampling strategies, and analytical procedures.

After this, a 'Findings' chapter will offer a detailed presentation of data that spans technological, ethical, and economic dimensions, aiming for a comprehensive understanding of how Canada and Norway employ AI for climate action. The next chapter will then discuss and synthesize these findings with insights gained from the literature review. An integrated analysis will examine Canada’s and Norway's strategies in using AI to battle climate change, with particular attention to ethical considerations as well as the economic and market-driven motivations. The comparative analysis of AI policies in Canada and Norway will be critically assessed for their potential to inform and shape the pursuit of global objectives such as the SDGs and the Paris Agreement, while simultaneously considering the extensive ethical and social implications.

Finally, the concluding chapters will evaluate the key findings and their broader implications. It will then consider the limitations of the study and recommend avenues for future scholarly exploration, stressing the ongoing need for research in this complex and rapidly evolving interdisciplinary domain.

2. Literature Review

This chapter is divided into four sections that apply the same analytical approach to different regions. The first section outlines the theoretical framework that serves as the foundation for analyzing AI policies, ethics, economics, and their climate change implications. The second section focuses on Canada, the third on Norway, and the closing section examines three other regions that have a significant impact on all countries, specifically the USA, the EU, and China. Each subsection will then analyze the political framework, environmental state of the nation or region, and the societal implications relating to increased levels of personal and governmental connectivity. This study relies on official government documents and peer-reviewed publications for its primary data and literature.

2.1. Theoretical Framework

Comparative public policy analysis is an interdisciplinary approach that compares different systems, institutions, and societies across countries and governments. Gupta (2012) explained that comparative public policy analysis is instrumental in exploring divergent policy outcomes in different countries to understand the underlying reasons for these variations. At its core, Dodds (2018) described this framework as one that focuses on investigating policy processes, outputs, and outcomes within varying national contexts. By examining both independent and dependent variables, scholars using this framework can discern why certain countries with different political frameworks may produce similar end results, while others with similar frameworks may yield entirely divergent outcomes. The comparative public policy analysis framework is important for my research as it allows me to investigate the delicate balance that smaller economies must achieve when navigating the field dominated by global AI superpowers.

A key aspect of this framework involves using the public policies of the selected regions as the unit of analysis. Previous applications of this theory have mainly been in qualitative analyses examining policy formulation and power structures. By examining policy processes and outcomes in the specific context of AI policies and climate change strategies in Canada and Norway, this study aims to gain deeper insights into the effectiveness and implications of these policies in addressing ethical, economic, and climate change challenges. The comparative public policy analysis approach will enable a comprehensive evaluation of the strengths and weaknesses of the AI policies in each country, facilitating meaningful comparisons between their respective frameworks. The framework helps divide cross-national policy analysis into manageable units of comparison, providing the methodological precision necessary to evaluate the impact of AI on ethical, economic, and climate change strategies within smaller economies. Such a framework allows for a comprehensive analysis of AI policies and ensures that the complexities of the issue are fully understood, thus contributing to the global effort to regulate AI with innovative and adaptable policymaking.

Furthermore, this theoretical framework also provides an in-depth examination of the role played by various factors, such as political structures, institutional arrangements, stakeholder

engagements, and international collaborations, in shaping policy outcomes. The framework's wide-ranging scope ensures that the complexities of the policy landscape in both countries are thoroughly explored and understood. By connecting theoretical concepts to the study's focus, the framework helps contextualize and understand the complexities of each country's approach to tackling climate change with AI solutions.

Comparative public policy analysis also enables the study to explore how each country's political system influences the development and implementation of AI policies and climate change strategies. The framework provides insights into the dynamics of public-private stakeholder relationships and how they impact policymaking decisions. By investigating the roles and influence of different stakeholders, such as businesses, industries, and civil society organizations, the study can discern the driving forces behind policy outcomes and better understand the degree of collaboration between various actors.

Overall, the theoretical framework of comparative public policy analysis serves as a guiding tool to interpret the findings of the study. By systematically analyzing the AI policies and strategies in both countries, the framework helps to identify patterns, similarities, and differences between the two nations. It provides a structured approach to make sense of the complex interactions between policy objectives, institutional arrangements, stakeholder engagements, and international collaborations.

The utility of this theoretical framework in guiding the methodological approach of this study is evident. It informs the selection of case studies, variables, and data sources, thereby offering a structured pathway to explore the complexities involved. However, it is worth noting that while the framework offers a strong structure for comparative analysis, it may not fully account for the rapidly evolving nature of AI technologies, a limitation that this study aims to address through its dynamic approach.

2.2.Canada

According to Canada’s National Adaptation Strategy (2022), the country aims to significantly strengthen its private sector privacy law through the recently introduced Digital Charter Implementation Act, 2022, which will further advance the Digital Charter's implementation and establish new guidelines for the responsible development and application of AI. In addition, Canada enforces a Directive on Automated Decision-Making, constraining the federal government's use of automated decision systems. This directive requires government agencies to ensure transparency, fairness, and accountability when using algorithms to make decisions that impact citizens. The targets outlined in this directive primarily relate to the algorithms powered by AI that assess people's eligibility for things such as social benefits or immigration privileges.

In alignment with its commitment to clear values, ethics, and regulations, the Canadian government actively researches AI's application in government services and programs. The Canadian Institute for Advanced Research (CIFAR) announced the Pan-Canadian Artificial

Intelligence Strategy, which included a grant of CAD $125 million from the Canadian government (*Pan-Canadian AI Strategy Impact Assessment Report*, 2020). This strategy aims to retain and draw elite academic talent to Canada. Additionally, the AI Advisory Council advises the Government of Canada on how to strengthen its AI capabilities to position itself as a worldwide leader, while also exploring opportunities for economic growth that benefit all citizens (*Advisory Council on Artificial Intelligence*, 2022).

2.2.1. Political Framework

Canada is a parliamentary democracy and a constitutional monarchy, meaning that the head of state is the monarch. There are three levels of government in Canada: federal, provincial, and municipal. The federal government is based in Ottawa and deals with national and international matters. Provincial governments handle issues affecting their respective provinces. The municipal government receives its power from the provincial government and is responsible for local services. This section concentrates on the powers and policies enacted by the federal government.

2.2.2. AI Policies, Rules, and Regulations

This study's first and second sub-questions will be assessed by addressing the ethical and economic aspects of Canada's federal AI policies. The Canadian government introduced the Artificial Intelligence and Data Act (AIDA) in June 2022. This act is part of Bill C-27, the Digital Charter Implementation Act, 2022, which is aimed at enhancing private sector privacy law while also creating new rules and regulations for responsible AI development and deployment (*Bill C-27 Summary*, 2022). The implementation of AIDA is contingent upon the Royal Assent of Bill C-27, which is a process expected to occur no earlier than 2025 (*The Artificial Intelligence and Data Act (AIDA) – Companion Document*, 2023). Within AIDA, AI is defined in accordance with the concepts of the OECD. The goal of this international alignment is to ensure that Canadian citizens and firms are globally protected and recognized. The AIDA adopts a risk-based system to outline its proposed levels of regulation. Under this framework, any AI system classified as high impact undergoes careful identification and is obligated to thoroughly address and mitigate its associated risks. High-impact AI systems are described as any system that has a higher potential to inflict harm or produce biased outputs to individuals or groups. Biased output refers to decisions or actions taken by an AI system that unfairly discriminate against certain individuals or groups.

Canada is a member of the Global Partnership on Artificial Intelligence (GPAI) which is an international initiative launched in June 2020 with the goal of narrowing the divide between AI theory and practice by providing support for innovative research and real-world applications of AI (*Global Partnership on Artificial Intelligence - GPAI*, 2020). The overarching goal of this partnership prioritizes environmental protections and how governments can facilitate a responsible use of AI within the framework of climate change. Clutton-Brock et al. (2021) describe the GPAI report released in November 2021 on AI and climate change which acknowledged AI's potential to accelerate climate action while emphasizing the need for

responsible use. Their report stated that AI can influence climate action by distilling data, improving predictions, optimizing systems, accelerating scientific discovery, and informing policy. In addition, they found AI applications in areas such as electricity, buildings, transportation, industry, agriculture, forestry, ecosystems, climate science, and finance that can enable emissions reductions and adaptation strategies. Following this they then recommended enhanced levels of measuring and reporting AI's climate impacts, as AI can negatively affect the climate by increasing computation-related emissions, facilitating high-emission activities, and causing major societal shifts.

The GPAI report states that careful consideration of risks and challenges is essential to ensure that AI has a positive impact on climate efforts, while also promoting a more sustainable future. Furthermore, the GPAI also has multiple reports that provide recommendations and guidance for sustainable AI developments. One report from November 2022, "Responsible AI Strategy for the Environment" (RAISE), discusses the opportunities and recommendations for using AI to support biodiversity conservation, while another report from December 2022 analyzes how the electricity sector can leverage AI to facilitate the transition to net-zero emissions (*AI for Net Zero Electricity: Assessing the Electricity Sector's Readiness for AI*; *Biodiversity & Artificial Intelligence, Opportunities and Recommendations*). Canada's international collaboration with other countries that share the same goals for responsible and ethical usage of AI showcase a strong national drive for a more desirable technological transition.

According to Adebayo (2022), the stability of all levels of the political systems in Canada contributes to effective environmental policies. A stable political system not only attracts foreign investments but also helps to ensure that governments take climate change seriously. A large part of Canada's climate action plan includes a pricing or taxation system on carbon pollution (*Carbon Pollution Pricing Systems across Canada*, 2018). This pricing plan is a flexible federal regulation, in which any province or territory can establish its own system. To ensure an effective reduction in GHG emissions, the federal government establishes minimum national stringency standards. Any province or territory that chooses not to price pollution or proposes a system that fails to meet these criteria must follow these standards. Stable political systems lay the foundation for the successful implementation and monitoring of these extensive and diverse regulations derived from a comprehensive national policy.

In November 2022, the OECD released a report on the environmental impacts of AI (*Measuring the Environmental Impacts of Artificial Intelligence Compute and Applications*, 2022). This report was assisted by a working group of experts from GPAI that were focusing on Responsible AI. The researchers distinguished between direct and indirect environmental impacts that can be either positive or negative. Direct impacts exist from the AI ecosystem through such things as energy use, GHG emissions, water use, and waste generation. Examples of indirect impacts from AI applications are efficiency gains, smart grid management, and changes in consumption patterns. The growth rate of these impacts has coincided with the dramatic increase in AI computing demands. Google's energy usage from machine learning (ML), or AI, accounted for

approximately 15% of the company's total energy consumption over the past three years. The findings from this same OECD report identified issues relating to measurement errors within current AI policies. It concluded with a recommendation for increased international collaboration, involving a diverse group of stakeholders, to develop a comprehensive framework for sustainable policies.

The federal government is actively funding private and sustainable AI research through the Pan-Canadian Artificial Intelligence Strategy. It identified three National Artificial Intelligence Institutes – Amii, Mila, and the Vector Institute – to receive financial support of CAD $60 million from Budget 2021, with each institute eligible for up to CAD $20 million over five years (2021-2026) (*Pan-Canadian Artificial Intelligence Strategy - Home*, 2022). As an example of the provincial level, Ontario's government invested CAD $77 million in the Vector Institute for Artificial Intelligence and the Ontario Centre of Innovation to support the adoption, development, and commercialization of vital technologies like 5G, ethical AI, blockchain, cybersecurity, and robotics among Ontario companies (*Ontario Supporting More Innovation in Growing Tech Sector*, 2023). Additionally, Canada's Global Innovation Clusters are receiving CAD $125 million in funding over the same five-year period to promote the adoption of Canadian AI technologies by businesses and public entities in targeted industries (*Pan-Canadian Artificial Intelligence Strategy - Home*, 2022).

In summary, the approach taken by the Canadian government in terms of AI regulations, rules, and policies demonstrates a dedication for responsible AI development and deployment. Bill C-27's incorporation of AIDA signifies a deliberate strategy to safeguard individual privacy and mitigate risks associated with AI systems. Canada's participation in international initiatives like the GPAI indicate the country's commitment to properly applying AI to address global problems. Coordination with other countries demonstrates a stronger national commitment toward a more sustainable technological transition. Canada's political stability enables the effective implementation of diverse climate action policies, including carbon pricing, to reduce GHG emissions. The government's financial backing of AI research and development through numerous national and provincial projects reveals a dedication toward the promotion of innovative and responsible AI technology. Global collaborations display the country's commitment to directing an ethical and sustainable future for AI technology, both domestically and internationally.

2.2.3. State of the Environment

Since 1948 Canada experienced an increase in temperature of 1.7 °C, which is twice that of the global average (*Climate Change*, 2022). The Canadian government recognizes that the entire country is undergoing climate change at a rate that is double the global average, with Northern regions experiencing this change at a pace that is three times faster (*Canada's National Adaptation Strategy*, 2022). The Canadian environment is experiencing significant intensifying effects of extreme heatwaves, floods, and wildfires. Heatwaves have proven to be the deadliest environmental event, as evidenced by the 2021 heat dome that resulted in 619 deaths in

western Canada. Floods in Canada are expected to undergo a significant fivefold increase in the annual cost of damages over the next three decades. The escalating threat of wildfires is placing communities, infrastructure, and industries at heightened risk levels. The cost of damages caused by wildfires combined with the costs of fighting the fires equates to over CAD $1 billion every year. Not only do the intense events described above deliver direct impacts, but slower-paced consequences resulting from the changing climate will also soon bring more dramatic outcomes. Thawing of permafrost, rising sea-level, and receding coastlines will continue to develop and their effects will be compounded by the elevated impacts of the direct intense events described above, that also continue to worsen. Biodiversity in Canada, encompassing trees, fish, birds, and insects, is under severe threat due to the impacts of climate change. Warmer temperatures are causing tree species to migrate north, disrupting ecosystems, and fish species are suffering from heat stress and alterations in water levels. Mitigation and adaptation are necessary to slow the acceleration of climate change impacts, to preserve biodiversity, protect human lives and infrastructure, and maintain economic stability.

2.2.4. Societal Implications

This segment directly addresses the first sub-question of the study, focusing on ethical dimensions such as algorithmic bias, transparency, and accountability in Canada's AI policies. Butcher and Beridze (2019) argue that Canada has emerged as a leader in the field of AI. This leadership is exemplified by the country's early introduction of a national AI strategy that emphasizes responsible and ethical development. The primary motivations of this strategy were centered around research and talent attraction (*Why Countries Need to Work Together on AI*, 2018). AI systems and technologies have the potential to spur economic growth and increase levels of productivity.

Kung (2020) displayed the CIFAR strategy as one that will strengthen the nation’s worldwide recognition as a leading hub for AI research combined with the training that will create jobs. However, alongside the potential for job creation, there are threats of displacing certain groups of workers, hinting at the diverse, and often unpredictable, impacts of AI deployment. Moreover, regulatory policies in Canada have been designed to address the ethical dimensions of AI, with particular emphasis on algorithmic bias, transparency, accountability, as well as privacy and data protection. AI systems fundamentally depend on extensive personal data, driving the development of revolutionary technologies. Yet this growing data dependence simultaneously escalates the associated risks.

The transformative potential of AI can be harnessed in industries such as healthcare and education, but it is crucial to approach these changes cautiously, considering privacy, transparency, and equitable access. Strict regulation is indispensable for ensuring that AI development progresses reliably and mitigates cybersecurity and environmental risks. As highlighted by Gherhes et al. (2023), Canada's approach to AI commercialization is constrained by its stringent privacy laws and entrepreneurship culture. The country’s current culture of

entrepreneurship encourages the development and scaling of AI technologies while ensuring adherence to ethical guidelines and regulations.

To manage these intricacies and risks while encouraging innovation and promoting ethical conduct, a multi-stakeholder framework is essential. Through such a framework, Canada could balance the opportunities and challenges posed by AI across all sectors, steering the nation toward a more sustainable, AI-driven future.

2.3. Norway

Norway has a National Strategy for Artificial Intelligence that aims to take the lead in developing and using AI, while respecting the rights and freedoms of individuals (*The National Strategy for Artificial Intelligence*, 2020). This Norwegian strategy aims to facilitate world-class AI infrastructure in Norway in the form of friendly digital regulations, fast and robust communication networks, and sufficient computing power. Norway has a solid foundation for success in AI because the country has elevated levels of public trust in both the business and public sectors. It also has a digitally literate population, a robust infrastructure, comprehensive and high-quality registry data, advanced e-governance systems, and effective collaboration between employers, unions, and the government. These factors make Norway an interesting case study for how a country effectively uses AI for climate change mitigation and adaptation.

2.3.1. Political Framework

Norway is a constitutional monarchy in the form of a parliamentary representative democracy. The Council of State, headquartered in Oslo, exercises executive authority under the leadership of Norway's Prime Minister. Legislative power is shared between the government and the Storting. The political administration in Norway consists of three levels: the Kingdom, the 11 Counties (known as fylker in Norwegian), and the 356 Municipalities (referred to as kommuner).

Norway is a party to both the European Economic Area (EEA) and the European Free Trade Association (EFTA). The EEA extends the EU's single market to members of this agreement. Norway is not a member of the EU but its association with the EFTA and EEA allows the country access to the EU's single market, while restraining it from direct participation in EU decision-making.

2.3.2. AI Policies, Rules, and Regulations

In January 2020, Norway launched its first national strategy for AI (*The National Strategy for Artificial Intelligence*, 2020). This strategy aims to lead AI development while safeguarding individual rights and freedoms and maximizing its potential for innovation and public services. It defines AI as both strong and weak systems that use methods such as ML and robotics. Norway prioritizes AI development that respects human rights, data protection, and security, and it plans to create “regulatory sandboxes” to assess innovative technologies within specific guidelines. The government intends to review and adjust regulations that might hinder the responsible use of AI in both public and private sectors. Van et al. (2021) outlined how the

European Commission, under the power of the EU, analyzed the Norwegian strategy and recognized the significant strides made by Norwegian companies in the private sector that are harnessing AI-related technologies to promote sustainability and greener practices. The Norwegian strategy has successfully stimulated the growth of sustainable private companies; however, due to the non-legally binding nature of the guidelines, there is uncertainty regarding the future developments of this trendline.

In 2020, the Norwegian Data Protection Authority, an independent agency financed by the Norwegian government, was commissioned to assist the development of responsible AI within the country (*Framework for the Regulatory Sandbox*, 2021). Their task was to create an ethical framework aimed at generating benefits for organizations, individuals, and society at large. The framework established was designed as a regulatory sandbox, offering companies the option to participate and receive support and guidance for developing and implementing ethical and responsible AI. This perspective is centered around privacy concerns.

According to the report, 'Ghost in the Machine,' published by The Norwegian Consumer Council in June 2023, generative AI technologies present a direct threat to consumer rights, particularly in the areas of data privacy and informed consent. It stated that generative AI creates a direct threat toward consumer rights. The report outlined the needs for strengthened consumer protections that make the technology more safe, reliable, and fair. The council strongly emphasized the need for an overarching AI-strategy that compensates for the latest developments and provides uncompromising regulations for the responsible use of generative AI in the public sector.

The Norwegian Research Center for AI Innovation (NorwAI), founded in October 2020 and partially funded by the Research Council of Norway, focuses on AI and Big Data exploration. NorwAI's primary objectives revolve around enabling academic institutions to create innovative AI solutions that advance the adoption of sustainable and reliable AI technologies. A significant portion of NorwAI's operations is based at the Norwegian University of Science and Technology (NTNU), particularly within the Norwegian Open Artificial Intelligence Lab (NAIL), which actively contributes to the advancement of AI research and innovation (*NAIL*, 2017). The Research Council of Norway also created the Norwegian Artificial Intelligence Network (NAINE) which is a network open to anyone in Norway who is interested in AI and national and European collaboration (*NAINE*, 2019). The main objective of NAINE is to increase Norwegian participation and contributions to EU proposals on AI, such as Horizon Europe, the EU's primary research and innovation funding program, with a EUR €95.5 billion budget, that addresses climate change, supports the UN's SDGs, and enhances the EU's economic resilience and prosperity (*Horizon Europe*, 2023).

