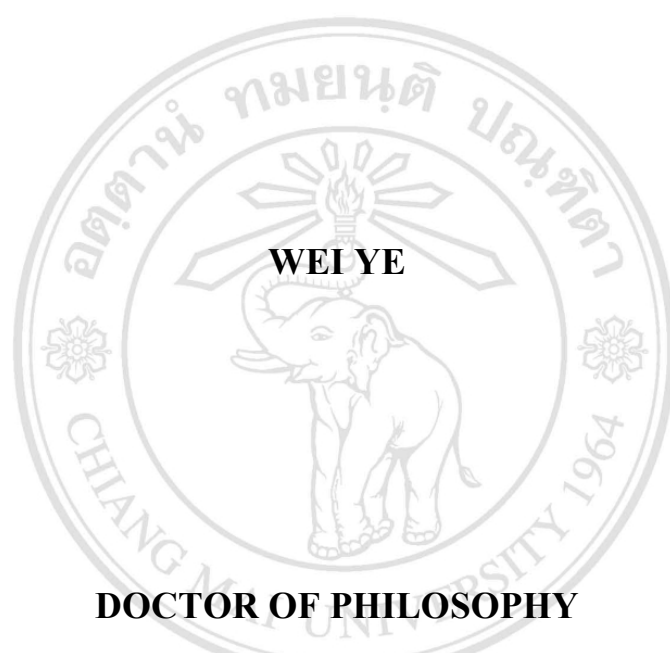


**A COMPARATIVE STUDY OF ENERGY
GOVERNANCE ON ENERGY RESILIENCE
IN LOW-CARBON TRANSITION**



WEI YE

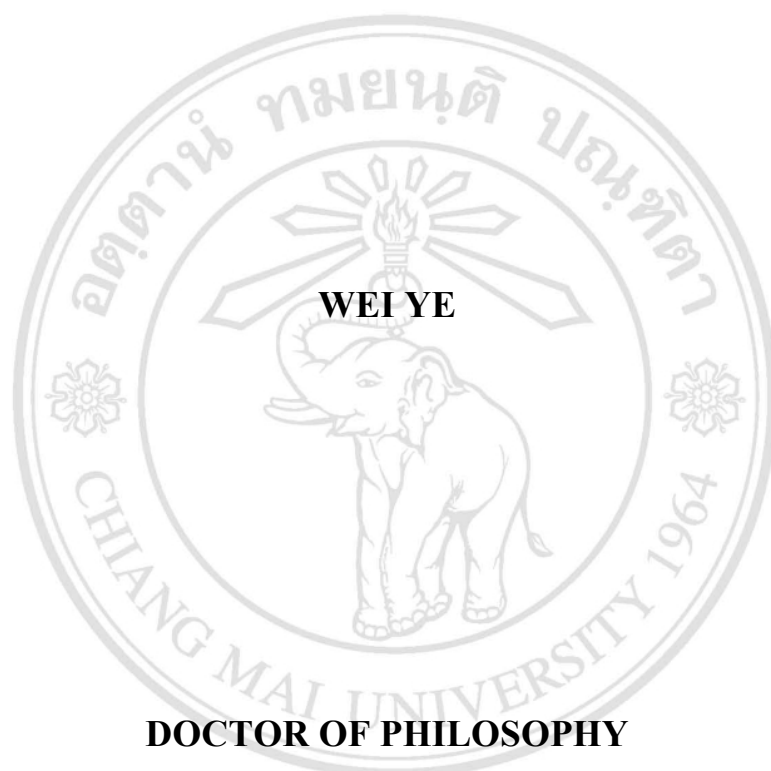
**DOCTOR OF PHILOSOPHY
IN PUBLIC POLICY**

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CHIANG MAI UNIVERSITY

APRIL 2024

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DOCTOR OF PHILOSOPHY

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APRIL 2024

**A COMPARATIVE STUDY OF ENERGY GOVERNANCE
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TRANSITION**

WEI YE

**A DISSERTATION SUBMITTED TO CHIANG MAI UNIVERSITY IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN PUBLIC POLICY**

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CHIANG MAI UNIVERSITY


APRIL 2024


**A COMPARATIVE STUDY OF ENERGY GOVERNANCE
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TRANSITION**


WEI YE


THIS DISSERTATION HAS BEEN APPROVED TO BE A PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN PUBLIC POLICY

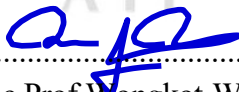
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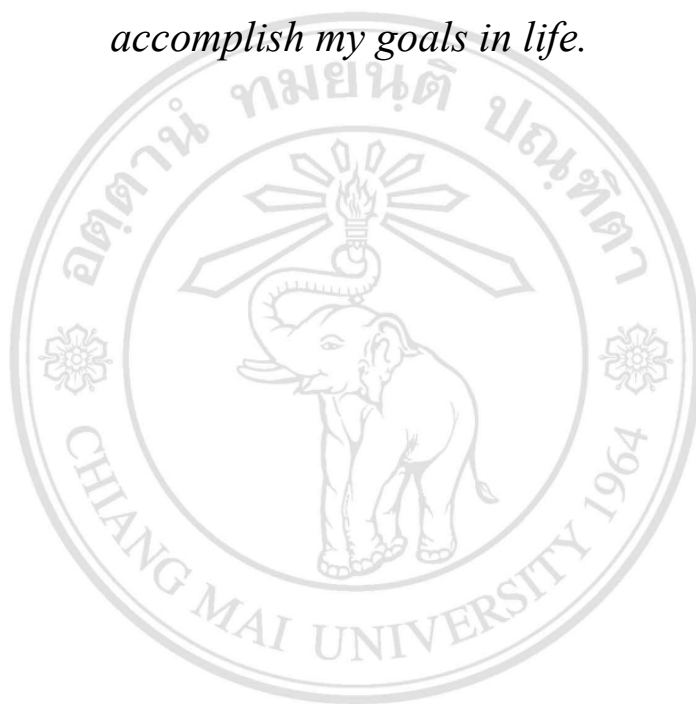

