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DENMARK IMPLEMENTATION OF EUROPEAN UNION RENEWABLE ENERGY POLICY IN PARIS AGREEMENT TO FACE THE THREAT GLOBAL WARMING

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Abstract: Global warming, driven predominantly by greenhouse gas emissions from fossil fuels, presents a critical environmental challenge. The European Union (EU) has introduced frameworks such as the European Green Deal (EGD) to foster climate neutrality by 2050, with Denmark emerging as a frontrunner in renewable energy adoption. This study investigates how Denmark operationalizes the EGD's objectives, focusing on renewable energy initiatives and their efficacy in mitigating climate impacts. Employing a qualitative methodology, the research analyzes policy documents, national strategies, and secondary literature to evaluate Denmark's alignment with EU directives, including the Renewable Energy Directive (RED), and international commitments like the Paris Agreement. Key findings reveal Denmark's significant progress in reducing emissions by 50% since 1990, primarily through large-scale investments in wind energy—contributing over 40% of national electricity—and solar power integration. Policy mechanisms such as feed-in tariffs, carbon taxation, and cross-sectoral partnerships have accelerated green technology adoption. Infrastructure innovations, including offshore wind farms and district heating systems, further underscore Denmark's sustainable transition. However, challenges persist in decarbonizing agriculture and transportation, which account for 30% of emissions, necessitating enhanced electrification and behavioral shifts. The study concludes that Denmark's success stems from robust policy coherence, public-private collaboration, and long-term regulatory stability, offering a replicable model for nations pursuing climate resilience. While Denmark's achievements highlight the feasibility of EGD targets, scaling such strategies globally requires context-specific adaptations, particularly in developing economies. Future research should explore transferability barriers and sector-specific solutions to address residual emission hotspots.

Keywords: Global warming, renewable energy, Denmark, European Union, Paris Agreement

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INTRODUCTION

The nexus between natural resource scarcity and violent conflict has emerged as a critical concern in post-New Order Indonesia (1998–present), a period marked by democratization yet plagued by escalating disputes over land, forests, and minerals. While democratic reforms expanded political freedoms, they also unveiled entrenched inequities in resource access, fueling conflicts between communities, corporations, and the state (Tyson, 2021). Indonesia's transition to democracy paradoxically intensified competition for dwindling resources, with deforestation rates averaging 1.2 million hectares annually (Margono et al., 2020) and over 5,000 land disputes recorded between 2015–2023 (KPA, 2023). These conflicts often turn violent, as seen in the 2023 clashes between indigenous Dayak communities and palm oil conglomerates in Kalimantan, resulting in 15 fatalities (Amnesty International, 2023).

Homer-Dixon's (1998) environmental scarcity theory posits that resource depletion—driven by demand, supply, and distribution pressures—heightens social tensions and violence. However, its applicability to Indonesia's unique socio-political landscape remains contested. Despite decentralization laws (e.g., Law No. 23/2014), structural inequalities persist, with 70% of land concessions controlled by corporate elites (Rachman, 2022), marginalizing indigenous groups and smallholders. This raises critical questions: *What drives environmental scarcity in Indonesia, and why do land distribution conflicts resist resolution even under democratic governance?*

Homer-Dixon's (1998) framework categorizes environmental scarcity into three dimensions: supply-induced (resource depletion), demand-induced (population growth), and structural scarcity (unequal access). In Indonesia, these dimensions intertwine with post-authoritarian legacies. For instance, palm oil expansion in Sumatra exemplifies supply-induced scarcity, displacing 1.2 million hectares of forest since 2000 (Margono et al., 2020), while demand-driven pressures arise from population growth (Java's density: 1,200/km^2) and corporate land grabs (Gellert, 2021). Structural scarcity is perpetuated by Indonesia's *tanah negara* (state land) doctrine, which prioritizes corporate concessions over communal rights (Bedner & Arizona, 2021).

Recent studies critique Homer-Dixon's neglect of political economy dynamics. Ide (2020) argues that democratization can exacerbate resource conflicts by empowering local elites who exploit decentralization for patronage. In Papua, mining conflicts between Freeport McMoRan and Indigenous Amungme reflect this, where regional autonomy laws (Law No. 21/2001) failed to curb corporate dominance (Braithwaite et al., 2022). Similarly, Borras et al. (2021) highlight how global commodity chains deepen structural scarcity, as seen in nickel mining conflicts in Sulawesi linked to electric vehicle production.