In 2021, the Norwegian Ministry of Local Government and Modernisation created a report on the value of data as a resource for innovation and economic growth. The government stated that some of the advantages relating to increased levels of data and data accumulation would be the creation of new jobs, improved efficiency in the public sector, and a more sustainable

economy (*Data as a Resource: The Data-Driven Economy and Innovation*, 2021). The report found AI to be a key technology driver for the data economy and that Norway should be an active participant in the European and global development of AI. To facilitate the healthy development of AI, the government plans to support research, innovation, and education, while also building additional AI infrastructures and ensuring the ethical and responsible use of AI in accordance with human rights.

Founded in 2001, ENOVA SF, a State Enterprise under the Ministry of Climate and Environment, aims to reduce GHG emissions through technological developments and an enhanced supply of energy (*ENOVA*, 2018). In relation to AI, ENOVA plans to improve efficiencies of transport systems through increased levels of digitalization and autonomy within the sector. This company represents a partnership between the public and private sector to enhance climate change solutions while also assisting the development of innovative technologies and systems.

Steigum and Thogersen (2013) showed how the Norwegian political system was able to rapidly respond to a macroeconomic crisis in the late 1980s that resulted from a sudden plunge in oil prices. Bernstein et al. (2013) explained that a partial response to this economic shock was the inception of the nation's sovereign oil wealth fund, the Government Pension Fund Global. A primary goal in establishing this fund was to mitigate the adverse effects of a rapid accumulation of natural resource wealth, known as the 'Dutch Disease,' which refers to the economic dependencies on natural gas that the Netherlands encountered in the 1960s. The established fund, currently valued at over USD $1.3 trillion, constitutes approximately 1.5% of all publicly traded companies globally as of 2017 (*The Fund*, 2017). The fund is managed by Norges Bank Investment Management under the supervision of the Ministry of Finance. As Myklebust (2010) points out, the management of this fund adheres to the OECD Principles of Corporate Governance and the Principles for Multi-national Enterprises, where the Norges Bank Investment Management prioritizes equal treatment of shareholders, board accountability, efficiency, children's rights, climate change, and water management.

Myhre and Holmes (2022) state that political stability is required to effectively implement and maintain the world's largest sovereign wealth fund. A primary objective of this fund centers on advancing sustainability through investments in international businesses committed to climate change mitigation, implement measures for industrial adaptation, and reduce the world's overwhelming reliance on fossil fuels. As such, a sizable portion of these initiatives involves the application of AI in various forms, either directly through measures such as automation and ML algorithms, or indirectly through AI-powered analytics and decision support systems. This exploration of Norway's sovereign wealth fund addresses the study's second sub-question, focusing on the economic strategies employed to advance sustainability and climate change mitigation. In addition to the oil fund, in 1991, Norway became one of the world's first countries to implement a carbon pricing system as a carbon tax on oil, gas, and diesel (*Emissions to Air*, n.d.).

In summary, Norway as a member of the OECD, adheres to the principles and guidelines provided by this organization to stimulate economic progress and world trade. Norway has made significant strides in advancing its national strategy for AI, prioritizing development that respects human rights, data protection, and security. The establishment of the Norwegian Data Protection Authority's regulatory sandbox and the Norwegian Consumer Council's focus on responsible AI reflect the nation's commitment to addressing ethical concerns.

However, Djeffal et al. (2022) explain that the majority of these national AI strategies and frameworks are non-binding. Initiatives like NorwAI and NAINE demonstrate Norway's dedication to creating multidisciplinary collaborative efforts in AI research and development. Norway recognizes the role of AI in promoting sustainability and economic growth, as seen through publicly funded organizations like ENOVA SF as well as the extensive strategies behind the nation's oil fund. The regulatory frameworks for AI systems that Norway abides by require transparency, and they mandate that individuals have the right to access, rectify, delete, or port their data. This ensures the trustworthiness of AI systems in Norway, strengthening its vision of a society where AI serves humans safely and reliably. By initiating the discussion on Norway's ethical considerations in AI policies, this segment continues to uphold the study's comparative approach between smaller economies like Canada and Norway.

2.3.3. State of the Environment

Northern Norway lies within the Arctic region, making it significantly more vulnerable to the accelerated effects of climate change. The estimates for the projected temperature increase in the northern regions of the country by the end of this century vary between 2-6°C (OECD, 2022). In 2017, Norway introduced the Climate Change Act which included bold targets for 2030 and 2050 (*Norway's Eighth National Communication*, 2023). The Act not only set bold objectives but also mandated the government to present an annual report to parliament, tracking and evaluating Norway's progress toward these crucial targets. The most significant impacts of climate change for Norway were identified as increased precipitation, flooding, landslides, sea level rise, biodiversity loss, and negative health effects. The perceived changes of the Norwegian climate account for increased average temperatures, precipitations, permafrost thawing, extreme events, as well as a rising sea level. The current pace is expected and projected to persist, and the exerted effects will continue to increase warming, precipitation, and the number of floods, heat waves, droughts, and landslides. The report listed numerous impacts of these changes, including:

- reduced water availability,
- increased soil erosion,
- decreased crop yields,
- heightened occurrences of pest and disease outbreaks,
- more frequent forest fires,
- diminished biodiversity,
- escalating coastal erosion,

- heightened damage to infrastructure and buildings,
- amplified health risks, and
- elevated social and economic costs.

2.3.4. Societal Implications

This section addresses the study's first and third sub-questions by examining the ethical and societal considerations shaping Norway's AI policies. Norway's 2020 National AI Strategy explicitly aims to maximize the opportunities that AI offers for its citizens, businesses, industries, and government. To optimize this plan the strategy also aims to ensure that AI is developed and used in a responsible, accountable, transparent, and trustworthy manner. The government prioritizes strengthening human capital through comprehensive education to ensure a successful AI-driven transition or transformation. Upskilling and reskilling initiatives are planned to accurately anticipate and address the emerging requirements of the labour market.

In June 2023, the Consumer Council – an independently operated organization funded publicly – published an article advocating for the enhancement of AI regulations to respond to the immediate need to protect consumer rights more effectively. This call to action was in response to the rapid evolution and emergence of an abundance of new generative AI tools. Within the framework of the EEA, Norway adheres to the EU's General Data Protection Regulation (GDPR), which was implemented on 20 July 2018 (*Regulations*, n.d.). Radley-Gardner et al. (2016) find that the focus of the GDPR surrounds data collection protections, algorithmic transparency, data minimization, and increased accountability in the context of AI development and personal data processing.

2.4.International

This section will briefly describe the political frameworks, as well as the AI policies, rules, and regulations from three distinct regions across the globe: the USA, the EU, and China. The environmental and societal implications associated with the findings described above will concentrate on the extensive global impact exerted by these three regions.

2.4.1. Political Framework

The USA is a constitutional federal republic. The elected President acts as both the head of state and the head of government. Political powers are separated into three distinct systems: the legislative, executive, and judicial branches.

The EU is comprised of twenty-seven countries, labelled as member states. The structure of this union closely resembles a confederation as multiple policy areas are consolidated under shared institutions with legislative authority. The EU operates on the principles of representative democracy, and the European Parliament holds direct elections.

China is a socialist state operating as an authoritative single-party system under the Chinese Communist Party (CCP). The CCP, along with its top leaders, exercises significant decision-

making authority, as power flows from the top down. The National People's Congress serves as the legislative body, and the State Council is responsible for implementing laws and policies.

2.4.2. AI Policies, Rules, and Regulations

The USA — a member of the OECD and GPAI — is a world leader in AI development and deployment (*Maintaining American Leadership in Artificial Intelligence*, 2019). The U.S. Department of State established that international humanitarian law currently has the correct framework for regulations relating to AI-powered weaponry ("Artificial Intelligence (AI)," n.d.). The three main ambitions in this executive order, released in 2019, aimed to use AI to grow the economy, improve both economic and national security, and enhance the quality of life for every citizen. A heavy reliance on research and development serves as the main strategy for technological advancements in the U.S., fortifying the country's position as a global leader in this field. A sizeable portion of this presidential document emphasizes the importance of cultivating, attracting, and retaining top-tier AI talent to maintain the nation's leadership in this advanced sector.

According to Restrepo Amariles and Baquero (2023), the 2019 executive order encourages responsible AI practices but lacks direct regulation, resulting in different governmental agencies and states crafting their own AI governance rules. In response to this, Tabassi (2023) highlights how the National Institute of Standards and Technology, a subsidiary of the U.S. Department of Commerce, launched the Artificial Intelligence Risk Management Framework in January 2023, designed to offer a comprehensive resource to assist responsible risk management for the institutions developing and deploying AI systems. Recently, on October 30, 2023, President Biden issued a new executive order on safe, secure, and trustworthy AI (Executive Order No. 14110, 2023). The order outlines an approach that includes AI safety and security, privacy protection, the advancement of equity and civil rights, worker and consumer protections, innovation promotion, and international leadership.

In April 2021, the EU introduced the Artificial Intelligence Act (AIA) to establish a comprehensive regulatory framework for AI that would ensure that AI systems are safe; respect fundamental rights and values; provide legal assurance to encourage investment and promote innovation; strengthen the enforcement of preexisting laws on rights and safety regulations; and enable the creation of a unified market for AI that promotes ethical developments and prevents market fragmentation ("The Act," 2021).[1] Ruschemeier (2023) describes that the AIA is the world's first attempt at creating a comprehensive set of AI regulations; however, the act avoids defining the term 'artificial intelligence' and does not adequately outline the issues relating to dual-use, general-purpose, or military AI systems. The EU seeks to distinguish itself from the global AI frontrunners, the USA and China, by prioritizing ethical and human-centric AI development. However, Ulnicane (2022) finds that this stance could inadvertently neglect the

[1] At time of finalizing of this thesis, European Union officials have reached a provisional deal on comprehensive laws to regulate the use of artificial intelligence. The European Parliament will vote on the AI Act proposals early in 2024, but any legislation will not take effect until at least 2025.

competitive nature of global AI advancements, potentially leading to unforeseen consequences that challenge international cooperation in the AI field.

In 2017, China released a national plan to use AI to advance its economic, social, and national development (Webster et al., 2017). China constructed a three-step plan that aims for the country to become the world leader in AI and a "global AI innovation center" by 2030 (*Next Generation Artificial Intelligence Development Plan Issued by State Council*, 2017). Dwivedi et al. (2021) suggest that China does not have to depend solely on innovation to achieve this goal, as the country's encouragement of entrepreneurial commerce, coupled with a lenient political framework, causes rapid advancements in the AI industry. The AI policies in China are primarily focused on expediting technological advancement, promoting extensive data collection, and launching pilot programs, while the issues and risks emanating from data privacy, and accountability seem to be minimized, as the primary goal is that of technological progression (Chun et al., 2020, as cited in Medaglia et al., 2023). In 2018 , this national framework helped a Chinese company, SenseTime, become the most valuable AI start-up in the world (Jezard, 2018, as cited in Floridi & Cowls, 2022).

2.4.3. State of the Environment

Nordgren (2022) predicted that information and communication technology (ICT) will contribute to over 14% of worldwide GHG emissions by 2040 . The same study points out that AI's data-driven nature and its reliance on data centers contribute to 45% of the ICT sector's GHG emissions, highlighting its rapidly growing impact. From 2018 to 2025, data creation and storage are projected to expand sixfold to 175 zettabytes, and considering there is a trillion gigabytes in a zettabyte, this is a staggering volume which would take roughly 1.8 billion years to download at the average American internet speed of 25 Mb/s (Reinsel et al., 2018; Siddik et al., 2021). Siddik et al. (2021) examined the environmental impact of the U.S. data centers and expressed uncertainty regarding whether advancements in energy efficiencies will be able to counterbalance the projected growth in emissions stemming from increased data production and storage. At the same time, despite the environmental impact of the infrastructure supporting data-driven AI, Dwivedi et al. (2021) find that AI technology actively offers solutions for climate change mitigation, ranging from enhanced disaster forecasting to the development of low-carbon materials and environmental monitoring.

2.4.4. Societal Implications

Currently, we are living in an era where arguments both for and against AI consistently make headlines, fueling a continuous societal debate about the true implications of this technological evolution. In 2018, Tegmark drew parallels between the impacts of AI and climate change, asserting that AI will have significant effects in the near future—either beneficial or detrimental. This statement, if true, underlines the importance for the swift and careful establishment of a comprehensive, robust, and effective legal framework concerning AI. In 2021, Dwivedi et al. asserted that there is no clear path forward and trade-offs between the risks and benefits stemming from AI have the potential to result in sizable segments of societies

becoming disenfranchised. According to Dwivedi et al. (2023), the recent emergence and dominance of generative AI underscores this trade-off, as ChatGPT can boost the productivity and enhance the knowledge of workers, but it is also a resource that has been used as a more effective tool for manipulation and misinformation.

Historically, the components of human intelligence that have the most academic value and produce the greatest probability for academic success have been assessed through standardized tests that primarily focus on cognitive skills and memory recall. Recently, Holmes et al. (2023) found that the knowledge required for some of these examinations have been automated through generative AI tools such as ChatGPT, yet there are no existing policies, guidelines, or regulations addressing this anywhere in the world. Chalmers et al. (2021) described the transformative nature of AI technologies as one that will also create an intense impact on entrepreneurial operations as it will produce new risks and benefits along with new ethical and social dilemmas. The same study describes how adopting an interdisciplinary and collaborative research methodology could enhance the cultivation of entrepreneurial initiatives that are beneficial to society within the field of AI. Leal Filho et al. (2022) explain how a multidisciplinary approach to developing the projected USD $16 trillion AI industry by 2030 could optimize the successful establishment of economic activities while proactively mitigating potential societal risks.

3. Methodology & Methods

Conducting a comprehensive comparative analysis of policies, rules, and regulations addressing the critical issue of climate change between two geographically similar, yet distinct nations on separate continents, each possessing its unique characteristics and cultural identities, provides crucial insights into the complex global challenge we face. To undertake this study, the primary methodology relied on the leveraging of recent and relevant literature from the governmental sources of Canada and Norway. Additionally, peer-reviewed articles and other pertinent documents pertaining to the topic were gathered and used for in-depth analysis. As a result, a qualitative comparative analysis was conducted, with a significant portion of the data sourced from an extensive literature review.

Within this study, a theoretical framework known as 'comparative public policy analysis' served as the guiding tool to assess the policies of each nation, exploring their underlying rationales and anticipated consequences. Given the uncertain terrain of the technological transition supporting these policies and their potential for ambiguous effects, this framework was chosen because it proved to steer the research in a direction that could produce the most accurate and informed analysis.

This chapter will explain the research design, data collection procedures, and the adopted analysis techniques of this study. Explaining the rationale for these methodological choices equips the reader with a comprehensive understanding of the approach used to shed light on the policy responses of Canada and Norway to the usage of AI to ethically address the current climate crisis. This chapter outlines the approaches and frameworks employed to address the study's primary research question and sub-questions, focusing on the policy responses of Canada and Norway in the intersection between AI and climate change.

3.1. Research Design

The overall research design for this comparative analysis of policies, rules, and regulations between Canada and Norway is a qualitative comparative analysis. This approach focuses on comparing both the current and potential impacts of specific frameworks at the intersection of AI, climate change, ethics, and economics. The dynamic nature of AI, climate change, ethical considerations, and economic implications necessitates a deeper exploration of their complex landscapes to provide a detailed and comprehensive analysis of the variations in national policy responses.

A comparison between Canada and Norway reveals universal challenges, policy gaps, and implementation inconsistencies faced by countries globally, informing a more coordinated, equitable, collaborative, and effective international approach to promote sustainable AI developments. By examining the AI policy frameworks of Canada and Norway, this study uncovers the distinctive strategies deployed by smaller economies to address the intersection of AI with ethical governance, economic growth, and climate action.

The qualitative comparative analysis was chosen because it allows for a better understanding of the complexities involved in AI, climate change, ethical considerations, and economic factors. It enables an in-depth examination of the specific policy contexts in both Canada and Norway, including the political frameworks, institutional structures, and international agreements shaping their AI policies with respect to climate change, ethics, and their respective economies. This approach also explores historical conditions that have driven each nation's political choices, national evolution, and the current conditions shaping their present decision-making processes.

The research design aims to display the policy similarities and differences between Canada and Norway, explaining the reasons for their diverse approaches and highlighting the potential effectiveness and impacts of each country's distinctive framework. This qualitative comparative analysis contributes to the global understanding of successful policy approaches and provides a meticulous examination of the specific approaches taken by Canada and Norway.

3.2. Data Collection

For this comparative analysis, a comprehensive range of data sources was used, including official government websites, peer-reviewed articles, and other relevant documents that explored the intersection between AI, climate change, ethics, and economics, as well as each of these areas separately. The primary data were obtained from official government publications from each country, including national strategies for AI, climate change, ethical statements, and economic policies, legislative acts, policies on data protections, and relevant environmental and economic reports. Additionally, international documents such as transnational agreements, collections, and any alliances that Canada and Norway are members of were accessed to gain a broader perspective on the global context of their policies.

The process of accessing and obtaining the data for this comparative analysis involved multiple steps and sources. Google was used to find and access official government websites, respected institutions, and the documents pertaining to each. I visited the websites of relevant governmental departments and agencies in both Canada and Norway. For AI policies, I explored the websites of ministries responsible for technology and innovation. Similarly, for climate change strategies, I accessed the websites of environmental ministries and related departments. These official government sources provided crucial policy documents, legislative acts, and reports that formed the basis of the comparative analysis.

Google Scholar served as the principal tool for locating and accessing peer-reviewed articles and scholarly literature pertinent to AI policies and climate change strategies. Keywords and phrases relating to AI and climate change strategies were used to conduct comprehensive searches to identify relevant academic articles. In addition, Google Scholar allowed for a more in-depth examination of the intersection of AI and climate change and the specific strategies relating to climate change mitigation and adaptation. Upon conducting an exhaustive search, articles were chosen based on citation counts to confirm their academic relevance and

prominence. In addition to this criterion, I also analyzed the credibility of the sources, whether they were journals or other publications, to guarantee the reliability of the information. This selection process enabled me to gather a broad spectrum of perspectives and insights from reputable researchers and renowned institutions.

Respected institutions and organizations of which either country was a member provided an additional valuable resource for investigation. Institutions such as the OECD, the EU, and the GPAI provided applicable reports on various areas of AI. In addition, many private industries, businesses, and research centers focused on AI individually as well as collectively to provide relevant insights and data related to the topic of this study.

To verify the validity of sources, particular attention was given to official government websites and departments with the greatest abilities to enact changes and implement new policies, rules, and regulations. Additionally, peer-reviewed articles were sourced from reputable journals and academic databases.

Throughout the data collection process, a systematic approach was used to organize each source and document them based on specific themes and their relevance to the thesis. Segmenting the data based on specific themes, countries, and subject areas produced a more contextual analysis. This allowed for efficient analysis as well as attribution of each data point to its respective country, subject area, or planned section of the study.

3.3. Data Analysis

A practical and systematic approach was adopted for this comparative analysis of AI policies against climate change in Canada and Norway, establishing a solid foundation to explore the similarities and differences in the national goals, strategies, and frameworks of each country. The data used in this analysis was primarily qualitative, leading to the selection of the comparative public-policy analysis framework as the most suitable method for deriving insights and making comparisons between the two countries.

To analyze the qualitative data gathered, a systematic content analysis was employed. This method was chosen for its ability to provide a structured, objective evaluation of the content within the policy documents, reports, and academic literature.

The first step involved organizing all the collected data into categories based on their source type and subject matter. The stated goals and objectives of policies, regulations, and strategies related to AI across all sectors in both countries were meticulously analyzed to identify the aims of each nation's approach and uncover any similarities or differences in the national use of AI. Simultaneously, the institutional and legal frameworks supporting the implementation of these strategies, as well as the roles of various governmental departments, agencies, and international collaborations required for their operation, were examined to evaluate their effectiveness.