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To

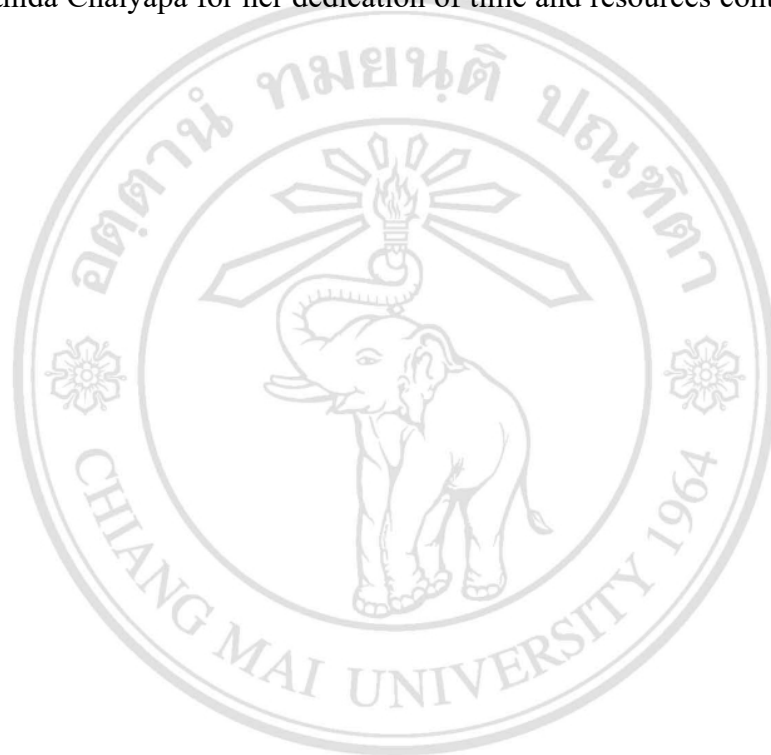
*my dearest son John and Leon, my parents (Ming and Lin) and
sister (Yen) for all their constant support and encouragement to
accomplish my goals in life.*



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Acknowledgement

Foremost, I would like to express my gratitude towards each and every faculty member of the School of Public Policy at Chiang Mai University. Then, my special thanks to Ajan Warathida Chaiyapa for her dedication of time and resources contributed to this research.



Wei Ye

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หัวข้อคุณสมบัติพิเศษ	การศึกษาเปรียบเทียบเรื่องธรรมาภิบาลด้านพลังงานเพื่อคงความต่อเนื่องของการเปลี่ยนผ่านสู่การใช้พลังงานคาร์บอนต่ำ	
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บทคัดย่อ

ท่ามกลางช่วงหัวเลี้ยวหัวต่อของจุดเปลี่ยนที่สำคัญทางประวัติศาสตร์ เช่น วิกฤตโควิด-19 และสงครามรัสเซีย-ยูเครน ความยืดหยุ่นทางการกำกับพลังงานส่งผลกระทบต่อภาคพลังงานและต่อสภาพภูมิอากาศโลก การศึกษานี้จัดทำขึ้นเป็นกรณีศึกษาเปรียบเทียบหลายชุดเพื่อทำความเข้าใจในอิทธิพลของการกำกับดูแลพลังงาน ที่ส่งผลต่อความสามารถในความยืดหยุ่นของพลังงาน

ผลการวิจัยชี้ให้เห็นถึงความยืดหยุ่นที่แตกต่าง ระหว่างแนวทางการกำกับดูแลพลังงานที่เน้นรัฐเป็นศูนย์กลางกับแนวทางที่เน้นตลาดเป็นศูนย์กลาง ในการกำกับดูแลที่เน้นตลาดเป็นศูนย์กลางนั้น โครงสร้างอำนาจแบบกระจายเอื้อต่อการปรับตัวและการเปลี่ยนแปลง ในขณะที่โครงสร้างที่เน้นรัฐเป็นศูนย์กลางทำให้สามารถรับมือกับสถานะปั่นป่วนหรือการหยุดชะงักที่เกิดขึ้นอย่างฉับพลันและการนำการปรับใช้พลังงานทดแทนแบบรวมศูนย์ขนาดใหญ่มาใช้ เนื่องจากนโยบายพลังงานมีพื้นฐานที่เกี่ยวข้องกับโครงสร้างการกำกับดูแล การทำความเข้าใจถึงผลกระทบของความยืดหยุ่นในการกำกับดูแล สามารถช่วยผู้กำหนดนโยบายในทั้งสองระบบ ในการเพิ่มความยืดหยุ่นและกำหนดนโยบายที่สอดคล้องกับความคาดหวังของผู้มีส่วนได้ส่วนเสีย ซึ่งจะทำให้การแสวงหาการเปลี่ยนแปลงสถานะคาร์บอนต่ำก้าวหน้าขึ้น

คำสำคัญ ธรรมาภิบาลพลังงาน, ความยืดหยุ่นของพลังงาน, การศึกษาเปรียบเทียบ

Dissertation Title	A Comparative Study of Energy Governance on Energy Resilience in Low-carbon Transition	
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Degree	Doctor of Philosophy (Public Policy)	
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ABSTRACT

Amidst critical historic junctures like the COVID-19 crisis and the Russian-Ukraine war, energy resilience holds significant implications for the energy sector and global climate. This study conducts a series of comparative case studies to comprehend the influence of energy governance on energy resilience. The findings suggest that energy resilience varies between state-centric and market-centric energy governance approaches. In market-centric governance, the distributed power structure facilitates adaptation and transformation, whereas state-centric structures excel in responding to immediate disruptions and implementing large-scale centralized renewable deployment. Given that energy policy is inherently intertwined with governance structures, understanding the impact of governance on resilience can aid policymakers in both systems to enhance resilience and craft policies that align with stakeholders' expectations, advancing the pursuit of a low-carbon transition.

Keywords: energy governance, energy resilience, comparative studies

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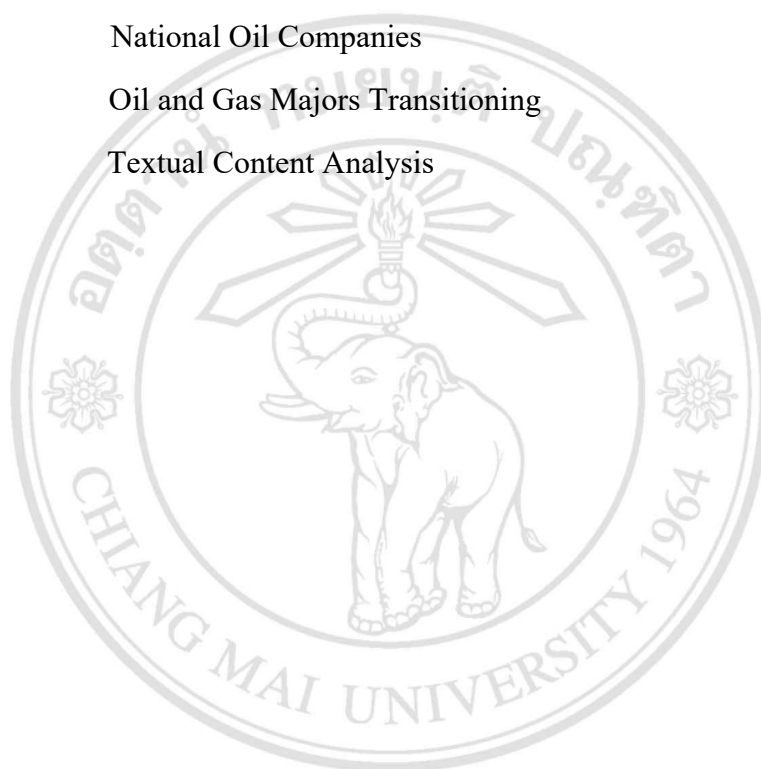
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LIST OF ABBREVIATIONS

CAS	Complex Adaptive Systems
CNOOC	China National Offshore Oil Corporation
FIT	Feed-in Tariff
IOCs	International Oil Companies
NOCs	National Oil Companies
OGMT	Oil and Gas Majors Transitioning
TCA	Textual Content Analysis



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GLOSSARY

Energy Governance

Energy governance refers to how the activities and relationships of the stakeholders in the energy sector are regulated and adjusted to deliver energy services along the low-carbon transition.

