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List of Abbreviations

A-PLAT	Climate Change Adaptation Information Platform
AI	Artificial Intelligence
ANRE	Agency for Natural Resources and Energy
BEEC	Building Energy Efficiency Certification
CAT	Climate action tracker
CCU	Carbon Capture, Utilization
CCUS	Carbon Capture, Utilization and Storage
CO ₂	Carbon Dioxide
COP21	21st Conference of the Parties to the UN Framework Convention on Climate Change
EMS	Energy Management System
ESS	Energy Storage System
ETS	Emissions Trading System
FEMS	Factory Energy Management System
FIP	Feed-in Premium
FIT	Feed-in Tariff
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GW	Gigawatt
GX	Green Transformation
HPTCJ	Heat Pump & Thermal Storage Technology Center of Japan
Hz	Hertz
ICAP	International Carbon Action Partnership
IEA	International Energy Agency
ILO	International Labor Organization
IOs	International Organizations
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
JAERO	Japan Atomic Energy Relations Organization
JCA	Japan Climate Alliance
JPY	Japanese Yen
K-ETS	Korea Emissions Trading Scheme
KACCC	Korea Adaptation Center for Climate Change
KEA	Korea Energy Agency
KEPCO	Korea Electric Power Corporation
KRW	Korean Won
kWh	Kilowatt-hour
LNG	Liquefied Natural Gas
MCEE	Ministry of Climate, Energy and Environment
METI	Ministry of Economy, Trade and Industry
MOE	Ministry of Environment

MOTIE	Ministry of Trade, Industry and Energy
MOTIR	Ministry of Trade, Industry and Resources
MSIT	Ministry of Science and ICT
Mtoe	Million tons of oil equivalent
MW	Megawatt
MWh	Megawatt-hour
NDC	Nationally Determined Contribution
NEDO	New Energy and Industrial Technology Development Organization
NGOs	Non-Governmental Organizations
NIMBY	Not in my backyard
OECD	Organization for Economic Co-operation and Development
PV	Photovoltaic
R&D	Research and Development
REC	Renewable Energy Certificate
REI	Renewable Energy Institute
RPS	Renewable Portfolio Standard
SFOC	Solutions for Our Climate
TEPCO	Tokyo Electric Power Company
TMS	Target Management System
UNDESD	United Nations Decade of Education for Sustainable Development
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
ZEBC	Zero Energy Building Certification
3E+S	Energy Security, Economic Efficiency, Environment, and Safety

1. Theoretical part

1.1. Introduction

1.1.1. Topic and research question

This thesis is going to answer the following research question:

How do national policy approaches towards the low-carbon energy transition differ between Japan and South Korea across political, environmental, techno-economic, and socio-technical dimensions since 2015?

This thesis addresses the research question through a descriptive-comparative analysis that systematically organizes and contrasts national policy approaches towards low-carbon energy transition in Japan and South Korea. Rather than evaluating the energy transition outcomes, successes, or failures, the focus of the analysis is on the design and orientation of the national policy approaches. Outcomes indicate the results of the energy transition, such as the levels of greenhouse gas (GHG) emissions, the renewable energy share, or the levels of carbon intensity. They cannot explain how the progress was achieved. Focusing on policy approaches allows us to examine countries' pathways, their national priorities, governance styles, and capacities. The unit of comparison is national policy approaches, which are categorized into four dimensions: political, environmental, techno-economic, and socio-technical.

To best highlight the differences in policy instruments, this analysis adopts a most similar case design (Seawright and Gerring 2008, 304–5). Comparing the two most similar cases shows that shared international commitments do not necessarily lead to the same national policy approaches and that national context plays a significant role in shaping national energy transition pathways. Japan and South Korea share similar characteristics but have different governance structures and choose different policy instruments and strategies, particularly regarding nuclear energy. By comparing these two cases, which share similar levels of economic development and industrialization, dependence on imported fossil fuels, and commitment to the international targets, but different policy approaches and strategic priorities, this thesis examines the role of national context in shaping policy strategies towards energy transition targets.

The global energy sector is responsible for approximately 75% of greenhouse gas emissions, and climate change issues are more urgent than ever before (IEA 2025c). During

the 2015 Paris Climate Conference (COP21), governments across the globe agreed to and committed to transitioning towards a more sustainable, low-carbon energy system by limiting GHG emissions and lowering the global temperature. 175 countries signed the Paris Agreement, which aims to limit “*the global average temperature to well below 2 °C above pre-industrial levels*” (UNFCCC 2016, 4). One of the ways to achieve this goal and to combat climate change is by reducing GHG emissions caused by the consumption and production of fossil fuels and transitioning towards a cleaner, low-carbon energy system. While innovations and economic growth drove previous energy transitions, the current one is mainly fueled by the necessity to prevent irreversible climate change consequences (Fouquet and Pearson 2012, 1–2).

Achieving a low-carbon energy system requires governance on various levels, including global, regional, national, and sectoral, as well as changes in laws. For instance, carbon taxation, emission regulations, or public investments to fund the transition, advance the development of new technologies, build new infrastructure, and help society adjust to new technologies and consumption behaviors. While the active involvement of other actors in the process of energy transition is important, the actions described above can only be done by the state (Meadowcroft 2011, 71). Since states have the mandate to regulate energy systems, decisions and changes at the national level are the most influential in the current energy transition (Cherp et al. 2018, 176).

Energy transition is a complex and time-consuming process that has occurred only a few times throughout history. The process affects multiple sectors of society and requires a lot of interconnected changes to unfold simultaneously. Governments decide on certain policy approaches to achieve energy transition based on the national interests, the level of economic development, established political institutions, existing natural resources and infrastructure, cultural characteristics, as well as the international frameworks (Harichandan et al. 2022, 12–13). Instruments such as national energy and climate laws, strategic plans and targets, investments, and other regulatory tools show how and why governments are trying to achieve energy transition. Analyzing these policy approaches and not just the outcomes, such as the levels of greenhouse gas emissions and renewable energy mix of the countries, allows a deeper understanding of national energy transition pathways, their direction, pace, and dynamics.

This thesis examines the energy transition of Japan and South Korea, as the geographical distribution of case studies in transition studies remains uneven. The majority of studies are qualitative case study research that mainly focuses on European countries and

China (Kamali Saraji and Streimikiene 2023, 3–11; Harichandan et al. 2022, 12–13). While there are studies that mention Japan, it is safe to claim that East Asian countries, as well as other Asian countries, remain under-researched. Both Japan and South Korea are advanced, heavily industrialized economies, dependent on energy imports, and committed to the net-zero goals. While developed countries are often seen as more equipped to achieve energy transition faster, it is not necessarily true. Grubler (2012) argues that transition takes more time for early adopters due to the investment into underdeveloped and expensive technology and the unknown risks (Grubler 2012, 11). On a global scale, Japan and South Korea are not early technology adopters as are the European Union or the United States, for instance, but they are, together with China, early regional adopters when it comes to the renewable energy transition (IEA 2024c). China is relevant to the topic of the energy transition, as it is an important actor in the East Asian region and in global renewable energy deployment. However, including China would introduce additional structural differences and would not allow a systematic comparison, therefore it is excluded from this thesis.

1.1.2. Relevance of the research question

The relevance of the research question can be explained not only by the importance of energy transition as a global challenge, but more specifically by the need to understand the differences in national policy approaches towards the same goal, but within different national contexts. By focusing on the ways countries approach energy transition rather than the outcomes, this thesis investigates how states interpret the same global commitments in their national policy strategies. Comparing Japan and South Korea, the most similar cases, offers a useful insight by examining how similar conditions, such as shared international climate commitments, high levels of economic development, and dependence on imported fossil fuels, can lead to different policy designs and policy approaches towards the energy transition.

Energy transition studies are a relatively new area of research. The number of studies on the matter has significantly increased after the ratification of the Paris Agreement (Kamali Saraji and Streimikiene 2023, 4). Despite the scientific interest in the topic, there is no universally accepted framework for analyzing energy transition, and there is an ongoing discussion on how to define the term “energy transition”. In order to properly situate the analytical framework, this thesis draws on the existing definitions of the concept. By looking at the political, environmental, techno-economic, and socio-technical dimensions of energy transition, this paper shows how two similar countries, such as Japan and South Korea,

choose different strategies and go through different decarbonization pathways. This thesis contributes to the literature by systematically comparing policy approaches in two similar countries within multiple dimensions of the energy transition. The insights from this comparative analysis provide a foundation for further comparative case studies on other industrialized countries that are facing similar challenges, as there is currently more literature on single case studies than comparative ones.

Energy transition involves politics. Political settings can provide opportunities, create obstacles, and shape the direction and pace of the processes. However, the current energy transition, including the goal of achieving sustainability, is more politicized than any previous energy transition has ever been. While markets can drive new clean technology, they cannot on their own change the existing energy system and make it carbon-free (Meadowcroft 2011, 72–73). Cherp et al. (2018) claim that the most significant decisions related to energy transition are made at the national level (Cherp et al. 2018, 181–82). This makes policy approaches such as strategic planning, regulatory frameworks, market-based instruments, public finance, innovation policies, and coordination policy tools an appropriate unit for the comparative analysis. The majority of the energy transition studies look into the economic dimensions of energy transition, making quantitative research a predominant approach of the field and neglecting unquantifiable factors. This thesis contributes to the energy transition literature by providing a structured, multi-dimensional comparison of policy approaches and by offering a qualitative policy perspective to a predominantly quantitative study field.

The topic of this thesis matters to a broad range of actors who are connected to or affected by the energy transition process. The findings of this paper can help policymakers of Japan and South Korea, as well as other countries, to understand how policy approaches differ within similar national contexts and identify alternative policy strategies to prevent potential challenges, such as public opposition or investment uncertainty, and adjust existing strategies accordingly through public awareness campaigns or financial incentive programs (ILO 2015, 4–5). Understanding how two countries approach common targets can highlight the contrasting strategies as well as the areas that still require improvement. Moreover, knowing the existing or potential challenges within the context of two countries can guide the process of policy development. Comparing Japan and Korea shows how a similar national context can still lead to different policy designs and national priorities towards the same political, environmental, techno-economic, or socio-technical targets. Countries with similar issues, such as import dependence, can be better informed on alternative policy approaches and strategic choices that are available under the similar conditions.

Moreover, the overview of policy approaches in Japan and South Korea is highly relevant to domestic and foreign companies. The private sector is an important force in the energy transition as it can accelerate innovation and technology development, attract new investment, or slow it down. On top of that, the research can also be helpful to investors and financial institutions, as they attract the capital flow that is important for the energy transition. For investors and firms, comparing policy approaches of Japan and South Korea allows for a better understanding of which policy approaches incentivize renewable energy deployment and infrastructure development, while also guaranteeing predictability and the state's long-term commitment.

Finally, this paper will also be useful for the broader public, particularly for the citizens of Japan and South Korea, as well as other countries. By illustrating how political, environmental, techno-economic, and socio-technical factors, and not just technology, shape the energy transition process, it provides a better understanding of how complex and multidimensional the process of energy transition is. A clear overview of the energy transition process in two countries may encourage public engagement for more efficient and equitable ways to achieve energy transition. For civil society and citizens, understanding the differences in policy approaches of Japan and South Korea supports an informed public debate regarding issues of the national energy transition, such as energy justice and public engagement. Moreover, it encourages a more active involvement of civil society and highlights alternative policy approaches towards a certain goal.

This research is organized as follows:

The theoretical part includes a literature review, which focuses on the discussion of the term “energy transition” and identifies key dimensions of the energy transition. The analytical framework identifies key policy approaches as criteria for the comparative analysis. The suggested framework is then applied to the case studies of Japan and South Korea in the empirical part. Finally, the analytical part discusses the findings of the analysis, together with limitations and research relevance. The thesis concludes with the summary of the key findings.

1.2. Literature Review

1.2.1. Objectives of the literature review

In order to be able to answer the research question of this thesis, the literature review attempts to achieve two main goals. First, it is necessary to discuss how scholars define the concept “energy transition” and its key characteristics with a particular focus on the current transition towards a low-carbon energy system. The literature conceptualizes energy transition as a multi-dimensional process. Following the frameworks proposed by Cherp et al (2018) and Köhler (2019), this thesis focuses on four dimensions of the current energy transition: political, environmental, techno-economic, and socio-technical. The structure and the order of the dimensions are organized according to the goals of the comparative analysis developed for this research. Within each of these dimensions, it examines specific policy approaches aimed at certain targets that contribute to the development of the low-carbon energy system and achieving energy transition. While there are other energy transition frameworks, these two were chosen as they conceptualize the energy transition as a complex and multi-dimensional process. In addition, rather than mainly focusing on the technological change of the energy transition, these frameworks balance political, environmental, techno-economic, and socio-technical aspects of the energy transition into a comprehensive analytical framework. The multidimensional perspective of this framework serves as the analytical lens for national energy transitions. Moreover, it allows the assessment of national policy approaches and governance styles and how they interact across the energy transitions.

Second, the four-dimensional structure serves as a base for constructing the analytical framework of this thesis. Within each dimension, the literature review section identifies key targets and policy approaches that lead to specific criteria and indicators for the comparative analysis of Japan and South Korea. Thus, this section aims to provide a structured review instead of providing an exhaustive overview of the energy transitions research.

1.2.2. Defining energy transition

Despite the fact that the term “transition” is widely used in various fields, there is no standard definition of this term (Sovacool 2016, 201–3; Araújo 2014, 112–13). The difficulty in defining this concept comes from the fact that, as a process, energy transition is extremely extensive and complex, and as a result, requires insights from various disciplines (Fouquet and Pearson 2012, 1–2). Although differences of opinion still exist, there appears to be some agreement that transition refers to a change in the fuel type, the technology that produces that

fuel, and devices that produce and use that energy (Sovacool 2016, 203; Hirsh and Jones 2014, 106–11). Grubler (2016) expands this definition by defining it as not just a change in fuel type, but a change in the entire energy system (Grubler et al. 2016, 18). Meadowcroft (2009) emphasizes that energy transition affects societal dimensions, such as changes in the main governing principles and social norms (Meadowcroft 2009, 324). This thesis uses the definition suggested by Grubler (2016) and Meadowcroft (2009), who see energy transition as a comprehensive socio-technical change and rather than a transition in the fuel type.

The current energy transition differs from the historical transitions in scope and goal. The authors highlight that the ongoing changes are not limited just to the technology change or the transition from fossil fuels to renewables. The transition also occurs in many other spheres, such as institutions, policy, and cultural discourses, energy markets, and many other spheres (Geels et al. 2016, 577). The term “energy transition” is mainly referred to in the literature as either a “low-carbon” or a “sustainable” energy transition, terms used interchangeably to highlight the decarbonization and sustainability goals. Markard et al. (2012) identify the current transition as:

“long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption. One particularity of sustainability transitions is that guidance and governance often play a particular role” (Markard et al. 2012, 956).

Köhler et al. (2019) identify several key features of sustainable energy transitions in their agenda for sustainability transitions research that help to better understand energy transitions. First, the authors emphasize that low-carbon energy transitions are *multi-dimensional and co-evolutionary*. The energy sector consists of multiple interconnected elements, including technologies, infrastructure, market practices, policies, and cultural meanings (Köhler et al. 2019, 2; Geels 2002, 1257–58). Moreover, Kohler et al (2019) state that the sustainability energy transition has a *normative directionality* (Köhler et al. 2019, 3). The term refers to the fact that the energy transition path is determined by societal goals and political priorities. Sustainable development has many definitions, and various actors interpret it differently. Public policies play a key role by providing a direction toward a desired goal through strategic planning, regulations and laws, market-based instruments, investment support, innovation policies, and coordination (Köhler et al. 2019, 3; Meadowcroft 2011, 71–72). This has been previously mentioned, but energy transition is a *multi-actor process* that involves governments, the private sector, civil society, and various other stakeholders, each with different interests and levels of influence (Köhler et al. 2019, 2;

Markard et al. 2012, 962; Geels et al. 2017b, 464–65). This diversity of various actors with different opinions and strategies involved in the process may lead to *contestation and disagreement*.

Overall, the energy transition process is a constant battle between *stability and change*. The elements of energy transition develop and co-exist for a long time, and the more they do, the more resistant they become toward changes (Geels et al. 2017b, 464–65). Furthermore, sustainable transitions, like any other transition, are *long-term processes* that take decades to develop. Ultimately, all the features listed above suggest that the outcomes of energy transitions cannot be predicted in advance. While countries aim to achieve certain global and national goals, such as limiting the temperature rise to 1.5 °C or transitioning to a low-carbon economy, it is impossible to predict the successful development path and the outcome of the energy transition (Benson et al. 2023, 2). As a result, energy transition is also characterized by *open-endedness and uncertainty* (Köhler et al. 2019, 3; Fouquet and Pearson 2012, 1–2; Benson et al. 2023, 2). Because energy transition is characterized by multiple pathways, this thesis is going to focus on the necessary targets, policy approaches, and governance, instead of the outcomes.

The literature shows that energy transitions are not just technical or economic processes. The current energy transition includes environmental agenda, political choices, and social transformations. To analyze such a complex, long-term, and multidimensional process, scholars often attempt to break it down into dimensions that identify main topics and capture characteristics of the process. Following on this approach, the next section is going to focus on the political, environmental, techno-economic, and socio-technical dimensions of the low-carbon energy transition. These dimensions also allow the implementation of a comparative analysis of national energy transitions.

1.2.3. Dimensions of low-carbon energy transition

Overview

The literature agrees that energy transition is a multi-dimensional and co-evolutionary process. It includes technologies, infrastructure, policies and regulations, cultural meanings, and many other elements (Cherp et al. 2018, 178; Köhler et al. 2019, 2–4). Those elements develop, co-exist, and co-evolve together for a long time (Geels et al. 2017b, 464–65). Therefore, to understand and capture the energy transition process as a whole, it is necessary to explore it from different perspectives: *political, environmental, techno-economic, and socio-technical*. Dissecting energy transition into dimensions helps to break down the

complexity of the process, to better understand its structure, and to systematically compare cases.

Transitions always require technological innovation, economic viability, and societal adaptation. Previous energy transitions were neither planned nor governed. They were more circumstantial and happened because a cheaper and more efficient source was discovered (Sovacool 2016, 210). On the contrary, the current low-carbon energy transition is a policy-driven process (Meadowcroft 2011, 71). The urgency of environmental problems pushes governments to take action and speed up the process through strategic planning, policies, incentives, and investments. Moreover, states have the most power to govern energy systems, and the decisions made on the national level have the largest influence on the overall process (Cherp et al. 2018, 176). This shows that the energy transition on a national level plays a crucial role in the global energy transition, thus making policy approaches chosen by the states a relevant unit of analysis.

International organizations such as the IEA, IPCC, and IRENA analyze the low-carbon energy transition through various pathways that recommend how countries can achieve long-term goals such as decarbonization and net-zero emissions. These recommendations suggest short-term goals that governments can work towards on the national level, such as increasing renewable energy capacity, building climate change resilience, improving public awareness, and increasing energy efficiency. Analyzing policy approaches through certain targets within each dimension makes analyzing national energy transitions clearer and more comparable. International organizations do not intend to provide a step-by-step instruction for the governments to follow in order to achieve energy transition. On the contrary, they set a direction that everyone should aim towards.

Following the recommendations of international organizations, this thesis identifies the intermediate targets that will lead to the desired outcome of transition towards a more sustainable low-carbon energy system. Moreover, these targets make a comparative analysis possible. Following this logic, the next sections are going to discuss the targets within each of the four dimensions and the policy approaches used to achieve them. These targets will later be transformed into criteria for the analytical framework, which will be applied for the comparison between Japan and South Korea.

Political dimension

From a political perspective, energy has always been tightly connected to the national interests, energy security, and economic prosperity. Over the last century, fossil fuels have

historically shaped international relations due to the uneven geographical distribution of natural resources. This imbalance of supply and demand resulted in a centralized supply infrastructure and created a certain power dynamic between the countries. As a result, energy-related issues became a political concern that influences the national strategies, trade relations, and overall policy decisions (Unruh 2000, 817–18).

The political dimension is central when discussing national energy transitions. It is generally agreed that the government and energy policies play a big role in the current energy transition process. However, for some time, the political dimension has often been neglected and overlooked in the energy transition studies, as there are disagreements regarding the significance of the state's role in the past energy transitions. For instance, Smil (2016) expresses his uncertainty regarding the role of policies in the current energy transition. While governing energy transitions makes it a more structured and organized process, it cannot speed up the process. The author argues that the energy transition has always been time-consuming, and nothing will change that (Smil 2016, 196–97).

Scholars point out that the political factors are difficult to measure and to distinguish from economic and social aspects. In the literature, the elements of the political dimension are often compared to the elements of a “seamless web” (Cherp et al. 2018, 181,184; Meadowcroft 2011, 72). This indicates that the political dimension and its factors are essential, as they shape the national energy transition pathways.

The governance of this current low-carbon energy transition is certainly a political matter. Technology and the market are no longer the only drivers; the state and its attributes, such as the political system, institutions, and national interests, can significantly contribute to the changes required in the energy transition process and can speed the process up as well as slow it down (Singh 2023, 2–3). Unlike the previous energy transitions, market forces are not enough to transition to low-carbon energy sources, as low-carbon technologies require higher costs and are less price competitive (IEA 2021d, 29–30). A new energy source, before it becomes dominant, is niche and expensive, but it possesses certain features that make it desirable. Fouquet (2016) provides an example with electric lighting, which used to be more expensive compared to gas lighting. Despite the price, it offered a sense of uniqueness and originality that restaurants and theatres were willing to invest in (Fouquet 2016, 8–9). While low-carbon energy sources have a factor that makes them a better energy source than fossil fuels, lower pollution levels, it is still not enough to drive the market, and fossil fuels remain cheaper and more convenient in the short-term. This shows that structured state intervention is an essential condition for the low-carbon energy transition.

Any kind of state intervention will not be fruitful for decarbonization. For the energy transition to happen smoothly, governments need to establish supportive policy frameworks. Supportive policy frameworks ensure continuity of policies, policy credibility of long-term targets, coordination across institutions and sectors, and institutional capacity for renewable energy implementation.

Meadowcroft (2011) defines politics as an enabler of the current energy transition. With the sense of urgency that climate change has, governments can set a direction and shape the path for the national transition. The national context of governance structure, such as the political system setup, institutional arrangements, and national interests, plays a significant role (Meadowcroft 2011, 71). While the literature identifies a wide range of factors that are relevant to the current energy transition, setting a direction for the national energy transition is a core condition of the supportive policy frameworks.

Grubler (2012) argues that since energy transition is a long process, policies should also be long-term. Moreover, the research and development process of new technology should also be supported on a continuous basis, as the innovation requires patience and continuous investment instead of a one-time initiative (Grubler 2012, 14–15). Sovacool (2017) supports this idea and highlights that policy stability sets the tone of the energy narrative through clear targets. Policy stability sets an example for the local authorities, supports social acceptance, ensures a just transition, and reduces the risk of radical policy reversals (Sovacool 2017, 578–81). Indeed, international frameworks encourage states to maintain continuity of policies as it guarantees long-term commitment and credibility for other actors engaged in the energy transition process. It attracts investors and strengthens all other processes of new technology deployment, such as market expansion, training for workers, and support for research and development (IEA 2024e, 214–15). On the other hand, the short-termism of the policies and the technological uncertainty that still surrounds the deployment of renewable energy can make it hard for decision-makers to commit to long-term strategies (Sovacool 2017, 578–81). This suggests that policy continuity is another essential element of the supportive policy frameworks.