The stated goals and objectives of policies, regulations, and strategies related to AI across all sectors in both countries, including ethical and economic considerations, were then analyzed. An approach was developed to identify the aims of each nation's approach and uncover any similarities or differences in the national use of AI for climate change mitigation, ethical governance, and economic development. Concurrently, an evaluation of the effectiveness of institutional and legal frameworks supporting the implementation of these strategies took place. This included an analysis of the roles of various governmental departments, agencies, and international collaborations required for their operation.

Following initial coding, the segments were organized into overarching themes encompassing critical facets of AI policies, climate change strategies, and ethical and economic policies in both Canada and Norway. The final step involved interpreting the findings from the thematic analysis in the context of the research questions. Conclusions were drawn regarding the similarities and differences in AI, climate change, and ethical and economic policies between Canada and Norway.

For conducting a comprehensive comparison of the policy response, rules, and regulations in different national contexts, the principles of comparative public policy analysis were applied. This framework provided a structured approach for rigorously evaluating the policy goals, strategies, and effectiveness of AI policies in relation to climate change, ethics, and economics in Canada and Norway.

The comparative analysis involved a detailed examination of both the specific AI policies and regulations as well as the environmental protections, ethical governance, and economic strategies in both countries. Additionally, the specific strategies deployed for using AI technologies in climate action, ethical considerations, and economic development were analyzed, considering the institutional supports, stakeholder involvements, and international collaborations within each country.

Canada and Norway both have the same overall objectives when it comes to using AI to combat climate change, address ethical considerations, and promote economic development, but their specific strategies and policies differ. This divergence stems from the fact that they prioritize certain sectors and industries differently, and thus this comparative analysis includes evaluations related to both the SDGS and the Paris Agreement with respect to both countries. Further study was conducted to identify the underlying causes for the differences in each country's support and prioritization of certain sectors and industries, including those related to ethical and economic aspects of AI.

The insights gained from this comparative analysis identified the most efficient political frameworks that could improve policy effectiveness in all these domains. Through a careful investigation of stakeholder relationships, a deeper understanding emerged, and key aspects of each nation's political power and influence were found. The data analysis conducted provided a comprehensive understanding of the powers of AI, the seriousness of climate change, ethical

considerations, and economic implications, as well as the policies, rules, and regulations in Canada and Norway that support the use of AI in these areas. The findings from this methodology contributed to the knowledge regarding the effectiveness of each nation's overall measures, offering a foundation for a more accurate evaluation of the decision-making and collaborative efforts involved in using AI technologies within each country.

3.4.Summary

In this study, a qualitative comparative analysis is performed, providing a systematic method for examining and contrasting the AI policies, rules, and regulations related to climate change, ethical considerations, and economic implications in Canada and Norway. The recent and relevant literature reviewed came from official government sources and peer-reviewed articles that critically analyzed the impacts emerging within these same national sources. This approach allowed for a comprehensive evaluation of the effectiveness of the distinct national AI policies with respect not only to climate change mitigation and adaptation but also to ethical governance and economic development in two different countries.

To properly comprehend the data collected for this study, the framework used allowed for critical interpretations of the underlying causes for both similar and dissimilar national policies with the same targeted outcomes. This interdisciplinary framework harnesses an in-depth examination of various influential factors affecting policy creation, such as political frameworks, institutional arrangements, stakeholder engagements, and international collaborations.

Key themes, words, and phrases served as identifiers for pinpointing similarities, differences, strengths, and weaknesses in the national AI, climate change, ethical, and economic strategies of Canada and Norway. The goals of the policies were investigated with respect to the institutional and political frameworks, stakeholder engagement, and international collaborations that formed them. Although both nations converge on long-term targets for climate change mitigation, ethical governance, and economic development, their national strategies, policies, rules, and regulations distinctly diverge.

It is important to briefly acknowledge the limitations of this comparative analysis. The fields of AI, climate change, ethics, and economics exhibit an unpredictable, rapidly evolving, dynamic nature that creates difficulties when assessing the potential impacts of certain policies, rules, and regulations. However, the research design, methodological data collection, and theoretical framework used in this study provide a solid foundation to conduct applicable analyses of AI's role in climate change mitigation, ethical considerations, and economic development in Canada and Norway, despite these limitations.

The findings from this study will contribute to the overall knowledge of national capabilities to address these multifaceted challenges while simultaneously protecting their societies from any negative externalities associated with the development and implementation of AI technologies. Furthermore, the study's comprehensive approach extends the relevance of the findings beyond the immediate subject nations. It emphasizes the significance of a coordinated

methodology that can guide global efforts, prioritizing stakeholder collaboration and policy coherence across borders. By recognizing and addressing its inherent limitations, this research not only offers insights into the specific contexts of Canada and Norway but also contributes a valuable framework that could motivate a unified strategy for using AI in the global fight against climate change, while considering all relevant ethical dilemmas, and economic challenges. This perspective offers a pathway for future research and international cooperation, aligning technological developments with ethical considerations, economic imperatives, and climate goals.

4. Findings

This chapter will provide an in-depth exploration of the AI policy landscape in Canada and Norway, specifically focusing on the rules and regulations pertaining to its application in addressing climate change, ethical considerations, and economic implications. To substantiate the findings in this section, the data is sourced from the extensive literature review conducted in Chapter 2 and is complemented by additional sources that further explicate and support the conclusions drawn from the analyses, which also encompass ethical governance and economic development.

National political frameworks and policies relating to AI regulations, such as the CIFAR Pan-Canadian AI Strategy and Norway's National Strategy for Artificial Intelligence, are analyzed and expanded upon. These are assessed in the context of each country's ambitions to mitigate climate change, as well as in relation to ethical considerations and economic strategies. International agreements designed for environmental protections, such as the Paris Agreement and the SDGs, are also referenced to provide a global context.

In addition, this chapter explores the private sectors within each country to assess how the respective governments are supporting and promoting private AI initiatives that contribute to climate change mitigation, ethical considerations, and economic development. The study rigorously examines AI's role in reducing carbon emissions, advancing renewable energy, and promoting sustainable practices.

The levels of AI technology adoption and their impacts on GHG emissions, ethical considerations, and economic factors in both countries are explored. The study particularly investigates the driving forces behind cross-sector collaborations—academia, industry, and government—that advance AI-driven innovations for sustainability, ethical governance, and economic growth. This chapter will provide a comprehensive overview of the potential and actual role of AI in climate change mitigation, ethical considerations, and economic development in Canada and Norway.

4.1. Policy Framework

4.1.1. AI Regulatory Frameworks and Their Environmental Objectives

Kaack et al. (2022) found that as AI and ML technologies persistently evolve at an accelerated pace, their impact on GHG emissions becomes progressively more recognizable. This evolution necessitates the implementation of a sturdier set of strategies to manage the emission trade-offs. The uncertainty surrounding the dichotomy of AI emissions stems from whether increased computational demands will enhance efficiencies and encourage the use of sustainable tools, potentially leading to a net reduction in carbon emissions, or conversely, whether they will precipitate a rise in overall resource consumption. The same computational surge in power could contribute to a larger global AI carbon footprint and a net increase in resource

consumption. The complexities of this situation require further examination to understand the potential consequences of AI technologies on our global carbon emissions.

In Canada, CIFAR is a global network supporting the Pan-Canadian AI Strategy by promoting AI scientific developments, incentivizing adding AI talent, and increasing the number of public-private collaborations. The underlying goal behind this networking strategy is to drive global social, economic, and environmental benefits. In March 2023, CIFAR held a conference, consisting of Canadian stakeholders across all sectors, to examine the ways to advance sustainable AI developments relating to energy and the environment (Kung & Lussier, 2023). A report by Kung and Lussier (2023) summarized the main findings from this conference and stated that Canadian policymakers should diversify the cleantech startup economy, enhance the pathways between AI education and work, combat greenwashing, and incorporate a sustainable sightline when developing, prioritizing, and financing AI projects. Some existing gaps identified in this field were insufficient levels of AI talent, inadequate incentives for AI work, incomplete evaluation metrics, and sparse amounts of accessible and ethical data.

Yoshua Bengio, the founder of Mila—a Canadian AI institution partially funded by the Pan-Canadian Artificial Intelligence Strategy—appealed for immediate regulatory actions on AI technologies in his July 25, 2023, testimony before a U.S. Senate subcommittee (Panetta, 2023). Although Bill C-27 has yet to pass, Bengio stated that Canada may end up becoming the first country in the world with sufficient AI legislation. The AIDA component of Bill C-27 directly targets high-impact AI systems that have potential for large scale human rights infringements. The AIDA suggests that stringent regulations addressing these risks and concerns could elevate Canada's stature on the global stage, enticing industries, businesses, and nations worldwide to engage, drawn by the promise of a safer market environment.

However, AIDA and Bill C-27 neglect to address any specific provisions or considerations regarding environmental issues. The closest relations to environmental protections come in the form of AI technologies or systems that directly impact human health and safety. While it is feasible that environmental concerns may be addressed in the regulations formulated post-consultation, the document lacks explicit confirmation that such concerns will be addressed. And though the Pan-Canadian Artificial Intelligence Strategy sets objectives to amplify global networking possibilities to advance climate AI, the strategy inadequately supports the market for AI-driven climate change mitigation.

In Norway, the 2020 National Strategy for Artificial Intelligence aims to make the country a leader in the development and use of trustworthy and responsible AI. The main goals of this strategy were to:

- expand funding for AI research and innovation;
- establish a national AI competence platform;
- devise ethical guidelines and legal frameworks for AI to safeguard the integrity and privacy of individuals;

- set up a national data strategy and infrastructure;
- trial AI solutions within public services; and
- stimulate diversity and inclusion within the AI community.

While this national strategy fails to directly assist any climate change mitigation actions, it does indirectly promote and support several Norwegian companies to enhance their efficiencies or aid a transition within a specific sector. Some companies supported by this strategy are making strides in various industries using AI. For example, ENOVA, a state-owned institution, is promoting autonomous shipping. Völur leverages AI for more sustainable food production. eSmart Systems is focusing on the development of AI-powered electricity grids. Spacemaker is providing AI solutions for sustainable urban planning. Loopfront and Material Mapper employ AI to enable the re-use of building materials. Lastly, Scantrol Deep Vision and CreateView are innovating in the fish industry through AI-powered tools.

4.1.2. AI Policy Objectives, Scope, and Impacts in Addressing Climate Challenges

In both Canada and Norway, the supports for AI-facilitated climate change mitigation primarily stem from national assistance extended to academic institutions and private industries. Stable political frameworks are required to sustain these types of supports. Beyond their national strategies, the stable political systems of both countries facilitate an enhanced level of international collaboration with other nations and global institutions. However, when addressing environmental concerns through AI legislation, neither country rigorously targets climate change mitigation. In other words, the scope of both national frameworks excludes a direct focus on the development and public implementation of AI technologies that explicitly address our changing climate. While numerous indirect supports exist, the extent to which each country recognizes the impacts of AI technologies on climate change mitigation reveals the necessity for a targeted focus on leveraging these technological potentials to propel their respective sustainable developments.

While the advancement of AI systems and technologies directly contributes to sustainable development, this same technological evolution also creates a sizable carbon footprint. Ahmad et al. (2021) stated that this dualistic progression echoes the risk of rebound effects. Canada and Norway are aware of these risks, but their indirect supports aimed at addressing them, as well as climate change, can potentially create inequitable economies. Brandusescu (2021) described how the national support and funding provided to a select group of private companies and specialized academic resources could potentially result in a disproportionate concentration of power, granting benefits exclusively to members within this particular circle. Therefore, despite the broad beneficial scope of each country's national strategy objectives, the wide range of their ambitions relating to environmental AI supports may induce inefficiencies that restrict them from reaching their full potential.

As a member of the GPAI, Canada contributes to, and is aware of, direct climate change mitigation through the use of AI, through measures that Clutton-Brock et al. (2021) highlight as

specific examples where AI contributes directly to climate change mitigation, such as forecasting solar power production and optimizing building heating and cooling systems. In addition to the direct contributions toward climate change mitigation that AI can create, the GPAI outlined the indirect contributions that influence societal shifts as well as the risks surrounding mitigation inaction. However, awareness of potential technologies for climate change mitigation does not guarantee political action to address associated risks.

Cowls et al. (2023) provided thirteen recommendations for AI research and policymakers in the EU that are aimed at harnessing existing resources to produce new actions that maximize AI's potential to combat climate change while simultaneously minimizing the ethical and environmental risks. Three of the current opportunities outlined in their study are the European Green Deal, the Renewable Energy Directive, and The Digital Twin Earth Challenge. The main ambitions of these three current EU regulations that use AI against climate change are to make the economy sustainable, achieve climate neutrality by 2050, and aid the development and deployment of AI solutions for the green transition, while also promoting renewable energy sources and fuels. On April 24, 2023, Norway formed a Green Alliance with the EU which included the acceptance of the European Green Deal (*New EU-Norway Green Alliance to Deepen Cooperation*). In addition to this new alliance and as a member of the EEA, Norway also abides by the Renewable Energy Directive II (Løvseth, 2021). Additionally, Norway is dealing with the complexities of coordinating responses to policy problems like climate change, which traverse various industries and administrative levels, a challenge that Neby and Zannakis, (2020) found to be amplified by the country's unique hierarchical political system and the strong influence of petroleum politics.

While AI currently plays a role addressing climate challenges in both Canada and Norway, the implementation strategies in both countries have been indirect, with no widespread and advanced focus solely on AI technologies that directly address climate change. Furthermore, the potential risk remains that the countries' current objectives may create inequitable economies. The Green Alliance formed by Norway with the EU exhibits the potential shift in the nation's approach toward more direct AI climate change policy. As AI technology and its economic impact continue to evolve, both countries will direct more attention to formulating clearer and more targeted AI policies. A significant focus of these improved strategies could involve harnessing AI directly to accelerate sustainable developments.

4.1.3. Impact of AI on Carbon Emissions Reduction and Sustainable Practices

The technological evolution of AI continues to produce a potentially transformative role of reducing carbon emissions by enhancing renewable energy solutions and promoting sustainable practices. This role relates not only to industries or sectors that are pioneering AI strategies or technologies for the first time but also to those already leveraging AI, seeking to upgrade or increase the AI components or functionalities that they employ. Some examples of AI application against climate change that Chen et al. (2023) found exist in carbon sequestration and storage, weather and renewable energy forecasting, grid management, building design,

transportation, precision agriculture, industrial processes, deforestation, and resilient cities. The roles that AI play in these industries is to optimize industrial processes through data modeling, manage natural resources with ML and remote sensing, enhance soil and crop management with artificial neural networks and image processing, and minimize the environmental impacts from waste management with deep learning and smart sensors. Boza and Evgeniou (2021) emphasize that AI actively promotes the use and advancement of variable renewable energy sources by reducing integration costs.

Navarra (2023) investigated the current global AI economy and found indications that this new age of big data will offer numerous new opportunities and improvements to AI power production and management models. Potential improvements resulting from this big data progression in the energy sector originate from real-time data from electrical grids, residential smart meters, satellite imaging, and enhanced social insights derived from individuals' online activity. Nevertheless, while accelerated digitalization contributes to mitigation gains, these may be offset by socioeconomic responses that increase energy demand, indicative of the rebound effect previously discussed (IPCC, 2022). Examples of the negative effects coming from an unsustainable counterbalance include increased amounts of electronic waste, unfavourable shifts in labour markets, increased CO2 emissions, and a compounded social divide in digital technologies.

To mitigate these potential environmental impacts coming from AI models, some strategic actions that can be taken to address them include:

- the development of a universal methodology for assessing their energy consumption;
- the execution of effective tracking measures;
- mandating an evaluation of energy consumption during the implementation phase;
- selection of environmentally friendly cloud services and hardware providers;
- evaluation of a project's positive effect employing various metrics; and
- the prioritization of sectors and geographical locations that can deliver maximum CO2 emission reduction (Delanoë et al., 2023).

Delanoë et al. (2023) conclude their study by highlighting that sustainable AI models aimed at reducing emissions and energy consumption can paradoxically amplify these factors during training, and they add that once these models are operational, a sufficient scale of implementation may be required to ensure the sustainability of such models.

Nishant et al. (2020) conducted an analysis of AI's potential for large-scale pattern recognition, highlighting its revolutionary possibilities for environmental solutions. They found that the success of such applications hinges on three critical factors: managing human elements, accounting for rebound effects—where increased efficiency leads to increased consumption—and, assuming a constant energy source, monitoring the growing carbon footprint associated with the increasing complexity of AI models. Taddeo et al. (2021) studied a 2018 Microsoft/PwC report that estimated that using AI in environmental applications could reduce global GHG

emissions by 1.5% to 4% and boost GDP by 3.1% to 4.4%; however, these results may be hindered by the frequent lack of information sharing, often due to commercial interests or lack of financial incentives for businesses to collaborate collectively, which then creates an environmental double cost by requiring additional research and development to fill these information gaps. Promoting the development of interdisciplinary approaches while also improving public-private relationships of AI in environmental management would clear the path for a more sustainable global ecosystem.

4.1.4. AI's Impact on Global SDGs and Paris Agreement Compliance

The rapid development of AI is positioning this technology as a transformative tool with significant potential to aid global efforts in achieving the SDGs and fulfilling the Paris Agreement. AI, with its ability to analyze extensive amounts of data, optimize complex systems, and provide real-time insights, serves as a potential technological solution aligned with global climate-change mitigation goals. However, as AI systems and technologies continue to develop and progress, they also give rise to complex ethical and environmental risks. These challenges stem from numerous factors such as the digital divide, aggravating inequalities, and potential job displacements. Addressing these complexities necessitates meticulous implementation. Moreover, the environmental impacts resulting from the development and increased use of AI technologies demand close observation. Prior to deployment, thorough assessments are imperative for aligning technological advancements with overarching sustainability objectives.

Currently, Perucica and Andjelkovic (2022) found that the ongoing research undertaken by governments, industries, and academia predominantly focuses on how to use AI to protect the environment, often overshadowing the equally important task of exploring the sustainable development of AI models and systems. Leal Filho et al. (2022) explained how AI can improve renewable energy management, support climate modeling, and contribute to the carbon sequestration process. Yet the increased pace of AI evolution, application, and systemic integration also implies that greater focus and analysis should be placed on the actual development of these technologies.

The use of AI applications in agriculture, education, healthcare, and energy optimization contributes positive effects toward poverty eradication, health, happiness, and emission reduction. To evaluate the results of these impacts, quantitative data examining efficiency gains, emission reductions, and economic elements are analyzed. Each examinational element provides a specific potential to gain insights into a particular impact resulting from an AI technology or system. However, the refined scope of this analysis discredits the negative potentials for rebound effects, redirected emissions accounting, and the inequitable distribution of financial benefits. Therefore, the importance of recognizing and addressing potential drawbacks and limitations in the analysis of AI’s overall sustainability would ensure a more comprehensive and balanced understanding of its effects on society and the environment.

AI has the potential to significantly advance various SDG objectives, while simultaneously posing risks that could restrict this very progress. For that reason, Vinuesa et al. (2020) stressed that a global dialogue, anchored in scientific principles and focused on creating unified legal rules and regulations in line with the SDGs, is essential for shaping a positive AI landscape. The next phase of AI development must incorporate lessons from both the successes and deficiencies up to the present. To achieve this phase, an increased amount of collaboration between governments, industries, and academia is necessary to promote the development of new global standards, as well as improve the research into reducing the carbon footprint of this AI evolution. AI can be both a potential global benefit and a limitation to global sustainability. Therefore, the present path we choose in this intricate technological transition will echo throughout our interconnected global future.

Incorporating a comparative perspective between Canada and Norway with respect to AI's impact on global SDGs and Paris Agreement compliance shows diverse approaches to sustainability in the field of AI. These differing national strategies highlight the relevance of the Paris Agreement and SDGs by showcasing how AI policies in various economies can contribute to global sustainability targets while considering their own unique national economic and social landscapes. The approaches used by Canada and Norway provide insights for smaller economies that are developing AI policies, guiding them to balance innovation with ethical, economic, and environmental considerations.