State-centric Governance

The industrial energy sector is dominated or guided by the central government, which takes a top-down approach. This structure does not effectively include multiple actors, such as the private sector, and reflects the government's significant influence and involvement in regulating and overseeing the energy sector.

Market-based Governance

A market-centric model is characterized by deregulation, privatization, competition, minimum state involvement, and prudent government. Public, private, and mixed companies coexist with a free-market mechanism to regulate the energy sector.

Energy Resilience

Energy resilience is the ability of an energy system to minimize disruptions to energy service during the low-carbon transition by anticipating, resisting, absorbing, adapting to, and recovering from a disruptive event.

Coping Capacity

Coping capacity is the ability of a system to maintain energy services during large-scale adverse events.

Adaptive Capacity

Adaptive capacity describes the gradual evolution of energy structure from central fossil-based to decentralized renewable-based.

Transformative Capacity

Transformative capacity refers to the ability of energy systems to harness the disruptive effects of sudden shocks or changes to invent new mechanisms for energy transition.

Complex Adaptive System

The term refers to a system where functionality arises not only from the multitude of (often nonlinear) interactions between the physical components and incumbent agents of the system but also from interactions with the surrounding environment.

National Oil Companies

NOCs are state-owned or state-controlled market players in the economy. Although the state is a major stakeholder in NOCs, a sizeable corporate stake in the companies may still be in the hands of private parties or traded publicly on the stock market.

International Oil Companies

Western oil giants such as BP, Royal Dutch Shell, and Exxon Mobil are IOCs. While the mission and strategies of NOCs are more aligned with state policies, IOCs are private corporations whose goals and actions are determined by business considerations in a largely competitive market. IOCs are profit-oriented entities whose decisions are driven by investors and technological advancements.

Oil and Gas Majors Transitioning

OGMT refers to the conscious, planned, and commissioned switch by oil and gas companies from oil and fossil assets and equities to renewables and other clean energy forms as either the exclusive or the predominant components of their corporate portfolios. OGMT describes corporate environmental and energy transition efforts that go beyond the boundary of green-washing.

STATEMENTS OF ORIGINALITY

- 1) This thesis investigates the role of energy governance in enhancing energy resilience amid crises in the low-carbon transition. As the comparison framework, it extracts three critical dimensions from the energy resilience concept: coping capacity, adaptive capacity, and transformative capacity.
- 2) By focusing on the two mainstream energy governance modes around the world, i.e., state-centric and market-based, the study conducts comparative studies to examine the impact of energy governance on energy resilience through the lens of the electricity sector, oil and gas sector, and solar deployment.
- 3) By understanding the power structure and interplay between the states and the market within different energy governance, the study evaluates to what extent these interactions facilitate or restrain the energy system's resilience.
- 4) The study examines the causal mechanism of the role of governance on energy resilience by process tracing solar power development in China and Thailand from 2000 to 2023, representing state-driven and market-based governance approaches.

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ข้อความแห่งการริเริ่ม

- 1) วิทยานิพนธ์นี้ศึกษาบทบาทของธรรมาภิบาลด้านพลังงานในการเพิ่มความยืดหยุ่นของพลังงานท่ามกลางวิกฤติในภาวะเปลี่ยนผ่านช่วงคาร์บอนต่ำ กรอบการเปรียบเทียบจะแยกมิติที่สำคัญ 3 มิติออกจากแนวคิดด้านความสามารถในการฟื้นตัวของพลังงาน ได้แก่ ความสามารถในการรับมือ ความสามารถในการปรับตัว และความสามารถในการเปลี่ยนแปลง
- 2) การศึกษานี้ดำเนินการศึกษาเปรียบเทียบ เพื่อตรวจสอบผลกระทบของธรรมาภิบาลด้านพลังงานที่มีต่อความยืดหยุ่นของพลังงาน โดยมุ่งเน้นไปที่รูปแบบการกำกับดูแลพลังงาน กระแสหลักสองรูปแบบทั่วโลก ได้แก่ แบบรัฐเป็นศูนย์กลางและแบบอิงตลาด ผ่านมุมมองของภาคไฟฟ้า ภาคน้ำมันและก๊าซ และการติดตั้งพลังงานแสงอาทิตย์
- 3) การศึกษาจะประเมินว่าปฏิสัมพันธ์เหล่านี้เอื้ออำนวยหรือยับยั้งความยืดหยุ่นของระบบพลังงานได้มากเพียงใด โดยการทำความเข้าใจโครงสร้างอำนาจและการมีส่วนร่วมระหว่างรัฐกับตลาด ภายใต้ธรรมาภิบาลด้านพลังงานที่แตกต่างกัน
- 4) การศึกษานี้ตรวจสอบกลไกเชิงสาเหตุของบทบาทของธรรมาภิบาลต่อความยืดหยุ่นด้านพลังงาน โดยการติดตามกระบวนการพัฒนาพลังงานแสงอาทิตย์ในประเทศจีนและไทย ตั้งแต่ปี พ.ศ. 2543 ถึง พ.ศ. 2566 ซึ่งแสดงถึงแนวทางการกำกับดูแลที่ขับเคลื่อนโดยรัฐและการอิงตลาด

CHAPTER 1

Introduction

1.1 Problem statement/Background

In the first half of 2020, energy demand slumped due to lockdown measures and fossil fuel prices plummeted with the outbreak of the COVID-19 pandemic. In the first months of the COVID-19 outbreak, some were optimistic that this could accelerate the global energy transition to renewable energy sources (Mohideen et al., 2021), while others were concerned that the COVID-19 crisis would deepen the gulf between leaders and laggards in the global energy transition (Quitow et al., 2021). Starting from 2021, the world suffered from global inflation. The electricity price records were broken in many European countries. For example, in Germany, the electricity price record was broken five times in 2021, increasing by almost 40% within twelve months (Carter, 2022). This has put substantial pressure on consumers within the country who are already struggling in the economic slump caused by COVID-19. With the economic recovery in September 2021, there was a sudden widespread blackout across three provinces in Northeast China, causing severe disruptions in the everyday lives of around 100 million people (Caixin Global, 2021). A coal shortage due to surging prices and a drop in wind power generation was blamed for the power outage. After that, China has a power rationing policy for business and industry users of electricity.

Thanks to technological advancement, little technical failure of the power system was known, which can be directly attributed to COVID-19. However, different phases of the pandemic have affected the global demand for electricity and the prices of fossil fuels. The Russian-Ukraine crisis since 2022 has worsened the supply of energy services with an interrupted supply chain and skyrocketing energy prices. Coupled with an increase of extreme weather events under climate change, during which the generation capacity of

wind and sun-dependent renewable energy is substantially diminished, the recent global turbulences have posed policymakers and academics with another challenge as to the resilience of an energy system in the face of growing climate-related disasters and disruptions.