Well-designed institutions guarantee that ambitious goals will be transformed into a stable political strategy (IPCC 2023c). Cherp et al. (2018) support this idea and claim that the capacity of the government determines its ability to pursue the energy policy it aims for. The authors also highlight that comparison of political institutions can be very useful for energy transition studies, as it shows how different arrangements shape the consistency and the speed

of energy policies (Cherp et al. 2018, 181–82). Institutional capacity shapes coordination, implementation credibility, and the ability to sustain policies over time.

While historical energy transitions have been happening unevenly in different countries, the current globalized energy system countries have the opportunity to share their successes and failures much faster (Kern and Rogge 2016, 13). Sharing policy knowledge and enhancing research and development (R&D) can reduce the gap between governance capacity of the early adopters who go through a slower energy transition process, as they adopt the new energy source first, and the rest of the world are able to adopt a fully developed technology (Sovacool 2016, 204–5; Grubler et al. 2016, 23). Therefore, the political dimension provides an insight into the legal anchoring and institutional coordination of the governments on how environmental, techno-economic, and socio-technical targets are achieved. This makes national policy frameworks an appropriate unit for the comparative analysis.

Environmental dimension

While national governance shapes the energy transition pathways, environmental issues provide the motivation for why it is crucial to urgently transition towards the low-carbon energy system at all international, regional, and national levels (Markard et al. 2012, 959; Köhler et al. 2019, 14). The energy system and its transition are tightly connected to the environment. Bridge et al (2013) even argue that energy transition is mainly a geographical process that affects relations between society and environment (Bridge et al. 2013, 331–32). It is safe to assume that the environmental dimension serves as a main motive for the current energy transition, as fossil fuels account for over 75% of global greenhouse gas emissions (IEA 2025c). While political, techno-economic, and socio-technical dimensions are mainly discussing *how* exactly these systems are organizing the process of energy transition through developing better, more sustainable technology, policies, and behavioural changes, the environmental dimension shows *why* these changes are necessary.

The literature identifies numerous targets that are relevant to the current energy transition, such as mitigation of GHG emissions, reduction of water and air pollution, biodiversity protection, increasing resource and energy efficiency, resilience to climate change and many others (UNEP 2025, 8; UNFCCC 2016, 3,51; IPCC 2023a, 18–19; Köhler et al. 2019, 22). These targets belong to the environmental dimension as their outcome is ultimately the same, to prevent climate change, reduce GHG emissions, and transition to a low-carbon energy system. However, all these targets are overlapping, as well as the

mechanisms, policy instruments, and all other processes within them, which are constantly interacting and coevolving. Therefore, due to the high volume of overlapping environmental targets, this paper narrows the focus down on two key targets appropriate for the comparative analysis.

Despite the long list of possible interconnected environmental targets, the literature identifies two goals that are the most appropriate objectives for the environmental dimension. Mitigation of GHG emissions and adaptation to climate change targets have been recognized as the key environmental objectives in such international frameworks as the Paris Agreement, the IPCC 6th Assessment Report, UNEP Emission Gap Report, and IEA Net Zero Pathway (UNFCCC 2016, Article 2; UNEP 2025; IPCC 2023a; IEA 2021d). Academic literature supports this point of view and also identifies mitigation and adaptation as the key environmental goals of the current energy transition. Both targets are implemented in national strategies and are well recognized in the academic and policy literature.

Sovacool (2016) has sparked a debate in the field of transition studies through his article “How long will it take? Conceptualizing the temporal dynamics of energy transitions” (2016). The author argues that the energy transition can occur much faster than historical transitions, due to the scarcity of natural resources, environmental agenda, and policy innovations (Sovacool 2016, 210). Moreover, transitioning to a low-carbon energy system comes with extra benefits for the countries, such as the improvement of public health, economic diversification of countries’ sources of income, and an increase in countries’ abilities to successfully compete in a global market (Sovacool 2016, 211; Kern and Rogge 2016, 13–14). While some authors support the idea, Smil (2016), on the contrary, disagrees with the ideas proposed in Sovacool’s article. Energy transition has always been time-consuming, and nothing will change that. Especially, now that energy consumption is higher than it ever was, and the massive development of fossil fuel infrastructure is ongoing. Smil (2016) also expresses his uncertainty regarding the role of policies in the current energy transition, as it can make the process more structured, but not faster. For instance, from 2000 to 2015, Germany managed to reduce fossil fuel energy consumption by 12% through a long-term strategy, while France reduced its reliance by 18% during the same period without having one (Smil 2016, 196–97). This debate shows that setting a goal for energy transition does not determine its path or the outcome. The national context of each country and its policy strategies also shape how mitigation and adaptation of climate change are approached. Accordingly, this thesis focuses on comparing policy approaches towards low-carbon energy transition, and not the speed or the success rate of the countries. Reducing GHG emissions

and building climate change resilience are two main environmental goals of the energy transition identified in this thesis. These goals become criteria in the analytical framework to analyze the policy approaches.

Environmental goals are not achieved automatically and require state intervention. To achieve environmental targets and to increase credibility and policy coordination, governments use different policy instruments. The literature identifies various types of policy approaches relevant to achieving mitigation and adaptation of climate change: strategic planning, regulatory, market-based, and coordination instruments (IPCC 2023b, 110–11; Kern and Howlett 2009, 399–401). A wide variety of policy instruments allows governments to pursue different energy transition pathways.

Techno-economic dimension

The techno-economic aspects of the energy transition are widely researched in the literature. Grubler (2012) claims that not only is it the most discussed topic in transition studies, but it is also the most developed one. The research around energy and energy transition is focused on the economic and technical analysis, specifically on the deployment of new technologies, supply and demand, and changing or adapting the existing infrastructure or building a new one (Grubler 2012, 14–15). This dimension relies on quantitative research and indicators and allows for the development of economic models (Cherp et al. 2018, 183). In this thesis, the techno-economic dimension captures the efficiency and deployment readiness of renewable energy technologies.

Besides the environmental urgency to stop fossil fuels, there are other reasons why this energy transition is necessary. According to international financial institutions, such as the World Bank Group, fossil fuels lead to unstable energy markets and create uncertainty for governments and investors (World Bank Group 2020, 1–5). Continuous investment in fossil fuels and infrastructure is problematic, as such projects require long-term commitment that is inconsistent with current decarbonization goals (IEA 2021d, 13–14). Moreover, a heavy reliance on fossil fuels creates economic risks for countries, regardless of whether they are resource-rich or resource-poor. Countries that do not have sufficient natural resources of their own but heavily depend on imports are also at risk, as they may face price fluctuations that can lead to economic instability, inequality, and poverty (IEA 2024b).

Risks that come with the fossil fuel system require a techno-economic transformation. Increasing the renewable energy share has been a globally recognized solution as it reduces GHG emissions as well as air pollution, leads to job creation, green growth, increases market

competitiveness of new energy sources, and reduces dependence on fossil fuel imports (IEA 2021d). However, there is a large debate in the energy transition literature regarding how large the renewable energy share must be for the energy transition to be considered in motion. According to the previously discussed article by Sovacool (2016), some authors believe energy transition happened from the moment new sources have been introduced to the market, while others argue that it should increase to 25% or, for some authors, up to 50% of the international energy market (Sovacool 2016, 203). This discussion shows that the renewable energy share is a measurable unit and is widely used in policy documents and discussed in the literature. On this basis, this thesis adopts it as a techno-economic target for the comparative examination.

Beyond deployment of new renewable energy technologies, increasing energy efficiency is considered to be the “first fuel” of the current energy transition (IEA 2023a). Kirikkaleli (2023) highlights that while energy efficiency policies emerged in various countries in the 1970s after the oil shock, the amount of literature on energy efficiency has increased only recently (Kirikkaleli 2023, 1). Unlike other energy transition targets, increasing energy efficiency does not interfere with any other national goals. On the contrary, it is a useful tool that can provide fast results and can be applied in both crisis and non-crisis situations, benefiting all sectors. Energy efficiency simultaneously ensures energy security, helps achieve environmental goals, reduces energy costs, and fosters economic competitiveness (Gajdzik et al. 2024, 6–7). Measurability, comparability, and its direct influence on national policies make energy efficiency an appropriate techno-economic criterion for the analytical framework.

The literature identifies a wide range of policy approaches that can address increasing renewable energy share and promote energy efficiency. These include strategic, market-based, regulatory, public finance, coordination instruments, systematized in the analytical framework (IPCC 2023b, 110–11; Kern and Howlett 2009, 399–401). Overall, the techno-economic dimension is foundational in the literature of the energy transition research. It is the most methodologically developed dimension and plays a central role in energy transition studies.

Socio-technical dimension

While the political, environmental, and techno-economic dimensions focus on policy frameworks, ecological consequences, and technological aspects of the current energy transition, the socio-technical dimension highlights the role of society and how it shapes the

direction and speed of transition. The importance of socio-technical aspects of energy transition has been increasingly recognized in the literature. Aspects such as social acceptance, behavioural changes, and distributional outcomes influence the energy transition process. While they do not directly affect infrastructure development or energy markets, making the transition acceptable, fair, and accessible, building trust among the citizens, influencing people's behaviours, and improving social conditions is crucial for the energy transition pathway (Cherp et al. 2018, 180). Some scholars define transition as a socio-technical change, as it involves close interaction of social and technical systems between each other (Geels et al. 2017a, 1242; Markard et al. 2012, 956). From this perspective, socio-technical transitions emphasize the co-evolution of technologies, institutions, cultural norms, and behavioral practices. Therefore, for this thesis, the socio-technical dimension focuses on how states interact with society in order to build social acceptance and social support for national energy transition policies.

There are two highly discussed targets within the socio-technical dimension that states aim to address through different policy approaches. These targets are most commonly addressed in the national energy-related policy documents and are observable through the policy measures of the states rather than the social outcomes.

First, the governments should foster public engagement and awareness regarding the energy transition process. Public support helps to speed up and make the process of switching towards a low-carbon energy system easier and faster, as well as helps the government identify the areas of social resistance and potential conflict (Evensen et al. 2018, 451–52; Boudet 2019, 446). A lack of public support can cause social resistance and inequality, which can make the process of switching to a low-carbon energy system more complicated and slow (Kamali Saraji and Streimikiene 2023, 9–10). One of the highly discussed issues of this dimension has to do with the “not in my backyard” (NIMBY) behavior, which implies that people support energy transition and renewable energy technologies, until they have to take action (Wüstenhagen et al. 2007, 2684–86). Trust in the industry and the local government plays a crucial role in public acceptance on both levels. Therefore, transparency and involvement of all actors are important for a smooth and successful energy transition (Emmerich et al. 2020, 1–2). In this thesis, increasing public engagement is a socio-technical target that refers to governments' efforts to implement policy measures that build trust, increase participation, and ensure transparency.

Second, governments need to address the distributional and social impacts of the transition. Distributional justice refers to the idea that costs and benefits of the low-carbon

energy transition are allocated fairly across cities and regions, sectors, and vulnerable groups, such as carbon-intensive workers (Newell and Mulvaney 2013, 132–33). Access to energy is a basic need necessary to ensure survival, good health, and a decent life, and changes required for a transition towards a new energy system may cause social inequalities for specific groups of people (Evensen et al. 2018, 451–52; Boudet 2019, 446). While the current energy transition provides long-term benefits, such as better health, a cleaner environment, new jobs, and improved energy security, it is important to ensure short-term benefits as well. States need to ensure affordability, compensation mechanisms, and protection of vulnerable groups. The institutional framework developed by the International Labor Organization (ILO) recommends that states keep an open social dialogue, ensure social protection for vulnerable social groups, and protect rights at work and employment (ILO 2015, 3–7). Accordingly, this thesis focuses on policy measures that address social impacts rather than evaluating justice outcomes.

There are different policy approaches through which states can influence society, its behaviour, norms, and social practices. As well as in the other dimensions, the policy approaches for the socio-technical dimension can be grouped into strategic planning, regulatory, market-based, and coordination mechanisms. The targets of the socio-technical dimension require softer, informational, and educational tools and not obligatory measures (Köhler et al. 2019, 7–8). States need to find ways to convince citizens to accept the changes needed to achieve energy transition and implement them in their daily lives (Kamali Saraji and Streimikiene 2023, 9–10).

1.3. Analytical Framework

1.3.1. Objectives of the analytical framework

The topic of low-carbon energy transitions has become increasingly relevant over the past decade, particularly following the Paris Agreement (Kamali Saraji and Streimikiene 2023; Köhler et al. 2019, 2–3). The energy transition is explored from various angles in different study fields. Due to the multidisciplinary nature of energy transition studies, scholars highlight that the research on this topic is rather complex, and transition studies currently do not have a dominant methodological approach (Cherp et al. 2018, 175; Harichandan et al. 2022, 3). The literature review revealed that energy transitions are not purely technological transitions, and the policy approaches can be categorized into four dimensions: political, environmental, techno-economic, and socio-technical.

This section of the thesis presents the framework that is going to be used to answer the research question: *How do national policy approaches towards the low-carbon energy transition differ between Japan and South Korea across political, environmental, techno-economic, and socio-technical dimensions since 2015?* The literature review has introduced a discussion of various policy approaches that can help countries achieve a low-carbon energy transition. In order to answer this question and to identify the differences in policy approaches, this chapter is going to introduce a framework that compares policy approaches between Japan and South Korea across four dimensions.

1.3.2. Overview of the analytical framework

This research adopts a comparative qualitative case study approach in order to analyze the key policy mechanisms of energy transitions used by Japan and South Korea. There are several reasons why this is the most suitable approach to answering the stated research question.

First, the framework aligns with the characteristics of sustainability transitions identified by Köhler et al. (2019), as the comparative analysis of energy transition policies in Japan and South Korea integrates multi-dimensionality, multi-actor involvement, normative directionality, and other features identified by the authors (Köhler et al. 2019, 2–4). This helps to understand transition processes better.

Second, the framework provides a comprehensive way to categorize the policy tools and mechanisms that are taking place within the national energy transitions and applies to other national case studies as well. Based on the literature, it is safe to assume that the most

common way to analyze energy transition is by dissecting its components by specific sectors or topics. While it is a good way to do that, the introduction of four dimensions, such as *political, environmental, techno-economic, and socio-technical*, seems more appropriate for such complex phenomena as energy transition. This way, the framework reflects the interconnection of the processes taking place within the energy transition and allows analytical comparison.

Finally, the framework not only offers a systematic overview of the energy transition but also elevates the role of political science in energy transition studies. As has been mentioned earlier, this ongoing energy transition is a policy-driven process (Meadowcroft 2011, 71). The government, together with its institutions, plays an influential role in the energy transition process, which has only recently been recognized in transition studies. Therefore, this framework gives a good opportunity to single out the political dimension of the energy transition (Köhler et al. 2019, 2; Geels 2002, 1257–58).

The proposed framework is specifically designed to identify and compare the policy tools of national low-carbon energy transitions in Japan and South Korea. In this context, the unit of comparison is national policy approaches aimed at specific targets. Such characteristics as net-zero commitment, the level of industrialization, and import-dependence, together with shared international frameworks, are what Japan and Korea have in common. National priorities, institutional structure, and policy instruments may be different. Categorizing policy approaches across certain targets allows qualitative comparison of two cases without ranking. In order to answer the research question, the empirical part is going to focus on what states aim to do by looking into their national targets, how they do it by looking at the policy instruments, and under what conditions they function, including their current state of implementation and the constraints that they face.

Due to the time and data constraints of this master's thesis, this study is unable to encompass the entire range of energy transition targets discussed in the literature. Instead, it focuses on a limited number of analytically manageable targets per dimension. These targets were selected for this thesis because they are consistently emphasized in the energy transition literature, are clearly addressed in the national policy documents, and can be comparatively analyzed by examining the policy approaches associated with each target. By relying on these targets, the empirical part is going to identify and compare specific policy approaches of national energy transitions in Japan and South Korea.

1.3.3. Definition of key terms, concepts, and ideas

Policy approaches

Energy transition can be achieved through different policy pathways. Focusing on policy approaches instead of the outcomes of energy transition offers a clearer view of the decisions and actions that states take to achieve low-carbon energy transition. Despite a wide range of policy instruments, the same tools can be applied to achieve multiple different targets. This allows us to look into the same policy approaches of the transition from different angles of different systems, which can be done best in qualitative analysis. Cherp et al. (2018) provide an example of a power plant. The same plant can be a unit of a techno-economic system, where it can be viewed as an infrastructure for energy production. It can also be a part of a socio-technical system, where it represents a certain type of technology that is used to produce electricity. Finally, the same power plant can be a topic of political debates, which can lead to the adoption of new GHG emission policies within the system of political actions (Cherp et al. 2018, 178–79).

The analytical framework identifies six main types of policy approaches that capture the variety of state action within national transitions: *strategic planning*, *regulatory*, *economic and public finance*, *innovation policy*, and *coordination* instruments (IPCC 2023b, 110–11; Kern and Howlett 2009, 399–401).

Strategic instruments include formulating specific goals, establishing national priorities, and developing clear national strategies towards them. Regulatory framework establishes binding rules and standards, such as environmental standards for manufacturing, labour and safety protections, or worker protection measures. Economic policies and public finance incentivize and support actors financially through such mechanisms as carbon pricing, subsidies, and funds. Coordination instruments include interministerial coordination, information transparency, voluntary programs, and other instruments to harmonize policy measures and ensure stakeholder alignment.

Despite a wide range of policy approaches, not all six of them are applied to every target. The selection of policy approaches depends on their relevance to a certain target and the data availability. By analysing policy approaches in relation to specific targets, this thesis does a qualitative comparison and focuses on states' policy design and priorities instead of ranking the outcomes.

Political dimension

A majority of studies highlight that the current energy transition is a policy-driven process, as market forces are insufficient to achieve urgent decarbonization (IEA 2021d, 29–30). Therefore, this dimension focuses on how states organize, coordinate, and sustain energy transition policies over time. It examines governments' existing institutional frameworks, their capacity and stability, and policy design. In this paper, the following target has been identified for the analysis: (1) *establish supportive policy frameworks*.

Establish supportive policy frameworks

Establishing supportive policy frameworks refers to the way governments develop their long-term policy structure to enable national energy transition across sectors. As a policy-driven process, energy transition requires the establishment of long-term strategies, institutional arrangements, and legal frameworks that provide a predictable roadmap for the implementation process (Cherp et al. 2018, 181,184; Meadowcroft 2011, 72). In the context of this criterion, a supportive policy framework means that such a policy framework seeks to establish policy coherence across all sectors, long-term institutional stability, and coordination among state actors involved in the energy transition process.

This criterion investigates whether states have a well-established policy framework that supports policy continuity, institutional coordination, and implementation of new technologies. The political dimension provides a governance context for how the environmental, techno-economic, and socio-technical dimensions are structured. Despite this, the dimensions and their targets are examined analytically equally. The empirical part is going to focus on energy and climate strategies, laws, institutions, and legal embedding, and coordination structure and its mechanisms, without assessing the effectiveness, ambitions, and outcomes of the energy transition process.

Environmental dimension

To analyze the environmental dimension, the framework has identified two main targets: (1) *reduce greenhouse gas emissions* and (2) *build resilience to climate change*. These targets capture the key environmental objectives that set direction for the national energy transition and its policies.

Reduce greenhouse gas emissions

Reducing GHG emissions is the central policy objective of the current sustainable energy transition. Without this target, the global temperature may continue increasing, which can lead to irreversible climate change consequences (UNFCCC 2016, Article 2; UNEP

2025; IPCC 2023a). As discussed in the 1.2.3. section of the literature review, in the context of low-carbon energy transition, reducing GHG emissions serves as a cross-cutting goal for the rest of the targets. The rest of the criteria identified for the analytical framework directly and indirectly contribute to the reduction of GHG emissions. While the purpose of this target is interrelated, reducing GHG emissions explicitly refers to reduction targets in national energy strategies, direct regulation of emissions, and overall policies that are focused directly on reducing GHG emissions. In the empirical part, this target is examined through the national strategic documents, binding laws, and national carbon pricing schemes.

While reducing GHG emissions overlaps with the rest of the targets of this analytical framework, this goal specifically focuses on the policy approaches that directly address GHG emissions. Policies that focus on renewable energy deployment, energy efficiency, or any other target that indirectly reduces GHG emissions are analyzed under different criteria separately. Targets such as renewable energy expansion and energy efficiency also contribute to reducing GHG emissions, but are going to be analysed under separate criteria. Overall, this criterion focuses on the policy design and existence of mitigation strategies rather than on the emission performance.

Build resilience to climate change

While the mitigation of climate change aims to reduce the main roots of the problem, adaptation to it focuses on addressing its consequences. Climate change adaptation strategies prepare countries, their energy systems, and infrastructure for such climate-related risks as extreme temperatures, floods, droughts, or wildfires, and help minimize the damage and other negative effects. Multiple international organizations, including IRENA and IPCC, emphasize the importance of energy systems being climate resilient on the same level as being low carbon (IPCC 2023a, 20–21).

In this thesis, this criterion refers to adaptation policies, integration of climate risk into strategic planning, and infrastructure resilience. In particular, the empirical part investigates if countries have national energy adaptation plans, dedicated climate-resilient programs, and funding mechanisms for resilience in the energy sector. Building resilience to climate change does not include social adaptation, climate mitigation, or general disaster management. The comparison of national adaptation approaches focuses on the policy design, presence, and scope.

Techno-economic dimension

The techno-economic dimension is one of the most frequently analyzed topics in the field of energy transition research. It enables energy transition by shaping the deployment of new renewable energy technologies and is focused on policy-driven economic and technological changes in national energy systems. To analyze this dimension, the following goals have been identified: (1) *increase the renewable energy share* and (2) *promote energy efficiency*.

Increase the renewable energy share

Increasing the renewable energy mix refers to the policy-driven growth of renewable energy sources in a country's energy mix, such as solar, wind, hydropower, geothermal, and other energy sources. While the reduction of GHG emissions focuses on the ways countries can either reduce fossil fuel use, regulate emissions, or implement carbon pricing, this criterion focuses on how states develop and expand renewable energy sources. Increasing renewable energy share is not just a mitigation target, as it indicates techno-economic transformation that includes development of energy infrastructure, market structures, and investment planning (IEA 2024e, 104). Thus, this target is analytically different from the reducing GHG emissions target, and it deserves a separate criterion.

Governments increase the renewable energy share not only through market mechanisms but also through various policies. They mitigate investment risks, ensure price stability of new technologies, and facilitate market access. The empirical part, therefore, is going to focus on national renewable energy targets, regulations, economic mechanisms, coordination instruments, innovation policies, institutional frameworks established for renewable energy expansion, and financial support mechanisms. Comparing how commitments are framed, policy direction, and instruments chosen by the states will allow us to assess how states pursue renewable energy expansion. This criterion does not include policies that are targeting phasing out fossil fuels or increasing energy efficiency, as they are analyzed under separate criteria.

Promote energy efficiency

Energy efficiency refers to reducing energy consumption by using less energy to achieve the same results or accomplish the same tasks (IEA 2023a). By reducing the energy demand through various policy instruments, energy efficiency policies reduce the amount of fossil fuel within the energy transition process.