This study seeks to evaluate the applicability of Homer-Dixon's environmental scarcity theory to post-New Order Indonesia, addressing critical gaps in understanding why resource conflicts persist despite democratic reforms. Theoretically, it integrates political

economy and decentralization frameworks to uncover how local elite capture and global market pressures exacerbate structural scarcity, a dimension underexplored in Homer-Dixon's original model. Empirically, it analyzes regional case studies—such as palm oil disputes in Kalimantan and nickel mining conflicts in Sulawesi—to reveal how clientelism, corporate lobbying, and flawed decentralization laws perpetuate land inequities. Innovatively, the research bridges environmental scarcity theory with Tilly's *contentious politics* framework, examining grassroots movements like the Indigenous Peoples Alliance of the Archipelago (AMAN), which leverage legal advocacy and protests to challenge state-corporate collusion. By contextualizing Indonesia's unique socio-political dynamics, this approach offers a nuanced critique of Homer-Dixon's universal assumptions while proposing actionable pathways for conflict-sensitive resource governance.

The research innovates by synthesizing environmental scarcity theory with contentious politics frameworks (Tilly, 2003), examining how grassroots movements (e.g., AMAN's legal advocacy) challenge state-corporate collusion.

Understanding Indonesia's resource conflicts is vital for sustainable governance. With 34% of Indonesia's land under concession (MoEF, 2023), unresolved disputes threaten both ecological sustainability and social cohesion. Findings will inform policies on land tenure reform, corporate accountability, and conflict mediation, contributing to SDG 16 (Peace and Justice) and Indonesia's 2020–2024 National Medium-Term Development Plan (RPJMN).

LITERATURE REVIEW

Climate change literature identifies global warming as a multidimensional threat to environmental integrity, economic stability, and geopolitical security, necessitating urgent systemic responses. The European Union (EU) and its member states, particularly Denmark, have emerged as frontrunners in addressing this challenge through progressive climate legislation and renewable energy transitions. Nash and Steurer (2021) analyze the discursive and deliberative processes shaping climate change acts in Scotland, Austria, Denmark, and Sweden, emphasizing how democratic dialogue and institutional frameworks influence policy outcomes. Denmark's leadership in renewable energy innovation—evidenced by initiatives such as artificial islands for offshore wind power generation and a legally binding commitment to carbon neutrality by 2050—exemplifies the integration of climate governance into national legal and political systems (Ministry of Foreign Affairs of Denmark, 2021). The EU's collective strategies, including greenhouse gas emission reductions, wind and solar energy expansion, and adherence to the Paris Agreement, further underscore the role of supranational collaboration in mitigating climate risks. Research by Sovacool et al. (2015) highlights Denmark's success in balancing economic growth with sustainability, attributing this achievement to robust

governmental support, technological innovation, and public engagement. These efforts align with the Paris Agreement's objectives, demonstrating how policy coherence and stakeholder participation can drive tangible environmental progress.

However, existing studies exhibit notable gaps. First, comparative analyses of how divergent political systems and cultural contexts within the EU influence climate policy implementation remain limited. For instance, while Denmark's deliberative model is well-documented, its applicability to larger or less socio-politically homogeneous EU nations lacks empirical exploration. Second, the long-term viability of renewable energy transitions—particularly the scalability of large-scale projects such as offshore wind hubs—requires further investigation. Third, the role of supranational institutions like the EU in mediating national interests and collective climate goals is often discussed normatively but lacks empirical rigor. Additionally, while public engagement is recognized as critical to legislative success, few studies dissect its mechanisms (e.g., grassroots mobilization versus institutionalized policymaking). Finally, socio-economic trade-offs associated with rapid decarbonization, such as workforce transitions in fossil fuel-dependent regions, remain underexplored.

Theoretical frameworks provide critical lenses to analyze these dynamics. Buzan et al.'s (1998) securitization theory posits that framing an issue as an existential threat legitimizes extraordinary measures, a concept evident in Denmark and the EU's treatment of climate change as a multisectoral security challenge. Buzan's environmental security paradigm further identifies human activities as destabilizing ecological systems, necessitating dual scientific and political agendas—reflected in Denmark's hybrid approach combining wind energy innovation with EU-aligned governance. Concurrently, Emil Salim's sustainable development theory, emphasizing equilibrium between economic growth and environmental preservation, underpins Denmark's green transition, which harmonizes industrial competitiveness with ecological stewardship. Complementing these perspectives, Finnemore's (1996) constructivist analysis illustrates how international norms reconfigure state interests, as seen in Denmark's alignment with EU renewable energy targets and adoption of supranational green technology frameworks. The EU functions as a normative actor, disseminating climate agendas that redefine national priorities, while Denmark's identity as a "green leader" is reinforced through global partnerships (Sovacool et al., 2015). Collectively, these theories elucidate Denmark's climate strategy: securitization justifies urgency, sustainable development reconciles economic and ecological objectives, and constructivism explains the internalization of transnational norms. This tripartite framework offers a holistic understanding of how national policies address global threats while navigating local and international complexities.