1.2 Gap in literature

Previous evidence suggests that destabilizing events are decisive turning points in historic sociotechnical transitions (Johnstone & McLeish, 2020). Energy systems are subject to strong and long-lived path dependence, and exogenous shocks catalyze path break-out that can shift the existing energy mix away from fossil fuels to renewables (Apajalahti & Kungl, 2022). With COVID-19 being a demand-side disruption and the Russia-Ukraine war a supply-side disruption, the energy transition under the recent global turbulence will profoundly influence the energy sector and global climate, like the 1973 and 1979 oil shocks. Energy transition is of critical significance in recent global turbulences.

The mainstream energy literature concentrates on the broad structure of the energy system in a cohesive manner, overlooking emerging agendas, systemic contradictions, and social dynamics in shorter timeframes and smaller-scale processes (Martinez, 2022). By tending to energy resilience in times of crisis, the present study contributes to energy studies with a process perspective, zooming in on how state-led interventions and the free-market mechanism perform in the face of disturbance. Moreover, although energy resilience studies have been used to bridge a variety of disciplines given their technical, social, and ecological elements (Hamborg et al., 2020), critics of the resilience theory contend that the existing approaches do not provide an adequate reflection of the power play among different stakeholders in the energy system (Jesse et al., 2019). There lacks a way to describe how different stakeholders with power can influence the system or the development of the system (Phelan et al., 2013).

Governance mode is a primary path-dependence source influencing energy policy (Fouquet, 2016). Energy infrastructure choices are determined by the dynamics and power structures within the governance mode (Edomah, 2021). With a growing decentralized energy system, many academic efforts have been made to understand the governance structure and policy frameworks that support renewable projects. However, there remains a gap in examining how disruptive events impact the low-carbon transition and how the impact differs in differentiating governance models. Studying the role of energy governance on energy resilience (balance of the role of the state and the market) provides insights to formulate intervention policies that foster the low-carbon transition without undermining the security of supply.

1.3 Research objectives

The study aims to comprehensively understand how different governance modes influence energy resilience during the transition to a low-carbon economy. The research objectives are listed below.

1.3.1. To analyze and compare the existing energy governance frameworks in different regions or countries undergoing a low-carbon transition.

1.3.2. To assess the level of energy resilience achieved under different energy governance structures during the transition to a low-carbon economy.

1.3.3. To identify the key factors influencing energy resilience within different energy governance models.

1.3.4. To evaluate the effectiveness of policy measures implemented under various energy governance frameworks in enhancing energy resilience.

1.3.5. To examine the role of stakeholders, including government agencies, industry actors, and civil society, in shaping energy resilience outcomes within different governance contexts.

1.3.6. To explore case studies or best practices from regions or countries with successful energy governance models that have contributed to enhanced energy resilience in the low-carbon transition.

1.3.7. To propose recommendations for policymakers and stakeholders on improving energy governance mechanisms to enhance energy resilience in the context of the low-carbon transition.

In summary, the study's research objectives are to find out how energy resilience differs in terms of governance mode, how the power structure and dynamics within governance affect energy resilience, the causal mechanism underlying the role of governance in energy resilience, and to make policy recommendations.

1.4 Research questions

1.4.1 Aside from policy responses, do different energy governance modes affect energy resilience in times of crisis? How does energy resilience differ in terms of governance mode?

1.4.2 How do the dynamics and power structures within the governance modes affect energy resilience? How do state-led interventions and the free-market mechanism enhance or restrain energy resilience?

1.4.3 What is the causal mechanism underlying the role of governance in energy resilience?

1.4.4 What are the advantages and limitations of the governance modes in improving energy resilience? What lessons can policymakers of different governing systems learn?

1.5 Conceptual framework

In normal times, energy security, energy efficiency, and energy democracy are considered the cornerstones of sound energy policies (Manley et al., 2013; Burke & Stephens, 2017). Seen through the prism of history, **energy security** has been the first and most acute energy goal in most states (Borovsky & Shishkina, 2021). Though context-dependent, the term primarily refers to the stable energy supply for domestic usage with minimum import disruptions (Ang et al., 2015). Energy security is often an essential national policy goal that has to be reconciled with international climate change mitigation commitments made by individual states (Schmidt et al., 2019). The European Commission emphasizes sustainability and environmental considerations in energy security (Green EC. Paper—Towards a European Strategy for the Security of Energy Supply, 2001). In 2007, the Asia Pacific Energy Research Center (APERC) introduced a generic “four As of energy security” (availability, accessibility, affordability, and acceptability) framework for the description and analysis of energy security, highlighting the environmental impacts exerted by energy policy and its sustainability (APERC, 2007).

Energy efficiency concerns both the economic and physical performance of the energy sector; it relates to costs of energy sources, technological efficiency, capital investment, management practices, etc. (Backlund et al., 2012; Li & Tao, 2017). Efficiency evaluation has been a hot area of research over the last decade (Li & Tao, 2017; Zhang et al., 2011; Zhou et al., 2012). Iram et al. (2020) established that energy efficiency is strongly bonded with carbon emissions. Thus, improving the environmental quality could be more pivotal than economic efficiency. Meanwhile, green innovation and institutional quality were significant positive influences on enhancing energy efficiency (Sun et al., 2019).

In the quest for energy transition towards a more sustainable future for humanity, **energy democracy** was brought forward as a new function of energy policy (Chaiyapa et al.,

2021). Besides increased public participation, the conceptualization of energy democracy calls for new energy governmentality as Szulecki (2018) mentalized “prosumer” (both producers and consumers of energy in a distributed energy system), energy cooperatives, and not-for-profit organizations to be truly included and empowered in the process of decision-making. By integrating technological innovation with socio-economic and political change, the movement to “democratize the energy sector” puts people at the center of the renewable energy transformation (Burke & Stephens, 2017).

This research tries to add the resilience element to the sustainability formula. Due to climate change-related extreme weather, public health emergencies, or terrorism, modern energy systems will be increasingly exposed to disruptions. Nevertheless, the core energy functions should be maintained in the face of adversity, regardless of the impact or consequences of the disturbances on the energy system. With the development of sustainability studies, the concept of resilience has evolved rapidly and is used in a range of cross-boundary disciplines (Gatto & Drago, 2020). Energy resilience was initially used to describe the recovering property of energy systems from a technical perspective. As a typical complex adaptive system, the resilience of an energy system in transition must involve both technical and social aspects (Jesse et al., 2019). In this regard, resilience should be applied in the sense of an ecological nature. This article draws on Folke's definition of resilience as the research examines an institution's capability to cope with disruptions while adapting or transforming its energy system in relation to the changing environment. Resilience is “about how periods of gradual changes interact with abrupt changes, and the capacity of people, communities, societies, cultures to adapt or even transform into new development pathways in the face of dynamic changes (Folkes, 2016).” **Energy resilience** is the ability of an energy system to minimize disruptions to energy service along the process of low-carbon transition by anticipating, resisting, absorbing, adapting to, and recovering from a disruptive event. Building on the study of Erker et al. (2017), the present study identifies three main elements of energy resilience based on the spatial-temporal context of disruption: coping capacity, adaptive capacity, and transformative capacity.