The IEA recommends that governments target energy efficiency through three policy mechanisms: regulations and standards, information tools, and economic incentives. Regulations and standards ensure that equipment, buildings, and manufacturing meet energy efficiency standards. Economic incentives such as subsidies, taxation, or other financial mechanisms are also playing an important role in promoting energy efficiency practices. Finally, information tools refer to the behavioral changes of the citizens by providing information, labeling systems, and guiding energy use practices that are not the key components of comparative analysis (Rasoulinezhad and Taghizadeh-Hesary 2022, 9–10). This thesis mainly focuses on the regulations and economic incentive mechanisms. The empirical section is looking into the national targets for energy efficiency, mandatory standards, institutional arrangements, and economic incentives that states adopt to reduce energy demand. While awareness campaigns, cultural practices, and behavioral initiatives are also contributing to this target, they are not key units of the comparative analysis. This criterion focuses on the policy approaches that states choose to promote energy efficiency at the national level.

Socio-technical dimension

The following targets define the socio-technical dimension of energy transition: (1) *strengthen public support*, and (2) *address regional and distributional justice concerns*. This dimension of energy transition addresses policy approaches that affect public support, fairness, and social aspects of energy transition. By examining actions taken by the countries to achieve these goals, the analysis will highlight countries' approach to the socio-technical dimension and provide insights into countries' mechanisms towards strengthening social acceptance of the energy transition process.

Strengthen public support

This criterion examines how governments influence public acceptance and perceptions of the energy transition. A lack of public support and engagement can be a significant barrier that governments face throughout the low-carbon energy transition process (Kamali Saraji and Streimikiene 2023, 9–10). The levels of public support are usually tracked through opinion surveys that show public attitudes.

To achieve this target, governments' actions may include strategy and educational campaigns to explain the importance and urgency of the energy transition, financial incentives to encourage acceptance, and other mechanisms to build support for renewable energy initiatives and encourage participation in planning and decision-making processes.

Visibility, public engagement, and transparency are key instruments through which governments seek to build public trust. Public support exists on different levels: cities and rural areas, individuals, and companies. Local rejection can affect renewable energy projects due to noise concerns or landscape impacts. This phenomenon is also referred to as “not in my backyard” (NIMBY) in the literature (Wüstenhagen et al. 2007, 2683–84). Understanding the new technology, its benefits, risks, advantages, and disadvantages contributes to public acceptance. Transparency of the process and involvement of all stakeholders are also highlighted as important factors for a smooth implementation of energy transition policies (IEA 2022). Finally, various public awareness activities, media campaigns, and surveys also contribute to public support. Therefore, this criterion focuses on educational and awareness campaigns, information and communication policies, transparency mechanisms, and acceptance-raising initiatives, aimed at shaping public perceptions and strengthening public towards the energy transition.

Address distributive justice concerns

This criterion examines the policy approaches that countries implement to address distributive justice concerns. The international frameworks suggest focusing on the following policy areas: social and worker protection, regional support, and stakeholder engagement (ILO 2015, 5–7). However, this thesis mainly focuses on the regional support, stakeholder engagement, and support for workers of carbon-intensive fields due to the scope and other constraints. Addressing regional inequalities and uneven distribution of socio-economic benefits of the energy transition, especially between rural and urban areas, is also a crucial component of this criterion (Kamali Saraji and Streimikiene 2023, 12). Without achieving this target, there is an increased risk of public opposition, which may lead to shaken policy stability and slow down the energy transition process.

Despite the existence of international guidelines and frameworks, such as the Guidelines for a Just Transition Towards Environmentally Sustainable Economies and societies for all by the ILO, the concept of just transition remains broad and open to various interpretations. As a result, the target of ensuring a just transition risks being a symbolic statement in countries’ documents (Newell and Mulvaney 2013, 137–38). This thesis narrows the focus to distributional and regional justice issues and the policy actions that address them. The analysis does not evaluate labor market analysis, employment outcomes, and income redistribution mechanisms. All of those efforts support not only just transition for the citizens, but also help with other energy transition targets, such as increasing public

acceptance, allowing renewable energy deployment, and providing policy capacity (Evensen et al. 2018, 451–52).

1.3.4. A table summarizing the analytical framework and research strategy

Key targets	Policy approaches (What kind of policy tools do governments use to achieve the target?)	Comparative indicators (How can policy approaches be compared?)	Sources
Political dimension			
Establish supportive policy frameworks	- Long-term national energy and climate strategies - Legal frameworks support long-term transition goals - Institutional arrangements and its capacity - Policy continuity - National frameworks aligned with international commitments	- Existence of long-term energy and climate strategies - Legal framework for energy transition goals - Institutional structure and coordination - Evidence of policy continuity - Alignments with international commitments	Strategic national documents, Renewable Energy Policies, UNFCCC NDC Registry, IEA Climate Change Reports
Environmental dimension			
Reduce greenhouse gas emissions	- Long-term net-zero commitments - Nationally Determined Contributions (NDCs) - Long-term mitigation strategies - Carbon pricing programs - ETS obligations	- Legal status of GHG reduction targets - Timeline of GHG reduction commitment - Structure of carbon pricing programs	Strategic national documents, national reports, press releases, IEA Reports, reports and statistics of IOs and NGOs
Build resilience to climate change	- National adaptation plans - Policies on climate risk - Climate-resilient infrastructure programs - Investment in climate change resilience systems - Integration of climate risk into strategic planning	- Reference of climate resilience in official documents - Presence of climate resilience strategies in official documents - Allocation of funding to climate resilience - Existence of climate change risk assessment measures	Strategic national documents, national adaptation plans, IEA Climate Resilience Report
Techno-economic dimension			
Increase the renewable energy share	- Renewable energy targets - Market-based support mechanisms - Institutional coordination frameworks for RE expansion - Public financial and investment support mechanisms - Innovation policies	- Existence of renewable energy targets - Presence of market-based mechanisms for new technologies - Existence of public investment to support RE deployment	Strategic national documents, IEA World Energy Outlook, IEA Reports, IRENA Renewable Energy Statistics
Promote energy efficiency	- Regulations and standards - Economic incentives	- Existence of the national energy efficiency strategy - Existence of regulations and standards for buildings and manufacturers - Integration of labelling systems - Financial incentives	Strategic national documents, national reports, press releases, IEA Energy Efficiency Report

Socio-technical dimension			
Strengthen public support	• Educational and awareness campaigns • Information and communication policies • Transparency mechanisms • Awareness raising initiatives	• Government-supported education initiatives • Existence of official documents that target public • Reference of transparency in the official documents, public involvement in the decision-making process	Strategic national documents, national reports, press releases, IEA Reports, surveys
Address distributive justice concerns	• Integration of just transition language in national strategic documents • Regional support policies • Stakeholder engagement • Worker retraining and support programs	• Reference to “just transition” in the official documents • Presence of targeted regional mechanisms • Presence of policies to ensure worker protection	Strategic national documents, ILO reports, national reports, IEA Reports, civil society reports

1.3.5. Overview of Case Selection

The majority of case studies conducted in the field of transition studies in the English language are focused on European countries. While the amount of research on China has significantly increased over the last decade, the East Asian region remains underrepresented in the field (Kamali Saraji and Streimikiene 2023, 3–11; Harichandan et al. 2022, 12–13). Understanding how the energy transition process is approached in specific regional settings can help identify certain policy approaches, characteristics of the process, and expand the knowledge on energy transitions worldwide. The East Asian region is playing an important role in the world economy, and as a result, is a great contributor to GHG emissions. According to the IEA, as of 2022, the Asia Pacific region is accountable for 51,2% of global CO₂ emissions, with Japan and South Korea being among the biggest emitters in the world (IEA 2025a). Therefore, it seems appropriate to make a comparative analysis of energy transition in these two East Asian countries: Japan and South Korea.

Following Seawright and Gerring’s (2008) case selection approach, this thesis is going to focus on those two countries as a most similar case design (Seawright and Gerring 2008, 304–5). Japan and South Korea are neighboring countries that share similar levels of economic development, fossil fuel import dependence, and industrial structure characteristics, whose energy transition is mainly led by the government. Both of them are highly industrialized and heavily dependent on imported energy (IRENA 2022, 3–5; Ritchie et al. 2020b). Finally, Japan and South Korea are members of climate and renewable energy-related organizations such as OECD and IEA, and are committed to international climate agreements, including the Paris Agreement, the Kyoto Protocol, as well as the agreement of

countries during COP28 to triple the amount of renewable energy (UNFCCC 2024). Thus, if two countries with similar characteristics develop and implement different policy approaches, their national context plays a significant role in the national energy transition pathway.

Despite the listed similarities, there are certain aspects that distinguish the energy transition strategies of these countries. For example, the Great East Japan earthquake and the Fukushima Daiichi nuclear accident in 2011 have significantly impacted the energy strategies of both countries. After the disaster in 2011, Japan significantly decreased the amount of nuclear energy, and the majority of nuclear reactors were shut down, while South Korea temporarily reduced its nuclear energy dependency for some time, but then continued to actively develop its nuclear energy policy (Bakshi 2023, 211). The accident has also increased public participation and civil society engagement in energy-related matters in Japan. Finally, Japan's main goal of energy transition is to ensure energy security, while Korea aims to become a major exporter in the field of green technology (REI 2023, 6–9). These similarities and differences make the two countries ideal for analyzing and comparing their national energy strategies. It is important to emphasize that instead of ranking these two countries and trying to determine the “winner”, this thesis attempts to determine energy transition characteristics across four dimensions.

2. Empirical part

2.1. Political dimension

2.1.1. Establish supportive policy frameworks

Japan

Japan is one of the largest economies and one of the top emitters in the world (World Bank Group 2024). Due to the geographical characteristics of the country, Japan is heavily dependent on imported fossil fuels. As a result, the country is highly vulnerable to the energy security risks and exposed to global energy supply shocks (IEA 2021b, 19). The Fukushima accident caused a major disruption in the energy policy strategy of Japan, which led the country to shut down nuclear power plants and to replace them with increased fossil fuel imports (IEA 2021b, 20–21). Thus, energy transition is not just a climate mitigation and decarbonization strategy, but a strategy to achieve energy security and strengthen economic competitiveness by reducing import vulnerability, increase industrial competitiveness, and ensure stable energy supply. It is also known as the 3E+S strategy, which prioritizes safety while aiming to achieve energy security, economic growth, and environmental sustainability (Bakshi 2023, 211). Japan is often characterized as a bureaucratic state that is oriented around consensus-building policy (Lepon 1978, 139–40). Moreover, the government traditionally relies on the administrative guidance, also known as “gyosei-shido” rather than on legal actions. The administrative guidance refers to the ministries and other bodies providing guidance, coordination, and consultations instead of only relying on legal repercussions (Lepon 1978, 139–40). Overall, the energy strategy of Japan aims to incorporate and balance out energy security, industrial policy, and decarbonization targets simultaneously. Within this context, a supportive policy framework that prioritizes planning and coordination plays a key role in the national energy transition.

In 2020, under the Paris Agreement, Japan committed to net zero by 2050 (METI 2020a). The plan is outlined in Japan’s Long-term strategy and was later reflected in the national climate strategy known as the Plan for Global Warming Countermeasures. Japan, as a part of the Paris Agreement, submits its National Determined Contributions to the UNFCCC. According to the most recent NDC, submitted by Japan in 2025, the government’s objective is to reduce GHG emissions by 60% by 2035 and by 73% by 2040 from 2013 levels, which is Japan’s highest year in terms of GHG emissions (Government of Japan

2025). The Plan for Global Warming Countermeasures is the climate mitigation framework that was established in response to the Paris Agreement GHG reduction target. It is a mitigation document that enables GHG emission reduction goals (MOE 2025b, 1–2).

While Japan has a legal obligation under the Paris agreement framework, the domestic national decarbonization strategy is structured around and implemented through strategic planning mechanisms rather than a single climate framework act. From the domestic legal framework point of view, Japan does not have a legally binding carbon neutrality framework. Instead, the Japanese rely on three key pillars: the Plan for Global Warming Countermeasures, the Strategic Energy Plan, and the Green Transformation (GX) policy. Key energy targets are described in Japan's Strategic Energy Plan, developed by the METI and revised periodically every three years. The Strategic Energy Plan sets an overall decarbonization direction, describes desired energy mixes, and sets technological priorities for the country. For instance, the most recent 7th Strategic Energy Plan is aimed towards ensuring energy security due to the geopolitical instability, stable energy supply due to potential electricity demand increase, and climate change mitigation (METI 2025b, 10–15). The national targets outlined in the 7th Strategic Energy Plan generally align with recently updated NDC targets (METI 2025a). It is Japan's key document when it comes to the energy sector and decarbonization processes.

Finally, the GX policy. In 2022, the government introduced the Green Transformation policy and the GX Promotion Act. The GX policy is a ten-year road map of transitioning away from the fossil fuel system to a clean energy system through economic growth (METI 2023b). The policy aims to ensure a stable energy supply, economic growth, industrial competitiveness, and decarbonization mainly by mobilizing over 150 trillion yen or approximately 1 trillion US dollars over the next decade through public funding and investment (Schilling 2024, 13). The GX policy is focused on achieving decarbonization together with industrial transformation and financial mobilization (Bakshi 2025, 3). In sum, the key documents for the national energy transition in Japan are long-term planning documents targeted by legislative measures. This shows that the Japanese government relies on strategic planning rather than on a single climate legal framework.

The energy transition process in Japan is coordinated by multiple different ministries. The key ministries involved in the energy transition and providing political leadership are the Ministry of Economy, Trade, and Industry (METI) and the Ministry of Environment (MOE). METI plays a dominant role in the energy transition process, especially in the energy sector. As has been mentioned earlier, it is responsible for developing and implementing national

climate mitigation policies, such as the Strategic Energy Plans (Bakshi 2025, 2–3). While METI's work is mainly oriented towards energy strategy and industrial decarbonization, the Ministry of Environment develops national GHG goals, sets a direction of climate change policies such as the Plan for Global Warming Countermeasures, and provides international reporting to the UNFCCC (IEA 2021b, 46).

The Agency of Natural Resources and Energy (ANRE) and the New Energy and Industrial Technology Development Organization (NEDO), agencies under METI, play a supportive role, mainly focusing on the implementation of energy innovation policies and programs (METI 2024). ANRE focuses specifically on formulating policies, while NEDO strengthens collaboration between the state, private sector, and academic institutions (NEDO 2025; IEA 2021b, 114). The Council for Science, Technology and Innovation is a decision-making body in regard to energy-related research and development matters. The Council is also responsible for monitoring and evaluating progress following the main criteria, such as necessity, efficiency, and effectiveness (Government of Japan 2021b, 52).

Finally, the local governments are starting to play a more significant role in the energy transition process. For instance, the Tokyo Metropolitan Government has established its own emission trading scheme, Tokyo Cap-and-Trade Program (ICAP 2020). In 2020, 56 local cities have signed commitments towards the net zero by 2050 goal (IEA 2021b, 46–47). Japan represents a ministerial coordination model that is mainly coordinated by METI with the support of the MOE and other specialized agencies. The local initiatives are also complementing the nationally coordinated energy transition framework.

(key challenges and limitations)

The energy transition framework of Japan has certain structural constraints as any other national framework. Japan's national energy strategy reflects its sensitivity towards energy security issues, as well as the economic growth and heavy industrial coordination concerns. The key policy approaches oriented towards incentivization and innovation. Japan is on its way to achieving energy transition, but it does not have a comprehensive climate act framework. This shows that the legal strength of the actions depends on the ministries and their administrative mechanisms. Moreover, heavy reliance on strategic planning documents such as the Strategic Energy plan that are regularly revised shows that the long-term policy stability and continuity depend on the bureaucratic commitment and the overall political stability. Additionally, the absence of legal embedding leads to flexibility of goals and limited accountability mechanisms that can also affect the long-term energy transition pathway. Overall, Japan's supportive framework towards decarbonization can be

characterized by the international alignment, the strategic planning documents, cross-ministerial coordination, and the absence of a legally embedded climate act framework.

South Korea

South Korea is also one of the major GHG emitters. According to the IEA, in 2023, Korea was the fifth emitter in the Asia-Pacific region (IEA 2023d). This can be explained by the fact that the country's economy is mainly oriented towards heavy industrialization, such as petrochemicals, steel, car manufacturing, and electronics (IEA 2020a, 17). This shows that a significant amount of GHG emissions comes from the energy-intensive industrial sector. Moreover, similarly to Japan, Korea does not have its own natural resources and is heavily dependent on the imported fossil fuels. As a result, the country is vulnerable to energy security and external energy price shocks (IEA 2025b, 4–7). In this context, transitioning towards a decarbonized energy system is beneficial for Korea not only from a climate perspective but also as a response to the air pollution, economic, and energy security concerns. However, the current industrial system of the country requires a structural reform of the energy-intensive sectors as a step forward towards the national energy transition pathway.

South Korea represents a presidential political system. Historically, the industrial development of the country was state-led, which reflects the current centralized governance structure, where the state and national policies play a central role in the energy, economic, and climate strategies development (IEA 2020a, 14). This shows that the role of the state, state intervention, and state planning matters a lot for the national energy transition in Korea. Therefore, a supportive policy framework is crucial for Korea to achieve its decarbonization goals.

From a legal perspective, Korea has established a comprehensive legal framework towards decarbonization. In 2020, under the Moon Jae-in presidential administration, Korea committed to the net zero by 2050 target (CAT 2023). In 2021, the government established the Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis, which legally embedded the net zero target in the national framework and established appropriate institutional mechanisms (Y. Lee et al. 2023, 6–7).

To achieve this long-term decarbonization target, under the Paris Agreement, the government has submitted its short- and medium-term goals towards the energy transition. According to the first NDC submitted in 2016, Korea committed to 37% reduction in GHG emissions from the estimated business as usual level of GHG emissions in 2030 (Government

of the Republic of Korea 2016, 1–2). In 2021, the government submitted an updated NDC with a new GHG emission reduction goal and baseline. The 2021 NDC states that the government aims to reduce 40% of GHG emissions by 2030 from the 2018 level (Republic of Korea 2021b, 2). In 2025, the government submitted an another updated NDC which reflects the GHG emission reduction target of 53-61% from the 2018 level by 2035 (Republic of Korea 2025, 1).

The domestic long-term energy strategy of Korea is established in the Energy Master Plan. The document establishes a 20-year framework for all energy related sectors and is revised every five years. The key goal of this document is to set a direction towards sustainable growth and innovative energy transition. The 3rd Energy Master Plan aims to increase renewable energy deployment, decrease energy intensity, reduce energy consumption, and continuously phase out coal (MOTIE 2019, 3–12).

Under the Framework Act on Carbon Neutrality and Green Growth, the government is required to establish and develop national strategic planning documents, the Basic Plan for Carbon Neutrality and Green Growth and the Basic Plan for Electricity Supply and Demand. These documents focus on the middle- and short-term energy targets that outline more quantitative targets. The Basic Plan for Carbon Neutrality and Green Growth, established in 2023, is a decarbonization plan adopted under the Presidential Commission on Carbon Neutrality and Green Growth, which aims to achieve goals in different sectors (Lee et al. 2023). For instance, it has set emission reduction strategies across sectors, climate mitigation measures, just transition principles, and a strategy for the development of the green energy industry together with the environmental targets (Government of the Republic of Korea 2023). The Basic Plan for Electricity Supply and Demand is a national energy strategy that determines the national energy mix, long-term electricity demand estimations, and targeted planning towards a specific energy mix, including coal, liquefied natural gas (LNG), nuclear, and renewable energy. The government has currently approved the 11th plan (Chang et al. 2025). Overall, Korea's energy transition framework is legally embedded by the Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis and is implemented through the strategic planning instruments.

From the institutional coordination perspective, the energy transition process in Korea is coordinated through multiple different ministries and executive bodies. Under the Framework Act on Carbon Neutrality and Green Growth, the government has established the Presidential Commission on Carbon Neutrality and Green Growth. The Commission serves

as a central coordination body for climate change mitigation and adaptation targets and policies (IEA 2025b, 11–12).

The key ministries that are taking the leading role in the energy transition governance are the Ministry of Trade, Industry and Energy (MOTIE), the Ministry of Environment (MOE), and the Ministry of Science and Information and Communication Technology (MSIT). MOTIE is focused on the national energy and industrial strategies. It sets out energy transition policies, focuses on energy efficiency, innovation policies, renewable energy, and nuclear energy deployment, and the electricity market (IEA 2020a, 197). MOE is responsible for climate change and environment preservation strategies, and it works closely with MOTIE to develop an efficient and integrated energy transition pathway (IEA 2020a, 197–98). Finally, MSIT focuses on the R&D, international cooperation, and partially nuclear energy research (IEA 2020a, 197).

However, in October 2025, the ministerial arrangement of South Korea has undergone some changes. The government established the Ministry of Climate, Energy and Environment (MCEE), which has taken over climate and energy-related responsibilities from the MOTIE. The new ministry is mainly focusing on climate, electricity, grid, and energy transition policies and issues. Moreover, MOTIE has been renamed into the Ministry of Trade, Industry and Resources (MOTIR), and it is now mainly overseeing industry policies as well as nuclear policy and fossil fuel-related policies (IEA 2025b, 4–5). As this reform is recent, this research is mainly focused on the energy transition policies and arrangements prior to this reform.

Besides ministries, state-owned corporations are also playing an active role in the energy transition process in Korea, such as the Korea Electric Power Corporation (KEPCO) and the Korea Energy Agency (KEA). KEPCO has a monopoly over the grid transmissions and distribution infrastructure, and it plays a central role when it comes to electricity market regulations and infrastructure management. KEA is responsible for technical support and development of energy efficiency programs (IEA 2020a, 198–99). Overall, the Korean energy transition framework reflects a centralized institutional arrangement coordinated through the multiple ministries as well as other agencies.

The Korean energy transition framework is not without limitations. The Climate Action Tracker (CAT) evaluates Korea's energy transition strategy as insufficient (CAT 2023). The first NDC goal has been criticized on the international level, as it was not aligned with the Paris Agreement pathway. Korea's political system allows for political and energy priority shifts between the administrations, which may affect the long-term political continuity of the energy transition pathway. Moreover, the industrialization of the country

creates a fossil fuel lock-in, as the economic development is heavily dependent on the industrial sector, which constrains the decarbonization pathway. Overall, Korea has a comprehensive, legally embedded energy transition framework. However, an effective energy transition process depends on efficient cross-ministerial coordination, as overlapping policies and responsibilities may create issues in the coordination of the decarbonization. Moreover, it is also affected by political continuity and administrative consistency. For instance, the shift towards the nuclear energy expansion that was announced by the new presidential administration in 2022 has signified a change in the energy mix priorities, which affected the policy continuity and political credibility (WNN 2023). Such insufficient coordination and short-termism can create political constraints for such a long-term energy transition process.