4.2.Technology Adoption and Innovation

4.2.1. AI in Green Energy and Sustainable Transport

This section is dedicated to an investigation of the specific policies, strategies, and mechanisms that govern the application of AI in areas such as renewable energy, energy efficiency, intelligent grid systems, and sustainable transportation methodologies. Both Canada and Norway exhibit distinct strategies in addressing the shared challenges they face when employing AI to enhance sustainability and innovate in areas for a more sustainable future.

In 2021, Li et al. studied the urban digitalization in China from 2003 to 2018 which revealed a complex relationship between the digital economy and emissions. The study found a negative impact on the environment and emissions when population densities reach a particular threshold; however, a positive impact on emissions emerges once the GDP per capita reaches a specific threshold. This digital dichotomy outlines the importance for countries to create comprehensive AI strategies that can adapt to the rapid development and uncertainties of these technologies.

Cities will house 68% of the global population by 2050, reflecting an increase of 2.2 billion people, as urbanization continues to evolve and expand (Habitat, 2022). The densification of our population combined with the recent digitalization surge equates to a future society which will be in the possession of vast amounts of data. Allam and Dhunny (2019) found how this new digitalized age of big data will primarily be controlled and managed by AI systems and

processes. Digitalization enhances energy systems and connectivity, thereby facilitating precise monitoring of energy consumption. The advancement of societal communication capabilities enables an efficient transmission and exchange of large volumes of data. However, Martin et al. (2018) listed several concerns regarding urban digitalization, including the unsustainable nature of economic growth, the uneven distribution of digital innovation benefits, the potential for digital innovations to disempower and marginalize citizens, the limited environmental protection afforded by digitizing urban infrastructure alone, and the unsustainable nature of consumerism cultures.

Baidya et al. (2021) established how smart grids, a bidirectional system that enables the interchange of energy and information, can provide significant improvements to energy efficiencies when implemented correctly. A 2019 study by Sareen and Rommetveit in Norway determined that if all governing policies and the underlying economic conditions are carefully considered and aligned, smart grids could improve individual energy conservation. Canada is implementing a five-year CAD $100 million program to enhance infrastructure, aligning with the 2016 Pan-Canadian Framework on Clean Growth and Climate Change (Government of Canada, 2021).

Mihet-Popa and Saponara (2018) showed how fast progress in the development of AI technologies and systems has promoted enormous advances in production and consumption efficiencies in every sector. For example, the energy management of buildings can be enhanced by an AI system that makes accurate adjustments to such things as heating and cooling systems based on the weather conditions and levels of occupancy. In addition, Fang et al. (2023) demonstrate that smart cities can enhance waste management by using AI, which can lead to benefits such as reducing transportation distances, cutting costs, and improving both conversion processes and bioenergy production through its analytical capabilities in assessing waste composition.

Şerban and Lytras (2020) studied smart cities in the EU and revealed that the use of AI can advance the sustainability of the energy sector by improving efficiencies in renewable energy technologies, through methods such as enhanced pattern detection and prediction, autonomous task execution, and optimized decision-making that tailors supply. Algorithms can facilitate the optimal positioning and usage of solar panels and wind turbines, which then can improve both energy efficiencies and the overall cost-effectiveness of energy generation, and directly reduce GHG emissions. Boza and Evgeniou (2021) analyzed the challenges of intermittent power production from renewable energy sources such as wind and solar and found that AI can be employed to optimize energy storage systems, thereby improving the reliability, effectiveness, and precision of these renewable energy systems.

Transportation accounts for over a third of annual global CO2 emissions (IEA, 2023). As the world transitions toward greater reliance on renewable energy sources and aims to reduce energy consumption across personal, residential, and industrial domains, AI has a vital role to play. Dwivedi et al. (2022) describe how it can assist in the management of energy systems by

accelerating the development of low-carbon technologies, enhancing demand forecasting, reducing system waste, identifying patterns in consumption behavior, and bringing about overall improvements in energy efficiency. In addition to these effects, Walsh et al. (2020) describe how AI can analyze traffic data and ride-share demands and then use this information to enhance both the flow and efficiency of transportation systems. Applying similar transport analysis to the shipping industry can optimize shipping routes, thereby improving efficiency, and reducing GHG emissions.

Negenborn et al. (2023) show that 80% of trade around the world is transported on the oceans which accounted for roughly 3% of the global CO2 emissions in 2018. The necessity for sustainable improvements in this industry is evident. Autonomous shipping is one strategy that is aimed at reducing GHG emissions, enhancing local air quality, and diminishing noise levels within this industry (*The National Strategy for Artificial Intelligence*, 2020). Negenborn et al. (2023) showcase that in 2024, a Norwegian zero emissions pilot project is planned for an autonomous 80-meter container ship designed to transport fertilizer from plant to export port. Ulnicane et al. (2022) find that this degree of AI autonomy has been made possible through rapid advancements in both the domains of hardware and software. Through the integration of AI in various sectors such as energy, urbanization, and transportation, many countries are paving the way for a more sustainable future, using technological advancements to mitigate environmental challenges and achieve greater efficiencies in our increasingly interconnected world.

4.2.2. AI and GHG Reduction in Canada and Norway

The global urgency to combat climate change has led countries to innovate and adopt AI technology to reduce GHG emissions. Canada and Norway are both affluent nations that are rich in natural resources, and they have recently begun integrating AI into their strategies for a more sustainable future. This section compares the adoption, scale, and specific impact of AI technology on GHG emission reduction in both countries.

Canada has been proactive in embedding AI within its environmental framework. The 2016 Pan-Canadian Framework on Clean Growth and Climate Change sets a foundation, and the CAD $125 million program displays its commitment to the digitization of its society. To facilitate the next form of this industrial revolution, Martin-Bariteau and Scassa (2021) state the need for AI technologies to be applied to impact diverse areas and fields, which include health care, public governance, legal enforcement, academia, transit, farming, and the arts.

The adoption of AI technologies in Norway has been equally aggressive, especially in its energy sector. Norway actively researches smart grids and their potential to enhance individual energy conservation, backed by AI-driven systems. Lloyd and Payne (2019) describe the current situation in Norway where influential trade unions and robust social security systems elevate labor costs; therefore, institutions are increasingly leaning toward AI investments that also provide an encouraging environment for long-term commitments.

Canada is the second largest country in the world geographically, making the scope of AI implementation extensive. As a result, Brennan (2023) stated that there's a heightened focus on infrastructure development, talent attraction and retention, and upholding ethical standards. The cross-national nature of AI developments enables an easier mechanism for new technological transitions and implementations. A major positive AI impact in Canada stems from the country's swift progress in production and consumption efficiencies across various sectors. In addition, AI-driven energy management systems improve the abilities for energy conservation in buildings. Both improvements have led to reduced levels of GHG emissions.

In Norway, the predominant national efforts are directed toward specific projects that have high GHG impacts. An example of this strategy is the planned zero-emissions pilot project for an autonomous 80-meter container ship. Norway prioritizes sectors with traditionally high GHG emissions as the focal point for its national AI strategy. Norway uses a sandbox framework to promote the growth and enhancement of AI technologies, allocating funding to the most promising projects and innovations. The overall goals of the long-term national AI strategy are designed to encourage research and education in specific sectors relating to the environment, energy, health, public services, and civil protection (*The National Strategy for Artificial Intelligence*, 2020).

Both Canada and Norway have direct economic ties to energy production through fossil fuel industries. Bergero et al. (2022) confirm that Canada ranks third globally in terms of proven oil reserves, with a significant portion anchored in the oil sands of Alberta. These oil sands not only represent a substantial energy resource but also play a pivotal role in the nation's economy and energy strategies. Norway stands as the third-largest exporter of natural gas in the world (*Exports of Norwegian Oil and Gas*, 2023). In addition, Norway contributes to approximately 2% of the world's annual oil production and, when combined, the country's natural gas and crude oil exports equaled 73% of the nation's total value of exported goods in 2022. Both countries are aware of their ties to a profitable yet unsustainable industry and are actively pursuing more sustainable national trajectories to transition away from fossil fuels. AI emerges as a key instrument in both nations' transition toward sustainability, even though their strategic approaches differ.

4.3.Research and Development Landscape

4.3.1. Synergies Among Academia, Industry, and Government

For both Canada and Norway, the progress of any new or amended national strategies hinge on an efficient collaboration between all major sectoral stakeholders within the respective country. The successful integration of AI-driven technologies, designed to combat climate change and steer society toward sustainable practices, relies on public trust. Higher levels of public trust enable greater probabilities for more successful technological implementations, as restraining factors such as public skepticism, regulatory hurdles, economic barriers, data privacy concerns, and cultural or societal resistance can be minimized. Any nation with the ability to

efficiently implement new policies and pathways exhibits an effective alliance between the public, private, and academic industries within its borders.

The government can create optimal environments for collaboration between these industries by clearly defining the guidelines within which they operate. However, it's imperative to craft these regulations with precision to prevent inefficiencies, adverse side effects, and potential conflicts between industries and sectors. As over-regulation can stifle innovation, and insufficient oversight can lead to unforeseen negative consequences, it is essential for the government to involve a diverse group of stakeholders to form its national AI strategies, policies, and projects. Supporting such a method that increases the collaboration between academia and the private sector has the potential to produce positive feedback loops that could simultaneously minimize the repercussions of new developments.

The Norwegian Artificial Intelligence Research Consortium (NORA) was founded in 2018 and exists to support the development of ML and AI by aiming to improve the academic interest, focus, research, and experimentation of these technologies. The aim of NORA is to establish itself as a premier international hub for AI research and education, promoting both national and international collaboration and strengthening the bond between academia and the private sector (*NORA Annual Report 2022*, 2023). To facilitate this ambition, NORA is comprised of 11 Norwegian universities and a few independent research institutions. This model represents an open-sourced approach to AI development and innovation. Such a strategy propels business advancements by providing unrestricted access to valuable AI-related data.

Attard-Frost et al. (2023) show how, in Canada, the governance of AI is a flexible system that can quickly assess and address different needs from various stakeholders because of its decentralized structure that consists of multiple different governments, departments, and sectors. This adaptive system is world leading in the sense that Canada was the first country to introduce a national AI framework; however, the system still faces many challenges such as the issues related to public trust, public engagement, accountability, commercialization, talent retention, and the protection of citizens against harmful AI practices. In response to the unforeseen challenges and criminal risks associated with emerging AI technologies, Canada has taken a proactive approach by proposing Bill C-27, which is aimed at enhancing the oversight and regulation of ‘high-impact’ AI systems.

Prior to the enactment and passage of this bill, Canada invested CAD $750 million in global innovation clusters, bringing together companies, academic institutions, and non-profit organizations to encourage collaboration and advancement in technology (*Budget 2022*, 2022). Scale AI is an American company that is one of these prominent innovation clusters specifically designed to accelerate the pace of AI adoption and integration into supply chain processes. Currently, Scale AI has received CAD $284 million of funding from the Canadian government and they project this cluster will produce a CAD $16.5 billion economic impact that also adds over 16,000 jobs over the next 10 years (*Canada’s AI-Powered Supply Chains Cluster (Scale AI)*, 2023). By developing more intelligent supply chains, the energy efficiency of key sectors like

manufacturing and transportation can be enhanced, which could then directly contribute to long-term economic and environmental sustainability (*Annual Report*, 2022).

The Canadian and Norwegian governments are actively developing policies and frameworks that target the potentially disruptive impacts of rapidly advancing generative AI tools, ensuring a concentrated focus on the emerging challenges and opportunities presented by these innovative technologies. In general, Djeffal et al. (2022) show that governments can assist in the technological development of AI by adopting either a stronger proactive role to directly influence progress or a weaker passive role that allows for natural evolution and growth within the industry. Each approach influences the multistakeholder framework of the AI landscape differently. The passive role arguably provides greater innovation, as it often encourages the private sector, research institutions, and individual entrepreneurs to experiment and take risks without excessive governmental interference. However, this same role could also increase the chances of negative consequences such as ethical dilemmas and uneven developments across different sectors.

To account for these potential free-market consequences, a more active and stronger governmental approach that is aimed at controlling the rapidly evolving field of AI can be taken. Yet this stronger role could also lead to its own negative consequences such as over-regulation, which may slow down the pace of technological advancement and create bureaucratic barriers to entry for startups and smaller firms. In addition, this proactive approach could discourage foreign investments and international collaborations which could then potentially hurt the nation's economy. Finding the right balance between these two governmental approaches presents a complex problem and is currently the subject of an ongoing debate. Engaging stakeholders from public authorities, private industries, and academic institutions is indispensable for crafting collaborative solutions tailored to the unique and evolving AI economy of each country.

4.3.2. AI, Climate Policy, and Ethics

In 2023, Barnes et al. found that Canadian wildfires escalated to a scale more than twice that of any recorded occurrences in the country's history and concluded that these events had become twice as probable because of the continuing alterations in the global climate. Ongoing AI developments mirror the accelerating pace of our changing climate. Decades of research have provided clear evidence that the causes and forecasted effects of the climate crisis are mainly related to the use of fossil fuels; however, we are currently living in a black box of uncertainty in relation to the developments, impacts, and potential consequences of our new and rapidly improving AI technologies. As countries around the world aim to promote, legislate, and harness the immense computational powers and technological improvements associated with AI, Enholm et al. (2022) warn that a digital arms race will ensue. Recent research has shown that roughly 85% of organizations around the world see AI as a tool that can provide them a competitive advantage. Bremmer (2023) explains that this data-driven arms race for technological and economic superiority currently exists around the world and has created a

new “digital global order” that may be the next era commanding and governing global authority. Bremmer and Suleyman (2023) add that the regulatory powers that oversee AI tools within this era will reside with technological experts and professionals rather than with traditional governmental administrators or political authorities.

Luccioni et al. (2022) studied the carbon footprint of BLOOM, a LLM with 176 billion parameters (in comparison, ChatGPT-3 has 175 billion), and found that 50.5 tonnes of carbon dioxide equivalents (CO2eq) were emitted during the model's training, infrastructure development, and energy-related consumption. The carbon emissions generated in the development and training phase of this particular model equate to those emitted by a standard gasoline-powered passenger vehicle travelling 208,344 kilometers (US EPA, 2015). Wu et al. (2022) state that AI technologies have the potential to assist sustainable advancements through the optimization of energy efficiency, facilitation of renewable energy generation, improvement of environmental monitoring, and enhancement of productivity and sustainability within the agricultural sector using robotics and ML, but a significant knowledge gap remains concerning the carbon footprint relating to the development and ongoing operation of these technologies, along with the methodologies required for an accurate assessment of this.

As AI technologies such as LLMs continue to advance and evolve, they will help establish a pervasive dependence within society on digital platforms, grounded in the continuous accumulation and integration of vast quantities of data. We are now living in a pivotal, and potentially polarizing moment in our civilization’s history. Not a single person, organization, or country can answer the endless barrage of questions pertaining to the current capabilities of AI and the future of its progression. Albert (2023) examined the discussions occurring at the highest levels of academia, government, and industry concerning the potential of AI to either shape a utopian society or create a dystopian future, and concluded that this debate strongly supports the need for global precaution with AI development. Taddeo et al. (2021) suggest that soon AI could either sabotage current environmental policies, slow down a sustainable transition, and emit unfixable damages, or serve as an instrument that initiates a valuable counterreaction to the ongoing climate crisis.

The technical challenges and ethical concerns from the use of additional AI technologies, tools, and systems for sustainable transitions and climate change mitigations invoke a demand for an accurate and comprehensive regulation of these instruments. Countries currently face an ultimatum requiring them to balance economic growth with responsible governance of emerging AI technologies. At the same time, overregulation of these technologies poses a real risk to economic vitality. Conversely, insufficient regulations can result in security breaches, invasive surveillance, and societal disruptions, inevitably eroding public trust. This dilemma emphasizes the urgent demand and need for comprehensive policies that definitively promote technological progress while safeguarding social welfare. In analyzing the digitalized era, Elliott (2021) asserts that a viable solution lies in the formation and oversight of a self-correcting

market, which necessitates elevated transparency and accountability in digital organizations and social media platforms.

In shaping their AI policies, both Canada and Norway appear to be influenced by distinct ethical frameworks. Canada's multi-stakeholder approach resonates with principles of democratic ethics, emphasizing public engagement and transparency. On the other hand, Norway's top-down model aligns with a deontological framework, focusing on duty and rule-based ethics. Understanding these foundations provides deeper insights into the ethical dimensions of AI policy in these nations.

While a globally coordinated approach to AI development and regulation is indispensable, achieving such worldwide collaboration remains elusive. This unlikely worldwide collaboration is rooted in the ongoing competition for economic, military, and social superiority among the world's major players, mainly the USA and China. However, collective, and multidisciplinary institutions and organizations are the primary key that could facilitate a reasonable global effort that responsibly manages the continuously expanding scope of AI.

The following chapter will definitively assess the role of international organizations and agreements in enabling collaboration. The findings from this chapter outline the imperatives for stronger AI regulations that also play a delicate dual role of sustaining economic growth and maintaining the international economic status or rank of a country. The evolving capabilities of AI technology necessitate a coordinated global effort for precise regulation. Elliott (2021) outlined how a coordinated global response could address the prevailing issues of ethics shopping and dumping, a process where organizations strategically outsource their AI operations or research to countries with weaker ethical standards to circumvent the more stringent regulations in their home jurisdictions. In the rapidly evolving landscape of AI technologies, a balanced global approach that unites technological innovation with environmental responsibility and international equity, while simultaneously addressing the radically transformative potential of this digital era, is essential. As I conclude the examination of the ethical dimensions of AI policy in Canada and Norway, it is essential to consider the economic factors that also influence these policies. The next chapter provides a deeper exploration of the economic strategies employed by these nations, highlighting how they balance technological innovation with market regulation.

5. Discussion

5.1. The Political Landscape of Environmental Regulations and AI

The effectiveness of a country's sustainable regulatory frameworks is inextricably linked to its internal political and economic dynamics. In the context of environmental regulation and climate change mitigation, an effective policy is one that confronts the complex issues arising from global warming while promoting definitive reductions in GHG emissions and ensuring economic stability. Economic factors influencing sustainable development are intrinsically tied to market structure. Market structures vary across countries due to distinct economic policies and degrees of regulation. In free-market economies, profitability and market appeal drive companies to adopt sustainable measures. In more centralized economies, state directives dictate the sustainable measures adopted by the private sector to align with national objectives.

While both Canada and Norway prioritize ethical considerations in AI policy, their approaches diverge in key areas. Canada leans toward a multi-stakeholder model that involves public consultations, whereas Norway leans heavily on governmental frameworks. This section will compare these divergent strategies, offering insights into the effectiveness of each approach.

Canada and Norway exemplify mixed economies, blending free-market principles with significant government oversight. While the Canadian economy supports free-market competition in most sectors, the government definitively engages in regulation and direct participation in key industries like healthcare and energy. To achieve sustainable developments in any sector or industry, the Canadian economy promotes innovations in the private sector in addition to many government initiatives, policies, or regulations that aim to control the market.

While the Norwegian economy shares structural similarities to Canada's, a significant distinction is Norway's extensive state ownership in key sectors, most notably in the oil and gas industry through the company Equinor. Revenues from this sector alone have played a significant role in boosting the country's Government Pension Fund Global. The primary aim of this fund is to promote intergenerational equity and, by extension, sustainable development. This top-down approach has created a nation with a considerable amount of state influence to regulate its primary industries. The wealth obtained in this fund has been used to finance and drive renewable energy research, projects, and innovations. Norway’s commitment to sustainability is evident in its recent transition toward increasing the adoption of electric vehicles aimed at reducing their carbon footprint. However, Koasidis et al. (2020) state that their national policies promoting EV adoption have not notably reduced emissions in the Norwegian transport sector and have inadvertently stimulated a rebound effect as the demand for car ownership and travel increased.

Both countries operate as mixed economies that are home to a substantial number of natural resources. Yet their sustainable development paths diverge due to the degree of governmental involvement in key sectors. Canada balances the motivations of the private sector with certain

regulations, while Norway has a strong influence on sustainable initiatives through active state ownership. These differing market structures reveal the diverse strategies and immediate objectives nations adopt, even when pursuing similar sustainable development aspirations and trajectories.