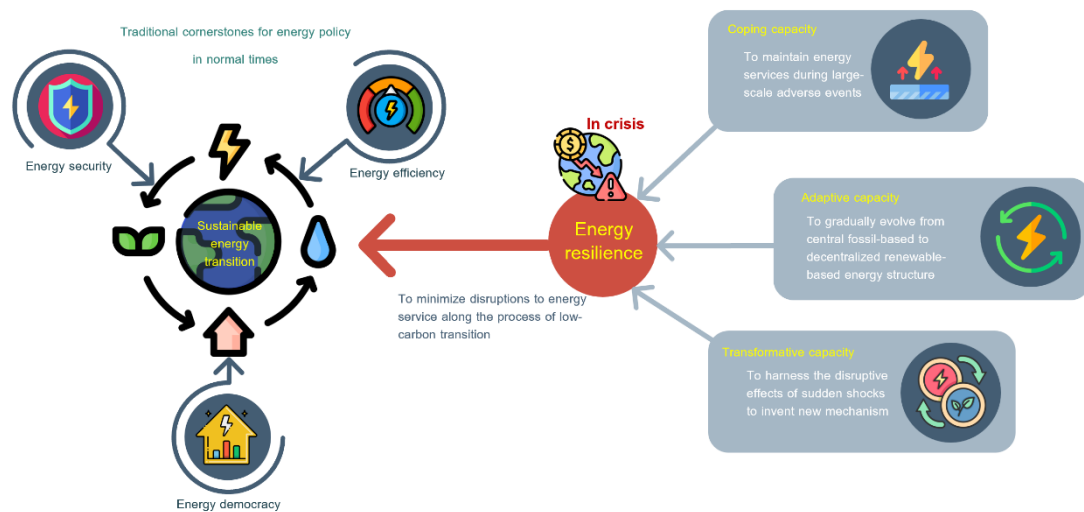


Figure 1 Conceptual framework of the study

1.5 Literature review

1.5.1 The theory and evolution of the term “governance.”

Governance is a multifaceted concept that has evolved and has been approached from various theoretical perspectives. In the traditional sense, governance refers to exercising authority and control over a group of individuals or an organization (Weber, 1919). Historically, it has been closely associated with government structures and processes, focusing on the formal mechanisms by which decisions are made and implemented within political systems (Machiavelli, 1532).

The emergence of New Public Management (NPM) in the late 20th century shifted the understanding of governance. NPM emphasized the importance of efficiency, accountability, and performance measurement in public sector management (Osborne & Gaebler, 1993). From this perspective, governance extends beyond government institutions to encompass a broader network of actors, including non-state entities and

private sector organizations involved in delivering public services (Osborne & Gaebler, 1993).

The concept of "good governance" gained prominence in the development discourse during the late 20th century, particularly with the rise of international development agencies' focus on promoting democracy, rule of law, transparency, and accountability in governance structures worldwide. Good governance is characterized by participatory decision-making processes, respect for human rights, and effective service delivery, aiming to enhance socio-economic development and reduce corruption (World Bank, 1992).

In business and corporate management, governance refers to the systems and processes by which corporations are directed and controlled. Corporate governance theory addresses issues related to the distribution of rights and responsibilities among stakeholders, the role of boards of directors, executive compensation, and mechanisms for ensuring corporate accountability and transparency (Monks & Minow, 2008; OECD, 2004).

With the increasing complexity of societal challenges and the growing interdependence among various actors, scholars have emphasized the importance of network governance as an alternative mode of governance. Network governance involves collaborative decision-making among stakeholders, including governments, businesses, civil society organizations, and community groups, to address common problems and achieve collective goals (Rhodes, 1996). It emphasizes collaboration and interdependence among diverse actors in governing complex societal issues.

In the era of globalization, governance has taken on a transnational dimension, with the emergence of global governance structures and institutions addressing issues such as climate change, trade, and human rights. Multilevel governance theory examines the distribution of authority and decision-making power across different levels of government, from local to global, and emphasizes the need for coordination and cooperation among actors at various levels (Bache & Flinders, 2005; Keohane & Jr, 1973).

Digital technologies have transformed governance practices, leading to e-governance, digital governance, and data-driven governance models. These approaches leverage information and communication technologies to enhance government efficiency, citizen engagement, and service delivery while raising concerns about data privacy, cybersecurity, and digital divides (Dunleavy et al., 2006; Fountain, 2001).

Despite its evolution and diversification, the concept of governance has faced critiques and challenges. Critics argue that governance discourse often neglects power asymmetries, inequality, and exclusion issues and may prioritize technocratic solutions over democratic deliberation and social justice (Jessop, 2002). Moreover, the increasing influence of non-state actors and private interests in governance processes raises questions about accountability and legitimacy (Bevir, 1999).

1.5.2 Meanings and types of governance

There are three broad approaches to analyzing governance: state-centered, society-centered, and state-society relational (Sandu et al., 2020). The state-centered approach focuses on governance, primarily centered around the state's exercise of authority and power within formal governmental structures. It emphasizes the role of government institutions in making decisions, implementing policies, and regulating societal affairs

(Kjaer, 2004; Skocpol, 1997). In contrast, the society-centered approach views governance as being driven by the interactions and activities of various societal actors beyond formal government institutions. It highlights the roles played by civil society organizations, grassroots movements, and other non-state actors in shaping governance processes and outcomes (Cherp et al., 2018). The state-society relational approach examines governance as a dynamic interplay between the state and society, recognizing the complex and reciprocal relationships between governmental and non-governmental actors. It emphasizes the importance of understanding how power, interests, and norms interact within the broader socio-political context to influence governance arrangements and outcomes (Bevir, 2010).

These three approaches offer distinct perspectives on energy governance analysis. The state-centered approach views energy governance as government entities pursuing national interests. Conversely, the society-centered approach focuses on power struggles among various socio-political actors shaping energy governance processes. In contrast, the state-society relational approach integrates state and societal actors into its analysis. It shifts the focus from individual actors to their interactions within the energy governance framework. By doing so, this approach offers a comprehensive understanding of the energy governance process, considering the dynamics between different stakeholders involved.

1.5.3 Policy instruments and their use in the energy sector

Policy instruments are tools or mechanisms governments and other stakeholders use to achieve specific policy objectives (Hettiarachchi & Kshourad, 2019). A brief review of policy instruments commonly used by governments in the energy sector is listed below.