Comparison

Overall, both countries are committed to the net zero by 2050 goal and have developed supportive policy frameworks toward energy transition. They both prioritize energy security as they are continuously relying on imported fossil fuels. Moreover, both Japan and Korea rely on long-term planning instruments such as the Strategic Energy Plan in Japan and the Energy Master Plan in Korea. However, according to the CAT reports, both governments are struggling to align their overall energy transition trajectories to the Paris agreement pathway (CAT 2024, 2023). Japan and South Korea have differences when it comes to their legal frameworks. Japan does not have a single legal carbon neutrality framework, and the government mainly relies on a planning-based governance style. Instead, the energy transition process is coordinated through strategic plans and ministerial coordination. Korea, on the other hand, has legally embedded the net zero by 2050 in the national framework, which indicates a higher level of the legal anchoring of the Korean framework and legal and a more institutionalized governance style. From the ministerial coordination perspective, the government of Korea has a structured coordination through the Presidential Commission on Carbon Neutrality and Green Growth. In addition, the state-owned corporations such as KEPCO play a key role and once again prove the centralized energy governance. Finally, recent administrative shifts have affected the technological priorities by refocusing on nuclear energy, which has affected the policy continuity. This shows that from the institutional perspective, Japan relies on bureaucratic ministries, while South Korea relies more heavily on state-owned utilities.

In sum, this suggests that the long-term political stability and continuity play a key role in the energy transition framework, even in countries with different levels of legal

embedding levels. Moreover, in both countries, energy security constraints affect the speed and the decarbonization pathway. This indicates the key structural constraints of Japan and South Korea that drive national policy design. Both Japan and South Korea have a clear state-led energy transition characterized by strong national coordination.

2.2. Environmental dimension

2.2.1. Reduce greenhouse gas emissions

Japan

Japan is one of the world's leading economies, with a GDP of \$4.03 trillion (World Bank Group 2024). Due to the lack of natural resources, the country is heavily dependent on imported fossil fuels such as oil, LNG, and coal (IRENA 2022, 3–5). According to the IEA, as of 2022, Japan has emitted approximately 973.667 Mt CO₂ from fuel combustion, which accounts for 2.9% of global emissions. Japan has been ranked third after China and India in the Asia Pacific region, and the fifth global emitter in a global ranking (IEA 2023c). Japan's GHG emissions have decreased by 27.1% since 2013, which equals to approximately 378.1 Mt CO₂ (MOE 2025a). The main sources of CO₂ emissions come from burning coal and oil, which account for 41% and 38% of the country's CO₂ emissions, respectively. Until the 2011 Fukushima Daiichi accident, the government aimed to reduce fossil fuel dependence by replacing it with nuclear energy. In 2010, nuclear energy accounted for approximately 30% of electricity use and approximately 13% of total energy use (Adebayo et al. 2021, 2; Hassan 2024). However, after the disaster, the government shut down nuclear power plants, which resulted in a reduction of the nuclear energy share to 3% and an increase in fossil fuel consumption (Bakshi 2023, 211). The most energy-demanding sectors are electricity and heating production, transportation, and industry sectors, respectively (IEA 2023c; Ritchie et al. 2020a).

Under the Paris Agreement, Japan is committed to achieving carbon neutrality by 2050. According to the most recent National Determined Contributions submitted by Japan in 2025, the government's objective is to reduce GHG emissions by 60% by 2035 and by 73% by 2040 from 2013 levels (Government of Japan 2025). In line with Japan's first NDC, the government adopted its climate mitigation strategy, the Plan for Global Warming Countermeasures, which incorporates the 2050 neutrality goal. The Plan was updated in 2025, and it sets the direction for the mitigation policies, establishes key targets, and implements policy measures (MOE 2025b, 10–12). As has been mentioned earlier in the

political dimension, the MOE sets a direction of climate change policies, while the METI is responsible for climate mitigation policies.

Due to the lack of natural resources as well as the country's vulnerability to natural disasters, such as the 2011 earthquake and the Fukushima Daiichi accident, energy security plays an important role in shaping Japan's energy and climate strategy. As a result, its energy policy is primarily based on the 3E+S strategy, which prioritizes safety while aiming to achieve energy security, economic growth, and environmental sustainability (Bakshi 2023, 211). The national energy targets outlined in the most recent 7th Strategic Energy Plan are aligned with the 3E+S strategy and the recently updated NDC targets. Moreover, the government has also outlined an alternative scenario, in the event that the country misses the main target by 2040, the government aims to achieve a 61% reduction in GHG emissions by 2040 (METI 2025a). The 7th Strategic Energy Plan is Japan's key national document that sets long-term goals and the overall mitigation strategy of Japan's energy policy. This government revises every three years to remain relevant and reflective of the current energy system of Japan. Besides setting targets, the document also outlines Japan's main areas of focus: a shift to non-fossil energy, energy efficiency, grid development, and engagement of the private sector (METI 2025b).

In 2022, Japan introduced a new economic strategy towards decarbonization. The Green Transformation (GX) policy framework is a narrower policy that is mainly focused on the financial aspect of energy transition. Its main goal is to transition Japan away from a fossil fuel-based energy system to a clean energy one by introducing policy mechanisms to incentivize public investment through "GX Economy Transition Bonds", establishing an institution "GX Promotion Organization" to manage emission trading systems and hybrid carbon trading schemes, as well as a range of other requirements and obligations (METI 2023b). As a part of the Green Transformation Strategy (GX), the government has also announced the new nuclear energy policy. Japan is aiming to increase nuclear energy use by 20% in 2040 (METI 2025a; Wadham et al. 2025). Overall, Japan has a well-established legal framework that is structured around national targets, strategic planning, and international commitments. This planning-based governance style allows the government to maintain policy flexibility and balance GHG emission goals with the energy security issues.

Beyond the legal frameworks, Japan has developed various policy mechanisms that play a crucial role in reducing GHG emissions. The government identifies increasing renewable energy and improving energy efficiency as its main instruments towards GHG reduction (METI 2025b, 22–23). However, they are going to be discussed separately. In

2012, the government established a carbon tax scheme, also known as the Tax for Climate Change Mitigation. The tax applies to fossil fuels at the point of import and production at the rate of 289 JPY, approximately 2 US dollars, per ton of CO₂ (MOE 2012).

The emission trading system (ETS) is a common mitigation strategy, which has been implemented on the prefectural level so far. In 2010, the government introduced the Cap-and-Trade Program of the Tokyo Metropolitan Government, which requires owners of large buildings and facilities that account for approximately 20% of Tokyo's emissions, the most polluting region of Japan. The program sets a legally binding target to reduce the amount of GHG emissions that tightens with each phase (ICAP 2020). However, in 2023, under the GX policy, Japan introduced the Green Transformation Policy Emissions Trading System (GX-ETS) (IEA 2023b). The GX-ETS is implemented as a voluntary system that will become mandatory from 2026.

The government has also introduced the J-Credit Scheme, a voluntary program that encourages the private sector to reduce GHG emissions. Participating companies receive credits for emission reduction, which can be later used for voluntary offsetting and corporate emission reporting (IEA 2021b, 60). Moreover, the J-Credit Scheme is applicable under the GX-ETS, and companies can use the credits to meet the compliance obligations (ICAP 2023, 1–2).

Japan is also supporting various R&D projects, specifically carbon capture, utilization, and storage (CCUS) projects, as a way to achieve GHG reduction targets (JOGMEC 2024). According to the METI, the government aims to store 120-240 million tons of CO₂ annually by 2050, which is approximately 10-20% of Japan's entire emissions (METI 2023a). However, due to the lack of storage availability on land, large-scale onshore storage of CO₂ is difficult for Japan to provide. As a result, the government is mainly focused on carbon recycling projects as part of its CCUS strategy, as well as the offshore storage (IEA 2021b, 14).

Japan has adopted national targets and developed a diversified policy mix addressing various aspects of energy transition. While the overall energy strategies are comprehensive, the Climate Action Tracker (CAT) rates Japan's policies and actions as insufficient to reduce GHG emissions and achieve carbon neutrality by 2050 (CAT 2024). For instance, the report highlights the low rates of the carbon taxing scheme of Japan, which has a limited effectiveness on the emission reduction process (CAT 2024). The 7th Strategic Energy Plan includes an alternative scenario, which, on one hand, provides a level of flexibility while maintaining energy transition commitments, however, on the other hand, it highlights that

policymakers themselves foresee the country's inability to achieve set targets within allotted timeframes. Japan highly prioritizes energy security, which makes it heavily dependent on imported coal, oil, and gas due to the lack of natural resources and land, as well as the country's vulnerability to natural disasters. The OECD report highlights that while the government invests in renewable energy development, it is still not enough for the decarbonization goal (OECD 2025b). Additionally, reliance on CCUS raises concerns as the efficiency of its contribution to GHG emission reduction is uncertain due to these programs' high costs, technological challenges, and the limited storage availability (FOE Japan 2024). The government is facing a great deal of challenges which could result in missing the Paris Agreement target, not aligned with the 1,5°C pathway (CAT 2024). Despite the achieved progress, in order to confront the challenges it faces, Japan must continue policy innovation and enhance its actions to achieve its emission reduction goals.

South Korea

In 2022, South Korea emitted 549.311 Mt CO₂ from fuel combustion, which accounts for 1.6% of global emissions (Ritchie et al. 2020a; IEA 2023d). According to the regional ranking of the IEA, Korea has been ranked the fifth emitter in the Asia-Pacific region (IEA 2023d). Since 2013, Korea's GHG emissions decreased from 592 Mt CO₂ to 549 Mt CO₂, which represents a slow reduction progress of 7% over the decade (IEA 2023d). While developed countries tend to emit more overall, the numbers might differ depending on the structure of the energy mix and the energy sector, as well as its economy. Korea's dependence on fossil fuels remains rather high, with coal and oil being the top two largest sources of CO₂ emissions. When it comes to the sectoral breakdown of emissions, heating and electricity account for 51,7% of total emissions, the transport sector accounts for 19,3%, and industry accounts for 12,1% (IEA 2023d; Ritchie et al. 2020a).

The Republic of Korea is committed to a net-zero target by 2050. According to the most recent NDC submitted in 2025, the country confirmed the emission reduction goal of 40% by 2030 from 2018 levels. This is a significant improvement on the initially submitted NDC that had targeted 24.4% reduction in GHG emissions from 2017 levels by 2030 (Republic of Korea 2025, 1–2).

On a national level, long-term GHG reduction targets are outlined in the Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis, published in 2021. Moreover, Korea has legally embedded a 2050 net-zero target in this Framework (Republic of Korea 2021a). The Framework also requires the government to revise and

publish the National Basic Plan for Carbon Neutrality and Green Growth every five years, emphasizes the importance of a just transition, and establishes the 2050 Carbon Neutrality and Green Growth Commission to coordinate the energy transition strategies and policies. However, in 2024, the Constitutional Court of Korea declared that parts of the Framework are unconstitutional (NHRCK 2024). According to the ruling, the government has not established a sufficient decarbonization strategy. Moreover, there is no legally defined framework for the climate mitigation pathway for the period 2031 and 2049, which places additional burden on future generations. As a result, this government was obliged to revise the Act and include a clearer decarbonization pathway (NHRCK 2024). At the beginning of 2025, the MOTIE published the 11th Basic Plan for Electricity Supply and Demand, which outlines Korea's short-term electricity generation strategy and the targeted energy mix. While the official document is only available in the Korean language, according to a reliable source in English, the Korean government aims to generate 31.8% of electricity from nuclear energy, 17.2% from coal, 25.1% from LNG, and 21.7% from renewable energy in 2030 (Chang et al. 2025).

According to the First National Basic Plan for Carbon Neutrality and Green Growth, another national strategic planning document, Korea aims to shut down coal power generation plants and replace them with LNG plants. Moreover, under the president, Yoon Suk-yeol, the government of Korea has also announced a shift of focus from renewable energy targets 2050 to nuclear energy, as well as hydrogen and ammonia. This is a significant refocus of the policy strategy as the government of Korea slowed down nuclear energy development after the Fukushima accident in Japan. Since then, energy policies have been updated to include the target to increase the nuclear energy share to 32.4% by 2030, and increase to 34.6% by 2036 (Jun-tae 2022).

To reduce GHG emissions, South Korea uses various mitigation policy instruments such as the Korea Emissions Trading Scheme (K-ETS), support for research and development of low-carbon technologies, and incentive programs for the local governments. The K-ETS is the first national emission trading system in East Asia, introduced in 2015, that plays a central role in Korea's mitigation strategy (IEA 2020a, 40). The K-ETS has been implemented through three phases. The first phase focused on establishing the system, while the second and the third phases aimed to expand the system and tighten the emission cap. It is mandatory for all entities with annual emissions more than 25 000 tCO₂ and for companies with more than 125 000 tCO₂ (IEA 2020b, 40-41). In 2022, the system covered 79% of the country's total GHG emissions, operating under the cap-and-trade principle and regulating almost 700 entities. The K-ETS applies to various sectors, including energy, industry,

buildings, transportation, and waste. In 2024, the average carbon price was approximately KRW 10,355, which accounts for approximately 7.60 US dollars (ICAP 2024).

The Korean government has also implemented a system complementary to the K-ETS, the GHG Target Management System (TMS). While the K-ETS focuses on the large emitters, the TMS addresses the medium emitters, whose emission threshold is 50 000 tCO₂ per year or 15 000 tCO₂ per facility (IEA 2025b, 23). By applying the TMS, the government sets emission reduction targets and supports companies' reduction efforts through subsidies and tax deduction incentives (IEA 2020a, 43–44).

Innovation policies, especially CCUS deployment, play a crucial role in Korea's decarbonization strategies. The government emphasizes focus on research and development and aims to gradually scale up CCUS deployment and capacity despite the storage availability constraints (Government of the Republic of Korea 2020, 47–49). In 2025, the Ministry of Science and ICT (MSIT) announced the Carbon Capture and Utilization (CCU) Initiative that focuses on the development of new technologies and the advancement of industry. The government supports the CCUS development through research, development, and demonstration projects across different sectors, including industrial and power (MSIT 2025).

Korea is an industrial economy with limited natural resources that heavily depends on imported fossil fuels such as coal, LNG, and oil (IEA 2023d). Even though the country sets GHG emission targets, the renewable energy technology deployment and energy mix transition remain slow, resulting in slower emission reduction progress. Korea has established a legally embedded energy transition framework through the Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis. However, according to the Constitutional ruling, there is the decarbonization pathway for 2031-2049 is not defined enough (NHRCK 2024). This creates policy uncertainty in Korea's long-term mitigation pathway. The political shift towards nuclear energy expansion also affected policy continuity. Moreover, due to the low carbon prices, the OECD also emphasizes that Korea's efforts to reduce GHG emissions through the K-ETS system are less effective compared to other OECD members (OECD 2019). According to the Climate Action Tracker (2023), the actions of South Korea are rated as insufficient and are not aligned with the 1.5 C° pathway (CAT 2023). Despite the existence of a comprehensive mitigation framework, South Korea is still facing significant challenges in reducing GHG emissions.

Comparison

Both Japan and South Korea are committed to the net-zero target by 2050 under the Paris Agreement and prioritize energy security. However, the baseline years are different, and the countries set different short-term goals, which affect the national energy transition pathway. Japan's actions to reduce GHG emissions are mainly based on energy security and rely on long-term planning and flexibility of short-term goals, which allows adjustment of mitigation measures in broad strategic frameworks. While Japan has more ambitious targets numerically, Korea's mitigation framework is more legally binding, holding industry and the government accountable for the goals and regulations. According to the analysis of various international organizations, the carbon taxing systems of both countries are weak. In both countries, nuclear energy plays a central role as a mitigation tool and a way to compensate for slow renewable energy implementation. At the same time, while Japan emphasizes the potential of the CCUS in the long-term mitigation strategy, Korea has significantly progressed in CCUS deployment and frames it as a mitigation pathway. Overall, the Climate Action Tracker rates Japan's policy actions as insufficient, and Korea's as insufficient, which reflects a slow decarbonization process, fossil fuel dependency, and policy gap of both countries (CAT 2024, 2023). In Japan, the insufficient policies can be explained by its flexible long-term planning and weak carbon pricing, while Korea's insufficient rating is mainly the result of continued dependency on fossil fuels and the limited effectiveness of instruments for emission reduction. Finally, Japan's mitigation strategy is mainly constrained by import dependence and energy security issues, while South Korea's mitigation policy is dependent on industrial competitiveness and intensive fossil fuel production. This shows that despite similar structural constraints, there are different political constraints that affect the mitigation strategies of the countries.

2.2.2. Build resilience to climate change

Japan

Japan has always been exposed to natural disasters such as earthquakes, tsunamis, and volcanic eruptions, as well as to climate disasters such as heavy rain, high temperatures, and tropical cyclones, also known as typhoons (IEA 2021c). According to the IEA, the temperature and rainfall in Japan have increased over the last century and will continue to increase (IEA 2021c). Due to its high exposure to natural disasters, the energy sector adaptation governance is one of the key concerns of the energy transition governance. The design of the established energy system and its infrastructure may increase countries'

vulnerability towards climate change disasters. For instance, in 2019, Typhoons Faxai and Hagibis left almost 900,000 houses without electricity, which demonstrates the vulnerability of the energy infrastructure to such extreme weather events (McCurry 2019). Moreover, heatwaves cause an increased electricity demand, especially during the summer months, which strains the stability of the grid system. Additionally, Japan's coal and nuclear energy power plants are concentrated near the coastal area. The typhoons, floods, storms, and sea-level rises damage transmission lines and make energy infrastructure more vulnerable to such weather events (IEA 2021b, 61). Although it was triggered by the earthquake and the tsunami and not by the climate change, the Fukushima Daiichi accident in 2011 exposed the vulnerability of coastal energy infrastructure to extreme weather events (Kato and Tajima 2023, 1,5). Moreover, Japan's dual grid transmission is fragmented into 50 hertz (Hz) in the East of Japan and 60 Hz in the West, which limits interconnection and slows down power reallocation during disasters (Miyamoto 2025, 23–25). Japan is prone to natural disasters, which increases the country's vulnerability to climate change disasters, including its energy system. While there is a low risk of existential threat to the availability of Japan's energy system, it may affect the stability and increase the risk of disruptions and infrastructure damage. Therefore, the adaptation strategy is crucial for maintaining Japan's energy system reliability.

Japan's climate adaptation framework operates within the well-established natural disaster governance (MOE 2018, Article 1). While Japan has a strong disaster risk management strategy towards the natural disasters, this target is specifically focused on the energy-sector climate adaptation framework of Japan. The Strategic Energy Plan highlights the importance of climate resilience as one of the core directions of Japan's energy strategy towards ensuring energy security (METI 2025b, 57). In 2015, Japan adopted the first Climate Change Adaptation Plan, which established key principles and climate change adaptation initiatives in seven sectors (Government of Japan 2015, 4–7). However, the Climate Change Adaptation Plan lacks information on the energy sector and is discussed in the context of changes in energy supply and demand, and suggests addressing these issues by improving energy efficiency. In 2018, the government adopted the Climate Change Adaptation Act, Japan's first law that is specifically targeting climate change adaptation strategies. The law defines the responsibilities of the central government, local authorities, private sector, and the public towards climate change adaptation (MOE 2018, Article 3-6). The Ministry of Environment is responsible for developing national adaptation plans and monitoring the progress every five years (MOE 2018, Article 7-10).

From the institutional perspective, there is no dedicated body that is responsible for climate adaptation. The MOE is taking the main responsibility over the adaptation governance, while other ministries develop their own adaptation plans for their respective sectors. Japan's climate adaptation framework is not strongly institutionalized within the energy sector. Instead, Japan addresses climate resilience and climate change adaptation measures through links to the disaster risk management measures. As a result, two frameworks, the climate adaptation and the disaster risk management, are closely interconnected to address energy security and disaster prevention and are often framed as one.

Most of Japan's efforts towards ensuring energy sector-related adaptation measures are disaster-triggered. Following the major power outages caused by Typhoon Jebi and Faxai in 2018 and 2019, the government adopted amendments to the energy-related laws aimed at strengthening the resilience of the electricity supply system. Japan also strengthened the transmission support between the regions and promoted grid modernization (IEA 2021b, 61–62). These efforts address energy sector adaptation, but they are mainly framed as a disaster response and energy security instruments rather than the adaptation ones. Japan also pursues various technical measures that address the climate resilience of the energy sector, such as grid hardening, development of smart grids, and digitalization measures (Schilling 2024, 22–23). However, these initiatives are also oriented towards a broader risk prevention strategy. Additionally, the central government is heavily encouraging local governments to establish their Local Climate Change Adaptation Centers for collecting risk data information and climate change assessment through the Climate Change Adaptation Information Platform (A-PLAT). A-PLAT provides data related to the climate adaptation measures, risk assessment, and technical support for the local authorities as well as the private sector (OECD 2025a, 14).

Overall, Japan's policy approaches contribute to building climate resilience in the energy sector. However, these measures are mainly framed as disaster prevention policy approaches and energy security frameworks rather than a specific climate adaptation strategy. According to the national adaptation plan, Japan does not consider climate change risks urgent within the energy sector and provides limited sector-specific measures for energy infrastructure (IEA 2021b, 62). Moreover, coordination of climate resilience is divided between MOE and METI. This separation limits the integration of the climate adaptation mechanisms into the long-term national energy planning. The IEA suggests expanding Japan's existing natural disaster management framework by including specific climate adaptation measures, especially in the energy sector (IEA 2021b, 64).

South Korea

Over the last century, the annual temperature in Korea has increased by 1.6 C°, which is higher than the global average temperature among the OECD countries (Jones 2025). The country has also been facing significant weather changes and other disasters such as extreme temperatures, floods, droughts, rainfall, and typhoons (Republic of Korea 2022, 5–6). All these events pose a threat to the society and the energy system. The energy sector of South Korea is facing similar issues to Japan. On top of that, Korea has an isolated electricity grid that limits its capacity during climate change disasters. Additionally, the majority of industrial complexes are located near the coast, making them vulnerable to sea rises and typhoons. South Korea is a highly industrialized economy, and climate change disruptions may not only affect the energy infrastructure but also pose a threat to the economic growth, investment, and export-oriented sectors (CMCC 2021, 18–19). Issues such as the isolated electricity grid, high import dependency, and coastal infrastructure affect energy vulnerability, making it more exposed to climate change disasters. Disasters pose an even a greater risk to the industrial sector than the energy supply. While climate change disasters do not threaten energy supply on the existential level, they increase these risks to industrial continuity and grid stability. Thus, climate resilience is a policy priority.

The Korean government expresses its commitment to adaptation to climate change. In 2010, under the Framework Act on Low Carbon, Green Growth, the government established its first climate adaptation framework. In 2021, Korea adopted the Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis, and now the adaptation planning is embedded under the 2021 Framework instead. Moreover, Korea mentions adaptation in the NDC as part of its climate policy (Republic of Korea 2025, 3–4). The government is legally required to develop national adaptation plans every five years in order to adapt to climate change across all sectors (Republic of Korea 2021a, Article 7). The Framework also obliges local authorities and public institutions to develop their own adaptation plans, which creates a multi-level climate resilience governance (Government of the Republic of Korea 2022, 6). Currently, South Korea has adopted the Fourth Adaptation Plan, which focuses on strengthening the resilience of the energy infrastructure and industries, establishing a climate risk platform for science-based risk assessment, protecting the infrastructure, and developing a resilient supply chain (Republic of Korea 2025, 3–4).