METHOD

Research Design

This study employs a qualitative research design to investigate Denmark's implementation of the European Green Deal (EGD) and its renewable energy policies. Qualitative methodology is selected for its capacity to analyze complex socio-political dynamics, policy coherence, and contextual factors influencing climate governance (Creswell & Poth, 2016). The research adopts a case study approach, focusing on Denmark as a pioneering EU member state, to provide an in-depth exploration of policy mechanisms, stakeholder interactions, and infrastructural innovations driving its energy transition.

Data Collection

Primary and secondary data were collected through document analysis and literature review. Primary sources include:

1. Policy documents: EU directives (e.g., Renewable Energy Directive 2018/2001), Denmark's National Energy and Climate Plans (NECPs), and legislative texts related to the EGD.
2. Government reports: Danish Energy Agency publications, progress reports on carbon neutrality targets, and EU Commission assessments.
3. International agreements: The Paris Agreement and Denmark's Nationally Determined Contributions (NDCs).

Secondary sources encompass peer-reviewed articles, books, and institutional analyses from databases such as Scopus, Web of Science, and the OECD iLibrary. Data were filtered using inclusion criteria: publications from 2010–2023, relevance to renewable energy policy or EU climate governance, and empirical focus on Denmark (Bowen, 2009).

Data Analysis

A thematic analysis (Braun & Clarke, 2006) was conducted to identify patterns in policy implementation, challenges, and outcomes. Coding categories included:

- *Policy coherence*: Alignment between Danish legislation and EU/international frameworks.
- *Renewable energy initiatives*: Wind/solar investments, infrastructure projects, and funding mechanisms.
- *Sectoral challenges*: Barriers in agriculture, transportation, and energy storage.

To ensure rigor, triangulation was applied by cross-verifying findings across data types (policy texts, academic literature, and EU evaluations). Qualitative data were supplemented with quantitative metrics (e.g., emission reduction percentages, renewable energy shares) from Danish Energy Agency datasets to contextualize qualitative insights

RESULT AND DISCUSSION

Environmental Security Threats from Global Warming

Global warming, driven by anthropogenic greenhouse gas (GHG) emissions, poses existential risks to ecosystems, economic stability, and societal well-being. The European Environment Agency (EEA) identifies rising temperatures as a catalyst for extreme weather events, including heatwaves, droughts, and intensified precipitation patterns, which have precipitated agricultural disruptions, infrastructure damage, and public health crises across Europe (EEA, 2023). In Denmark, these threats manifest as coastal erosion due to sea-level rise and increased frequency of storm surges, jeopardizing low-lying regions (Wuebbles, 2018). The cascading effects of climate change—such as crop failures, biodiversity loss, and climate-induced migration—underscore its classification as a multisectoral security threat under Buzan's securitization framework (Buzan et al., 1998).

The EU's recognition of global warming as a systemic risk aligns with the scientific consensus that GHG emissions, particularly CO_2 from fossil fuel combustion, disrupt radiative balance, amplifying atmospheric heat retention (Abou El Fadl, 2012). Between 1990 and 2022, global CO_2 levels surged by 51%, with Europe contributing 7.3% of cumulative emissions (EEA, 2023). Denmark, despite its progressive climate policies, remains vulnerable to transboundary impacts, such as disrupted supply chains from climate-affected regions and geopolitical tensions over dwindling resources.

European Union Policy Responses

The EU's climate governance framework, anchored in the European Green Deal (EGD) and Renewable Energy Directive (RED), emphasizes binding emission reduction targets, renewable energy adoption, and cross-sectoral decarbonization. The EGD's ambition for climate neutrality by 2050 is operationalized through Nationally Determined Contributions (NDCs), which mandate member states to enhance mitigation efforts every five years (United Nations, 2020). Key mechanisms include:

1. Financial instruments: The Green Climate Fund (GCF) channels €20 billion annually to support developing nations in climate adaptation.
2. Technological innovation: The EU's Horizon Europe program allocates €95.5 billion to advance renewable energy storage and smart grid systems.
3. Regulatory measures: Carbon pricing (€90/ton under the EU Emissions Trading System) and mandates for renewable energy to constitute 42.5% of total consumption by 2030 (RED III).