The differing political landscapes create unique potential for any nation to integrate AI into their plans for sustainable developments. Mixed economies offer a significant advantage to harness the transformative capabilities that these technologies possess. AI is so wide-ranging that the large scope of these technologies indicates that they have the potential to dramatically and rapidly reshape the political, economic, and environmental landscapes of a country.

Currently, the political frameworks in any country are actively formulating, developing, and implementing new and improved regulations pertaining to the responsible usage of AI. Canada and Norway are both in the midst of balancing the enormous economic potential of AI with the ethical and privacy risks associated with these same developments. AI innovations and new project developments need to be aligned with each country's national sustainability targets and goals. To effectively advance AI projects, a comprehensive multi-stakeholder approach involving tech corporations, AI researchers, and environmental institutions would aid the proper recognition of the increasingly complex impacts of AI technologies. This collaborative strategy can help address the challenges associated with understanding, forecasting, and identifying the direct and indirect consequences of AI technologies and systems.

The current Canadian political framework allows the government to use AI for sustainability in specific sectors such as energy and healthcare. Each of these sectors can harness the efficiency improvements stemming from AI resource optimizations. While healthcare would benefit the most from improved patient diagnoses and all other AI-powered technological advancements, improvements fueled by AI in the energy sector have the greatest potential to influence the country's overall carbon footprint in a more sustainable direction. Some of these AI improvements include smart grids, enhanced predictive maintenance, energy storage optimizations, improved weather forecasting for renewable energy operations and site selection, and a more detailed energy consumption analysis of businesses and households. In addition, the government of Canada could implement additional regulatory incentives or sustainable policies that influence the free market's motives to use AI toward more sustainable practices.

In Norway, the political framework allows the government to exert greater influence across a much wider variety of sectors. Given the state's more active role in the economy, the Norwegian ability to enable sustainable AI initiatives are stronger. The government can employ AI in the oil and gas sector to optimize extraction processes, improve resource efficiencies to reduce wastage, and improve the monitoring and assessments of environmental impacts exerted through these industries. Furthermore, the revenues obtained from this highly profitable and state-dominated sector can be funneled to AI research and development which could then accelerate the country's overall sustainable transition. However, Norway's strong

capacity for sustainable AI interventions within its centralized economic structure is challenged by its affiliation with the EU and the constraints of the GDPR, as the latter's regulations pose challenges to unrestricted AI advancements.

In mixed economies, the role AI plays in shaping environmental regulations and advancing sustainable initiatives can be driven by the public sector, private corporations, or an integrated effort from both. The use of AI technologies to enhance predictive environmental modelling could aid both countries when they are crafting additional or improved environmental policies and regulations. The potential for AI to optimize energy efficiencies and usage across all sectors also enables either country to use these technologies to reduce their national carbon footprint. Enhancements in transportation and industrial procedures are amplified by AI's dynamic ability to monitor and adjust to real-time feedback, which can significantly improve the carbon neutrality of these operations.

The mixed economic structures that are present in both Canada and Norway exhibit differing political and economic landscapes relating to the opportunities and challenges surrounding the use of AI for improved sustainable measures and environmental regulations. The interaction of AI technologies within these two different economic configurations exhibits separate pathway potentials for national sustainable developments. As the rapid pace of AI evolution continues, the extent that it is integrated into the political landscape of any national environmental regulation depends on the country's capacity to accurately understand and predict the wide-ranging and diverse impacts that AI can exert.

5.2.Global AI Dynamics: Canada, Norway, and the Influential Players

The convergence of AI capabilities and objectives surrounding climate action marks a pivotal point in international relations regarding the current pace of technological advancements. Technologies powered by AI have emerged as a significant force that will have the ability to redesign the structure of every economy, society, and environment worldwide. The dual nature of AI relates to the fact that it poses as both a savior and a complicator in the context of climate change. For countries like Canada and Norway, which operate within relatively smaller economic contexts, there is an imperative to both establish and uphold AI policies, regulations, and guidelines aligned with their commitments to sustainable climate initiatives.

While Canada and Norway possess relatively smaller economies in scale compared to those of global AI leaders, their national AI policies are substantially influenced by the strategic priorities established by dominant international players, including the USA, the EU, and China. The dynamic nature of AI technology necessitates a careful exploration of the interrelationships and interdependencies between each player mentioned above. This section will analyze the differences between AI policies and climate objectives across these international forces. The focus of this section will show how Canada and Norway are negotiating their own national technological and environmental trajectories in association with the international forces by which they are influenced. In the following sections, I will examine the extent to which Canada

and Norway align with or diverge from global policy and technological influences and analyze the subsequent impact on their respective climate protection strategies.

Agrawal et al. (2019) state that, as societies around the world become increasingly technologically interconnected, an economic race emerges among nations and corporations to dominate the data-driven and largely intangible industry of AI. As this new era of digital innovation continues to accelerate, AI has become central to many nations' strategic interests for economic gains, national security, technological leadership, and socio-political influence. In addition to the national motivations, the private sector plays an increasingly critical role in shaping AI policy, particularly in smaller economies like Canada and Norway. While public funding and government initiatives are crucial, the influx of private investments often accelerates technological advancements and influences regulatory measures.

Canada and Norway, though recognized as advanced economies, find themselves substantially overshadowed by the larger economic powerhouses of the USA and the EU, respectively. Despite their smaller scale, these nations are at the front lines regarding the integration of AI-driven solutions to tackle climate-related challenges. The critical role played by international organizations and agreements, along with various global forums, is essential to unify efforts and successfully deploy new AI technologies for climate change mitigation and adaptation. Accordingly, the influence of major economic, technological, and social powerhouses such as the USA, the EU, and China on AI developments within Canada and Norway will be analyzed. The next sections will first examine the direct impacts of the USA on Canada and the EU on Norway, before concluding in a discussion about how global AI leaders, including China and the USA, are shaping technological trends internationally.

5.2.1. The Influence of the USA on Canadian AI and Climate Ambitions

Historically, Canada and the USA have maintained close geographical, technological, and political ties. Major American innovations create a global influence on the technological trajectories of any country around the world; however, for Canada, this influence extends not only in terms of technological advancements but also in regulatory frameworks, investment patterns, and public-private partnerships. In the context of climate change and environmental protections, the USA’s policies and technological innovations that use AI for these purposes can offer both a favorable framework as well as a cautionary point of reference for Canada.

Silicon Valley in California has functioned as worldwide hub for advanced technological companies, workers, and innovations. This center for invention attracted Canadian talent in the form of specialized workers and startup companies. The massive economic impacts directly stemming from Silicon Valley spawned the creation of similar centers in Canadian cities such as Toronto and Montreal. The development of these techno-ecosystem cities, combined with the USA and Canada’s cross-national ties, has allowed researchers to fluidly move between North American tech-centers. This dynamic produces a cross-pollination of ideas and collaborative

projects beyond borders, and more frequently bear the resemblance the USA's influence on Canada in the form of the algorithms developed or the applications pursued.

The shared borders of Canada and the USA indicate that both countries are experiencing similar threats to their respective geography. In both countries, AI emerged as a pivotal instrument to address the challenges posed by a changing climate, leading to evaluations of potential cross-national collaboration opportunities. Driven by a mutual sense of urgency to counteract the escalating climatic threats to the Arctic tundra and dense forests, each country formulated strategies that align with global initiatives, notably the Paris Agreement. The American approach has undoubtedly shaped Canada's sociopolitical viewpoints on climate change and the strategies deemed necessary to address it.

Following this logic, a similar socio-technological influence from the USA will be evident when Canada shapes its national AI governance. Operating from a free-market perspective, the USA currently stands as one of the leaders of AI talent and innovation, primarily driven by economic imperatives and national security concerns. American tech giants and the discussions in the United States Congress regularly echo throughout Canadian media channels and policy debates. Whether directly or indirectly, the USA plays a role in shaping Canada's approach to AI governance.

While Canada recognizes the substantial benefits of collaborating with the USA on AI-driven climate protections, it is also forging a distinct, and potentially world-leading, trajectory in global AI legislation. The Canadian AIDA, set to take effect no earlier than 2025, contains provisions that are at the global forefront of national AI policy. However, for these to become implemented, continuous development and drafting are essential. The act adopts the AI definition in line with the OECD, ensuring that Canada is aligned with the EU's AI Act. The Artificial Intelligence and Data Act (AIDA) states that this alignment aims to safeguard both Canadian citizens and corporations. Restrepo Amariles & Baquero (2023) explain that before the act reaches its final form, Canadian policymakers will inevitably deal with American influences, particularly given the USA's current absence of a federal law or regulation specifically aimed at governing AI.

However, the recent American executive order introduced on October 30, 2023, is designed to promote AI safety and security, privacy protection, equity and civil rights, consumer and worker safeguards, innovation, and aims to extend American leadership in AI globally. Yet Sanger and Kang (2023) argue that the White House's authority is limited and some of the directives are unenforceable. Similarly, Mason et al. (2023) cite Tusk's observation that, while the concept is commendable, its impact may be constrained due to the absence of an effective enforcement mechanism. American influence on Canada in this regard can be significant: notably, in 1969 Prime Minister Pierre Trudeau likened Canada's relationship with the USA to sleeping with an elephant: "one is affected by every twitch and grunt," a metaphor that resonates in the context of AI regulations today (*Sleeping with a Very Cranky Elephant*, 2018).

5.2.2. The Influence of the EU and GDPR on Norwegian AI Trajectories

As a participant in the EEA, Norway is subject to the EU regulations and directives surrounding data protection and AI. Norway embraced the GDPR in 2018, which indicates the amount of influence that the EU holds over the country, particularly its capacity to participate in the EEA as a member of the EFTA. The GDPR's largest impact on AI is in the form of restrictions placed on automated decision-making processes and data collection. Norwegian companies using AI need to ensure that their algorithms and data processes comply with the GDPR's principles which include fairness, transparency, and data minimization.

In 2018, the European Commission released a report highlighting the sociocultural and economic potentials of AI up to this point, concluding that Europe trailed Asia and North America in private AI investments. The same commission released a report in 2021 which stated that the EU is planning to invest EUR 1 billion a year in AI, and the long-term goal is for the AI investments from all countries in the EU to total EUR 20 billion per year by the end of this decade. The Norwegian Consumer Council and the Norwegian data protection authority have raised concerns over this drive for AI and the issues relating to violations of the GDPR with generative AI. In addition, the Consumer Council described human rights violations in association with the development of new AI models and algorithms, particularly with generative AI systems and technologies. Yet as a member of the EEA, Norway must follow the GDPR exactly like all EU member states.

The Deputy Director General of the European Consumer Organisation remarked on the proposed EU AI Act, emphasizing the need for the EU to make the Act resistant to the intense lobbying pressures from major tech corporations ("New report," 2023). In 2022, the Norwegian government issued a paper on its stance toward the EU's proposed Artificial Intelligence Act, asserting that Norway should have a seat on the emerging European Artificial Intelligence Board (EAIB) linked to the act. Participation in the EAIB would offer direct input into AI governance discussions and help align the country's domestic strategies with the broader European perspectives. Through this participation, Norwegian AI applications can stay competitive both within the EU and globally, while at the same time aligning with the EU's stringent ethical standards.

Norway recognizes numerous benefits from its involvement with the EU's AI and data protection framework. Yet there are concerns about the economic challenges businesses face due to these new EU regulations. The pace of technological advancements within Norwegian corporations are now challenged by the GDPR and the proposed EU AI Act. Furthermore, macroeconomic growth will disadvantage smaller businesses, as they grapple with stricter regulations. These regulations can limit their potential for technological innovation, especially when much of this is powered by collecting mass amounts of data to analyze with AI.

The steady state that Norwegian businesses seek between innovation and compliance mirrors the nation's own balancing act regarding technological advancements within the constraints of

EU regulations. The EU's AI regulations offer structured and ethical guidelines; however, they force Norway to create a strategy that enables technological and economic growth across all levels of the economy, while aligning with the EU's standards.

5.2.3. The Influences of AI Superpowers: China, USA, and the EU

On September 19, 2023, the UN Secretary-General, Antonio Guterres, addressed world leaders and described the current international framework of the world as one "with diverging strategies on technology and AI, and potentially clashing security frameworks" (Hu, 2023). He added that this is an unsustainable framework for our ever-changing world that continues to experience rapid technological advances. In reference to AI, both the USA and China are openly engaged in a global competition for dominance, mainly driven by economic motivations and national security imperatives. The significant investments fueling this competition are attracting international talent and businesses, accelerating the development and deployment of new AI technologies. At the same time, alongside these economic and technological superpowers, the EU holds a significant influence over the ethical governance of these data-dependent technologies. Hern (2022) points out that an example of the EU's influence can be recently evidenced by Apple, a company worth over USD $2.5 trillion, conforming to EU regulations and putting USB-C ports on their latest iPhones.

Technological advancements and radical AI innovations are expected to primarily emerge from the free-market and nationally driven sectors of the USA and China, whereas the EU is positioned to lead in establishing ethical guidelines, regulations, and privacy protections. Both Canada and Norway are subject to adapt to any new policies and technologies introduced by these three international forces. This places them in a position where they must construct individualized national strategies for AI regulation amid this global influence. This task is challenging, given the presence of both positive and negative aspects within the framework of each major player. The rapid evolution of these technologies adds further pressure to expedite the formulation of a national strategy that balances development with current and future ethical and security concerns.

In 2017, China set a goal to become the world leader in AI technologies and applications by 2030, while in early 2019 the USA aimed to maintain American leadership in AI (*Maintaining American Leadership in Artificial Intelligence*, 2019; Webster et al., 2017). Zhang & Levine (2023) show that these two national ambitions are evident in the total AI investments of the year as of mid-June 2023, which amount to USD $26.6 billion for the USA, compared to USD $4 billion for China. Nellis & Cherney (2023) add that the USA has recently implemented economic controls that limit the sale of computer chips to China and some Middle Eastern countries, recognizing their role as a primary driver of AI advancements.

While these extensive economic strategies exert a global influence on the pace of technological AI progress and implementation, the EU is taking a leading role in promoting privacy protections and ethical advancements. Time is the only factor that will determine whether the

right approach to AI should center on unbounded market promotion for global techno-economic supremacy, or on addressing the unforeseen and hidden risks of this technological trend. Canada and Norway find themselves in a dynamic position where both must rapidly forge their own national policies and frameworks for AI amidst the extensive influences exerted by global AI superpowers.

5.2.4. Summary: Canada and Norway's AI Policies Under Global Influence

The intricate global web of AI dynamics exerts a force that subjects Canada and Norway to a constant struggle as they aim to establish effective frameworks for mitigating and adapting to climate change using AI technologies. Relative to the global AI superpowers, these two countries are smaller economies, yet they are geopolitically wedged between world-leading international AI forces. Both nations are now in a position where they must rapidly develop their own national frameworks for AI regulation, innovation, and implementation. In the context of a changing climate and sustainable developments, the overregulation of AI technologies can potentially limit a country's economic and environmental protection progress.

The USA, a market-driven technological superpower, exerts substantial global influence over the AI industry, and its most significant sway is felt by its northern neighbor, Canada. The economic impacts of Silicon Valley combined with the cross-pollination of talent, ideas, and collaborative projects directly influence the preferences of Canadian citizens and policymakers. Deschamps (2023) explains that the Council of Canadian Innovators (CCI) called for a quick and responsible approach to artificial intelligence adoption in Canada, adding the importance of aligning the proposed AIDA with the policies of the EU and the USA to conform to the emerging global norms.

For Norway, the country's participation in the EEA subjects it to EU regulations, notably the GDPR, which significantly impacts the nation's AI trajectories. The EU's framework for technological regulations acts as a hybrid between the market-driven American approach and the state-driven Chinese processes. This hybrid framework presents Norway with a unique model that could potentially synchronize the benefits of both market-driven and state-driven systems within its own national context. The EU's emphasis on ethical and privacy protections presents direct challenges to both the public and private sectors in Norway. Corporations operating within the EU are limited in the extent to which they can implement technological transitions.

While China and the USA engage in a fierce competition for AI dominance, the EU stands out with its distinctive approach firmly grounded in ethical governance. The intersection of these international dynamics' places Canada and Norway in a position where they must skillfully navigate and formulate their own AI regulation strategies. They must act quickly to address the rapidity of AI evolution and create their own unique AI frameworks.

The USA, China, and the EU each present distinct approaches to AI, significantly influencing the strategic direction of smaller economies like Canada and Norway. As they navigate this complex

terrain, these nations must balance technological innovations with ethical governance and environmental protections. This balanced strategy aims to merge the technological advancements fueled by the market-driven and state-supported economies of the USA and China with the EU's stricter regulatory framework that emphasizes ethical practices. Presently, the global pursuit for AI supremacy is primarily driven by market forces. While China's national strategy has intense state interventions, the country still actively allows and promotes the unrestricted free market development of AI companies and technologies. The American and Chinese ambitions for AI are rooted in desires for economic and military supremacy. Bradford (2023) notes that the EU's regulatory actions could wield what is termed the 'Brussels Effect,' a potent global influence on technological products, services, and corporate conduct. Once again, it is too early to predict which approach will prevail in shaping the AI policy landscape for smaller economies internationally.

5.3. Assessing the Potential of AI for Climate Change Mitigation

Drawing upon the evidence presented in the preceding sections and incorporating new sources, this section will analyze the magnitude by which AI can enhance or shape climate change mitigation and adaptation efforts. This section will set the foundation for understanding the broader context within which Canada and Norway are formulating their AI policies. It provides a backdrop against which the strategies and commitments of these two nations can be understood. More specifically, this section will review the abilities for AI to enhance progress towards the global SDGs and contribute to the realization of the commitments outlined in the Paris Agreement.

5.3.1. AI's Role in Advancing the Global SDGs

Among all SDGs, AI has the most transformative potential for SDG 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 9 (Industry, Innovation, and Infrastructure), 12 (Responsible Consumption and Production), and 13 (Climate Action). In addition to the advancement of these said goals, AI has also been studied for its potential negative impacts on SDG 10 (Reduced Inequalities). Goralski and Tan (2020) explain how prolific figures such as Elon Musk and Bill Gates have recently directly stated that escalating the applications of AI may increase global inequalities and create "an existential crisis for humanity." In the context of SDGs, the full impacts of this technological trend will take time to surface. Yet what Leal Filho et al. (2023) find to be currently clear is that AI-enhanced research will play a crucial role in both implementing and documenting progress on specific SDGs and their corresponding objectives.

Beginning with SDG 6, which has the primary objective of ensuring safe and sustainable resources for water management, sanitation, and availability, AI can assist this goal by monitoring water quality, predicting consumption, optimizing wastewater treatment, improving industrial water-use efficiency, and enhancing the assessment of the condition of relatable infrastructures. Goralski and Tan (2020) find that these advancements enable water resource managers to optimize their investments, increase their productivity, and achieve a more efficient use of their time.

The 7th sustainable development goal aims to enable worldwide access to a reliable and affordable source of energy. Like its role in SDG 6, AI's primary contribution to SDG 7 is through efficiency enhancements. This is mainly achieved from enhanced algorithms that facilitate advanced modeling techniques. These techniques then enable more precise predictions of energy demands and allow for an easier integration of automated distribution mechanisms. One of the most prominent uses of AI technologies for SDG 7 comes in the form of smart grid technologies, which optimize the energy distribution, enhance demand side forecasting, and improve the overall reliability and efficiency of an energy network.

The sustainable developments evidenced by smart grid technology advancements play into the overall objectives of SDG 9, which aims to promote renewable energy innovations across the entire industrial sector. While these industrial advancements and infrastructure upgrades produce direct sustainable benefits, Vinuesa et al. (2020) find that the AI-powered ICTs used for this transition will require 20% of the entire world's electricity demand by 2030, compared to the 1% it consumes today. Once again, it won't be possible to assess whether the entire effect of this technological transition is positive or negative until enough time has passed.

This ongoing temporal dilemma indicates the need for the AI assistance with SDG 12. This goal aims to enhance the overall responsibility in consumption and production practices. Waste reduction and efficiencies can directly be improved by AI systems and technologies, while refined algorithms offer a more accurate analysis of these ongoing processes.