In terms of the institutional coordination, the adaptation strategy, the Presidential Commission on Carbon Neutrality and Green Growth is the main decision-making body,

however the Ministry of Environment is doing the implementation and is responsible for the development of the national adaptation plans. The Korea Adaptation Center for Climate Change (KACCC) provides technical policy support and assists with developing national adaptation plans by providing scientific data and conducting risk evaluations (KACCC 2025). Local authorities and public institutions are also involved, as they are responsible for energy infrastructure (Government of the Republic of Korea 2022, 7).

Although Korea has established a well-institutionalized adaptation framework, the main strategic energy documents mention climate adaptation only briefly. The Basic Plan for Carbon Neutrality and Green Growth and the Basic Plan for Electricity Supply and Demand mainly focus on climate mitigation and energy mix diversification to ensure climate resilience in the energy sector (IEA 2020a, 47–48). However, to strengthen adaptation planning, the government has also established risk assessment measures through regular reporting of the Korean Climate Change Assessment Report. The report provides qualitative data that helps central and local governments to evaluate existing climate risks and establish adaptation planning. For the same purpose, in 2022, the government launched the Integrated Impact Assessment Platform for Climate Change Adaptation (Government of the Republic of Korea 2022, 4–5). Moreover, the government is implementing artificial intelligence to develop a disaster prediction system that monitors flooding or extreme heatwaves and contributes to the climate change data collection (Republic of Korea 2025, 3–4). While these are adaptation policy mechanisms, they do not address the energy sector directly.

Additionally, Korea also attempts to develop its energy infrastructure and make it more climate resilient. The government is mainly focusing on strengthening resilient energy infrastructure, developing smart grids, and continuously integrating sustainable energy sources (Government of the Republic of Korea 2022, 18). The island of Jeju is used as a trial site to test new smart grid technologies and energy storage systems to later apply them to the rest of the country (IEA 2020a, 47–48). Finally, the Korea's Green New Deal fund, which amounts to 42.7 trillion Korean won or approximately 36.6 billion US dollars, allocates funding towards adaptation measures as well as the overall energy transition process (IEA 2020a, 24–25).

Korea shows a well institutionalized climate resilience framework. However, the strategic documents mainly prioritize decarbonization and mitigation policies and barely mention extreme climate change disaster risks (IEA 2020a, 47). Moreover, the national adaptation plans do not provide measures for protecting the energy sector. Additionally, while the government puts effort into climate change monitoring and evaluation, the majority

of scientific assessments are qualitative, and it lacks quantitative analysis (IEA 2020a, 48). As a result, the adaptation planning may be less precise as it does not assess energy infrastructure vulnerability, and the investment in the infrastructure becomes problematic. Finally, Korea's industrial economy increases the country's vulnerability toward climate change disasters.

Comparison

Overall, Japan and South Korea are facing increased climate risks such as heatwaves, flooding, extreme rainfalls, and typhoons. Both countries are heavily industrialized economies with coastal energy infrastructure and isolated energy grids, which increase their vulnerability to climate disasters. Energy security is one of the key priorities for both countries. Therefore, climate resilience is framed as a response to energy security concerns in the energy transition governance.

From the institutional framework perspective, the climate adaptation strategy of Japan is heavily interconnected with the disaster management framework. While Japan has adopted the Climate Change Adaptation Act and established the national adaptation plan, the focus on the energy sector remains rather low. Moreover, the responsibility for energy infrastructure adaptation is divided between MOE, which is responsible for climate adaptation strategies, and METI, which is implementing the energy-related framework. In contrast, Korea's adaptation strategy is embedded in the Framework Act on Low Carbon, Green Growth, and is governed at the national, regional, and local levels. Japan implements such policy approaches as grid hardening, smart grid modernization, disaster response reforms, and the A-PLAT platform as a way to ensure infrastructure resilience, energy security, and natural disaster preparedness. Korea's policy approaches are more focused on monitoring and evaluating climate change risks through climate risk assessment reports, AI disaster prediction, and a pilot project on smart grids on the Jeju Island. While the country is also working on improving grids, it is mainly focusing on assessing and monitoring climate risks. Overall, both Japan and South Korea consider climate mitigation and energy mix diversification as a contributing mechanism towards climate adaptation. Moreover, the adaptation strategy of Japan reflects reactive climate resilience and a disaster-driven policy design, while Korea is more of a planned resilience with stronger institutionalization. This shows that climate resilience governance of Japan and South Korea differs in the policy logic, not only in instrument choices.

2.3. Techno-economic dimension

2.3.1. Increase the renewable energy share

Japan

Due to the lack of natural resources, Japan is heavily dependent on imported fossil fuels (IRENA 2022, 3–5). As of 2021, renewable energy accounted for 8,84% of the country's entire energy consumption. Of that 8.84%, solar PV, hydropower, wind energy, and geothermal energy are the country's top renewable sources (IEA 2021a). While the percentage of renewables remains rather low, the numbers have been gradually increasing each year. According to Japan's Electricity Survey Statistics, in 2023, the share of renewable energy accounted for 25,7% of the entire electricity generation, which shows a significant increase of 3% from last year (ISEP 2024). Solar PV is Japan's leading renewable energy source. In 2024, the cumulative installed solar PV accounted for 77,3 GW, ranking Japan 4th in the world after China, the US, and India for the amount of solar PV installed in 2024 (REI 2025). The second-highest renewable energy source of Japan, hydropower, reached approximately 50 GW in 2024. It is one of the most established, most well-developed sources and has been operating for over 60 years (REI 2025). As a result of this long-term stability and continuous development, the capacity levels have hardly fluctuated since 2018 (Yano Research Institute 2025; REI 2025). The rest of the renewable energy mix belongs to bioenergy and geothermal energy. To achieve such results, the Japanese government has been incentivizing renewable energy initiatives, expanding investments in research and development of new renewable energy technology, and establishing renewable energy promotion zones through the Strategic Energy Plans (Zaretskaya et al. 2024).

As has been previously discussed, Japan is committed to carbon neutrality by 2050. Experts highlight that Japan sets realistic national goals for renewable energy development, which will help attract investors more easily (Obayashi and Golubkova 2024). Japan's national targets for increasing the renewable energy share are outlined in the Strategic Energy Plan, which is revised every three years to adopt targets and policies. The 7th Strategic Energy Plan, published in 2025, aims for 40-50% of electricity generation to come from renewable energy by 2040. The plan also outlines specific goals set for each renewable energy type: 23-29% for solar energy, 4-8% wind energy, and 8-10% hydropower (METI 2025b). The most significant change that has been made since the 6th Strategic Energy Plan is the shift in nuclear energy policy. While the Fukushima accident in 2011 has significantly shifted

Japan's energy policy towards fossil fuels, after over a decade, the government is ready to restart nuclear energy reactors and maximize their use. According to the 7th Strategic Energy Plan, Japan aims to increase the share of nuclear energy to approximately 20% from the current 5% by 2030. In addition, the Strategic Energy Plan dedicates a specific chapter to the expansion of the hydrogen energy source (METI 2025b, 96). In 2018, the Japanese government has published its first hydrogen strategy that aims to achieve net zero by 2050 by using hydrogen energy. According to the 5th Strategic Energy Plan, Japan aims to be the first hydrogen society and become a world leader in the field of hydrogen energy (METI 2025b; IEA 2021b, 111).

The government has introduced certain policy frameworks to achieve the goals outlined in the Strategic Energy Plan and to achieve a low-carbon energy transition. The feed-in tariff (FIT) system introduced in 2012 played a crucial role in Japan's energy transition process. Under this scheme, power companies were obliged to purchase electricity produced by the renewable energy sources under fixed prices, which led to an overall boost of Japan's renewable energy sector and an increase in renewable energy investment, especially of solar PV and onshore wind energy deployment (Sakamoto and Tsubosaka 2024). However, the FIT scheme had its disadvantages, as fixed pricing discouraged renewable energy producers from responding to market signals and grid optimization, as well as consumers were burdened by higher costs due to the "Renewable Energy Levy" (Sakamoto and Tsubosaka 2024). To fix those issues, in 2022, the government of Japan has introduced a more market-oriented approach by replacing the feed-in tariff scheme with the feed-in tariff premium (FIP). Under FIP, the renewable energy producers earn money based on the market prices of the electricity and the extra bonus or "a premium" instead of the fixed prices (IEA 2021b, 88; Sakamoto and Tsubosaka 2024; Hassan 2024; InfluenceMap 2025a).

Another crucial policy mechanism that supports the increase of renewable energy share is the Green Transformation (GX) Decarbonization Power Supply Bill, introduced in 2023. The bill serves as a legislative and financial tool to achieve Japan's renewable energy targets. According to the government of Japan, the GX strategy is based on five pillars: budgetary measures, regulations and systems, financial packages, including GX Economy Transition Bonds that encourage long-term investments, the development of the GX League for the private sector, and global strategies for international cooperation (Government of Japan 2023). It was estimated that it would require approximately 150 trillion JPY (1 trillion USD) to achieve decarbonization outlined in the GX strategy (Government of Japan 2023). Moreover, the (GX) Decarbonization Power Supply Bill played a crucial role in the revision

of the 7th Strategic Plan (METI 2023b; Government of Japan 2023; Hassan 2024; InfluenceMap 2025b).

The Japanese government supports renewable energy deployment through strengthening the role of research and development. The Green Innovation Fund, established under the Green Growth Strategy, allocates 2 trillion yen for 10 years. While the money is not limited to R&D of new renewable technologies alone, it plays a key role in supporting early-stage low-carbon technologies and attracting private R&D and investment (METI 2020b, 6; NEDO 2025). Japan has also been strengthening R&D tax incentives and providing risk finance support for companies engaged in low-carbon and other energy-related technology development. For instance, to encourage enterprises to invest, the R&D tax deduction rate has been raised from 25% to 30% (METI 2020b, 7–9; Jupesta et al. 2025, 235–36).

Despite the ambitious goals and developed policies, the Japanese government is facing certain challenges in its decarbonization process. As has been previously stated, Japan is heavily dependent on imported fossil fuels, and one of the main importers of coal, crude oil, and LNG is Russia. However, due to current political tensions, Japan has chosen to reduce imports from Russia. As a result, the long-term goal of decarbonization has slowed down due to the short-term focus on stability (Government of Japan 2023).

Additionally, Japan is dealing with the issue of grid integration. Due to the fact that the country is split into two grid zones, the northern region is operating at 50Hz, while the southern region is operating at 60Hz. As a result, the electricity transmission is limited across the country and leads to power curtailment (Miyamoto 2025, 23–25). According to METI, 6.7% of electricity produced by solar and wind energy was curtailed in 2023 (Li et al. 2025, 2–3). To increase the national renewable energy share, the government plans to upgrade the grid and increase interconnection between the high-energy demand and low-energy demand regions (Vector Renewables 2023).

South Korea

Korea is the world's 14th largest economy and a leader in the manufacturing of petrochemicals, steel, car manufacturing, shipbuilding, and electronics (Statista 2025; IEA 2020a, 17). Its economy is based on the energy-intensive industrial sector, which explains Korea's high level of emissions. Fossil fuels accounted for approximately 85% of Korea's primary energy supply in 2019 (IEA 2020a, 18–19). The country is highly dependent of fossil fuels, especially on oil, coal, and LNG, which account for approximately 37%, 22%, and 20% of South Korea's total primary energy supply (IEA 2023d). As of 2022, renewables account

for 7.8% of electricity generation. Solar PV, hydropower, and wind energy are the country's top renewable energy sources, which account for 72.5%, 19.5%, and 7.3% of renewable electricity generation accordingly (IEA 2023d). Although renewable energy consumption remains relatively low, it has significantly increased over the past decade. While in 2010 renewable electricity accounted for approximately 1% of total renewable electricity consumption, and in 2022 the share increased almost up to 8% (IEA 2023d). However, compared to the IEA countries, the renewable energy share of South Korea has been the lowest (IEA 2020a, 80). As well as for Japan, it is rather challenging for Korea to do renewable energy deployment due to geographical issues, high population density, and limited land availability (IEA 2020a, 77). Despite these challenges, the Korean government has, instead, been focusing on offshore wind development as well as various other initiatives to continuously increase the renewable energy share. These characteristics form Korea's renewable energy policy approach.

Similar to Japan, the government agrees that diversifying the energy mix will ensure energy security and offer other advantages. In 2017, the Korean government established the Renewable Energy Implementation Plan 3020 (RE 3020). Under the RE 3020, the country plans to increase the share of renewable energy electricity to 20% by 2030 by prioritizing solar and wind energy sources. Moreover, the RE 3020 states that the government is going to align its interpretation of renewable energy with the international one (IEA 2020a, 82). Previously, the category of "new and renewable energy" included waste energy, industrial by-products gases, which made the share of renewable energy higher than it actually was (Republic of Korea 2006, Article 2). This made the renewable energy statistics more transparent and internationally comparable.

The Energy Master Plan (EMP) outlines the country's long-term framework that is revised every five years. According to the EMP, in 2019, Korea has set a goal to increase electricity generation from renewable energy sources from 6% in 2017 to 30-35% by 2040 (MOTIE 2019, 12). The document emphasized gradual steps towards phasing out nuclear energy, which was introduced under the Moon Jae-in administration (MOTIE 2019, 18).

Under the 2010 Framework Act on Low Carbon, Green Growth, the Korean government publishes the Basic Plan for Electricity Supply and Demand, which outlines a renewable electricity expansion roadmap. The plan is revised every two years. According to the 10th Basic Plan for Electricity Supply and Demand, established in 2023, the government aims to increase the share of renewable electricity to 21.6% by 2030 and to 30.6% by 2036 (Tachev 2024). The plan also outlined a significant shift in nuclear energy policy strategy

towards its expansion. According to the document, the government aims to increase nuclear energy up to 32.4% of the entire electricity generation mix in order to ensure energy security, signifying a reversal of the nuclear phase-out strategy (Tachev 2024). This marks a major political shift in energy strategy, rebalancing the energy mix by increasing nuclear energy on top of the renewable energy expansion.

Under the 2015 Paris Agreement, the NDC shows Korea's international commitment to the decarbonization goals. The NDC submitted by the Korean government aims to increase renewable electricity power generation to at least 30% by 2035 from approximately 9% in 2024 as part of the mitigation strategy (Republic of Korea 2025, 2).

To increase the renewable energy share, the Korean government has developed various policy approaches on top of setting numeric targets. In 2012, the state introduced the Renewable Energy Portfolio Standard (RPS), which requires power companies with a power capacity larger than 500 megawatts (MW) to continuously increase the share of renewable energy in their total power generation. In 2022, the policy goal was set to increase renewable energy generation to 25% by 2026 (IEA 2020b; InfluenceMap 2024). To comply with the RPS, companies can either produce and generate renewable energy or purchase renewable energy certificates (RECs). REC is a tool in the renewable energy market that represents 1 MWh of electricity generated by renewable energy (Chen and Jou 2025). This system creates a market for renewable energy certificates with the prices formed based on the market interactions.

Another approach to develop the renewable energy sector and increase renewable energy is through auctions. The auctions are organized by the Korea Energy Agency's New and Renewable Energy Center, which offers fixed-term contracts for solar, wind, offshore projects, and energy storage systems (ESS) in competitive bidding. In 2024, South Korea granted 2,085 MW of offshore wind capacity and 1 GW of solar energy capacity, which also indicates the country's strategic priority towards offshore energy (Enerdata 2025). This shows that the government uses auctions as a direction-setting mechanism and encourages major stakeholders to participate (IEA 2025b)

The country has been dealing with transmission issues due to its insufficient grid capacity. As a result, the transmission expansion and modernization processes faced significant delays. Moreover, KEPCO's monopolized control over grid transmission and distribution which has limited competition and created financial constraints for grid infrastructure investment (Kim 2025, 6–7). To address this issue, Korea has put a strong focus on innovation, research, and development. For instance, one of the key focus areas is

the decentralization of the grid system and the development of smart grids. The pilot project of smart grids was launched on Jeju (ESCI 2025). The government is also trying to promote energy storage and other transmission regulatory reforms. Despite these efforts, the transmission grids continue to create issues for renewable energy deployment.

The government has also established the Green New Deal. Under this initiative, there is a climate fund that plans to invest approximately 144 billion US dollars in renewable energy deployment, including green infrastructure, the industrial sector decarbonization, and green mobility (Chowdhury 2021). Until 2023, the responsibility for the funds was under the Ministry of Finance, however now the responsibility lies with the Ministry of Climate, which strengthens the coordination of decarbonization and energy transition policies (MOE 2023).

The government has also introduced incentive approaches to promote renewable energy. For instance, it has introduced the Housing Support Scheme, according to which the government provides subsidies for houses that install and use renewable energy to get heating and electricity. In 2017, the government even offered a discount from 10% up to 75% for the renewable energy electricity bill (IEA 2020a, 89–90)

Korea still has a long way to go to achieve decarbonization. While the country sets ambitious renewable energy targets, the progress is rather slow. The country is facing various challenges, such as transmission delays due to the grid constraints, land constraints for solar energy, and continued fossil fuel dependence. The shift towards nuclear energy expansion indicates policy reorientation, which can create investment uncertainties (CAT 2023). The IEA recommends to continue promoting renewable energy expansion through incentive programs, effective communications with citizens, especially in the local areas, and improved communication with citizens, especially from local regions (IEA 2020a, 95).

Comparison

From the techno-economic development perspective, Japan and South Korea are at different stages of renewable energy deployment. As of 2023, Japan was producing approximately 25% of electricity through renewable energy resources and is currently focused on optimizing and restructuring the existing renewable energy system (ISEP 2024). By contrast, Korea's renewable electricity production remains at the earlier stage of the expansion phase and accounts for approximately 8% of the entire electricity generation, which suggests that the country is still at the starting point of renewable energy deployment (IEA 2023d). In terms of the official targets, both countries are aiming for renewable energy expansion alongside with the nuclear energy restart, however, the emphasis is different.

Japan's strategy is more long-term oriented, and nuclear energy is complementary to the renewable expansion framework, while for Korea, nuclear energy plays a more central role in the overall energy mix. To achieve these targets, Japan uses price-based support models through policies such as policy approaches as FIT, FIP, and GX financial mobilization, to reduce investment risks and guarantee stable prices. Whereas Korea uses a quota-based framework that creates competition by using competitive auctions and RPS. This shows that Japan aims to reduce investor risks and encourage energy market growth by ensuring state-driven prices. South Korea, in contrast, sets quantifiable targets and encourages market competition between the companies. This shows different economic choices behind the goal of increasing the renewable energy share. Finally, both countries face grid constraints that affect their renewable energy deployment progress. However, Japan's issues come from the technical fragmentation, which contributes to renewable energy curtailment, while Korea's require institutional regulations, as the issues are mainly related to the KEPCO's centralized grid control.

2.3.2. Promote energy efficiency

Japan

Japan is ranked 11th among the IEA members in regard to energy efficiency (IEA 2021b, 69). Due to the country's energy vulnerability, energy efficiency strategies play a crucial role in Japan's energy policy, as they can simultaneously reduce GHG emissions, provide energy stability, increase economic competitiveness, and, most importantly, guarantee energy security. The lack of natural resources, frequent natural disasters, and other global crises, such as the oil crisis in 1973 or the Fukushima accident, have encouraged the government of Japan to strengthen its policies and concentrate on developing energy-saving technology. The Japanese government launched initiatives and campaigns to save energy, and the practice of energy saving remained even after the crisis was over. As of 2018, Japan's total final consumption accounts for 283.0 Mtoe (IEA 2021b, 69). According to the IEA report, total energy consumption levels decreased by 8% over the period from 2011 to 2018. At the same time, the country's GDP increased by 8%, which led to energy intensity reducing by 15% (IEA 2021b, 69). More specifically, the numbers went from 127 kWh in 2011 to 105kWh in 2022 (Ritchie et al. 2020a).

Improving energy efficiency can not only help a country to achieve environmental targets and contribute to the reduction of GHG emissions, but it can also guarantee energy security. Therefore, the government of Japan has been actively promoting energy efficiency

through different measures. The energy efficiency measures have been heavily outlined throughout the revised versions of the Strategic Energy Plans. The Act on the rational use of energy, also known as the Energy Conservation Law, was established in 1979 and serves as a pillar for Japan's energy efficiency strategy. Under the Act, Japan uses different regulatory and promotional measures to encourage energy-saving practices (IEA 2017).

Regulatory measures include energy management through internationally recognized systems, performance standards such as the Top-Runner Program, and visualization, for instance, through the Energy-Saving Labeling System (IEA 2024d). The Top Runner program was introduced in 1999 and mandates product manufacturers to comply with stronger, more energy-efficient standards for technical devices and equipment. As of today, the program is targeting 32 products such as passenger vehicles, freight vehicles, air conditioners, electric refrigerators, electric freezers, electric rice cookers, microwave ovens, lighting equipment, electric toilet seats, television sets, video cassette recorders, DVD recorders, computer, magnetic disk units, copying machines, space heaters, gas cooking appliances, gas water heaters, oil water heaters, vending machines, transformers, routers, switching units, AC motors, LED lamps, sashes, multi-paned glazing, multi-function devices, printers, electric water heaters, showcases and insulation materials (IEA 2017, 2024d).

Under the Top-Runner Program, the government has introduced the Energy-Saving Labeling System for retailers that aims to reduce energy consumption in households. The system was established in 2006 and encourages consumers to purchase energy-efficient products by providing consumers necessary information on the label. The program covers the products included in the Top-Runner Program (ECCJ 2018).

Promotional measures are playing a crucial role in the efforts to promote energy efficiency. They include subsidies for industry and commercial energy efficiency investments, facility purchasing and interest payments, tax incentives for facilities, buildings, automobiles, and R&D, and public awareness activities (Baker McKenzie 2025). For instance, companies that have been classified as energy-efficient for two years have an opportunity to deduct 30% of the purchase cost of new energy-saving equipment in the first year (IEA 2021b, 78–79). On the local level, municipal governments of Tokyo, Mie, Toyama, and Fukui prefectures are offering rebates for replacing old equipment with new and more energy-efficient ones (Tochibayashi and Ota 2024). Promoting energy efficiency through public awareness campaigns, through various exhibitions, promotional flyers, and workshops, is playing an important role. During the crisis of the Great East Japan Earthquake and the Fukushima accident, which caused a large blackout, the government launched the

Setsuden campaign. The movement not only helped to manage the energy levels after a sudden loss of nuclear power, but also shaped consumer behavior and a culture of energy saving (METI 2022; Kakuchi 2011).

Overall, the energy efficiency strategies of Japan receive positive feedback from the international organizations. Three pillars helped Japan develop such a strong energy efficiency policy: cultural, economic, and policy. From a cultural perspective, avoiding waste, which aligns well with saving energy, has always been part of Japan's cultural norms. Japan has quickly realized that energy efficiency can benefit economically, as the industry competitiveness can continue growing while the energy costs are reduced. Finally, the government has implemented the storage policies and regulations (VNEEP 2024). Indeed, Japan has developed a strong energy management coordination system among ministries and established effective communication with the public. The government's efforts to actively cooperate with the private sector and develop incentive programs and standardization systems have significantly fostered technology innovation and industry competitiveness (Panjaitan et al. 2024, 117–18; IEA 2021b, 69–87).