1) Regulatory frameworks

Regulatory frameworks establish rules, standards, and oversight mechanisms to govern the energy sector's operations. These regulations cover safety, environmental protection, market competition, and grid reliability. Examples include licensing requirements for energy companies, environmental impact assessments for energy projects, and market rules for electricity and natural gas markets (Joskow, 2006).

2) Subsidies and incentives

Governments provide subsidies and incentives to promote certain energy technologies or activities. These can include subsidies for renewable energy projects, tax credits for energy efficiency improvements, feed-in tariffs for renewable electricity generation, and grants for research and development in clean energy technologies. Subsidies and incentives aim to reduce market barriers, stimulate investment, and accelerate the transition to sustainable energy systems (Yang et al., 2019).

3) Pricing mechanisms

Pricing mechanisms influence energy consumption patterns, investment decisions, and market behavior. Governments may use taxation, levies, tariffs, and price controls to influence energy prices. For example, carbon taxes internalize the external costs of carbon emissions, while price controls may stabilize energy prices or ensure consumer affordability (Goulder, 1995).

4) Renewable energy targets and mandates

Governments set renewable energy targets and mandates to increase the share of renewable energy sources in the energy mix. These targets specify the percentage of electricity generation or energy consumption sourced from renewables within a specific timeframe. Renewable energy mandates require utilities or energy suppliers to procure a

minimum of their energy from renewable sources, driving investment in clean energy technologies (Jacobsson & Lauber, 2006).

5) Energy efficiency standards and programs:

Energy efficiency standards and programs promote energy conservation, reduce waste, and improve energy productivity. Governments establish standards for appliances, buildings, vehicles, and industrial processes, prescribing minimum efficiency levels. Energy efficiency programs offer incentives, rebates, and technical assistance to encourage adopting energy-saving practices and technologies (Allcott & Greenstone, 2012).

6) Carbon pricing and emissions trading

Carbon pricing mechanisms, such as carbon taxes and emissions trading schemes, put a price on carbon emissions to incentivize emission reductions. Carbon taxes impose a fee on each ton of carbon dioxide emitted, while emissions trading systems allocate limited emissions permits to regulated entities. Carbon pricing provides economic signals to polluters, encourages low-carbon investments, and generates revenue for climate mitigation efforts (Stavins, 1998).

These policy instruments are essential for governments to shape the energy sector, address environmental challenges, promote sustainable development, and achieve national energy goals. Each instrument has strengths and limitations, and its effectiveness depends on policy design, implementation, enforcement, and stakeholder engagement.

1.6 Energy governance

Energy governance in the study refers to how the activities and relationships of the stakeholders in the energy sector are regulated and adjusted to deliver energy services along the low-carbon transition (Peters & Pierre, 1998). Energy commodities and services are governed through government mandates and markets (Florini & Sovacool, 2009). The energy sector is vital to a state's economy, security, and overall well-being. As a result, many states maintain a significant level of involvement and regulation in their energy markets. Based on the state and market dynamics in the sector, prevailing energy governance can be divided into state-centric and market-based categories (Bell et al., 2010).

Representatives of state-centric power systems include China, Japan, South Korea, etc., where the central government dominates the industrial energy sector with a top-down approach (Zhang & Andrews-Speed, 2020). State-centric governance does not allow the effective inclusion of multiple actors, such as the private sector (Andrade & Taravella, 2009). It reflects the significant influence and involvement of the government in regulating and overseeing the energy sector.

A market-based model features deregulation, privatization, competition, minimum state involvement, and prudent government (Yu, 2022). Multiple stakeholders are actively involved in the energy sector, with a free market at the core to govern player relationships. Public, private, and mixed companies coexist in the energy market (Heddenhausen, 2007). The role of the state changes from control to steering to ensure the effective operation of the market mechanism (Arlota, 2021) through setting goals and priorities (Peters & Pierre, 1998), with tools such as incentives and education (Hall, 2011). Aside from being “rule takers,” businesses and other non-governmental actors play a critical role in negotiating the design of climate and energy regimes as “rule makers,” particularly in developed countries such as the United States, the United Kingdom, and Germany (Andrade & Puppim de Oliveira, 2015).

Countries with different energy governance modes are making different progress in energy transition. In the face of a crisis, the response mechanisms of the two governing patterns differ, as shown in the live case of the coronavirus pandemic and the Russian-Ukraine conflict.

1.7 Structure of the study

The study conducts comparative studies to examine the impact of energy governance on energy resilience through the lens of the electricity sector, oil and gas sector, and solar power deployment. Electrical power systems are among the critical infrastructures of modern societies. The electricity sector is the main arena for energy transition. A greener electricity system with reduced GHG emissions would mitigate the impact of climate change (UNERC, 2009). The global transition to oil after the Second World War has evolved under the dominance of multinational oil companies (Bricout et al., 2022). Similarly, how the oil majors respond to climate change mitigation and sustainability in times of crisis will profoundly impact the success of the ongoing energy transition (Alova, 2022). Compared with international oil companies (IOCs)¹ and smaller independents, national oil companies (NOCs)² play a central role in the oil and gas transitioning³ amid

¹ IOCs are Western oil giants such as BP, Royal Dutch Shell, and Exxon Mobil. While the mission and strategies of NOCs are more aligned with state policies, IOCs are private corporations whose goals and actions are determined by business considerations in a largely competitive market. IOCs are profit-oriented entities whose decisions are driven by investors and technological advancements (Shojaeddini et al., 2019).

² NOCs are state-owned or state-controlled market players in the economy. Although the state is a major stakeholder in NOCs, a sizeable corporate stake of the companies may still be in the hands of private parties or be traded publicly on the stock market.

³ Oil and gas majors transitioning (OGMT) refers to “the conscious, planned, and commissioned switch by oil and gas companies from oil and fossil assets and equities to

the recent turbulence, given their access to proven global oil reserves⁴ and the fact that they are state-backed players in the international market (Guttman, 2020). Though most states have made voluntary commitments to cut emissions under the Paris Agreement, with the ongoing Russia-Ukraine war, oil-poor sovereignties, including China and Europe, are under tremendous pressure to make ends meet. Global energy shortage in the wake of post-pandemic recovery has provoked interventionist policies for energy security (Fatih, 2023). NOCs in those regions face the trilemma of complying with national emission requirements, securing the region's energy supply, and withstanding market volatility. It is essential to study the power structure and interplay between state and NOCs within different energy governance to evaluate to what extent these interactions facilitate or restrain the energy system's resilience. Lastly, as promoting diversity in energy systems, either in terms of energy production or energy consumption, can enhance energy resilience, solar deployment plays an essential role in the low-carbon transition of the power sector.



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renewables and other clean energy forms as either the exclusive or the predominant components of their corporate portfolios” (Abraham-Dukuma, 2021). OGMT describes corporate environmental and energy transition efforts that go beyond the boundary of green-washing.

⁴ NOCs (including INOCs) accounted for 65.7% of global oil reserves, 57.8% of oil production, and 44% of oil upstream investment in 2018 (IEA, 2020).