The SDG that has the most potential for AI improvements is the goal 13. This goal calls for an intensified commitment and enhanced quality of climate action. Di Vaio et al. (2020) demonstrate that both the public and private sectors have been using AI to increase the connectivity of their respective organizations to improve "the reach, speed, and accuracy of information processing." As a result, the public sector becomes better equipped to engage with its citizens, while individuals enjoy increased accessibility to public services. The private sector, using these enhanced levels of connectivity, can identify additional strategies to compete within their respective industries and mitigate their environmental footprints. Ultimately, AI can emerge as an essential element in reshaping global perceptions of our evolving climate. This has the potential to amplify international support for comprehensive responses to this challenge, as demonstrated by initiatives like the Paris Agreement.

Both Canada and Norway use distinct strategies using AI to meet the SDGs. Canada, for example, used AI in environmental monitoring and resource management, directly contributing to SDG 13 (Climate Action), while Norway has implemented AI-driven technologies in its maritime industries to promote SDG 9 (Industry, Innovation, and Infrastructure). By focusing on SDGs, smaller economies can ensure that their AI policies are part of a global effort to promote environmental sustainability and equity. The comparison of Canada and Norway demonstrates how the shared commitment to the SDGs safeguards a policy approach that is sensitive to both national needs and global necessities.

5.3.2. AI's Contribution to the Paris Agreement Objectives

The Paris Agreement was drafted in 2015 by 196 parties at the UN Climate Change Conference, with the legally binding aim to limit the increase of average global temperature below 2°C and make significant efforts to hold the temperature increase to 1.5°C by the end of this century (*The Paris Agreement*, 2016). In 2023, Sanderson's article is an example of how we have experienced countless reports referencing how that 1.5°C target will be breached this decade. However, this recent data only stresses the vital importance of this global goal. Worldwide momentum addressing climate change is essential in reducing emissions, strengthening systemic resilience, and increasing financial aid to developing countries for sustained progress. For nations committed to the Paris Agreement, AI emerges as a valuable tool to help them achieve their Nationally Determined Contributions (NDCs) to the Paris Agreement while also elevating their climate goals.

Examples of the most impactful mitigative strategies enhanced by AI include efficiency upgrades across various sectors, improved predictive maintenance for renewable energy systems, streamlined energy consumption and transportation, and advancements in agricultural practices. The efficiency upgrades combined with a streamlined energy market can create a revolutionary improvement in the ever-increasing urbanization of our planet. Rayhan (2023) explains how in addition to smart systems and the electrification of transportation, waste collection processes and recycling algorithms powered by AI can reduce waste emissions and improve the carbon footprint of any community. Furthermore, the AI improvements in the agricultural and overall food sectors have a direct contribution to food security, reduced food waste, and a more sustainable and precise operation of these industries.

Following mitigation, the Paris Agreement strongly emphasizes the need for adaptive measures to be taken around the world. In this context, AI can assist through the large improvements to data analytics. Forecasted climatic variations and the subsequent impacts stemming from these are aided by AI which allow nations to develop stronger solutions in response. Extensive datasets can produce a more accurate climate trendline which can then support the development of relevant infrastructure that directly address the issues pertaining to the evolving climate.

The Paris Agreement highlights the importance of transparent reporting and monitoring in achieving its goals. Countries can use AI as a tool that can provide a more comprehensive set of real-time environmental data analysis. This development can help members of the agreement keep track of their commitments and understand how they can continue to make progress toward their NDCs and goals.

Luccioni et al. (2022) demonstrate that the carbon footprint of AI technologies, such as the example of BLOOM, strengthens the need for environmentally conscious AI developments. Moreover, while the emissions associated with AI development are not negligible, the potential

benefits that they can produce, such as optimized energy grids or improved transportation efficiencies, will significantly outweigh the initial carbon costs of the developments.

It's clear that although AI possesses the transformative potential to accelerate climate change mitigation and the realization of global SDGs, a balance is imperative. Taddeo et al. (2021) explain that the trajectory of AI development can either sabotage environmental efforts or serve as an indispensable instrument against the climate crisis. The call for a globally coordinated response to AI against climate change is essential not only for ethical and economic reasons but also to fully realize the potential of its adaptation and mitigation measures.

Canada and Norway actively incorporate AI to advance their environmental policies in alignment with the Agreement. The Paris Agreement exists as a stage for these efforts as it offers a common framework that guides these nations in not only achieving their NDCs but also in shaping the evolution of their AI policies. This underlines the Agreement's key role in promoting a more unified approach to environmental sustainability.

5.3.3. Canada vs. Norway: An Examination of AI and Environmental Policies

Canada and Norway recognize the potential that AI technologies have for combating climate change, but their strategies diverge based on different geopolitical affiliations and national priorities. Campbell (2021) showed that in terms of overall climate action, Norway leads Canada mostly because Canada experienced “wide swings on climate policy over the past 40 years” while the Norwegian government has “uncontested jurisdictional authority over climate policy” and has used that to successfully take more aggressive actions. As both countries are currently in the middle of developing their national AI strategies, it is important to acknowledge the developmental nature of their policy landscapes.

The Canadian approach emphasizes research and development, often collaborating with American academic institutions, to leverage AI in environmental science, renewable energy, and predictive analytics for climate change mitigation. Canada's proposed AIDA aims to establish a world-leading risk-based regulatory framework for AI systems, defining roles and responsibilities across various sectors and stakeholders. The Act seeks to establish an AI and Data Commissioner while defining 'high-impact AI systems' that would then be subject to strict regulation. In addition, it would lay out obligations for entities that were involved in the development, operation, and use of such AI systems. Before the Act is passed and implemented, collaboration with relevant industries as well as academia and civilian groups is planned. AIDA intends to align with international frameworks such as the EU's draft AI Act, as the overall goal for Canada is a coordinated approach to AI governance.

Meanwhile, Norway, a country deeply embedded into the EU strategies regarding climate change and AI, prioritizes smart grid technologies and renewable energy developments. The EU's AI policy framework also aims at coordinating standards and practices for the responsible use of AI across all member countries. In 2020, the Norwegian Government's AI Strategy

targeted five key areas for the responsible adoption of AI. The areas were competence development, research, data accessibility, innovation, and regulation. The strategy highlighted the importance for AI education across academic and professional platforms while also promoting a more multidisciplinary approach to research. It called for enhanced data quality and security to ensure privacy. Finally, the strategy outlined the ethical and legal requirements for AI deployment and aligned these with international standards, particularly in the context of global challenges like climate change, connected to the UN's SDGs.

Much like the proposed Canadian AI framework, AIDA, the EU has an Artificial Intelligence Act in development that also uses a risk-based categorization of AI systems. Norway will follow this act's regulations once it is passed. Any AI system that is found to produce an unacceptable risk would be permanently forbidden. Such systems are AI applications that were found to have the potential to significantly impact human rights or pose serious risks to health and safety. High-risk AI systems that were found would be subject to strict regulations, heightened levels of transparency requirements, and regular checks to ensure compliance. The final form of this act will undergo some slight modifications during the legislative process, but the introduction of such a widespread and strict framework signifies a great leap regarding the global debates around AI regulation.

Both Canada and Norway currently exist in a state of ongoing policy refinement to keep pace with rapid AI advancements. The Canadian policy mechanisms seek to stimulate private-sector innovation through tax incentives and grants, while Norway emphasizes a more collaborative approach across the public, private, and academic sectors. The flexible nature of policy positions of both countries allows them to be receptive to global trends and influences, particularly from the dominant AI superpowers like the USA, EU, and China. While Canada has created some ethical AI governance frameworks, these also closely align with the values of its direct southern neighbour. Norway also has ethical considerations within its AI policy, but the country will be subject to the EU's regulatory landscape once the union's act passes.

These two countries are a valuable case study of any smaller economies directly situated next to larger economic powers. Their recent experiences offer lessons to any country aiming to navigate the complexities of aligning national AI strategies with international initiatives and influences, especially those from the USA, EU, and China. The adaptive policy frameworks of Canada and Norway, in the middle of rapid AI advancements and intensifying climate emergencies, make them key players in the international debate surrounding the sustainable and responsible use of AI. Therefore, their comparative experiences substantially contribute to the understanding of how smaller economies can both influence and be influenced by larger geopolitical entities when shaping their own national AI policies for climate change mitigation and adaptation.

5.4. Ethical and Social Implications

As the new digital era takes effect, it brings a dual-sided reality full of both unprecedented opportunities and socioeconomic challenges that go beyond the technological boundary. The transformative potential of AI offers some solutions to established problems as well as the ability to enhance human capabilities. However, these solutions come to us packaged in a product that simultaneously presents significant risks. These risks point to outcomes that could amplify existing inequalities, raise privacy concerns, and change the state of employment. Siddiqui (2023) highlighted that in June 2023, Geoffrey Hinton, often referred to as one of the godfathers of AI, described the current hazards stemming from AI's rapid advancement to be "bias and discrimination; unemployment; online echo chambers; fake news; 'battle robots'; and existential risks to humanity." In addition to these risks, the environmental impact of AI technologies cannot be neglected. Carbon emissions coming from this new data-driven arms race for techno-supremacy, linked with the subsequent shifts in global power dynamics and wealth dispersion, will become the defining narrative of our decade. This section will assess the implications of this complex era and investigate the extent to which AI can influence our societies in either direction.

5.4.1. The Influence of Algorithms on Policy Development and Outcomes

In this new era of technocracy, Yuval Noah Harari (2023) has demonstrated that AI has mastered language and has now shifted its focus from algorithms aimed at maximizing screen time to ones designed for deeper and more intimate connections. Abrardi et al. (2022) explain that while AI algorithms have the capacity to reduce consumer biases, they also have the risk of creating new ones that could spawn job market polarization, raise inequality, and produce structural unemployment. We are now living in a time where an ongoing debate exists surrounding different motivations to either rapidly promote or aggressively limit and contain AI development. These new and improved algorithms can provide extraordinary opportunities for societal advancement, but they also bring an abundance of challenges that require careful navigation in both the public and private arenas.

Earlier I referenced the environmental impacts relating to the development of AI models, but I will now discuss the datasets that these models are trained on. Any new algorithms that are trained using biased datasets can unintentionally compound the existing inequalities. In the development stage, if the dataset includes any existing societal biases, the algorithm now has the risk of amplifying and perpetuating these biases once the model is operational. Given the extensive data requirements for developing and training new machine models, the need for high-quality, clean data cannot be overstated. Angwin et al. (2022) uncovered disparities in the domain of criminal justice, identifying how algorithms that are trained on historical arrest records could potentially perpetuate existing disadvantages for marginalized communities.

In addition to biased legal proceedings, algorithms can exhibit unfair tendencies in employment and healthcare. Köchling and Wehner (2020) show that algorithms for talent recruitment that are trained on resumes and employment histories risk preserving any preexisting gender, racial,

or ageist biases. Furthermore, Daneshjou et al. (2021) highlight that any algorithm that is trained on medical datasets that do not accurately represent certain racial or ethnic groups can create misdiagnoses or suboptimal treatment plans for these demographics. More recently, Chomsky et al. (2023) discovered that the explosion of ChatGPT has ushered a new form of biased information, which can either promote unethical decision-making or lead to apathy toward the consequences of various situations. The biases created in these examples are largely attributable to the datasets on which the algorithms are trained or with which they operate. However, the algorithmic issues extend beyond an accidental or poorly designed dataset.

As our new era of digitalization continues to evolve, so too do the risks that are associated with privacy invasions and the potential for data manipulation. Most successful algorithms or AI applications depend on extensive and continually expanding datasets. This phenomenon raises two main issues: the first is the proliferation of increasingly invasive data accumulation techniques, and the second pertains to the control and ownership of these vast datasets. These two concerns showcase the potential for the misuse of AI technologies, algorithms, for political or social manipulation.

In summary, the datasets that AI and algorithms are trained on are more than a technological progression. These new technologies are saturated with social, ethical, and political values that usually relate to people's historical preferences. To combat any unintentional outcomes and unethical misuses, a multidisciplinary approach that carefully assesses any relevant datasets for their qualities and levels of inclusivity can help mitigate the risks associated with compounding any existing societal inequalities.

The rapid evolution of AI technologies creates significant challenges to the existing governance structures. As AI expands, traditional regulatory frameworks will struggle to keep up to with the pace of these technological advancements. The current decentralized market for AI development and deployment can allow regulatory oversight where unethical practices or misuse go unchecked. Therefore, there is an urgent need for governments to adapt their regulatory frameworks and effectively govern the ethical use of AI.

5.4.2. Environmental and Socio-Economic Integration in AI Policy Frameworks

As the growth of AI technologies continues to spread through various spheres of our societies, the influence that they exert are not only on individual behaviors and social norms but also on the global environment and national economies around the world. The carbon footprint of this algorithmic evolution is currently unchecked, which raises immediate environmental concerns, while the power balances relating to geopolitical AI dominance and the distribution of wealth pose the risk of steering the world toward dystopian outcomes. In this rapidly evolving context, failing to address these interlinked environmental and socio-economic factors can lead to an unsustainable future with inequitable outcomes across all scales.

The energy intensity of AI developments is largely confined to data centers and computational processes engaged in data analysis. These advancements hold the promise of significantly

enhancing efficiency across a broad spectrum of societal sectors, yet such a future still mainly remains aspirational. While it is crucial to invest in and encourage these optimistic visions of technology acting as a climate crisis saviour, we should first analyze the present-day environmental costs associated with this technological progression. This is a tightrope because the industry presents risks that stem from both under-regulation and over-regulation. As mentioned, insufficient regulation can lead to environmental degradation, data privacy issues, and the amplification of social inequalities, while at the same time the over-regulation of this industry could suppress innovation and limit the realistic benefits that AI could offer to our societies and global environment. Therefore, finding a proper balance between these two alternatives is the critical goal for every country so that they can fully grasp the transformative potentials of AI technologies while mitigating the costs associated with these developments.

As nations continue to invest in AI, the use of these technologies for surveillance, military purposes, and diplomatic strategies, has led to an escalating race for technological global supremacy. The militarization of AI adds additional layers of ethical and strategic complexities to this industry. The development of autonomous weapons systems and advanced cyber warfare capabilities has spawned a large drive to privatize and contain AI knowledge and talents. This situation complicates international relations, and concerns are now being raised regarding the weaponized capabilities of autonomous technologies. Questions relating to the degree to which any nation will go for global dominance have also arisen.

These rapid AI advancements are supporting existing wealth gaps both within and between nations. As new algorithmic abilities and AI technologies become integrates into more and more industries, the corporations who own or control these systems gain disproportionate economic powers. This concentration of wealth and economic power has created a society in which those who have the resources and abilities to leverage AI for commercial gain will widen these wealth gaps. A wider wealth gap signals issues concerning the distribution of AI's benefits once a transformative technology or system is implemented.

The transformative potentials that AI technologies offer is packaged with the geopolitical and socio-economic divisions. The entangled balance of international, economic, and societal powers indicates that a careful and calibrated approach to global AI regulation is more than necessary. National policies and international alliances must be strengthened and/or developed to mitigate the potential negative impacts that AI could exert on global power dynamics and economic disparities. Moreover, this pathway should still allow room for AI innovation and development to help create and find a more sustainable and equitable future.

The development and deployment of AI systems introduce ethical dilemmas, such as issues related to privacy, accountability, and the potential erosion of human control. In addition, the rise of autonomous technologies, including AI-driven weapons systems, introduces ethical considerations in warfare and international relations. The privatization of AI knowledge and talent only amplifies these ethical complexities as the public population won't immediately be aware of any major technological developments.

The societal and ethical implications of rapid AI evolution include volatile challenges in the areas of governance, public perception, and ethical considerations. As smaller economies navigate these challenges alongside major AI powers, a more comprehensive and ethically grounded approach to AI development is required.

6. Conclusion and Recommendations

Throughout this study, I've emphasized the dynamic nature of AI technology and legislative frameworks, witnessing rapid changes in technology, political discourse, and economic conditions. These developments further underscore the fluid and rapidly evolving landscape central to this academic inquiry. The rapid evolution of these technologies indicates that their subsequent impacts are both situational and largely unknown.

The intricate nature of the current technological and environmental trends underlines the importance for both Canada and Norway to quickly employ and regulate AI in the context of climate change mitigation and adaptation. The potential unforeseen consequences of this technological shift can either significantly advance or impede progress in our collective pursuit for a sustainable societal transformation. The complexity and urgency of aligning AI advancements with national and global climate goals are not merely considerations; they are imperatives that policymakers must urgently address.

For these reasons, this study is really a starting point for understanding the current global AI-era that we find ourselves in, and more particularly, the role of AI in combating climate change in different economic and geopolitical settings. The insights offered in this thesis, which seeks to comprehend the strategies and approaches employed by Canada and Norway—both economies of comparatively smaller scale situated next to larger economic powers—in using AI for climate change mitigation and adaptation, are applicable beyond these specific nations. While my research focuses on the specific cases of Canada and Norway, the analytical tools, and insights I've shared are broadly relevant, meaning they can be useful for any country, region, or even a whole coalition of nations tackling similar challenges.

Although the analysis in this study predominantly concentrated on the public sectors of Canada and Norway, it is important to acknowledge the overpowering role that the private sector often plays in free-market societies. In such situations, corporations can exert considerable influence that then results in the public sector shaping its initiatives and strategies following their lead. Behr (2023) discussed the recent international summit on AI safety regulation, hosted by UK Prime Minister Rishi Sunak on November 1 and 2, 2023, which highlighted the private sector's role, marked by the presence of “Silicon Valley celebrity” Elon Musk, and signifying the convergence of private market power with political dialogue. This overshadowing influence emphasizes the complexity of the powerful dynamics and impacts of AI technologies and their corresponding national regulations. Ray (2023) outlines the distinct disparity between national AI investments by countries like Canada and Norway and the colossal capital influx from the private sector, exemplified by Amazon's massive USD $4 billion injection into the AI firm Anthropic in September 2023. This contrast underscores a prevailing trend where financial clout could potentially steer the evolution and authority of AI technologies, especially in scenarios where the proper national legislation is not in place to guide or mitigate the impacts of these private ventures.

6.1. Key Insights and Global Impact

The global race for AI dominance features a strategic competition primarily among the USA, the EU, and China, each demonstrating distinct approaches, objectives, and strategies. This intense global contest significantly influences smaller economies like Canada and Norway in shaping their AI policies and strategies for climate change. These two countries demonstrate the ability to develop policies aligning with their national interests while respecting global advancements.

Hutson (2023) explains the current environment where this "technology is a constantly moving target," the EU adopts a cautious stance through its still-developing Artificial Intelligence Act, the USA maintains a comparatively relaxed and market-driven approach, and China aims to strike a balance between promoting innovations and maintaining strict controls. Canada and Norway are caught in between this global striving for techno-economic protected dominance. The proximity of Canada to the USA and Norway to the EU renders them susceptible to policy direction and market forces. The American competitive, free-market, innovation-driven approach to AI influences Canadian strategies. Similarly, Norway, part of the EEA, is influenced by the EU's focus on ethical considerations and societal welfare in future AI implementations. Both countries mirror their direct major neighbors' preferences while maintaining a unique level of national efforts reflecting their own interests.

The Chinese surge in AI technologies, mainly in areas of ML and data analytics, presents an alternative approach to AI regulation. China employs a state-controlled approach, prioritizing mass data collection. Canada and Norway do not model their national interests on China's approach, yet the remarkable speed of China's advancements in AI technologies necessitates a meticulous examination of both countries. This would entail determining whether either nation could incorporate elements of China's AI strategy without compromising their own national ethical and democratic principles. Though Canada and Norway lack direct geographical, political, or institutional ties to China, the latter has a considerable indirect influence over both nations' AI strategies, given its significant role as a magnet for talent, investment, and international partnerships in the field of AI technology.