South Korea

Korea is considered one of the most energy-intensive countries, and compared to Japan, energy efficiency progress has been significantly slower. According to the IEA report, it is ranked 33rd among 38 OECD countries (Yun-mo and Birol 2019; IEA 2020a). The majority of energy is consumed by the industrial sector. Heavy industry, such as iron and steel, chemical, and machinery, accounts for the majority of the energy consumption (IEA 2023d). Between 2000 and 2023, the country's carbon intensity remained relatively unchanged, with the numbers decreasing from 0.19 kWh in 2000 to 0.16 kWh in 2023 (Ritchie et al. 2020b).

In response to the oil shock in the 1970s, the Korean government established the Act on Rational Energy Use to prioritize energy efficiency. This law serves as a legal framework for all energy efficiency policy mechanisms and standards (Republic of Korea 2024). The Act on Rational Energy Use established the minimum efficiency standards, the labeling system, and the measures for manufacturers that fail to comply with the rules (Vine et al. 2006, 1108–9). Additionally, under this Act, the government is supposed to come up with five-year targets. For instance, the most recent, the Sixth Basic Plan for Rational Energy Use, targets to reduce energy intensity by 13% by 2024 (Anwar et al. 2023, 38–39). The long-term strategic direction of the energy efficiency of Korea is outlined in the Third Energy Master Plan

published in 2019. The document emphasizes energy efficiency as a key instrument towards decarbonization and sets a target to reduce energy consumption by 18,6% by 2040. According to the Master Plan, the target will be approached by sector (MOTIE 2019). On top of that, the Korean government has established a separate body responsible for energy efficiency strategy, called the Energy Innovation Policy Bureau (IEA 2020a, 56).

There are several main measures aimed to promote energy efficiency in the industrial sector: the Energy Champion Program, the Voluntary Energy Intensity Reduction Agreement, the Factory Energy Management Systems (FEMS), and the Target Management System (TMS) (IEA 2020a, 59–63; KEA 2025). While mandatory instruments exist, the Korean government tends to rely more on voluntary mechanisms to promote energy efficiency.

The Energy Champion Program, established in 2015, encourages companies to reduce their energy consumption on a voluntary basis (IEA 2020a, 60–61). In 2018, 25 companies that registered to participate in this program managed to reduce their energy consumption by 2,5%. Another voluntary program, the Voluntary Energy Intensity Reduction Agreement, stimulates companies to reduce energy consumption by 1% each year (IEA 2020a, 60–62). Additionally, the government established the Target Management System (TMS), a regulatory program that mandates companies to set targets to reduce carbon emissions and energy use (IEA 2020a, 62). Finally, the Energy Management System (EMS), a digital system applicable to industry and building sectors, is aimed at monitoring the efficiency, analyzing the amount of energy wasted, and optimizing the usage (Anwar et al. 2023, 55–56; IEA 2020a, 61).

The government has also established certain mechanisms to increase energy efficiency in the residential sector alongside the EMS. In 1992, the Korean government established the Energy Efficiency and Labeling Standard system, which, as the Japanese system, encourages consumers to purchase energy-efficient products and requires product manufacturers of 35 types of products to comply with energy-efficient standards (IEA 2024a). Another mandatory program is energy audits for new buildings. Moreover, the government has also established a mandatory certificate scheme for public buildings. According to the program, there are three types of certificates: Building Energy Efficiency Certification (BEEC), Zero Energy Building Certification (ZEBC), and Green Building Certification. BEEC has the lowest standards of all and is required to receive other certificates. It rates energy performance and the amount of GHG emissions buildings emit. ZEBC rates the building on a five-level scale, based on the level of self-sufficiency. Finally, the Green Building Certification pays attention not so much to the energy efficiency, but to

the overall environmental performance of the buildings (Narita et al. 2020, 28–29). This shows that the policy instruments in the building sector are stricter and more regulated compared to the industrial sector.

Overall, Korea's energy efficiency policies need adjustment. Many energy efficiency efforts of the Korean government are heavily criticized by the international organizations. The country's main energy consumption comes from heavy industry, and the majority of the measures enforced on the industrial sector are voluntary, which has led to limited compliance among the private sector and limited effectiveness of the policy approaches. Moreover, the lack of minimum standards can lead to slow progress in improving energy efficiency. As a result, the IEA, in its analysis of Korea's energy policies, suggests funding cost-efficient projects, strengthening economic incentives for the industry, and setting the minimum standards for equipment (IEA 2020a, 74–75). This way, the country will be able to save up to 600 billion dollars USD (Yun-mo and Birol 2019).

Comparison

Both Japan and South Korea recognize energy efficiency as a core component of their energy policies. However, the policy approaches adopted by the two countries differ significantly. This difference can be partially explained by the different economic structures of Japan and Korea. South Korea's economy is heavily dependent on the heavy industry, which makes it more difficult to regulate efficiency improvement and reduce the industrial energy demand. Japan's economy is more diversified, and as a result, it is comparatively easier to implement energy efficiency standards.

Japan's energy efficiency policy has been implemented for decades, and it has been gradually tightened through various regulatory instruments. Since then, the government has developed a stable, regulatory-driven energy efficiency strategy with mandatory standards and normalized energy-saving practices. For South Korea, on the other hand, the implementation process of energy efficiency policies took more time and relies on a different set of policy approaches. Although a significant number of measures and initiatives have been introduced, the progress in reducing energy intensity is moderate compared to Japan. Moreover, despite the high energy intensity that is mainly caused by heavy industry, the government continues to rely on voluntary measures. Overall, this shows that Japan mainly relies on mandatory standards and follows a regulatory-driven governance model, whereas South Korea chooses to encourage the private sector through voluntary agreements rather than strict regulations and follows a voluntary and industry-oriented governance model.

2.4. Socio-technical dimension

2.4.1. Strengthen public support

Japan

According to the Global Market Research and Public Opinion Specialist (IPSOS) report, 81% of Japanese people are concerned with climate change. However, only 40% of survey participants believe that individual actions are necessary to tackle climate change, which is the lowest result among 32 countries that participated in the survey (Nippon Communications Foundation 2025; Japan beyond coal 2025). The national survey conducted by Japan Climate Alliance (JCA) shows that 72,1% of the Japanese citizens are paying attention to climate and energy policies when it comes to elections and choosing candidates to vote for (Nakata 2025).

While nuclear energy is not considered a renewable energy source, it is impossible to discuss the topic of public support in Japan without it. The accident at TEPCO's Fukushima Daiichi Nuclear Power Station in 2011 has significantly affected the public perception of nuclear energy, which led to the government's decision to shut down the majority of nuclear reactors in the country (Inajima and Okada 2011). The survey conducted by the Japan Atomic Energy Relations Organization (JAERO) shows that 49,4% of the participants do not mind continuing to use nuclear energy, but would prefer to gradually reduce it to zero (Shiraki et al. 2021, 378). As a result of the Fukushima accident, the public has become actively involved in Japan's energy policy, and the government has been putting effort into raising awareness on energy-related matters and promoting renewable energy and energy conservation.

The 7th Strategic Energy Plan has a section dedicated to promoting an understanding of energy among the public. The document highlights energy education, information, and transparency in decision-making processes as the key strategies to address the matter. The Energy Plan also recognizes the loss of public trust due to the Fukushima accident, and the government aims to restore communication, build informed acceptance and support in national energy policy (METI 2025b, 103–6).

There are various policy mechanisms that are adopted by the Japanese government to shape public perception on the energy transition process. Public awareness strategies for the energy transition process are mainly based on environmental education in Japan. As the developer of the UN Decade of Education for Sustainable Development (UNDESD), the

Ministry of Environment, together with 11 other ministries and agencies of Japan, has integrated the framework on a national level through education, local and community engagement in various projects, and participation mechanisms, such as public forums, partnerships and awareness campaigns for public, private sector and local residents (MOE 2009). These instruments are aimed at rebuilding public trust and normalizing the energy transition process.

There are various public campaigns organized by the government entities to encourage behavioral changes and increase visibility. For instance, Japan's Ministry of Environment launched the "Cool Biz" initiative in 2005, targeted to reduce CO₂ emissions and reduce the use of air conditioners by adjusting room temperatures and wearing lighter clothing (Government of Japan 2021a). The Heat Pump and Thermal Storage Technology Center (HPTCJ) is actively involved in public awareness campaigns on energy efficiency through such initiatives as "Thermal Storage Month", seminars, exhibitions, and published materials. HPTCJ does not promote renewable energy, but they focus on technologies that can make the integration of renewable energy easier (HPTCJ 2025).

The Japanese government is increasing public support and fostering public awareness through economic incentives, which provide financial support and increase acceptance through cost reduction. A great example of such measures is the solar subsidies in Tokyo. According to the new regulations, new houses are required to have solar panels installed (Nakayama 2025). On the national scale, Mizuho Bank offers subsidized loans for low-carbon investments (Mizuho Financial Group 2025).

Japanese government builds public support by prioritizing information, incentives, and normalization of the energy transition process. Despite the government's efforts and public's understanding of climate change urgency, there are certain factors that cause public skepticism towards renewable energy that has been growing over the last years especially on a regional level. People's reluctance to implement renewables is mainly explained by economic concerns, spatial concerns in local areas, and cultural aspects. For instance, local opposition has led to cancellation of several renewable energy projects throughout the country. In 2022, Kansai Electric Power Co. had to abandon the project of building the wind farm, that was supposed to generate 96,600 kilowatts of electricity in Miyagi Prefecture. The local residents were concerned about the landscape of the popular tourist attraction, the Okama Crater Lake (The Yomiuri Shimbun 2023). This suggests that insufficient local engagement can lead to lack of public support.

South Korea

According to the Renewable Energy Target Group Segmentation Survey Report conducted by the Solution for Our Climate (SFOC) in 2024, eight out of ten Korean citizens feel affected by climate change. The study shows a positive perception of energy transition within the Korean society. According to the report, the ideal energy mix for the Koreans includes 31% of renewables and 26% of nuclear energy. The Korean public does not believe that individual efforts can significantly help, and the main responsibility for achieving energy transition lies with the government and the private sector (SFOC 2024). Another survey suggests that general public as well as local residents are supportive of renewable energy deployment when there are socio-economic benefits. As a result, noticeable benefits significantly affect public opinion on renewable energy technology and energy transition overall. However, the participants of the survey still expressed concerns regarding the impact of renewable energy deployments on the environment and disruption of local areas (Moon et al. 2023, 1–2, 11–12). This suggests that public support of Korean citizens is conditional, as it depends on government actions and clear economic benefits.

Korea does not have a clear public awareness strategy that is articulated in one national energy strategy. However, various sectoral policies outline ways to increase public support for renewable energy development. The 8th Basic Plan for Long-term Electricity Supply and Demand emphasizes the importance of providing support and early engagement with the local communities. The document highlights Korea's target to install renewable technology in public buildings such as schools, public buildings, and rural areas. There is also a high emphasis on the fairness of the energy transition in the document. The installation of solar PV panels on public rooftops, together with the supporting infrastructures, has significantly increased the visibility of renewable energy technology, which may strengthen public support (MOTIE 2017). The Korean government also attempts to increase public awareness through the institutionalized energy education. According to the Environmental Education Promotion Act, energy education is a state responsibility and is used as a tool to build long-term public support, which is led by the Ministry of Education (Hyein Lee 2025). This indicates sectoral approach towards increasing public support rather than central.

Despite the lack of a formal strategy, there are various initiatives and projects that promote carbon neutrality and renewable energy development, which can increase public awareness. For instance, Korea Energy Agency (KEA) highlights energy welfare through a voucher program to increase energy accessibility in certain areas, national consensus-building

through social media, TV, and newspapers, as well as exhibitions and interactive programs for local communities, and energy education together with the Office of Education through educational and professional training programs when it comes to raising public awareness (KEA 2023).

Public support is strengthened through local initiatives. The Carbon Free Island Jeju by 2030 policy aims to completely stop using fossil fuels by 2030. One of the main ways to achieve the set target is through eco-tourism. By attracting visitors, the local government creates a positive image of renewable energy, spreads awareness, not only among the Korean citizens, but also among visitors from all over the world (OPSI 2022, 2–4). This shows local government initiative and increases the visibility of renewable energy development.

The Renewable energy target group segmentation survey report conducted by the Solution for our climate (SFOC) in 2024 highlights that the main concern of Korean citizens when it comes to energy transitions are the costs of implementation and maintenance of renewable energy technology, supply, demand, and system reliability, and an overall practicality of renewables being the main source of energy mix (SFOC 2024). In response to these concerns, the Korean government has provided financial incentives to reduce the burden of renewable energy deployment.

Overall, while Korean citizens generally express concern about climate change, there is a certain level of skepticism. It can be explained by the lack of a central policy strategy for public engagement, which results in inconsistent and project-oriented public engagement approaches (IEA 2025b, 46–47). Engaging only with a certain group of stakeholders and informing the public late can lead to a lack of trust and a sense of unfairness, especially in local communities. For instance, due to these issues, offshore wind projects are facing significant delays and financial losses, as the fishermen whose livelihood directly depends on the marine spaces are not systematically involved at the early stages of project deployment (SFOC 2025, 8). Finally, financial incentives used to encourage local public acceptance are narrow and insufficient, as they are not addressing broader socio-economic impacts of energy transition processes (SFOC 2025, 8; Moon et al. 2023, 11–12). According to the IEA, public support can be significantly strengthened with a comprehensive national policy strategy for public awareness through communication with the public, engagement with local authorities and incentive mechanisms (IEA 2020a, 22–23).

Comparison

In both countries, the public expresses a high level of concern about the impacts of climate change. However, citizens in both Japan and South Korea also do not believe in the effectiveness of individual efforts and place the responsibility on the government and other major actors involved in the energy transition. The historical events play an influential role in forming public trust. In Japan, the accident at Fukushima Daiichi Nuclear Power Station has significantly shaped citizens' trust and perception of energy policy, which also influenced the way the Japanese government approaches public support strategy. As a result, the government strives to develop a relatively explicit public awareness strategy through such mechanisms as education campaigns, community engagement mechanisms, and increased transparency. South Korea, by contrast, does not have an explicit national public awareness strategy. However, instead, public awareness and acceptance are promoted indirectly through visibility of renewable energy projects, encouragement of the local initiatives, and economic incentives. While Japan has developed instruments to increase public support through education, communication, and transparency, the renewable energy development still faces the local opposition. In South Korea, the implementation of renewable energy is supported by the citizens mainly when the projects guarantee immediate social or economic benefits. This suggests that Korea follows a less centralized governance style and focuses on targeted sectoral policies and economic incentives to ensure public support. Japan implements a more centralized governance style through national awareness strategies. Overall, public support heavily depends on policy design, trust-building mechanisms, and economic incentives.

2.4.2. Address distributive justice concerns

Japan

Japan's policy documents do not explicitly mention just transitions, and there are no specific policy frameworks that target the just transition process in Japan. At the same time, the Japanese government frames its energy strategies around fairness, industrial competitiveness, disaster recovery, and regional equity. For instance, Japan's NDC mainly focuses on transparency and fairness on the global level (Government of Japan 2025, 13–14). The 7th Strategic Energy Plan mentions fairness referring to electricity consumers in the context of grid development and to market and trade practices (METI 2025b, 59, 73, 86). The same context is applied in the GX policy document (METI 2023b, 21,24). While Japan has ratified the Paris Agreement, which explicitly mentions a just transition towards the workforce in the preamble and is committed to the 2030 Agenda for Sustainable

Development, Japan's energy policy has not incorporated these concepts into the national energy strategy (UNFCCC 2016, Preamble; UN 2015). As a result, despite referencing fairness and transparency in the transition policy frameworks, the topic of justice has not been fully institutionalized.

Despite no actual framework on just transitions, the Japanese government highlights that the carbon neutrality by 2050 goal is going to be achieved inclusively, and no one is going to be left behind (Sokołowski and Kurokawa 2022, 187). Attempts and initiatives to achieve a just transition can be more visible on the regional levels. For instance, the Kyoto government has joined the Powering Past Coal Alliance, and the Fukushima prefecture is aiming to become 100% renewable by 2040 (Asaoka 2021; Bassetti 2020). Overall, local authorities are being more proactive to address the issues of justice, although the scope of local policy actions depends on the regional economic capacities (Mabon et al. 2022, 11).

The topic of just transition in Japan is actively discussed by various NGOs and civil societies in Japan. These stakeholders play an advocacy role between workers, businesses and local authorities. The key organizations, such as the Renewable Energy Institute (REI), Friends of the Earth, the Kiko network, the Japan Climate Initiative, and various Fukushima-based groups, demonstrate the bottom-up approach towards just transitions (Kiko Network 2021, 10–11). Depending on the proportion of carbon-intensity sectors in the prefectures, local governments would require more support for just transition. For instance, one of the top regions with the majority of carbon-intensive jobs is Tohoku and Minami-Kanto, making them especially vulnerable to the energy transition process (Mabon et al. 2022, 12–14). According to one of the Japanese NGOs that actively promotes just energy transition, approximately 151,000 workers of fossil fuel-related industries are at risk all over Japan (Kiko Network 2021, 11). The government has provided mechanisms such as labor reskilling, regional decarbonization zones, and energy subsidies. The Green Transformation policy specifically mentions the training courses to support the decarbonization process (METI 2023b, 30). However, current solutions proposed by the Japanese government carry only short-term measures. The lack of clarity in national policy documents regarding the labor and regional protection shows that there is no clear path and no clear understanding of what a just energy transition should look like in Japan. Just transition is a long-term process that requires long-term commitment and financial support.

The nuclear Fukushima accident in 2011 and the aftermath of it shows the consequences of insufficient justice mechanisms, which also affect energy transition pathway. The disaster led to the collapse of the nuclear energy sector, the displacement of

communities, and the long-term decline of the Fukushima and Tohoku regions (Mabon et al. 2022, 4–5). Even after more than a decade after the accident, the developments highlight Japan's lack of effective mechanisms to ensure distributional justice towards the affected citizens. Rural areas with nuclear and carbon-intensive industries have carried and still carry the majority of the social and economic costs, while other regions and prefectures benefit from a secure energy supply. From a procedural justice perspective, the Fukushima accident exposed disproportionality between the central government and the local authorities. The decision to restart the nuclear energy policy clearly shows this imbalance, as local communities of certain regions have been opposing the nuclear restart. These unaddressed concerns resulted in the post-Fukushima NIMBY conflicts and can be a potential issue in the low-carbon energy transition processes (Sokołowski and Kurokawa 2022, 188).

Although Japan is putting effort into complying with international frameworks on just transitions, such as the ILO's Just Transition Guidelines, the policies remain fragmented and insufficient. Challenges, such as demographic decline, aging population, and relocation of the younger population to the larger cities, make decarbonization processes much harder, especially in rural areas (Mabon et al. 2022, 29). The majority of Japanese citizens recognize the issue. According to the Climate Survey conducted by the European Investment Bank in 2023, 62% of the participants considered challenges of achieving a just transition as the third most significant issue (Froimovici 2023). As a result, international organizations emphasize the importance of developing a national level just transition framework that prioritizes social dialogue with local authorities, communities, and civil societies. Such dialogues ensure that no one is indeed left behind and that vulnerable groups are also recognized as stakeholders of the current energy transition. In addition to the retraining programs already offered by the government, a just transition requires financial support through energy subsidies or investment to protect vulnerable regions and their residents. Finally, there is a knowledge gap. Scholars highlight that there is not enough research done on the just transition in Japan. The topic has started to develop after 2017, and even the Fukushima accident has not triggered interest in the topic (Sokołowski and Kurokawa 2022, 192).

South Korea

The economic structure of South Korea is heavily dependent on intensive manufacturing and exports. This leads to Korea being a top country for GHG emissions in rural areas among OECD countries, as the majority of coal and other industrial plants are located in the rural provinces (OECD 2023, 7–11). High focus on coal production and other

fossil fuel industries creates regional lock-ins, which result in low levels of the economic diversification of rural areas and making it more difficult for them to adapt to the low-carbon energy transition processes. As a result, the distributive justice concerns are particularly noticeable in local regions, as high concentration of coal and gas-based industries and renewable energy deployment create a large amount of transition constraints. This leads to a double burden for the carbon intensive regions. Renewable energy sources, such as offshore wind, solar panels lead to the unequal environmental and socio-economic benefits at the national level such as reduce GHG emissions and increase energy security, while burdening the local areas by creating land use conflicts, infrastructure pressure, and community opposition. Coal and gas create a regional lock-in as the carbon-intensive industry provides jobs and consistent energy supply, making it extremely hard to transition away from fossil fuels and creating renewable energy deployment conflicts.

Unlike the Japanese energy frameworks, just transition is one of Korea's policy agendas. In 2021, the term "just transition" was adopted as a legally recognized guiding principle as a part of Korea's energy agenda and outlined in the Framework Act on Carbon Neutrality and Green Growth (Republic of Korea 2021a). Korea was the only Asian country that adopted a just transition on a national level among 25 OECD countries (Hanbee Lee et al. 2024, 2). The 2050 Carbon Neutrality Strategy, the national long-term strategy, emphasizes the protection of vulnerable groups, including carbon-intensive regions and fossil fuel workers, by job creation, retraining programs, and support mechanisms, which connects justice within the national long-term strategy (Government of the Republic of Korea 2020, 47). Additionally, this goal is also outlined in the NDC, which explicitly states a just transition as a clear goal, placing carbon-intensive regions and workers in the category of vulnerable groups (Republic of Korea 2025, 4).

Despite this commitment, in 2022 the policy agenda has undergone a shift. Under the new presidential administration, the justice narrative was replaced with "fairness" or "fair transition" (Hyun-woo 2021). Although the legal framework still exists, the target was reframed to avoid political conflict due to the association of the term "justice" with the ideological polarization (Hanbee Lee et al. 2024, 2, 14). Despite this discursive shift, the government has put effort into ensuring fairness during the decarbonization process through the implemented policy instruments.

Korean government has established a strong legal framework to ensure distributive justice. In order to address uneven regional impacts of energy transition, the government aims to identify the special targeted areas, Special Districts for Just Transition, that require an extra

focus to ensure just transition. Such areas include regions that may be prone to suffer the most from the decarbonization efforts. These regions will receive extra attention and support through job-creation measures, tax benefits, and business support. On top of that, Korea has established the Just Conversion Support Centers, which aim to provide necessary support as well as monitor and assess the progress of ensuring fair energy transition (OECD 2023, 29–30).

Moreover, in 2022 under the Carbon Neutrality Act, the government developed the Climate Response Fund. This fund aimed towards decarbonization in general, more specifically towards various targets such as GHG reduction mechanisms, R&D, and green infrastructure, including support of carbon-intensive workers. In 2026, the fund had expanded to KRW 2.9057 trillion or approximately 2 billion US dollars (MCEE 2026). More specifically, under the Korean New Deal, an economic and green transformation strategy, the government aims to allocate approximately 144 billion US dollars by 2025 specifically for creating new jobs and ensuring social protection for carbon-intensive regions (Chowdhury 2021).

Finally, under the 2050 Carbon Neutrality Strategy, Korea aims to set national vocational standards, expand training programs for workers from the carbon-intensive fields, and strengthen social security for citizens, especially in the regional area (Government of the Republic of Korea 2020, 116–17).