First paper examined the impact of COVID-19 on energy transition to put forward research hypothesis

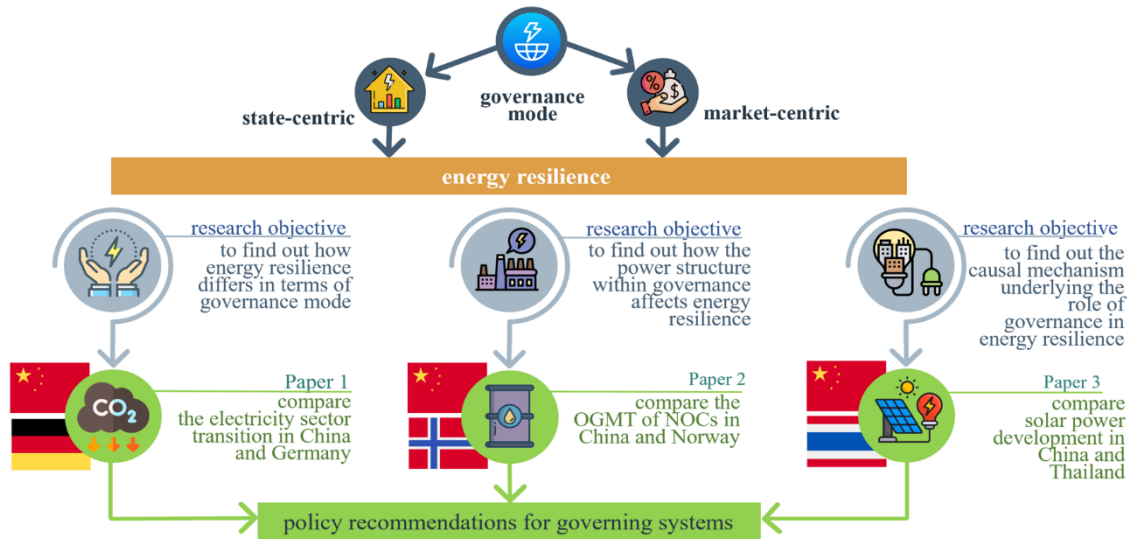


Figure 2 Structure of the study

1.8 Methodology

The study conducted a series of qualitative comparative analyses to examine energy governance's role in energy resilience during the transition to a low-carbon energy system. The conference paper *Evolution and Reshaping of the Energy Landscape in Northeast Asia in the Post-COVID19 Era* conducted a policy pyramid analysis to review the energy policy of China, Japan, and South Korea before and after COVID-19. The journal paper *Impact of Governance on Resilience in the Energy Transition. An Analysis of China and Germany* used policy review and discourse analysis to compare the electricity sector transitioning of China and Germany in crisis. The journal paper *What does energy resilience mean for transitioning oil majors: A study of the impact of energy governance on energy resilience* did thematic content analysis with MAXQDA of the annual reports of CNOOC in China and Equinor in Norway to find out how the power structure within governance affects energy resilience. The last paper *A comparative study of energy governance on energy resilience: process tracking of China and Thailand's solar power development* conducted process tracing and qualitative content analysis to compare the solar power development in China and Thailand from 2000 to 2023.

CHAPTER 2

Research Articles

2.1 Published paper

2.1.1) Wei Ye, “Evolution and Reshaping of the Energy Landscape in Northeast Asia in the Post-COVID19 Era,” The 25th International Public Management Network Conference, Seoul, South Korea, 19-20 August 2021

Research Objectives/Hypothesis:

The study aims to review the impacts of COVID-19 on the energy sector of Northeast Asia, using a policy pyramid analysis of the energy policy of China, Japan, and South Korea before and after COVID-19.

Significant Findings:

COVID-19 has undermined renewables’ competitiveness with fossil fuels. The pandemic has posed severe challenges to developing renewable energy. Regional energy cooperation is needed for a ‘green recovery’ and the long-term sustainability and resilience of the energy sector in the post-pandemic era.

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2.1.2) Wei Ye, Warathida Chaiyapa, “What does energy resilience mean for transitioning oil majors: A study of the impact of energy governance on energy resilience,” *Social Sciences & Humanities Open*, Volume 8, Issue 1, 2023, 100686, ISSN 2590-2911, <https://doi.org/10.1016/j.ssaho.2023.100686>.

Research Objectives/Hypothesis:

The study aims to find out how the power structure within governance affects energy resilience, using thematic content analysis with MAXQDA to compare the OGMT of CNOOC in China and Equinor in Norway.

Significant Findings:

NOCs in state-centric governance exhibit stronger coping capacity in crisis yet need to catch up regarding adaptive and transformative capacity compared with NOCs in market-centric governance. In crisis times, the state’s capacity as a regulator should outweigh that as a shareholder. stimulate responses from other agents in the system and increase public involvement

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2.1.3) Wei Ye, Warathida Chaiyapa, “Impact of Governance on Resilience in the Energy Transition. An Analysis of China and Germany”, Utilities Policy, Volume 87, 2024, 101732, ISSN 0957-1787, <https://doi.org/10.1016/j.jup.2024.101732>.

Research Objectives/Hypothesis:

The study aims to find out how energy resilience differs in terms of governance mode, by conducting a policy review and discourse analysis to compare the electricity sector transitioning of China and Germany in a crisis.

Significant Findings:

Energy resilience differed between state-centric and market-centric governance. The distributed power structure in market-centric governance promotes adaption and transformation, whereas a state-centric structure is more effective in responding to immediate disruptions and implementing larger-scale centralized renewable deployment. Energy policy in crises needs to be adjusted while keeping the policy flow consistent and comprehensive; both top-down and bottom-up approaches can be employed to achieve the low-carbon transition.

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2.2 Unpublished manuscript

2.2.1) Wei Ye, Warathida Chaiyapa, “A comparative study of energy governance on energy resilience: process tracking of China and Thailand's solar power development.”

Introduction

Asia, the world's highest emitting region with surging electricity demand, faces a critical need to transition to clean energy sources for sustainable development. Despite significant progress in solar deployment, its penetration in the electricity mix remains relatively low. This study employs process tracing to compare solar power development in China and Thailand from 2000 to 2023, representing state-driven and market-based governance approaches.

Materials and Method

This study used a comparative case study to understand the role of energy governance on energy resilience. We applied process tracing and qualitative content analysis to understand whether and how energy governance influences energy resilience. We started by mapping the evolution of policy instruments used in China and Thailand since 2000 to incentivize solar generation, then we reviewed the policies. We drew on extensive document studies from the websites of intergovernmental organizations (IEA, IRENA, and ASEAN), industry associations (Global Solar Council, China Photovoltaic Industry Association (CPIA), and Thai Photovoltaic Industries Association (TPVA)), solar companies, energy literature, and news articles. The secondary data review was complemented by semi-structured interviews. We conducted online interviews with regulating organizations, solar associations, SOEs, private companies in power generation, transmission, and distribution, and companies that have installed distributed solar PV. The interviews were conducted between the period of January 2022 and January 2024.