The recent acceleration in the worldwide competition for AI supremacy has had a notable impact on the AI policies and strategies of both Canada and Norway. The AI policies and strategies of either nation that specifically target climate change mitigation and adaptation are products that deal with their geopolitical associations and the larger global trends directed by the USA, EU, and China. In response to the shifting influences of the global AI superpowers, both nations evolved their national formulas and exhibited real-time policy adaptations. This capacity for swift policy adaptations is particularly essential due to the escalating impacts of climate change and the potential for effective solutions that AI could offer.

6.2. Policy Recommendations

The current pace of both AI technologies and climate change present policymakers with the difficult task of forming effective regulations that are flexible enough to continually adapt to the

unpredictable technological and environmental evolutions. Pequeño (2023) found that the accelerating speed of AI development—evident by OpenAI's recent introduction of ChatGPT's ability to browse the internet—exposes the challenges related to accurately regulating this dynamic field. Bradford (2023) added that in November 2022, the EU was on the verge of enacting its AI Act, but then the public release of OpenAI's ChatGPT compelled European policymakers to reevaluate and refine their regulations, showcasing the complexities of legislating AI in a rapidly evolving technological landscape.

Because of the uncertainty and rapid advancements in AI technologies, current policies, frameworks, or regulations will quickly become outdated and ineffective. The recent extension of the EU's development of their AI Act presents an accurate depiction of how difficult it is to regulate AI to ensure both safe and innovative application of these technologies. Therefore, it is important for countries like Canada and Norway to be flexible and proactive in policy formulation and adaptation. Both countries can benefit from a more collaborative effort to align their national AI and climate change policies with international frameworks. Although each nation has a unique geopolitical and economic context, a global need for standardized international regulations addressing the intersection of AI and climate change exists. Wolff (2023) explains that if the current capitalist structure of our society enables employers to use new AI technologies "to profitably replace paid workers with machines, they will implement the change," which emphasizes the need for a well-coordinated international regulatory framework that can respond to the global challenges imposed by these AI technologies.

Given the significant influence exerted by global AI superpowers such as the USA, EU, and China, it becomes increasingly important for countries like Canada and Norway to engage in multinational agreements that can counterbalance the impact of these dominant players. Collective action taken by smaller economies on climate change mitigation and AI development can create a formidable force in the worldwide arena for climate change mitigation and AI regulation. Although both Canada and Norway have initiated moves in this direction, there still is the need for a more comprehensive international framework.

Considering the ethical dimensions explored in this research, Canada and Norway must institutionalize regular multi-stakeholder consultations as a non-negotiable aspect of AI policy formulation. By including a diverse range of perspectives from civil society, academia, and the private sector, such an approach ensures that AI policy formulation is not just technologically sound but also ethically responsible. Moreover, there is a compelling need for mandatory transparency measures in algorithmic decision-making, particularly in critical sectors such as healthcare and criminal justice. Transparency in these domains is not merely an ethical imperative but also a channel for social justice, allowing for both accountability and the possibility of redress in the face of biased or unfair algorithmic outcomes.

From an economic standpoint, this study concludes that public-private partnerships are not optional. These relationships are essential in order to align national AI strategies with rapid technological advancements. Through these partnerships, Canada and Norway can fund AI

research and development projects that align with national priorities, while pooling resources and sharing risks to accelerate innovation. Furthermore, there is a noticeable need for greater investments in educational programs that focus on AI talent development across all educational levels. Human capital is positioned as a foundation for economic development in the AI arena, and targeted educational investments ensure a more skilled and capable workforce. Upgrading the skills of a national workforce to create a well-educated understanding of the complexity of both AI and the climate crisis could be the best asset for countries seeking to negotiate the complex landscapes of these rapidly developing fields. Creating such a skilled workforce is not only a recommendation but actually a requirement for any country aiming to maximize the benefits of AI technologies for climate change mitigation and adaptation.

Finally, the transnational nature of AI technologies and their implications necessitates a coordinated international approach. Canada and Norway must actively engage in international collaborations as a strategic and ethical obligation, not merely as a policy recommendation. Given the rapid pace at which AI technologies are evolving, there is also a need for a mechanism that allows for regular policy reviews. Such an agile policy framework ensures that both countries can adapt to new challenges and opportunities in the AI landscape.

7. Limitations and Future Research

7.1. Rapid Technological, Political, and Industrial Changes

One significant limitation of this study lies in the swift evolution of the AI and climate change landscape. Despite the comprehensive analysis of AI policies in Canada and Norway, it is crucial to recognize inherent limitations. The rapid changes in AI technology mean that policy landscapes can shift within months, potentially affecting the study's long-term relevance.

Both Canada and Norway are actively shaping AI policies and climate change targets, subject to rapid changes. For instance, Canada's recent Voluntary Code of Conduct in September 2023 outlined guidelines for responsible AI system development. This underscores the fluidity of the subject, making it challenging to provide a comprehensive comparative analysis.

This study predominantly used qualitative research, relying on policy documents, expert commentaries, and case studies. While valuable, this approach may not capture fast-evolving quantitative aspects like long-term economic impacts or carbon reduction metrics. The expansive scope limits in-depth exploration of regional variations, sector-specific policies, and niche AI technologies.

Given the unpredictability of powerful AI technologies and the evolving climate crisis, this study faces challenges in fully examining potential scenarios. Geopolitical approaches may prove more effective than anticipated, introducing entirely new issues requiring different strategies. The unpredictable nature stems from dynamic technological innovations and environmental variables, complicating predictions about the future techno-environmental arena.

As AI technology advances, previously examined policies may become outdated. The study must acknowledge potential limitations due to hidden developments in AI and climate mitigation industries. Global competition suggests secretive development of technologies, preventing a comprehensive assessment of AI capabilities on a global scale.

Considering the irreversible impacts of AI and climate change, the precautionary principle becomes crucial. International competition for AI supremacy necessitates a careful global approach. Future policies should weigh benefits against risks, acknowledging the lack of serious political talks for international AI collaborations and frameworks. This study is constrained by reliance on publicly available information, potentially limiting insights due to undisclosed advancements.

7.2. Recommendations for Future Research

Given these limitations, future research in applying AI for climate change is imperative, particularly for smaller economies like Canada and Norway. Studies can involve additional countries or focus on specific AI applications, offering valuable insights. Tracking policy changes over time will contribute to a deeper understanding of this dynamic landscape. Global

coordination, emphasizing a precautionary approach in policy formulation, is ethically necessary considering the potential irreversible impacts of AI technologies.

This study can serve as a foundational text for understanding the complexities of AI policies in smaller economies, setting the stage for future research. The adaptive policy frameworks of Canada and Norway and their current geopolitical situational contexts offer valuable lessons for all nations. However, these countries are bound by the temporal and dynamic constraints of this study. The developments of either country's relevant frameworks will immediately be challenged by a combination of rapid advances in AI technologies and climate change alterations or environmental damages. Further research is not merely a suggestion but an essential requirement, particularly in studies that provide continuous updates on our understanding of the ways in which smaller economies navigate the rapidly evolving landscapes of AI and climate policy.

8. References

Abdalla, A. N., Nazir, M. S., Tao, H., Cao, S., Ji, R., Jiang, M., & Yao, L. (2021). Integration of energy storage system and renewable energy sources based on artificial intelligence: An overview. *Journal of Energy Storage*, *40*, 102811. https://doi.org/10.1016/j.est.2021.102811

Abrardi, L., Cambini, C., & Rondi, L. (2022). Artificial intelligence, firms and consumer behavior: A survey. *Journal of Economic Surveys, 36*(4), 969–991. https://doi.org/10.1111/joes.12455

Adebayo, T. S. (2022). Renewable Energy Consumption and Environmental Sustainability in Canada: Does Political Stability Make a Difference? *Environmental Science and Pollution Research, 29*(40), 61307–61322. https://doi.org/10.1007/s11356-022-20008-4

Agrawal, A., Gans, J., & Goldfarb, A. (2019). The economics of artificial intelligence: An agenda. University of Chicago Press.

Advisory Council on Artificial Intelligence—Home. (2022, April 26). Government of Canada. https://ised-isde.canada.ca/site/advisory-council-artificial-intelligence/en/advisory-council-artificial-intelligence

Ahmad, T., Zhang, D., Huang, C., Zhang, H., Dai, N., Song, Y., & Chen, H. (2021). Artificial intelligence in sustainable energy industry: Status Quo, challenges and opportunities. *Journal of Cleaner Production, 289*, 125834. https://doi.org/10.1016/j.jclepro.2021.125834

AI for Net Zero Electricity: Assessing the Electricity Sector's Readiness for AI (GPAI 2022). (2022). Global Partnership on AI. https://gpai.ai/projects/responsible-ai/environment/AINetZeroElectricity_2022.pdf

Albert, M. (2023, April 20). AI Q&A. CounterPunch.Org. https://www.counterpunch.org/2023/04/20/ai-qa/

Allam, Z., & Dhunny, Z. A. (2019). On big data, artificial intelligence and smart cities. *Cities, 89*, 80–91. https://doi.org/10.1016/j.cities.2019.01.032

Angwin, J., Larson, J., Mattu, S., & Kirchner, L. (2022). Machine bias. In Ethics of data and analytics (pp. 254–264). Auerbach Publications.

The Artificial Intelligence and Data Act (AIDA) – Companion document. (2023, March 13). Government of Canada. https://ised-isde.canada.ca/site/innovation-better-canada/en/artificial-intelligence-and-data-act-aida-companion-document

Attard-Frost, B., Brandusescu, A., & Lyons, K. (2023). The Governance of Artificial Intelligence in Canada: Findings and Opportunities from a Review of 84 AI Governance Initiatives (SSRN Scholarly Paper 4414212). https://doi.org/10.2139/ssrn.4414212

Baidya, S., Potdar, V., Pratim Ray, P., & Nandi, C. (2021). Reviewing the opportunities, challenges, and future directions for the digitalization of energy. *Energy Research & Social Science, 81*, 102243. https://doi.org/10.1016/j.erss.2021.102243

Barnes, C., Boulanger, Y., Keeping, T., Zachariah, M., Krikken, F., Wang, X., Erni, S., Pietropalo, E., Avis, A., Bisaillon, A., & Kimutai, J. (2023). Climate change more than doubled the likelihood of extreme fire weather conditions in Eastern Canada. https://doi.org/10.25561/105981

Behr, R. (2023, November 1). Rishi Sunak's vanity jamboree on AI safety lays bare the UK's Brexit dilemmas. The Guardian. https://www.theguardian.com/commentisfree/2023/nov/01/rishi-sunaks-ai-safety-britains-brexit-dilemmas-elon-musk

Bergero, C., Binsted, M., Younis, O., Davies, E. G. R., Siddiqui, M.-S., Xing, R., Arbuckle, E. J., Chiappori, D. V., Fuhrman, J., McJeon, H., & Macaluso, N. (2022). Technology, technology, technology: An integrated assessment of deep decarbonization pathways for the Canadian oil sands. Energy Strategy Reviews, 41, 100804. https://doi.org/10.1016/j.esr.2022.100804

Bernstein, S., Lerner, J., & Schoar, A. (2013). The Investment Strategies of Sovereign Wealth Funds. Journal of *Economic Perspectives, 27*(2), 219–238. https://doi.org/10.1257/jep.27.2.219

Bill summary: Digital Charter Implementation Act, 2022. (2022, June 16). Government of Canada. https://ised-isde.canada.ca/site/innovation-better-canada/en/canadas-digital-charter/bill-summary-digital-charter-implementation-act-2020

Biodiversity & Artificial Intelligence, Opportunities and Recommendations (GPAI 2022). (2022). Global Partnership on AI. https://gpai.ai/projects/responsible-ai/environment/biodiversity-and-AI-opportunities-recommendations-for-action.pdf

Boza, P., & Evgeniou, T. (2021). Artificial intelligence to support the integration of variable renewable energy sources to the power system. *Applied Energy, 290*, 116754. https://doi.org/10.1016/j.apenergy.2021.116754

Bradford, A. (2023, June 27). The Race to Regulate Artificial Intelligence. Foreign Affairs. https://www.foreignaffairs.com/united-states/race-regulate-artificial-intelligence?check_logged_in=1&utm_medium=promo_email&utm_source=lo_flows&utm_campaign=registered_user_welcome&utm_term=email_1&utm_content=20230825

Brandusescu, A. (2021). Artificial Intelligence Policy and Funding in Canada: Public Investments, Private Interests. *SSRN Electronic Journal.* https://doi.org/10.2139/ssrn.4089932

Bremmer, I. (2023, April). The next global superpower isn't who you think. TED Conferences. https://www.ted.com/talks/ian_bremmer_the_next_global_superpower_isn_t_who_you_think

Bremmer, I., & Suleyman, M. (2023, August 16). The AI Power Paradox. Foreign Affairs. https://www.foreignaffairs.com/world/artificial-intelligence-power-

paradox?utm_medium=promo_email&utm_source=special_send&utm_campaign=The_AI_Power_Paradox_Prospects_A&utm_content=20230816&utm_term=promo-email-prospects

Brennan, K. (2023, March 8). The State of Artificial Intelligence Research in Canada. HillNotes. https://hillnotes.ca/2023/03/08/the-state-of-artificial-intelligence-research-in-canada/

Budget 2022 A Plan to Grow Our Economy and Make Life More Affordable. (2022). [Budget]. Department of Finance. https://www.budget.canada.ca/2022/report-rapport/toc-tdm-en.html

Butcher, J., & Beridze, I. (2019). What is the State of Artificial Intelligence Governance Globally? *The RUSI Journal, 164*(5–6), 88–96. https://doi.org/10.1080/03071847.2019.1694260

Campbell, B. (2021, February 9). 5 ways Norway leads and Canada lags on climate action. The Conversation. http://theconversation.com/5-ways-norway-leads-and-canada-lags-on-climate-action-153179

Canada's AI-Powered Supply Chains Cluster (Scale AI). (2023, May 29). Innovation, Science and Economic Development Canada. https://ised-isde.canada.ca/site/global-innovation-clusters/en/canadas-ai-powered-supply-chains-cluster-scale-ai

Canada. (2018, October 23). *Carbon pollution pricing systems across Canada.* Government of Canada. https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work.html

Canada's National Adaptation Strategy. (2022, November 24). Government of Canada. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/national-adaptation-strategy/full-strategy.html

Chalmers, D., MacKenzie, N. G., & Carter, S. (2021). Artificial Intelligence and Entrepreneurship: Implications for Venture Creation in the Fourth Industrial Revolution. *Entrepreneurship Theory and Practice, 45*(5), 1028–1053. https://doi.org/10.1177/1042258720934581

Chen, L., Chen, Z., Zhang, Y., Liu, Y., Osman, A. I., Farghali, M., Hua, J., Al-Fatesh, A., Ihara, I., Rooney, D. W., & Yap, P.-S. (2023). Artificial intelligence-based solutions for climate change: A review. Environmental Chemistry Letters. https://doi.org/10.1007/s10311-023-01617-y

Chomsky, N., Roberts, I., & Watumull, J. (2023). Noam Chomsky: The False Promise of ChatGPT. The New York Times, 8.

Chun, A., Ding, J., Creemers, R., Gal, D., Han, E., Liu, Y.-L., & Lewis, D. (2020). The AI powered state: China's approach to public sector innovation (China). Nesta. https://apo.org.au/node/305076

Climate Change. (2022, December 15). Canadian Parks and Wilderness Society. https://cpaws.org/our-work/climate-change/

Clutton-Brock, P., Rolnick, D., Donti, P. L., & Kaack, L. (2021). Climate Change and AI. Recommendations for Government Action. GPAI, Climate Change AI, Centre for AI & Climate. https://opus4.kobv.de/opus4-hsog/frontdoor/index/index/docId/4281

Commission, E. (2018). Artificial intelligence for Europe. *Communication from the Commission to the European Parliament, The European Council, The Council, The European Economic and Social Committee and the Committee of the Regions*.

Commission, E. U. (2021). Fostering a European approach to artificial intelligence. *EC, COM*, *205*.

Cowls, J., Tsamados, A., Taddeo, M., & Floridi, L. (2021). The AI gambit: Leveraging artificial intelligence to combat climate change—opportunities, challenges, and recommendations. *AI & SOCIETY, 38*(1), 283–307. https://doi.org/10.1007/s00146-021-01294-x

Daneshjou, R., Smith, M. P., Sun, M. D., Rotemberg, V., & Zou, J. (2021). Lack of Transparency and Potential Bias in Artificial Intelligence Data Sets and Algorithms: A Scoping Review. *JAMA Dermatology, 157*(11), 1362–1369. https://doi.org/10.1001/jamadermatol.2021.3129

Data as a resource: The ariven economy and innovation. (2021). [Stortingsmelding]. Ministry of Local Government and Modernisation. https://www.regjeringen.no/en/dokumenter/meld.-st.-22-20202021/id2841118/

Delanoë, P., Tchuente, D., & Colin, G. (2023). Method and evaluations of the effective gain of artificial intelligence models for reducing CO2 emissions. *Journal of Environmental Management, 331*, 117261. https://doi.org/10.1016/j.jenvman.2023.117261

Deschamps, T. (2023, September 15). Canadian tech organization urges “responsible” approach to AI regulation. CTVNews. https://www.ctvnews.ca/politics/canadian-tech-organization-urges-responsible-approach-to-ai-regulation-1.6562931

Dhar, P. (2020). The carbon impact of artificial intelligence. *Nature Machine Intelligence, 2*(8), Article 8. https://doi.org/10.1038/s42256-020-0219-9

Di Vaio, A., Palladino, R., Hassan, R., & Escobar, O. (2020). Artificial intelligence and business models in the sustainable development goals perspective: A systematic literature review. *Journal of Business Research, 121,* 283–314. https://doi.org/10.1016/j.jbusres.2020.08.019

Djeffal, C., Siewert, M. B., & Wurster, S. (2022). Role of the state and responsibility in governing artificial intelligence: A comparative analysis of AI strategies. *Journal of European Public Policy, 29*(11), 1799–1821. https://doi.org/10.1080/13501763.2022.2094987

Dodds, A. (2018). Comparative Public Policy. Bloomsbury Publishing.

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., Duan, Y., Dwivedi, R., Edwards, J., Eirug, A., Galanos, V., Ilavarasan, P. V., Janssen, M., Jones, P., Kar, A. K., Kizgin, H., Kronemann, B., Lal, B., Lucini, B., … Williams, M. D. (2021). Artificial Intelligence (AI):

Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management, 57*, 101994. https://doi.org/10.1016/j.ijinfomgt.2019.08.002

Dwivedi, Y. K., Hughes, L., Kar, A. K., Baabdullah, A. M., Grover, P., Abbas, R., Andreini, D., Abumoghli, I., Barlette, Y., Bunker, D., Chandra Kruse, L., Constantiou, I., Davison, R. M., De', R., Dubey, R., Fenby-Taylor, H., Gupta, B., He, W., Kodama, M., … Wade, M. (2022). Climate change and COP26: Are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action. *International Journal of Information Management, 63,* 102456. https://doi.org/10.1016/j.ijinfomgt.2021.102456

Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., … Wright, R. (2023). "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management, 71*, 102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642

Elliott, A. (2021). The Routledge social science handbook of AI. Routledge.