The target of achieving fair transition is rather new in Korea, but the government has established some policy approaches towards this policy goal. The policy strategy of Korea towards fair transition is mainly focused on coal and phasing out the fossil fuels. The IEA strongly advises Korea to focus on community support by offering retraining and relocation options for the workers as well as expanding social safety nets (IEA and KEEi 2023, 8–9). The rural areas remain the most vulnerable ones in this transition process. The wages in rural regions are significantly lower, making it much harder for the workers to deal with economic shocks and adjust to the energy transition. Despite the policy efforts, poor regional attractiveness and an aging population lead to a lack of their own resources (OECD 2023, 38–39). The IEA emphasized the need for continued governance reform to support a just energy transition in Korea. Transparency in this process plays a key role, as a result, civil society, labor unions, small businesses, and academic institutions need to have an opportunity to communicate and reach an agreement (OECD 2023, 39). Moreover, the majority of the funding is part of a decarbonization agenda and not established as a separate justice instrument. As a result, just transition funding remains fragmented and insufficient, showing

the implementation gap (SFOC 2025, 13). Finally, the political shift in the energy transition from just transition towards an energy security and nuclear- oriented also questions policy credibility.

Comparison

Both countries face similar challenges, such as vulnerability of rural regions characterized by structural transition constraints, uneven regional distribution of energy transition impacts, and regional lock-ins in the carbon-intensive regions. However, despite the similarities in challenges, their policy approaches are significantly different in terms of governance structure and policy coherence. Justice discourse in Japan remains underdeveloped, as it is not identified as a separate policy target. Japan does not have an explicit legal justice framework, but instead it uses indirect justice mechanisms to address distributional concerns. The majority of the policy approaches are short-term, reactive, and fragmented. As a result, local governments and civil society play a key role in ensuring justice by promoting and implementing regional transition support initiatives. This suggests that Japan follows a bottom-up approach, where local governments and civil society play a more active role in addressing distributive justice concerns. In contrast, South Korea has legally embedded a just transition in the national long-term strategy and is developing a more centralized approach towards addressing distributive justice issues. Unlike Japan, the governance in South Korea is more centralized, and it introduced such mechanisms as territorial designation instruments, climate finance mechanisms, and retraining programs. South Korea's policy framework shows a centralized and state-led approach, where justice issues are coordinated at the national level by the ministries and other governmental institutions.

Overall, both countries face shared structural and socio-economic constraints such as an aging population, rural depopulation, and economic lock-ins. However, they follow different governance models despite facing similar pressures. Japan's distributive justice framework remains underdeveloped, and it is not clearly established in the national energy strategy. South Korea, on the other hand, officially recognizes energy justice issues within its policy framework. This comparison shows that successful energy transition requires recognition of social justice issues as part of the climate and energy transition framework.

3. Analytical part

3.1. Discussion of the research question and the methodology

This chapter is going to analyze the findings of the empirical part. This thesis attempts to answer the following research question: *How do national policy approaches towards the low-carbon energy transition differ between Japan and South Korea across environmental, political, techno-economic, and socio-technical dimensions since 2015?* Policy approaches refer to the combinations of instruments, such as strategic planning mechanisms, regulatory instruments, economic incentives, public finance tools, innovation policy, or coordination instruments that the government chooses to use to achieve energy transition targets. There is a wide range of policy approaches that governments implement to achieve energy transition, and they are typically implemented in combination and not individually. Rather than evaluating the outcomes of national energy transition or relying on performance indicators, the present study was designed to determine specific policy approaches that states chose to achieve a common goal of achieving a low-carbon energy system. The reason why outcomes are not analyzed is because they just show the result, the end product, and they cannot tell how exactly this energy transition has been achieved, what external factors affected the process, and how. Policy approaches show how governments attempt to achieve energy transition under the existing geographical and structural constraints. Moreover, they show national energy transition strategies and the decision-making process behind them.

The urgency of the climate change requires urgent action in order to transition towards more low-carbon energy sources. Unlike in historical transitions, market forces alone are not able to achieve an energy transition in the required period of time. Governments have the capacity to coordinate the energy transition process, set the timeline, foresee and handle risks based on policy objectives and national interests. This makes national policy approaches a key unit of the energy transition process and an appropriate comparative unit. While such indicators, such as the levels of GHG emissions or the energy share mix, can determine whether countries are successful at achieving the energy transition goal and lowering the global temperature to the preindustrial levels, these indicators can show direction of the energy transition. However, policy approaches chosen by the countries to achieve energy transition show more than that. They show national priorities, their existing capacities, unique governance styles, and how the national context affects the entire process. Therefore, they show different pathways of energy transition and not just their speed or the outcomes.

Following the most similar case design proposed by Seawright and Gerring (2008), this paper focuses on two country cases, Japan and South Korea (Seawright and Gerring 2008, 304–5). Japan and Korea both have a similar level of industrial development, they are both within a similar regional context, face the same issues related to a high level of import dependence, and both are committed to achieving net zero. Moreover, these two countries both face similar energy security constraints, have similar technological capacities, and similar levels of economic development. However, despite these similarities, they make different policy choices when it comes to the energy agenda, have different government centralization, treat the public differently, and rely on different mechanisms. These differences cannot be explained by the level of economic development or the regional context, as those are the political choices. As a result, this is why a most similar case designs have been chosen to observe different transition pathways.

The analytical framework is based on the four dimensions of energy transition, identified in the conducted literature review: environmental, political, techno-economic, and socio-technical. Each of these dimensions explains a distinct analytical component of the energy transition process. The academic literature and international organizations identify various targets for successfully achieving the energy transition. These targets serve as analytical lenses for the policy approaches for the empirical part. They allow us to conduct a comparison of how countries approach the energy transition process.

The political dimension is centered around the governance, institutional capacity, coordination, and policy credibility of the national energy transition. It has one target to establish supportive policy frameworks that capture how governments ensure policy coherence, long-term institutional stability, and coordination among the actors.

The environmental dimension focuses on the main ecological causes and constraints of the energy transition. It includes two targets: reduce GHG emissions and build climate resilience. The first target addresses the mitigation of GHG emissions through setting climate goals and achieving them through the distinct policy instruments. The second target focuses on the balance between mitigation and adaptation. It captures how governments address risk cause by climate change.

The techno-economic dimension focuses on the reliability of the system, cost management, the investment conditions, and risk sharing. The techno-economic dimension consists of two targets: increase the renewable energy share and promote energy efficiency.

The socio-technical refers to the public acceptance, participation, and the distributional effect of the national energy transition. There are two targets in this dimension that show how governments address public acceptance and distributional justice concerns.

Energy transition targets are all interconnected and interdependent. Therefore, the success of the energy transition depends on the combination of policies across dimensions, and analyzing a single policy would be misleading. This analytical framework structure shows that policy approaches are also work all together and have to be assessed together. Therefore, the framework attempts to capture the policy arrangement that countries develop to achieve national energy transition. The comparative analysis is going to discuss how policy approaches are operationalized within each target. The focus is mainly narrowed to strategic framing, instrument mix, degree of state intervention, sectoral focus, institutional coordination, and other comparative dimensions. This will allow us to clearly identify existing differences in the national policy approaches towards energy transition.

This research focuses on the policy approaches towards a low-carbon energy system adopted by Japan and South Korea. The following section is going to conduct a comparative analysis across the four dimensions of the data of these countries to identify differences in policy approaches of Japan and Korea.

3.2. Discussion of the research

3.2.1. Political dimension: comparative interpretation

Establish a supportive policy framework

The political dimension of this thesis focuses on one target, which is establishing a supportive policy framework. The purpose of this dimension is to evaluate how the energy transition process is coordinated in two countries. It looks into the legal embedding of the framework, institutional coordination structure, policy coherence, enforcement mechanisms, and political continuity. The empirical findings show that Japan and South Korea have developed two different governance models.

Japan does not have a single carbon neutrality framework, and the energy transition governance mainly relies on strategic planning instruments. The international commitments, such as the GHG emission targets outlined in the NDC, are included in the domestic strategy of Japan. Korea, on the other hand, has established a legal energy transition framework. The international net zero target commitment is legally embedded in the framework, which obliges the government to develop strategic decarbonization plans. This shows that Japan

mainly follows the planning-based governance style that allows some sort of flexibility, while South Korea has committed to the legally binding climate framework. However, these findings also indicate that legal embedding does not establish policy stability and does not guarantee policy continuity.

From the institutional coordination perspective, the countries are different as well. METI is playing a central role in the energy transition of Japan. The coordination is mainly conducted through the administrative guidance and ministerial coordination rather than the centralized executive authority (MOE 2025b, 1–2). In contrast, under its climate framework, South Korea has established a committee, a coordination body that is providing a strong executive role and coordinates the ministries. Therefore, it shows that Japan is following a bureaucratic coordination, and the governance is ministry driven. Korea adopted a coordination style centered around the executive body. While the coordination is done by the commission in Korea, the implementation of the energy transition strategy is done by the ministries.

The systems of both countries depend on the political stability. To ensure stability the government of Japan relies on gradual revisions of the strategic plans, bureaucratic continuity, and minimal institutional restructuring. Korea, on the other hand, has undergone through several political changes. Over the last decade, the government has revised NDC targets, shifted its focus from renewable towards nuclear energy expansion, and more recently has undergone a ministerial restructuring (Y. Lee et al. 2023, 6–7). This clearly reflects Japan’s administrative stability, while Korea is in the process of adjusting its policy priorities and the energy transition direction.

Overall, Japan and South Korea represent two different styles of energy transition governance. Japan’s governance framework is centered around planning and bureaucratic coordination. Moreover, Japan industrial and energy policies are closely coordinated, which shows policy coherence across the sectors. South Korea, on the other hand, follows a legally embedded executive governance. However, the country coordinates the energy transition process through multiple ministries, which may cause the overlap of responsibilities. The two policy frameworks of Japan and South Korea show that while a rigid legal framework offer formal accountability, but it does not guarantee policy continuity.

Policy approaches	Japan	Korea	Difference
Legal embedding	Mainly based on strategic planning	The Framework Act on Carbon Neutrality and Green Growth for Coping	Flexible vs legally embedded

		with Climate Crisis	
Institutional coordination	METI-centered	Presidential Commission on Carbon Neutrality and Green Growth + other ministries	Bureaucratic vs executive
Political stability and continuity	Gradual policy revisions	Political path reorientation	Administrative stability vs political shift
Governance model	Bureaucratic governance centered around strategic planning	Legally embedded executive governance	Administrative flexibility vs legal governance

3.2.2. Environmental dimension: comparative interpretation

Reduce GHG emissions

Reducing GHG emissions assesses how governments design their mitigation strategy that directly addresses emissions (UNFCCC 2016, Article 2; UNEP 2025; IPCC 2023a). Following the analytical framework, the research focuses on such policy instruments as the legal embedding of the mitigation targets in the national strategies, alignment with the Paris Agreement, market-based mechanisms, and overall policy design.

From the target-setting perspective, Japan commits to carbon neutrality and has adopted mid-term GHG reduction targets. There is no single decarbonization framework, and the national mitigation targets are mainly outlined in strategic documents such as the Plan for Global Warming Countermeasures and the Strategic Energy Plan (METI 2025a). Energy security issues are heavily influencing the mitigation strategy of Japan. The energy strategies are in line with the 3E+S strategy, and the strategic documents outline the alternative scenarios to ensure flexibility of the national decarbonization pathway (Bakshi 2023, 211). In contrast, Korea's net-zero goal and the NDC targets are legally embedded in the Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis. The Framework establishes mandatory national plans and the executive coordination commission (Republic of Korea 2021a). The 2024 Constitutional Court decision regarding the emission reduction pathway indicates the existence of judicial accountability for climate change policy commitments (NHRCK 2024). Overall, the legal frameworks of Japan and South Korea represent two different mitigation governance models. While Japan leans more towards flexible strategic planning, Korea chose the path of legal embedding. Moreover, the court ruling demonstrates judicial monitoring of climate policy commitments.

Japan implements various instruments to achieve GHG reduction goals. However, the majority of the market-based mechanisms are limited in scope and partially voluntary. This shows that Japan prioritizes technological deployment over strict regulations. The instruments implemented by South Korea are more institutionalized. Moreover, the government heavily relies on the market-based instruments as well as the innovation policies. This indicates that the institutional tools of Korea are strong and market-oriented, while Japan mainly relies on strategic planning.

Overall, both countries are facing similar structural constraints. Japan and Korea are both fossil fuel dependent countries with energy security concerns. As a result, both mitigation strategies are shaped by the energy security issues, which determine the speed and the policy design of the decarbonization process. Moreover, both countries have recently restarted their nuclear energy expansion strategy. Japan is mainly constrained by the energy security issues, and the government follows a flexible technology-driven mitigation policy to ensure a stable energy supply. However, the policy flexibility weakens the mitigation pathway, as alternative scenarios weaken the enforcement pressure. Korea's GHG reduction strategy is also constrained by its industrial dependence, fossil fuel lock-ins, and political shifts. As a result, this shows that legal embedding of the climate mitigation does not guarantee successful emission reduction results.

Policy approaches	Japan	Korea	Difference
Legal embedding	Strategic planning, no single framework	Legally binding centralized framework	Flexibility vs legal embedding
Policy flexibility	Flexible strategic planning, alternative scenarios	Fixed targets within the legal framework	Flexible planning vs legal obligations
Instrument logic	Low carbon taxing, voluntary ETS trading, innovation instruments + nuclear restart	Mandatory K-ETS, TMS, innovation instruments + nuclear expansion	Focus on technological mitigation, but stronger legal regulations in Korea
Structural constraints	Energy security, fossil fuel dependence	Industrial fossil lock-in Energy security	Security-driven vs industrial-driven constraints

Build resilience to climate change

Building resilience to climate change refers to the ways countries choose to adapt to unavoidable climate change long-term risks, complementing the mitigation efforts. This target is usually addressed through such policy approaches as adaptation plans, climate-risk integration, infrastructure resilience, and risk assessment tools (IPCC 2023a, 20–21).

From the institutional framework perspective, Japan has implemented the Climate Change Adaptation Act and established the climate adaptation plans. Due to the country's vulnerability to natural disasters, the climate resilience strategy of Japan is integrated into the disaster risk management framework. There is no dedicated adaptation coordination body, and the responsibility is divided between the MOE and METI (MOE 2018, Article 1). Korea's climate adaptation strategy is legally embedded in the Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis, which obliges the government to establish the national adaptation plans and is coordinated by the presidential commission (Republic of Korea 2021a, Article 7). The implementation of the adaptation strategy is done by the ministries and by the multilevel government authorities. This shows that Japan's climate adaptation framework is interconnected with disaster management. The adaptation framework in Korea is institutionalized and represents a stronger legal governance. However, despite the different governance models, both countries do not integrate climate adaptation of the energy sector into their energy strategies.

From the way climate adaptation is implemented in practice, Japan mainly focuses on the infrastructure development and resilience. The mechanisms are aimed towards ensuring energy security, preparedness towards potential disasters, and monitoring climate risks. South Korea is mainly addressing the risk assessment. The country's policies are aimed towards planning and predicting potential climate disasters, expanding its planning capacity, and risk assessment of the infrastructure. This shows that Japan's policy approaches are more reactive and focused on the infrastructure strengthening, while South Korea is emphasizing planned risk assessment and monitoring.

Overall, both Japan and Korea are exposed to shared risks and similar structural constraints, such as coastal infrastructure and significant concerns regarding energy security. Despite similar risks, the climate adaptation strategy of Japan is mainly shaped by the disaster management, making it more reactive, disaster-driven, and aimed towards protecting the energy infrastructure. Korea, on the other hand, is following a more planned governance style through monitoring climate risks and planning the resilience measures.

Policy approaches	Japan	Korea	Difference
Planning logic	Adaptation Act, national adaptation plan Framed through disaster prevention framework	Legally embedded in the centralized climate framework	Adaptation linked to disaster prevention vs legally embedded framework
Institutional coordination	No dedicated body, split between METI and	Presidential Commission on Carbon Neutrality and	Fragmented coordination vs

	MOE	Green Growth + all levels involved	structured institutional coordination
Instrument logic	Infrastructure development	Risk assessment and monitoring	Infrastructure resilience vs planning measures
Resilience model	Reactive, focus on strengthening	Planned	Reactive vs planning

Environmental dimension: overall comparison

The environmental dimension examined how governments address climate change issues through their mitigation and adaptation strategies. Both Japan and South Korea are facing similar structural constraints, such as energy security concerns due to limited domestic natural resources and fossil fuel import dependence, vulnerability of coastal infrastructure, and the economic structures of the two countries. This shows that climate policies are not just addressing environmental issues, as they are strongly shaped by those structural conditions. The environmental governance of Japan can be characterized by strategic planning, flexible targets, a heavy focus on energy security, and the deep interconnection of the adaptation strategy with disaster management. Korea's environmental governance represents a more institutionalized model with a legally embedded framework, mandatory mitigation mechanisms, centralized institutional coordination, and a planned adaptation strategy. This shows that, compared to Korea's environmental framework, the governance style of Japan is more flexible and reactive. From the instrument choice perspective, Japan follows a more technology- and infrastructure-oriented policy approach, while the Korean government relies more on regulatory measures. Overall, the environmental dimension shows different institutional approaches towards the same climate policy goals, but similar challenges that limit the political capacity of the two countries.

3.2.3. Techno-economic dimension: comparative interpretation

Increase the renewable energy share

Increasing the renewable energy mix refers to the decarbonization efforts through the policy-driven growth of renewable energy sources. While the reduction of GHG emissions aims to reduce fossil fuel consumption, this target focuses on the deployment of new technologies, the development of new energy infrastructure, market design, and investment mobilization (IEA 2024e, 104).

From a target setting perspective, Japan relies on long-term planning through the Strategic Energy Plans. Targets outlined in those plans are stable and regularly revised. The

government sets the goals and develops alternative scenarios for the energy mix. In the most recent Strategic Energy Plan, Japan has set a target to reintroduce nuclear energy in the energy mix and to become an innovation leader in hydrogen (METI 2025b, 96). Korea also has well-established national targets on fossil fuel phasing out and renewable energy expansion, which are outlined in the Energy Master Plans. However, under the new presidential administration, the established direction has shifted from the nuclear phase-out target to nuclear expansion (Tachev 2024). The shift towards nuclear energy signals the political readjustment of energy priorities towards energy security instead of the previous fossil fuel phase-out strategy. The long-term direction reduces investors' uncertainties and affects technology preferences, overall capital allocation choices, and infrastructure development decisions that affect renewable energy deployment. Therefore, the planning logic of the two cases suggests that Japan's renewable energy expansion strategy is more stability- and technology-oriented, which shows institutional continuity of the energy transition framework. South Korea, on the other hand, is more target-driven, and the national strategy is affected by the political situation. Additionally, while in the Japanese strategy, nuclear energy expansion serves as a way to diversify the national energy mix, Korea targets nuclear energy to ensure energy security, which results in competition between nuclear and renewable energy projects for capital and policy prioritization. Finally, while hydrogen is not considered a renewable energy source, it is relevant to the renewable energy expansion, as it affects investment flow and the infrastructure direction. In the energy strategy of Japan, the hydrogen target aims to diversify the national energy mix and to ensure technological competitiveness, while for Korea, the development of hydrogen plays a more central role in the industrial strategy.

Countries follow contrasting policy mix logics. Japan approaches renewable energy expansion with predictable support mechanisms and risk-reduction instruments. The government uses price-based mechanisms such as FIT and FIP to decrease price instability and investor uncertainty and aims to mobilize capital through the GX policy (METI 2023b; Government of Japan 2023; Hassan 2024; InfluenceMap 2025b). Based on the policy approaches used by the Japanese government to increase the renewable energy share, it is clear that the state is strongly aiming to reduce possible risks and to provide financial guarantees while increasing the renewable energy share and diversifying the energy mix. Korea, on the other hand, is focusing more on market competition. Its core mechanisms to increase the renewable energy share are competitive auctions, certificate trading, and obligation-based instruments such as RPS (Chen and Jou 2025). This shows that the Japanese

government is aiming to ensure stability by absorbing price risks through its state capitalization model, while South Korea is encouraging the private sector through a competitive compliance model, which is less centralized.

Both countries are facing grid constraints when it comes to renewable energy deployment and infrastructure. Japan is facing technical issues with its grid. The grid has been fragmented into 50 and 60 Hz zones, which results in limited electricity transmission bottlenecks and power curtailment (Miyamoto 2025, 23–25). The grid constraints in Korea are caused due to the institutional and regulatory issues, including KEPCO’s institutional monopoly over the transmission grids (Kim 2025, 6–7). These are two different constraints.

Overall, the policy approaches of Japan and South Korea show that they are at different phases of renewable energy expansion. Japan is currently at the optimization stage, as the government focuses on pursuing the integration of renewable energy into the existing system, optimizing infrastructure, and preventing investor risks. Korea, on the other hand, is still at the renewable energy expansion stage, as it is increasing renewable energy deployment, forming the energy market, and adjusting its policy direction. This shows that Japan and South Korea represent different techno-economic governance models.

Policy approaches	Japan	Korea	Difference
Planning logic	Institutional stability and continuity	Political readjustment	Stability vs political redirection
Instrument logic	Price-based support (FIT/FIP) + risk reduction mechanisms by the state	Quantity-based mechanisms (RPS) + auctions	Risk prevention policies vs market competition-driven policies
Investment	GX bonds + tax incentives + Green Innovation Fund	Auctions + Green New Deal Fund	State fund mobilization vs fund allocation through competition
Role of nuclear energy in renewable energy expansion	Complementary to the energy mix	Central to the energy strategy	Nuclear energy as a supplement vs core base
Grid constraints	Technical issues (50/60 Hz)	Governance and regulatory issues	Physical vs institutional constraints
Transition stage	Integration and optimization of the existing system	Capacity expansion stage	Full-scale integration vs early expansion stage

Promote energy efficiency

Promoting energy efficiency is a target that focuses on how governments attempt to regulate energy demand and consumption. Using less energy to achieve the same results is

crucial to ensure energy security and decarbonization. It can be achieved by setting up standards and developing incentive mechanisms (IEA 2023a).

From a regulatory perspective, both Japan and South Korea established a solid foundation to ensure energy efficiency. However, the strictness of the regulations and the sectoral application differ between the two countries. The regulatory framework of Japan can be characterized by the outlined targets, mandatory standards, incentive mechanisms, and promotional measures. It has a long-established administrative coordination, well-structured cross-ministerial coordination that contributes towards policy stability and continues the tightening of energy efficiency standards (VNEEP 2024). South Korea, on the other hand, combines the mandatory framework with the voluntary agreements in the industry sector. The country has established a dedicated bureau, the Energy Innovation Policy Bureau. However, the uneven implementation and the institutional coordination of Korea have been highly criticized by the international organizations (IEA 2020a, 74–75). This comparison suggests that the two countries use different levels of state intervention. Japan relies on a strong regulatory framework, while Korea uses a mixed model and voluntary compliance in the industrial sector.

The biggest difference among policy approaches is visible in the sectoral focus of energy efficiency mechanisms, specifically in the industrial sector, which accounts for the majority of Korea’s energy consumption. While in Japan, policy instruments are broadly applied across all energy-related sectors, including the industry, Korea mainly relies on voluntary agreements. The industrial sector plays a central role in Korea’s economy, which suggests that the industrial competitiveness issues limit the state’s ability to expand mandatory efficiency regulations.