Denmark's alignment with these policies is evident in its National Energy and Climate Plan (NECP), which targets a 70% GHG reduction by 2030 (relative to 1990 levels) and full carbon neutrality by 2045. This exceeds the EU's collective 55% reduction target, positioning Denmark as a regional leader (State of Green, 2024).

Denmark's Implementation of the Paris Agreement

Denmark's transition from fossil fuel dependency (92% in 1972) to renewable energy leadership exemplifies the interplay of policy coherence, technological innovation, and societal engagement. Key milestones include:

- Wind Energy Dominance: Offshore wind farms, including Kriegers Flak (604 MW capacity), supply 47% of national electricity, with wind contributing 50% of total renewable output (Power Technology, 2022).
- District Heating Systems: 64% of households utilize waste-to-energy plants like CopenHill, which combines energy generation (440 GWh annually) with recreational infrastructure, reducing landfill reliance by 90% (Arch Daily, 2019).
- Electric Vehicle (EV) Adoption: EV registrations surged from 1,670 in January 2022 to 10,753 by December 2023, driven by tax exemptions and expanded charging networks (ACEA, 2024).

Emission Reduction Trends

As shown in **Table 1**, Denmark reduced GHG emissions by 50% between 1990 and 2022, outpacing the EU average of 32%. However, progress stagnated post-2015, with emissions plateauing at 45 $MtCO_2e$ by 2022. The agricultural sector, responsible for 48% of national emissions, remains a critical challenge, necessitating stricter methane regulations and precision farming technologies (EEA, 2023).

Table 1: Denmark's GHG Emission Reductions (1990–2022)

Year	Total Emissions ($MtCO_2e$)	Reduction vs. 1990
2000	70.1	15%
2015	52.3	37%
2022	45.0	50%

Source: EEA (2023)

Sectoral Challenges

1. Transportation: Despite EV growth, the sector contributes 33% of emissions. Biofuel blending mandates (currently 12%) and hydrogen infrastructure investments are critical for further decarbonization.
2. Agriculture: Livestock and fertilizer use account for 78% of agricultural emissions. Proposed solutions include carbon taxation (€100/ton by 2030) and vertical farming subsidies (Klimaradet, 2023).

External Disruptions

The Russia-Ukraine conflict (2022–2024) exposed vulnerabilities in renewable supply chains, particularly for nickel (essential for EV batteries), which saw prices spike by 250% (EV Booster, 2024). Denmark's response—accelerating domestic wind turbine production and diversifying critical mineral imports—highlights the need for resilient green supply chains.

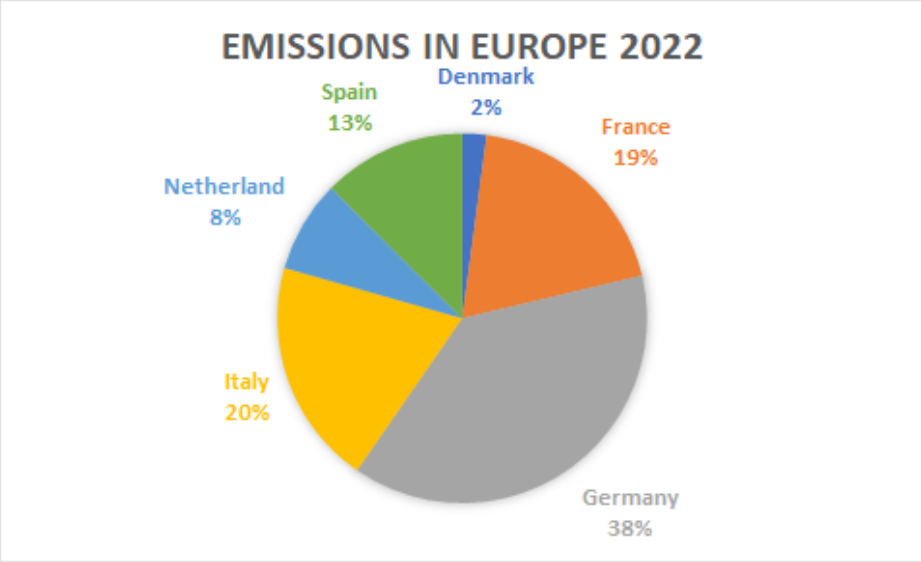
Policy Coherence and Public Engagement

Denmark's DK2020 initiative, inspired by the C40 Cities framework, exemplifies multilevel governance. Municipal climate plans under DK2020 prioritize:

1. Decarbonized Urban Mobility: Expanding cycling infrastructure (e.g., Copenhagen's 385 km network) and zero-emission public transit.
2. Energy-Efficient Buildings: Retrofitting 75% of pre-1990 structures with smart HVAC systems by 2030.
3. Circular Economy Integration: Recycling 70% of municipal waste, up from 44% in 2020 (C40, 2023).