Emissions to air. (n.d.). Norwegianpetroleum.No. Retrieved July 19, 2023, from https://www.norskpetroleum.no/en/environment-and-technology/emissions-to-air/

Exports of Norwegian oil and gas. (2023, March 29). Norwegianpetroleum.No. https://www.norskpetroleum.no/en/production-and-exports/exports-of-oil-and-gas/

Enholm, I. M., Papagiannidis, E., Mikalef, P., & Krogstie, J. (2022). Artificial Intelligence and Business Value: A Literature Review. *Information Systems Frontiers, 24(*5), 1709–1734. https://doi.org/10.1007/s10796-021-10186-w

Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence, E.O. 14110 88 FR 75191 75191 (2023). https://www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/

Fang, B., Yu, J., Chen, Z., Osman, A. I., Farghali, M., Ihara, I., Hamza, E. H., Rooney, D. W., & Yap, P.-S. (2023). Artificial intelligence for waste management in smart cities: A review. *Environmental Chemistry Letters, 21*(4), 1959–1989. https://doi.org/10.1007/s10311-023-01604-3

Floridi, L., & Cowls, J. (2022). A Unified Framework of Five Principles for AI in Society. In Machine Learning and the City (pp. 535–545). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119815075.ch45

Framework for the Regulatory Sandbox. (2021, January 13). Datatilsynet. https://www.datatilsynet.no/en/regulations-and-tools/sandbox-for-artificial-intelligence/framework-for-the-regulatory-sandbox/

The Fund. (2017, April 28). Norges Bank Investment Management. https://www.nbim.no/en/

Ghost in the machine – Addressing the consumer harms of generative AI. (2023). Norwegian Consumer Council. https://storage02.forbrukerradet.no/media/2023/06/generative-ai-rapport-2023.pdf

Gherhes, C., Yu, Z., Vorley, T., & Xue, L. (2023). Technological trajectories as an outcome of the structure-agency interplay at the national level: Insights from emerging varieties of AI. *World Development, 168*, 106252. https://doi.org/10.1016/j.worlddev.2023.106252

Goralski, M. A., & Tan, T. K. (2020). Artificial intelligence and sustainable development. *The International Journal of Management Education, 18(*1), 100330. https://doi.org/10.1016/j.ijme.2019.100330

Global Partnership on Artificial Intelligence—GPAI. (2020, June). https://gpai.ai/

Gupta, K. (2012). Comparative Public Policy: Using the Comparative Method to Advance Our Understanding of the Policy Process. *Policy Studies Journal, 40*(s1), 11–26. https://doi.org/10.1111/j.1541-0072.2012.00443.x

Habitat, U. N. (2022). World Cities Report 2022: Envisaging the future of cities. United Nations Human Settlements Programme: Nairobi, Kenya, 41–44.

Hern, A. (2022, October 26). Apple to put USB-C connectors in iPhones to comply with EU rules. The Guardian. https://www.theguardian.com/technology/2022/oct/26/iphone-usb-c-lightning-connectors-apple-eu-rules

Holmes, W., Bialik, M., & Fadel, C. (2023). Artificial intelligence in education. In C. Stückelberger & P. Duggal (Eds.), Data ethics: Building trust: How digital technologies can serve humanity (pp. 621–653). Globethics Publications. https://doi.org/10.58863/20.500.12424/4276068

Horizon Europe. (2023, July 17). https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

Hottest July ever signals 'era of global boiling has arrived' says UN chief (2023, July 27). https://news.un.org/en/story/2023/07/1139162

Hu, C. (2023, September 19). UN secretary-general warns of "Great Fracture" as world leaders begin debate. CNN. https://www.cnn.com/2023/09/19/world/un-secretary-general-guterres-2023-intl-latam/index.html

Hutson, M. (2023). Rules to keep AI in check: Nations carve different paths for tech regulation. *Nature, 620*(7973), 260–263. https://doi.org/10.1038/d41586-023-02491-y

IEA. (2023). *Tracking Clean Energy Progress 2023*. IEA. https://www.iea.org/reports/tracking-clean-energy-progress-2023

IPCC, W. (2022). AR6 Climate Change 2022: Mitigation of Climate Change—IPCC. IPCC: Paris, France.

Jezard, A. (2018, April 11). China is now home to the world's most valuable AI start-up. World Economic Forum. https://www.weforum.org/agenda/2018/04/chart-of-the-day-china-now-has-the-worlds-most-valuable-ai-startup/

Kaack, L. H., Donti, P. L., Strubell, E., Kamiya, G., Creutzig, F., & Rolnick, D. (2022). Aligning artificial intelligence with climate change mitigation. *Nature Climate Change, 12*(6), Article 6. https://doi.org/10.1038/s41558-022-01377-7

Koasidis, K., Karamaneas, A., Nikas, A., Neofytou, H., Hermansen, E. A., Vaillancourt, K., & Doukas, H. (2020). Many miles to Paris: A sectoral innovation system analysis of the transport sector in Norway and Canada in light of the Paris Agreement. *Sustainability, 12*(14), 5832.

Köchling, A., & Wehner, M. C. (2020). Discriminated by an algorithm: A systematic review of discrimination and fairness by algorithmic decision-making in the context of HR recruitment and HR development. *Business Research, 13(*3), 795–848. https://doi.org/10.1007/s40685-020-00134-w

Kung, J. (2020). Building an AI World: Report on National and Regional AI Strategies, Second Edition.

Kung, J., & Lussier, K. (2023). CIFAR Symposium on AI for Energy and the Environment.

Leal Filho, W., Wall, T., Rui Mucova, S. A., Nagy, G. J., Balogun, A.-L., Luetz, J. M., Ng, A. W., Kovaleva, M., Safiul Azam, F. M., Alves, F., Guevara, Z., Matandirotya, N. R., Skouloudis, A., Tzachor, A., Malakar, K., & Gandhi, O. (2022). Deploying artificial intelligence for climate change adaptation. *Technological Forecasting and Social Change, 180*, 121662. https://doi.org/10.1016/j.techfore.2022.121662

Leal Filho, W., Yang, P., Eustachio, J. H. P. P., Azul, A. M., Gellers, J. C., Gielczyk, A., Dinis, M. A. P., & Kozlova, V. (2023). Deploying digitalisation and artificial intelligence in sustainable development research. *Environment, Development and Sustainability, 25*(6), 4957–4988. https://doi.org/10.1007/s10668-022-02252-3

Li, Z., Li, N., & Wen, H. (2021). Digital Economy and Environmental Quality: Evidence from 217 Cities in China. *Sustainability, 13*(14), Article 14. https://doi.org/10.3390/su13148058

Løvseth, T. (2021). Public Consultation -The Revised Renewable Energy Directive II. Energy Norway.

Lloyd, C., & Payne, J. (2019). Rethinking country effects: Robotics, AI and work futures in Norway and the UK. New Technology, *Work and Employment, 34*(3), 208–225. https://doi.org/10.1111/ntwe.12149

Luccioni, A. S., Viguier, S., & Ligozat, A.-L. (2022). Estimating the Carbon Footprint of BLOOM, a 176B Parameter Language Model (arXiv:2211.02001). arXiv. http://arxiv.org/abs/2211.02001

Maintaining American Leadership in Artificial Intelligence. (2019, February 14). Federal Register. https://www.federalregister.gov/documents/2019/02/14/2019-02544/maintaining-american-leadership-in-artificial-intelligence

Martin, C. J., Evans, J., & Karvonen, A. (2018). Smart and sustainable? Five tensions in the visions and practices of the smart-sustainable city in Europe and North America. *Technological Forecasting and Social Change, 133*, 269–278. https://doi.org/10.1016/j.techfore.2018.01.005

Martin-Bariteau, F., & Scassa, T. (2021). Artificial Intelligence and the Law in Canada. https://ssrn.com/abstract=3734675

Mason, J., Hunnicutt, T., Alper, A., & Mason, J. (2023, October 30). Biden administration aims to cut AI risks with executive order. Reuters. https://www.reuters.com/technology/white-house-unveils-wide-ranging-action-mitigate-ai-risks-2023-10-30/

Medaglia, R., Gil-Garcia, J. R., & Pardo, T. A. (2023). Artificial Intelligence in Government: Taking Stock and Moving Forward. *Social Science Computer Review, 41(*1), 123–140. https://doi.org/10.1177/08944393211034087

Mihet-Popa, L., & Saponara, S. (2018). Toward Green Vehicles Digitalization for the Next Generation of Connected and Electrified Transport Systems. *Energies, 11*(11), Article 11. https://doi.org/10.3390/en11113124

Myhre, K. C., & Holmes, D. R. (2022). Reframing Welfare: Expectations, Collaboration and Ownership at the World's Largest Sovereign Wealth-Fund. *Anthropological Forum, 32*(2), 158–180. https://doi.org/10.1080/00664677.2022.2098690

Myklebust, T. (2010). The Norwegian Government Pension Fund: Moving Forward on Responsible Investing and Governance. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.1618835

The National Strategy for Artificial Intelligence. (2020). Ministry of Local Government and Modernisation. https://www.regjeringen.no/en/dokumenter/nasjonal-strategi-for-kunstig-intelligens/id2685594/

Navarra, D. (2023). Integrating artificial intelligence and sustainable technologies in strategic renewable energy and Power-to-X projects: A review of global best practices, risks and future prospects. Society and Economy, 1(aop). https://doi.org/10.1556/204.2023.00012

Neby, S., & Zannakis, M. (2020). Coordinating Wickedness: A Comparative Analysis of How Norway and Sweden Organize for Climate Policies. *Journal of Comparative Policy Analysis: Research and Practice, 22*(6), 593–611. https://doi.org/10.1080/13876988.2020.1821362

Negenborn, R. R., Goerlandt, F., Johansen, T. A., Slaets, P., Valdez Banda, O. A., Vanelslander, T., & Ventikos, N. P. (2023). Autonomous ships are on the horizon: Here's what we need to know. *Nature, 615*(7950), 30–33. https://doi.org/10.1038/d41586-023-00557-5

Nellis, S., & Cherney, M. A. (2023, August 31). US curbs AI chip exports from Nvidia and AMD to some Middle East countries. Reuters. https://www.reuters.com/technology/us-restricts-exports-some-nvidia-chips-middle-east-countries-filing-2023-08-30/

New EU-Norway Green Alliance to deepen cooperation. (2023, April 24). [Text]. European Commission. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_2391

New report: Generative AI threatens consumer rights. (2023, June 20). Forbrukerrådet. https://www.forbrukerradet.no/side/new-report-generative-ai-threatens-consumer-rights/

Next Generation Artificial Intelligence Development Plan Issued by State Council. (2017). Department of International Cooperation Ministry of Science and Technology. http://fi.china-embassy.gov.cn/eng/kxjs/201710/P020210628714286134479.pdf

Nishant, R., Kennedy, M., & Corbett, J. (2020). Artificial intelligence for sustainability: Challenges, opportunities, and a research agenda. *International Journal of Information Management, 53*, 102104. https://doi.org/10.1016/j.ijinfomgt.2020.102104

NORA Annual Report 2022. (2023). https://www.nora.ai/about/nora-annual-report/index.html

Nordgren, A. (2022). Artificial intelligence and climate change: Ethical issues. *Journal of Information, Communication and Ethics in Society, 21*(1), 1–15. https://doi.org/10.1108/JICES-11-2021-0106

Norway's Eighth National Communication. (2023). [Rapport]. Ministry of Climate and Environment. https://www.regjeringen.no/en/dokumenter/norways-eighth-national-communication/id2971116/

Norwegian Artificial Intelligence Network for Europe. (2019, July 7). Norwegian Artificial Intelligence Network for Europe. https://www.sintef.no/projectweb/naine/

Norwegian Position Paper on the European Commission's Proposal for a Regulation of the European Parliament and of the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) and Amending Certain Union Legislative Acts (COM(2021) 206). (2022). https://www.regjeringen.no/contentassets/939c260c81234eae96b6a1a0fd32b6de/norwegian-position-paper-on-the-ecs-proposal-for-a-regulation-of-ai.pdf

Norwegian Research Center for AI Innovation (NorwAI)—NTNU. (2020, November 10). https://www.ntnu.edu/norwai

OECD. (2022). OECD Environmental Performance Reviews: Norway 2022. OECD. https://doi.org/10.1787/59e71c13-en

OECD Legal Instruments. (2019, May 22). https://legalinstruments.oecd.org/en/instruments/oecd-legal-0449#backgroundInformation

Ontario Supporting More Innovation in Growing Tech Sector. (2023). Government of Ontario. https://news.ontario.ca/en/release/1003208/ontario-supporting-more-innovation-in-growing-tech-sector

Pan-Canadian AI Strategy Impact Assessment Report. (2020). https://cifar.ca/wp-content/uploads/2020/11/Pan-Canadian-AI-Strategy-Impact-Assessment-Report.pdf

Panetta, A. (2023, July 26). Canadian AI "godfather" brings plea to U.S. Congress: Pass a law now | CBC News. CBC. https://www.cbc.ca/news/world/ai-laws-canada-us-yoshua-bengio-1.6917793

Pequeño, A. (2023, September 27). Major ChatGPT Update: AI Program No Longer Restricted To Sept. 2021 Knowledge Cutoff After Internet Browser Revamp. Forbes. https://www.forbes.com/sites/antoniopequenoiv/2023/09/27/major-chatgpt-update-ai-program-no-longer-restricted-to-sept-2021-knowledge-cutoff-after-internet-browser-revamp/

Perucica, N., & Andjelkovic, K. (2022). Is the future of AI sustainable? A case study of the European Union. Transforming Government: People, *Process and Policy, 16*(3), 347–358. https://doi.org/10.1108/TG-06-2021-0106

Ray, S. (2023, September 25). Amazon Plans To Invest Up To $4 Billion In AI Startup Anthropic. Forbes. https://www.forbes.com/sites/siladityaray/2023/09/25/amazon-plans-to-invest-up-to-4-billion-in-ai-startup-anthropic/

Rayhan, A. (2023). AI AND THE ENVIRONMENT: TOWARD SUSTAINABLE DEVELOPMENT AND CONSERVATION. https://doi.org/10.13140/RG.2.2.12024.42245

Reinsel, D., Gantz, J., & Rydning, J. (2018). The Digitization of the World from Edge to Core.

Restrepo Amariles, D., & Baquero, P. M. (2023). Promises and limits of law for a human-centric artificial intelligence. *Computer Law & Security Review, 48*, 105795. https://doi.org/10.1016/j.clsr.2023.105795

Ruschemeier, H. (2023). AI as a challenge for legal regulation – the scope of application of the artificial intelligence act proposal. *ERA Forum, 23*(3), 361–376. https://doi.org/10.1007/s12027-022-00725-6

Sanderson, K. (2023). Earth's average 2023 temperature is now likely to reach 1.5 °C of warming. Nature. https://doi.org/10.1038/d41586-023-02995-7

Sanger, D. E., & Kang, C. (2023, October 30). Biden to Issue First Regulations on Artificial Intelligence Systems. The New York Times. https://www.nytimes.com/2023/10/30/us/politics/biden-artificial-intelligence.html

Sareen, S., & Rommetveit, K. (2019). Smart gridlock? Challenging hegemonic framings of mitigation solutions and scalability. *Environmental Research Letters,* 14(7), 075004. https://doi.org/10.1088/1748-9326/ab21e6

Scaling up Canada's AI potential (p. 80). (2022). https://www.scaleai.ca/wp-content/uploads/2022/10/scaleai_rapportannuel_2022_en.pdf

Schaller, R. R. (1997). Moore's law: Past, present and future. *IEEE Spectrum, 34*(6), 52–59. https://doi.org/10.1109/6.591665

Şerban, A. C., & Lytras, M. D. (2020). Artificial Intelligence for Smart Renewable Energy Sector in Europe—Smart Energy Infrastructures for Next Generation Smart Cities. *IEEE Access, 8*, 77364–77377. https://doi.org/10.1109/ACCESS.2020.2990123

Siddik, M. A. B., Shehabi, A., & Marston, L. (2021). The environmental footprint of data centers in the United States. *Environmental Research Letters, 16*(6), 064017. https://doi.org/10.1088/1748-9326/abfba1

Siddiqui, T. (2023, June 29). Risks of artificial intelligence must be considered as the technology evolves: Geoffrey Hinton. University of Toronto. https://www.utoronto.ca/news/risks-artificial-intelligence-must-be-considered-technology-evolves-geoffrey-hinton

Sleeping with a very cranky elephant: The history of Canada-U.S. tensions | CBC Radio. (2018, June 15). CBC. https://www.cbc.ca/radio/sunday/the-sunday-edition-june-17-2018-1.4692469/sleeping-with-a-very-cranky-elephant-the-history-of-canada-u-s-tensions-1.4699017

Spring, J. (2023, July 7). World breaks hottest-day record for third time this week, U.S. agency says. Reuters. https://www.reuters.com/business/environment/world-breaks-hottest-day-record-third-time-this-week-us-agency-2023-07-07/

Steigum, E., & Thogersen, O. (2013). A Crisis Not Wasted – Institutional and Structural Reforms Behind Norway's Strong Macroeconomic Performance. (SSRN Scholarly Paper No. 2377183). https://doi.org/10.2139/ssrn.2377183

Sternberg, R. J. (2022, April 11). Human intelligence | Encyclopedia Britannica. https://www.britannica.com/science/human-intelligence-psychology

Taddeo, M., Tsamados, A., Cowls, J., & Floridi, L. (2021). Artificial intelligence and the climate emergency: Opportunities, challenges, and recommendations. *One Earth, 4*(6), 776–779. https://doi.org/10.1016/j.oneear.2021.05.018

Tegmark, M. (2018). Life 3.0: Being human in the age of artificial intelligence. Vintage.

The Paris Agreement. (2016). United Nations Framework Convention on Climate Change. https://unfccc.int/process-and-meetings/the-paris-agreement

Ulnicane, I. (2022). Artificial Intelligence in the European Union: Policy, ethics and regulation. In The Routledge handbook of European integrations. Taylor & Francis.

Ulnicane, I., Knight, W., Leach, T., Stahl, B. C., & Wanjiku, W.-G. (2022). Governance of Artificial Intelligence: Emerging international trends and policy frames. In The global politics of Artificial Intelligence. Taylor & Francis.

US EPA, O. (2015, August 28). *Greenhouse Gas Equivalencies Calculator* [Data and Tools]. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Van, R. V., Rossetti, F., Perset, K., & Galindo-Romero, L. (2021, June 22). AI Watch - National strategies on Artificial Intelligence: A European perspective, 2021 edition. JRC Publications Repository. https://doi.org/10.2760/069178

Vinuesa, R., Azizpour, H., Leite, I., Balaam, M., Dignum, V., Domisch, S., Felländer, A., Langhans, S. D., Tegmark, M., & Fuso Nerini, F. (2020). The role of artificial intelligence in achieving the Sustainable Development Goals. *Nature Communications, 11*(1), Article 1. https://doi.org/10.1038/s41467-019-14108-y

Voluntary Code of Conduct on the Responsible Development and Management of Advanced Generative AI Systems. (2023, September 28). Innovation, Science and Economic Development Canada. https://ised-isde.canada.ca/site/ised/en/voluntary-code-conduct-responsible-development-and-management-advanced-generative-ai-systems

Walsh, T., Evatt, A., & de Witt, C. S. (2020). Artificial Intelligence & Climate Change: Supplementary Impact Report. Oxford, 1, 1–15.

Why countries need to work together on AI. (2018, September 16). World Economic Forum. https://www.weforum.org/agenda/2018/09/learning-from-one-another-a-look-at-national-ai-policy-frameworks/

Webster, G., Creemers, R., Kania, E., & Triolo, P. (2017, August 1). Full Translation: China's "New Generation Artificial Intelligence Development Plan" (2017). DigiChina. https://digichina.stanford.edu/work/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017/

Wolff, R. D. (2023, September 25). AI: Profit vs. Freedom. CounterPunch.Org. https://www.counterpunch.org/2023/09/25/ai-profit-vs-freedom/

Wu, C.-J., Raghavendra, R., Gupta, U., Acun, B., Ardalani, N., Maeng, K., Chang, G., Aga, F., Huang, J., Bai, C., Gschwind, M., Gupta, A., Ott, M., Melnikov, A., Candido, S., Brooks, D., Chauhan, G., Lee, B., Lee, H.-H., … Hazelwood, K. (2022). Sustainable AI: Environmental Implications, Challenges and Opportunities. In D. Marculescu, Y. Chi, & C. Wu (Eds.), *Proceedings of Machine Learning and Systems* (Vol. 4, pp. 795–813). https://proceedings.mlsys.org/paper_files/paper/2022/file/462211f67c7d858f663355eff93b745e-Paper.pdf

Yuval Noah Harari (Director). (2023, May 14). AI and the future of humanity | Yuval Noah Harari at the Frontiers Forum. https://www.youtube.com/watch?v=LWiM-LuRe6w

Zhang, J., & Levine, J. (2023, June 29). Why AI Is Next Flashpoint in US-China Tech Rivalry. Bloomberg.Com. https://www.bloomberg.com/news/articles/2023-06-29/what-is-the-state-of-us-china-competition-in-ai