Overall, Japan has developed a long-term efficiency strategy with standards and regulations embedded across all sectors, which allows the government to progressively tighten the standards. In contrast, South Korea’s energy efficiency strategy can be characterized as a mixed framework that combines regulatory and voluntary mechanisms, especially in the industry sector. While both countries recognize the benefits of energy efficiency and aim to ensure energy security and decarbonization, Japan has made energy efficiency the key element of its energy transition strategy. Korea, on the contrary, applied a sector-based approach which reflects its priorities and industrial structure.

Policy approaches	Japan	Korea	Observed difference
Regulatory	Mandatory	Mixed	Both have a legal

framework			base
Instrument logic	Regulatory instruments + incentives measures	Voluntary measures + targeted regulatory instruments	Different policy mix
Sectoral focus	Applied broadly across all sectors	Voluntary approach to industry sector, but stricter approach to the building sector	Political economy difference
Institutional coordination	Long-term ministerial coordination and policy stability	Dedicated bureau, but overall uneven coordination	Different institutional coordination

Techno-economic dimension: overall comparison

The techno-economic dimension aims to address how governments approach renewable energy expansion and energy efficiency by deploying new technologies, structuring the energy market, allocating investment, and regulating energy supply and demand. The key targets of the techno-economic dimension discussed in the research paper are increasing the renewable energy share and promoting energy efficiency. Together, these targets show how the governments use the energy market and technology deployment to control the energy transition path and manage potential risks.

The findings suggest that Japan relies on state-led coordination, mandatory standards and regulations, and system optimization mechanisms. This is consistently noticeable across both targets of the techno-economic dimension. To expand the share of renewable energy, the Japanese government aims to manage price risks and to ensure a stable investment environment and price predictability. To promote energy efficiency, Japan has introduced mandatory regulations and standards that are gradually tightened. This indicates a centralized and stability- and continuity-oriented energy transition strategy.

Korea's pattern for the techno-economic dimension is also consistent throughout the two targets. To achieve energy expansion, the government is implementing competitive compliance policies by creating market competition among private sector stakeholders by setting quantitative targets, using obligation-based mechanisms to create pressure, and exposing investors to the competition. To promote energy efficiency, Korea is mainly focusing on the voluntary mechanisms that are different based on the sector. This shows that the Korean government is following a competitive compliance-based model to achieve techno-economic targets, which is shaped by the structure of the industrial sector and the energy market competition.

Across the techno-economic dimension, Japan has been consistently prioritizing stability, policy continuity, and investment certainty through such policy approaches as centralized coordination and continuous regulatory approaches. On the other hand, Korea's energy policy is structured around the competitive mechanisms and sector-dependent policies shaped by the industrial political economy. Therefore, it is clear that Japan's approaches are focused on ensuring price predictability, while the Korean government relies on the market to allocate resources.

3.2.4. Socio-technical dimension: comparative interpretation

Strengthen public support

Strengthening public support refers to the ways the government shapes and influences public perception towards the energy transition process, prevents regional opposition, and builds trust (IEA 2022). According to the findings, the citizens of Japan and South Korea share similar views on the national decarbonization efforts. However, despite that and similar challenges when it comes to strengthening public support, the government uses different policy approaches and chooses different pathways of building and ensuring public support.

Both countries have outlined the importance of public acceptance in the long-term energy plans. However, they have different angles to it. Due to the Fukushima accident, the main focus of the Japanese government is on restoring public trust. Japan has developed an explicit national strategy towards rebuilding public trust that is centralized and well-coordinated across ministries (METI 2025b, 103–6). In contrast, Korea mainly focuses on the fairness of the energy transition process. The national public support strategy remains fragmented and sectoral. The ministries and local governments attempt to raise awareness and build trust of the citizens through local initiatives and projects (KEA 2023). This suggests that Japan treats the lack of public support as a credibility issue, while the Korean government considers it a distributional matter. Moreover, institutional coordination seems stronger in Japan, while Korea's public support approach seems uneven and decentralized.

Both countries use various policy approaches to achieve the target. Japan puts more effort into ensuring transparency by providing educational programs, awareness campaigns, and subsidies (MOE 2009; Nakayama 2025; HPTCJ 2025). Korea also implements education and awareness campaigns, but on a smaller, less centralized scale (IEA 2025b, 46–47). However, there are significantly more initiatives oriented towards socio-economic benefits, including voucher and compensation programs, as well as other local initiatives in South Korea. This shows that Japan is focusing on building long-term awareness and normalizing of

the energy transition process, while Korea heavily relies on economic and visibility mechanisms to secure public support.

Promoting public support is a constant process that is not as easily comparable as other targets, since it is conditional and context dependent. Both countries, despite their efforts, face local opposition in local areas due to the geographical constraints of both countries. Despite the challenges, Japan and Korea recognize that public support is crucial for the energy transition process but use different policy models to strengthen it.

Policy approaches	Japan	Korea	Difference
Strategic framing	Rebuilding trust strategy	Fairness-oriented strategy	Different framing
Instrument logic	Norm-building Education + transparency	Incentive-based Incentives + visibility	Different
Institutional coordination	Centralized	Fragmented	Different
Local resistance	Local opposition exists	Local opposition exists	Conditional support

Address distributive justice concerns

Addressing distributive justice concerns refers to policies that are aimed towards ensuring social protection and regional support, protecting vulnerable groups, local communities, and carbon-intensive regions from unequal socio-economic effects of the energy transition process and renewable energy deployment (ILO 2015, 5–7; Kamali Saraji and Streimikiene 2023, 12).

Japan does not have a legal framework or a national strategy that addresses justice. While the term “fairness” is mentioned in some official documents, it is not institutionalized. Despite the lack of a legal framework and centralized institutional mechanisms, the Japanese government puts effort into ensuring that justice concerns are addressed through the reskilling programs, energy subsidies, and regional decarbonization initiatives (Sokołowski and Kurokawa 2022, 187). In contrast, South Korea has legally embedded a just transition in the Framework Act on Carbon Neutrality and Green Growth (Republic of Korea 2021a). The government has also mentioned it in the national strategy and the NDC. In addition, Korea has also established institutions dedicated to the just transition matters, established the Climate Response Fund, created just transition support centers, and developed funding mechanisms for the vulnerable groups. Moreover, in terms of stakeholder involvement, Japan and Korea also differ. In Japan, civil society and local governments play a more noticeable role in pushing justice-oriented initiatives, while in South Korea, the justice governance

model is driven by the state. This suggests a clear difference in the level of institutionalization of distributive justice matters. Korea has taken an approach of legally embedding just transition within its national energy transition strategy, while Japan addresses distributive justice concerns indirectly without a centralized framework.

From a political agenda perspective, the Fukushima accident in 2011 could have served as a trigger for a potential justice framework. However, the justice discourse remains very limited, and the topic has not been developed into a comprehensive national framework. Moreover, the majority of the mechanisms are short-term and strongly supported by civil society rather than embedded by the government. Korea, on the other hand, has recently adopted the justice framework. Despite the recent step back from “just energy transition” to “fair”, distributive justice became an important part of Korea’s energy transition agenda, whereas in Japan, distributive justice concerns remain a secondary issue within the energy transition governance.

The regional vulnerability is a common issue when it comes to renewable energy deployment, including Japan and Korea. Both countries face regional resistance, but in South Korea, regions that are dependent on the manufacturing face carbon lock-ins, especially in coal-focused areas. In Japan, regional vulnerability is a result of demographic decline and the consequences of the Fukushima accident. This shows that while countries share similar geographical constraints in the energy transition process, the key drivers towards the distributive justice are different.

Policy approaches	Japan	Korea	Difference
Strategic framing	None	Legally binding since 2021	Different levels of institutionalization
Instrument logic	Fragmented short-term measures	Institutionalized mechanisms + structured funding	Different degrees of systematization
Political agenda	Justice remains secondary issue	Justice is nationally recognized	Different levels of prioritization
Regional issues	Legacy of the Fukushima accident + aging population in the regions	Manufacturing lock-ins	Vulnerability

Socio-technical dimension: overall comparison

The findings suggest that the Japanese government prioritizes legitimacy and norm-building when it comes to the socio-technical dimension. Public support is addressed through

a clear national strategy that is focused on trust-building instruments, transparency, step by step normalization of the decarbonization and the energy transition processes. However, addressing distributive justice concerns remains decentralized and indirect.

Korea's approach is reversed towards the socio-technical targets. The distributional justice is legally embedded in the national climate strategy and is supported by certain institutions and funding mechanisms. Public support approaches, in contrast, are more decentralized and are mainly addressed through financial and incentive-driven mechanisms rather than through a centralized national strategy. This suggests that two countries prioritize different pillars of the socio-technical dimension. Japan relies more on ensuring legitimacy, whereas Korea institutionalizes justice protection.

3.3. Research findings

This research was designed to determine how the policy approaches of Japan and South Korea toward the low-carbon energy transition differ. The study applied a descriptive-comparative case study analysis focusing on four dimensions: political, environmental, techno-economic, and socio-technical. Instead of evaluating energy transition outcomes of the two countries, this thesis focused on the institutional frameworks, governance approaches, and policy instruments that governments use to achieve decarbonization and energy transition targets. The empirical research revealed three key findings. First, national energy transition pathways follow different governance models. Second, Japan and South Korea rely on different policy instrument mixes. Finally, despite the differences in the policy approaches, countries are facing similar structural constraints.

Finding 1. The energy transition of Japan and South Korea follows different governance models

Japan does not have a comprehensive climate framework, and it mainly relies on strategic planning through such documents as the Strategic Energy Plan and the GX policy. The government clearly defines its targets in those plans and relies on flexible strategic planning instead of legally binding targets. The implementation of the energy transition strategy is coordinated primarily by METI. In contrast, Korea has established a legally binding energy transition framework that defines the energy transition process, dedicates coordination to the Presidential Commission on Carbon Neutrality and Green Growth, and sets legally binding obligations for the government. This shows that Korea has a

centralized coordination mechanism for energy transition and a stronger legal anchoring overall. However, Korea's case shows that even with a legally binding framework, the policy continuity is not guaranteed. The government has shifted its policy direction from renewable energy expansion towards nuclear energy expansion, which shows that the existing legal framework does not prevent such policy reorienting. These results suggest that while Japan relies on strategic planning and bureaucratic continuity to achieve energy transition goals, Korea institutionalizes the energy transition process by establishing a legally binding framework and centralized coordination mechanisms for energy transition.

Finding 2. Japan and South Korea rely on different policy mixes to achieve a low-carbon energy transition

Japan and South Korea prioritize different political objectives while pursuing energy transition. The findings suggest that Japan is aiming to ensure stability and reduce any possible market risks. Therefore, the government uses FIT and later FIP to stabilize electricity prices, enforces strong energy efficiency regulations, and provides public funds through the GX financial mobilization model. However, the carbon tax of Japan is weak, and the voluntary ETS is developing very slowly, which indicates limited incentives to reduce for emission reduction. South Korea, on the other hand, focuses on creating market competition while aiming for energy transition. The government uses K-ETS, RPS regulations, auctions, the REC market, and voluntary efficiency measures in the industry to ensure that regulatory compliance is strong. This indicates that Japan is aiming to stabilize the energy transition process through the state intervention and state-supported instruments, while South Korea relies on the market-based compliance mechanisms to boost the energy transition process and technological deployment. This can also be explained by the fact that Korea mainly focuses on the renewable energy expansion.

Finding 3. Despite the policy differences of Japan and South Korea, both countries face similar structural constraints

Finally, despite those policy choices, Japan and Korea are facing the same challenges. Both countries are dealing with energy security constraints, as they are both import dependent countries whose economies are heavily relying on fossil fuels. As a result, two countries are also vulnerable to any external shocks and geopolitical risks. While renewable energy can be a long-term solution to the energy security challenges, renewable energy deployment can also cause short-term energy supply instability. To decrease such risk, both countries aim to

diversify their energy mixes by including nuclear energy in their long-term energy strategy. Moreover, the industrial structure of Japan and South Korea also affects their energy transition pathways. Korea is in an industry lock-in, while Japan is facing concerns regarding the industrial competitiveness. Additionally, both countries are facing grid constraints. Technical challenges caused by the grid fragmentation in Japan and institutional constraints in Korea due to the KEPCO monopoly over the country's grid transmission system are slowing down the energy transition process in both countries. Finally, the unequal distribution of socio-economic benefits between city and rural areas may weaken public support in the two countries. Such an issue creates local opposition to the renewable energy projects, which also constrains the speed of the energy transition process. Therefore, energy transition strategies of Japan and South Korea are shaped not only by their political goals and choices, but also by their constraints. All these factors heavily influence the pathway, speed, and direction of the energy transition.

Overall, the descriptive-comparative analysis demonstrated that Japan and South Korea pursue the similar goals of energy transition and decarbonization, though with different governance systems and political choices. Japan is pursuing a planning-based model that is more focused on ensuring stability and energy security. Korea, on the other hand, established a strong, legally embedded climate framework and is emphasizing regulation-driven market instruments and prioritizing market competition. This study highlights that the energy transition path is shaped not only by the policy ambition of a state, but by its institutional design, structural conditions, and national political economy.

3.4. Research relevance

This research provided a comparative framework focused on the national policies towards energy transition. Energy transition literature tends to be very sector-specific and lacks a dominant methodological approach (Cherp et al. 2018, 175; Harichandan et al. 2022, 3). This paper attempts to provide a comprehensive way to categorize and analyze the policy tools and mechanisms that are taking place within such a complex and multidimensional process as the national energy transitions. By offering a systematic overview of the energy transition, the framework emphasizes the interconnection of the policy approaches within the energy transition and allows analytical comparison that can be reused for the future research. The results of this research provide valuable insight for the stakeholders mentioned in the introduction section, which include policymakers, the private sector, the academic world, civil society, and the public.

This paper helps policymakers of Japan and South Korea, and policymakers of other countries with similar constraints, to better understand the policy design and how policies function together under a certain national context. The comparative framework shows that despite Japan and Korea facing the similar issues and constraints, they make different political choices. This allows policymakers to learn from each other which approaches may be most effective and minimize possible costly mistakes in the policy design. Moreover, it can show how different policies interact and co-exist, which is especially useful during such a complex and multidimensional process as energy transition. Additionally, the framework allows for anticipating potential challenges, such as a lack of social acceptance or credibility issues and avoiding them in the future.

The findings of this research can also be useful for the private sector. In particular, the paper looks into such factors as policy credibility and stability, governance differences, and potential uncertainties and risks of Japan and South Korea. Comparing two countries with similar constraints but different policy approaches increases awareness of existing risks and uncertainty issues, which allows firms to make informed decisions for long-term planning and investment.

Finally, the findings of this research are valuable for the public and civil society. The comparative analysis of Japan and South Korea shows different levels of public participation in the energy transition process and different government approaches towards addressing distributional issues. Moreover, the comparison of two countries makes existing issues and gaps more visible.

Overall, the findings of this paper provide the analytical and comparative relevance. This framework-based research does not provide any evaluations or recommendations, but it helps to better understand how Japan and South Korea approach energy transition. Additionally, the structured comparison is applicable to other cases.

3.5. Research limitations

This research is not without limitations. The main weakness of this study is the unequal language access. The study requires investigation of the official government documents, such as laws, national strategy plans, national reports, and official statements. I have strong knowledge of the English and Japanese languages, but not of Korean. As a result, the national documents of Japan were accessed in the original language. However, Korean documents, on the other hand, were mainly accessed through English translations. Moreover, Korean official websites, such as MOTIE or MOE, as well as a lot of national reports, often do not offer

English translations, which significantly limits access to the necessary data, including primary policy documents. For instance, there is no official English translation of the 10th Basic Plan for Long-term Electricity Supply and Demand (2022–2036). While current technology offers the translation of the webpages and the documents, the machine translation may not be reliable enough to offer precise translation of legal nuances. This may have created a minor asymmetry in the interpretation depth between the two cases of Japan and South Korea. However, despite the language limitation, the key strategic documents were accessed and examined for both country cases. To ensure the analytical balance, the study accessed Korean academic literature, publications of the Korean research institutions, law firms, and national news, as well as international organization reports, were used to cross-check the key information.

Second, the current study is limited by its scope, as it focuses on only two cases of Japan and South Korea. It is also limited by the timeframe, as the study mainly looks into the policy approaches established since 2015. This was done to ensure the analytical depth of the two country cases and to maintain the most similar case design. While the analytical framework developed for this research is applicable to all countries of all regions, the findings of this research are not generalized and are mainly applicable to the East Asian region.

Third, the usage of similar terminology does not guarantee the same function. For instance, terms such as “just transition”, “fairness, or “supportive framework” are used by both governments, but they carry different legal status and institutional function within the national contexts. This shows that political terminology is very context dependent. In addition, translation adds another layer of complication. Although comparable policy terms are applied in both case studies, the legal status and level of implementation may differ, which may cause conceptual imbalance. As a result, the research focuses on observable policy instruments rather than stylistic framing.

Moreover, some targets identified for this research are not measurable. While this study is qualitative and does not attempt to interpret the outcomes of the energy transition process, targets that focus on strengthening public support and establishing a supportive policy framework limit the precision of the research. However, since the paper is focusing on the qualitative research, assessment of these targets through interpretation is appropriate.

Finally, this research is following the comparative-descriptive design and does not attempt to establish a causal relationship between national policy design and the energy transition outcomes. Such causal mechanisms can be explored in the future research through process-tracing or causal modeling.

3.6. Conclusion

In the context of global decarbonization efforts, this research aimed to compare the policy approaches towards the low-carbon energy transition of Japan and South Korea. The most significant decisions and actions related to energy transition are made at the national level by the state, as the state has the authority to regulate and govern its energy systems (Cherp et al. 2018, 176). Japan and South Korea present an interesting study cases as both countries have a similar set of structural characteristics, making them suitable for a comparative analysis. Both of them are industrialized economies, highly dependent on imported fossil fuels, and strong state involvement in the energy transition process, but with different policy approaches towards the low-carbon energy transition. By narrowing the focus on these two comparable countries, this research aimed to answer the following research question: *How do national policy approaches towards the low-carbon energy transition differ between Japan and South Korea across political, environmental, techno-economic, and socio-technical dimensions since 2015?* The analysis has been done through a descriptive comparative design following the most similar case study approach (Seawright and Gerring 2008, 304–5). Energy transition is a complex, multi-dimensional process that requires changes across various sectors. This thesis narrows down its focus to the approaches that states choose to achieve desired decarbonization. For the purpose of comparison, these policy instruments have been categorized into four dimensions: political, environmental, techno-economic, and socio-technical.

From a political dimension perspective, Japan represents a planning-based governance model with strong bureaucratic coordination, whereas South Korea follows a more centralized and legally embedded energy transition framework. From an environmental dimension perspective, both countries are committed to mitigation targets, but they differ in how they implement policy design and institutionalize their mitigation strategies. The techno-economic dimension shows that Japan and South Korea follow different renewable energy expansion strategies. Japan is more focused on price-based mechanisms, while South Korea follows a more quota-based policy approach. Finally, the socio-technical dimension introduced how public support and distributive justice concerns are addressed in two countries. Japan is focused on public awareness and social mobilization mechanisms when it comes to energy transition. South Korea is basing its energy transition strategy mainly on economic incentives and a centralized justice framework.

Upon the completion of this research, the study has identified that Japan and South Korea follow different governance models and different policy instrument mixes while addressing similar structural constraints. The study showed that energy transition pathways are shaped not only by the national policy design but also by existing structural challenges such as energy import dependence, fossil fuel reliance, grid constraints, and the industrial structure. Taken together, these results suggest that the institutional governance and policy design play a central role in the energy transition process. First, it confirms that energy transition does not have a universal single universal pathway and the process may vary from country to country. Countries may rely on different types of governance models, bureaucratic planning, legal frameworks, and market mechanisms while pursuing similar decarbonization targets. Second, the evidence from this study suggests that the legal framework is not enough to ensure policy implementation consistency. Even though South Korea has a strong legal energy transition framework, it did not guarantee policy continuity. Long-term policy stability is crucial for the energy transition process. It depends on well-established institutional coordination, policy continuity, and the bureaucratic capacity of the country. Finally, the current data highlights the importance of energy security in the development of the energy transition strategy. In the case of Japan and South Korea, energy security shapes not only the energy pathway but the entire national energy strategy. Renewable energy deployment may cause short-term energy supply disruptions. This explains why both countries are gradually and cautiously expanding renewable energy sources while simultaneously trying to diversify the energy mix with nuclear energy.

These particular findings will be of interest to East Asian energy policy. The analytical framework developed in this thesis can be applied in future comparative research to identify the differences and similarities in policy approaches of other Asian countries, or between the EU and the US. Overall, the findings of this study have demonstrated that energy transition is not only a technological process, but it is also not just a change from one energy source to another. Energy transition is an institutional and political process. Political decisions, economic structure, and institutional governance shape the national energy transition pathway.

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Appendix

Abstract in English

This thesis investigates the policy approaches adopted by Japan and South Korea to transition towards a low-carbon energy system. Moving beyond the conceptual definitions of energy transition, the research focuses on the policy approaches and the governance styles that countries choose in the context of global low-carbon energy transition following the 2015 Paris Agreement. The study adopts a descriptive-comparative analysis that systematically organizes and contrasts national policy approaches towards the low-carbon energy transition in two countries. Specifically, it focuses on four dimensions: political, environmental, techno-economic, and socio-technical. The empirical part investigated the national energy strategies, regulatory frameworks, and policy instruments implemented by the governments of Japan and South Korea. The findings suggest that the two countries are facing similar structural constraints, but they rely on different governance styles and policy instrument mixes to overcome them. Thus, the contribution is twofold: a comparative insight into policy approaches towards the energy transition in two East Asian countries, Japan and South Korea, and a reusable comparative framework applicable for analyzing other national energy transition policies.

Zusammenfassung in Deutsch

Diese Masterarbeit untersucht die politischen Ansätze, die Japan und Südkorea zur Umstellung auf ein kohlenstoffarmes Energiesystem verfolgen. Jenseits konzeptioneller Definitionen der Energiewende konzentriert sich die Forschung auf die politischen Richtlinien und den Verwaltungsstil, die die Länder im Kontext der globalen kohlenstoffarmen Energiewende nach dem Pariser Klimaschutzabkommen von 2015 wählen. Die Studie erhebt innerhalb einer deskriptiven Vergleichsanalyse die systematischen Differenzen nationaler Gesetzgebungen hinsichtlich der Reduktion von CO₂ in beiden Ländern. Insbesondere werden vier Dimensionen beleuchtet: Politik, Umwelt, Techno-Ökonometrie und Sozialökonomie.

Im Praxisteil der Arbeit werden nationale Energie-Strategien, regulatorische Rahmenbedingungen und politische Maßnahmen analysiert, die von den Regierungen Japans und Südkoreas umgesetzt wurden. Die Ergebnisse deuten darauf hin, dass beide Länder ähnlichen strukturellen Einschränkungen gegenüberstehen, jedoch auf unterschiedliche Verwaltungsstil und Instrumentenmischung zurückgreifen, um diese zu bewältigen. Zusätzlich lässt sich sagen, dass der Beitrag zweifach ist: ein vergleichender Einblick in die politischen Ansätze zur Energiewende in zwei ostasiatischen Ländern, Japan und Südkorea, sowie ein aufschlussreicher vergleichender Rahmen zur Analyse weiterer nationaler Energiewende-Richtlinien.