Results and Discussion

We find state-driven governance exhibits resilience in addressing immediate crises, while market-based approaches offer flexibility and responsiveness to stakeholder needs. Both have merits and drawbacks in adaptive capacity. Market mechanisms show transformative potential in fostering widespread adoption of renewable energy, especially at the community level.

Conclusion

Our study highlights the importance of understanding energy governance's role in resilience in the face of disruptions, balancing state and market roles to facilitate a low-carbon transition while ensuring energy security. Insights derived can inform intervention policies to accelerate the shift towards renewable energy without compromising supply security. There is a need to balance supply-side policies with demand-side management in achieving sustainable energy transitions.

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CHAPTER 3

Conclusion

3.1 Results of the study

The study's findings highlight significant disparities in energy resilience across different modes of energy governance. Specifically, it reveals that state-centric governance tends to foster coping resilience, while market-based governance demonstrates strengths in adaptive and transformative resilience. This disparity underscores the crucial influence of power structures and dynamics within governance systems on energy resilience outcomes.

Furthermore, the study frames the energy system as a complex adaptive system, wherein the evolutionary dynamics emerge from the interactions, learning, and adaptation of various entities within the system to a changing environment. This perspective underscores the interconnectedness and interdependence of actors and factors shaping energy resilience.

Importantly, the study identifies policy design and sectoral organization as key causal mechanisms through which energy governance influences energy resilience. It emphasizes the need for thoughtful policy interventions and strategic organizational arrangements to enhance energy resilience in the context of the low-carbon transition.

Overall, the study advocates for a balanced integration of state and market roles in energy governance to facilitate the low-carbon transition effectively. By leveraging the complementary strengths of both governance approaches, policymakers can foster

resilience-building strategies that address the complex challenges of transitioning to a sustainable energy future.

3.2 Contribution of the study

The study adopts a holistic approach to investigate the pivotal role of energy governance in fostering energy resilience, particularly in times of crisis. By addressing this crucial aspect, the research fills a significant gap in the field of energy studies, offering a nuanced process perspective. It zooms in on the intricate interplays between the state and market forces during periods of disturbance, shedding light on how these interactions either facilitate or hinder the pace of energy transition.

Notably, this study serves as a bridge between two vital areas of inquiry within energy studies: energy resilience and energy governance. It takes a novel approach by examining resilience through the lens of governance structures and power dynamics inherent within energy systems. By doing so, the research contributes valuable insights to the discourse on energy governance.

Furthermore, the study delves into the nuanced roles of state intervention and market-based models across different sectors of the energy industry, including oil and gas, electricity, and solar power deployment. It pays particular attention to how these governance frameworks operate amidst crises and the pressing imperative of decarbonization.

In essence, this research offers actionable guidance to accelerate the transition of energy sectors towards sustainability. By illuminating the intricate dynamics of energy governance and resilience-building strategies, policymakers and stakeholders are equipped with invaluable insights to navigate and expedite the shift towards a low-carbon future.

3.3 Policy recommendations

The study offers several recommendations for policymakers to navigate the challenges and opportunities in enhancing energy resilience and facilitating the low-carbon transition:

1) Emphasize regional energy cooperation: Policymakers should prioritize regional energy cooperation to foster a "green recovery" and ensure the long-term sustainability and resilience of the energy sector in the post-pandemic era. Collaborative efforts among neighboring countries can promote resource sharing, technology transfer, and coordinated policy initiatives to address common energy challenges.

2) Ensure timely adjustment of energy policies: Policymakers need to adjust energy policies promptly in response to crises, ensuring that policy frameworks remain consistent and comprehensive. Both top-down and bottom-up approaches should be employed to facilitate the low-carbon transition, leveraging a mix of regulatory interventions, market mechanisms, and stakeholder engagement strategies.

3) Prioritize regulatory capacity over shareholder interests: During crisis periods, the state's role as a regulator should take precedence over its role as a shareholder in energy enterprises. Policies should aim to stimulate responses from all stakeholders within the energy system while increasing public involvement and transparency. This approach can enhance resilience by fostering a collaborative and adaptive governance framework.

4) Balance Supply-side policies with demand-side management: Policymakers should adopt a balanced approach that integrates supply-side policies with demand-side management strategies to achieve sustainable energy transitions. In addition to promoting renewable energy deployment and infrastructure development, efforts should

be made to incentivize energy efficiency, conservation, and demand response measures to optimize resource utilization and minimize environmental impacts.

By implementing these recommendations, policymakers can enhance the resilience of energy systems, promote sustainable development, and accelerate the transition to a low-carbon future. Collaboration, flexibility, and innovation will be essential in navigating the complex challenges and opportunities in the evolving energy landscape.

3.4 Limitations and suggestions for future research

The study compares various energy governance modes; however, it may not adequately control for numerous other factors influencing energy resilience in the case studies. Nevertheless, we try to ensure that the selected case studies represent diverse contexts and account for variability in geographical, economic, political, and social conditions. This helps in capturing a broader spectrum of factors influencing energy resilience. In addition, the research process involves relevant stakeholders, including policymakers, industry experts, and community representatives. Their input can enrich the analysis and ensure its relevance to real-world contexts. For future studies, advanced statistical techniques such as multivariate regression analysis can be employed to simultaneously analyze the impact of multiple variables on energy resilience. This approach can help isolate the effect of energy governance modes while controlling for other factors.

Relying solely on secondary data sources and online interviews may introduce data quality, reliability, and representativeness limitations. Incorporating primary data collection methods like field surveys and in-depth interviews could strengthen the study's credibility. It is recognized that the limited sample size of the interviews restricts the generalizability of the findings to a broader population (Coleman et al., 2013). The present study focuses on elucidating the meanings and interpretations of stakeholder interactions in energy governance concerning energy resilience rather than formulating

generalized hypotheses (Mason, 2010). Interviews were conducted until access was exhausted, and the results were triangulated with a diverse range of secondary data sources until theoretical saturation was achieved; subsequent interviews did not yield additional insights into other factors influencing responses to the energy crisis.

While the qualitative approach employed in the study offers valuable insights, it also comes with inherent limitations such as potential biases, subjectivity, and challenges in interpretation. In content analysis, deducting texts into abstract codes risks overlooking data that may not fit within the theoretical framework, and assigning significance based solely on word count may disregard the data context (Tunison, 2023). Content and discourse analysis may not be entirely objective, as theoretical assumptions and ongoing reflection may influence the researchers' interpretations throughout the study. To mitigate these limitations, employing complementary research methods and triangulating findings could improve the validity and reliability of the study results.

Given the qualitative nature of this study, statistical methods were not utilized, and consequently, the findings apply solely to the studied cases within the specified timeframe. In forthcoming research endeavors, it would be beneficial to incorporate additional case studies to augment the generalizability of the findings. Moreover, delving deeper into stakeholder perspectives, encompassing local communities, industry actors, and civil society organizations, could provide valuable insights into how governance affects energy resilience.

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