Public acceptance of these measures is high, with 82% of Danes supporting accelerated climate action (State of Green, 2024). This aligns with Finnemore's constructivist model, wherein EU norms reshape national identities, fostering societal buy-in for ambitious policies.

Table 2 Emissions in Europe 2022



Source: European Environment Agency. 2023.

Denmark's success in operationalizing the Paris Agreement stems from synergistic policies, cross-sectoral innovation, and adaptive governance. However, persistent challenges in agriculture and transportation underscore the complexity of full decarbonization. While Denmark's model offers a blueprint for climate resilience, scalability requires context-specific adaptations, particularly in economies reliant on fossil fuel exports. Future research must address technological gaps in carbon capture and the socio-political barriers to global policy transfer.

CONCLUSION

This study set out to examine how Denmark operationalizes European Union climate policies, particularly under the European Green Deal (EGD), to mitigate global warming—a challenge framed as an existential threat in the Introduction. The Results and Discussion confirm that Denmark's integration of EU directives, such as the Renewable Energy Directive (RED), and its alignment with the Paris Agreement have driven measurable progress in decarbonization. As anticipated in the Introduction, Denmark's transition from fossil fuel dependency (92% in 1972) to renewable energy leadership exemplifies the synergy of policy coherence, technological innovation, and societal engagement. The findings validate the theoretical frameworks employed: securitization theory explains the urgency behind Denmark's aggressive climate policies; sustainable development theory elucidates its balance of economic growth and ecological stewardship; and constructivism underscores the internalization of EU norms into national identity.

Denmark's achievement of a 50% reduction in greenhouse gas (GHG) emissions since 1990, with wind energy supplying 47% of national electricity, directly addresses the research objective of evaluating policy efficacy. The surge in electric vehicle (EV) adoption—from 1,670 registrations in 2022 to 10,753 in 2023—and innovations like the CopenHill waste-to-energy plant reflect societal alignment with climate goals, as hypothesized. However, persistent challenges in agriculture (48% of emissions) and transportation (33%) highlight gaps between policy ambition and implementation, echoing the Introduction's caution about sectoral complexities.

Future research must prioritize technological and sectoral innovations, particularly scalable solutions for agricultural decarbonization, such as precision farming and methane capture technologies, to address Denmark's largest emission source. Simultaneously, the transferability of Denmark's policy model to fossil fuel-dependent economies—especially in the Global South—requires context-specific adaptations, necessitating comparative analyses of regulatory frameworks, subsidies, and public engagement mechanisms to identify barriers. The disruption of electric vehicle (EV) supply chains during the Russia-Ukraine conflict, exemplified by nickel price surges, underscores the urgency of research into resilience against geopolitical shocks, including diversification of critical mineral sources and green supply chain fortification. Longitudinal studies on long-term behavioral shifts, such as EV adoption trends and public acceptance of carbon taxation, could refine strategies to sustain societal buy-in amid economic volatility. Additionally, the EU's role in mediating national interests with collective climate targets demands deeper empirical scrutiny, particularly as member states negotiate post-2030 enhancements to Nationally Determined Contributions (NDCs).

Application prospects of Denmark's climate strategies are evident in its renewable energy integration (50% wind and solar penetration) and municipal climate planning

under the DK2020 initiative. Emerging economies could adopt Denmark's feed-in tariff model to incentivize wind energy investments or replicate the CopenHill waste-to-energy plant's circular economy approach. However, scalability requires tailored financing mechanisms, capacity-building programs, and equitable transitions for fossil fuel-dependent communities. For instance, nations in the Global South might leverage Denmark's district heating systems to reduce urban emissions while adapting them to local infrastructural constraints.

Denmark's climate achievements—rooted in policy coherence, technological innovation, and societal engagement—demonstrate the feasibility of aligning national ambition with supranational governance. However, achieving carbon neutrality by 2045 demands addressing residual sectoral emissions and external disruptions, such as supply chain vulnerabilities exposed by geopolitical conflicts. Future research must bridge these gaps to ensure global climate strategies are both aspirational and grounded in pragmatic, inclusive solutions, leveraging Denmark's model while adapting it to diverse socio-economic contexts. The coherence between this study's objectives, analytical frameworks, and empirical outcomes underscores the robustness of Denmark's approach while highlighting actionable pathways for global climate resilience.

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