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EVALUATING STRATEGIC APPROACHES TO ENERGY TRANSITION: LEADERSHIP, POLICY, AND INNOVATION IN EUROPEAN COUNTRIES

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ABSTRACT: Purpose: This paper explores the strategic challenges of transitioning to renewable energy in various EU countries while reducing greenhouse gas emissions. Methodology/Approach: The research utilises case studies to analyse national policies, stakeholder engagement, and the EU's role, particularly through the European Green Deal. Findings: Germany faces grid stability issues, Denmark excels in public-private partnerships, and Spain effectively utilises its solar resources. Research Limitations/Implications: Future research could investigate the scalability of these strategies in other regions. Practical Implications: The findings offer practical insights for regions transitioning to low-carbon energy systems. Social Implications: Inclusive stakeholder engagement is essential for minimising public opposition to renewable energy projects. Originality/Value: This research contributes novel insights to the literature on renewable energy transitions by integrating leadership, policy, and innovation strategies within a comparative, multi-country European framework.

KEYWORDS: Leadership, innovation, energy transition, strategic planning

Introduction

The global energy landscape is transforming rapidly due to the need to combat climate change, enhance energy security, and support sustainable development (Batel & Devine-Wright, 2015). Strategic planning and management (SPM) has thus become essential in navigating this complex transition (Apostol et al., 2017). Historically, energy policy and strategy have evolved through disruptive shifts (Agora Energiewende, 2019).

In the 21st century, new and complex challenges have emerged. Research on renewable energy's impact on economic growth has yielded mixed results, largely due to variations in data, periods studied, and methodologies (Gogu et al., 2021). Some studies find no causality, while others observe two-way causality between renewable energy consumption and economic growth (Ocal & Aslan, 2013). The energy-economic development relationship can be tested using either aggregate energy consumption or a "disaggregate level" focusing on specific energy sources (Balitskiy et al., 2016).

The 2019 European Green Deal aims to make Europe climate-neutral by 2050, supported by the European Climate Law, which mandates a 55% emissions reduction by 2030 and net zero by 2050 (Dobravec et al., 2021). This strategy marks a paradigm shift in energy production, consumption, and management across the EU, requiring member states to align their national strategies with these ambitious goals (European Commission, 2018).

At the heart of the EU's energy transition efforts is the need for robust strategic planning and management (European Commission, 2018). Unlike traditional energy policies, which often focus on short-term energy security and market stability, strategic energy planning adopts a proactive approach to ensure that energy systems are resilient, adaptable, and aligned with broader climate goals (Deng et al., 2022).

Table 1. European Green Deal Energy Targets

Target	2030 Objective	2050 Objective
Greenhouse gas reductions	55% compared to 1990	Climate-neutral (net-zero)
Share of renewable energy	40% of total energy	100% renewable energy
Energy efficiency	32.5% improvement	Maximize efficiency

This paper analyses strategic energy planning in three leading European countries: Germany, Denmark, and Spain, each with unique approaches influenced by their national contexts, resources, and political landscapes (Khoshnava et al., 2019).

Germany's Energiewende aims to phase out nuclear and coal, focusing on renewable energy expansion but faces challenges like grid stability and public resistance to wind farms (Knorr et al., 2014). Despite these hurdles, it provides key lessons in decarbonising an industrial economy (Agora Energiewende, 2019).

Denmark, a leader in wind energy, generates over 40% of its electricity from wind, underscoring the value of early renewable investments and supportive policies for innovation (Danish Energy Agency, 2020).

Spain, leveraging its abundant solar resources, prioritises solar expansion under the Plan Nacional Integrado de Energía y Clima (PNIEC) 2021–2030. The plan sets ambitious renewable targets, with solar expected to play a central role.

Though Germany, Denmark, and Spain pursue different renewable pathways, they share challenges, such as the intermittency of sources like wind and solar, requiring investments in storage and grid modernisation (International Energy Agency, 2018; Government of Spain, 2020).

This research integrates leadership, policy, and innovation within a European comparative framework, bridging these dimensions to clarify their combined impact on energy transitions. By establishing long-term visions, engaging stakeholders, and adapting to technological advances, countries can align energy strategies with climate goals (Heffron et al., 2020). The experiences of these three countries offer valuable insights for other regions in achieving a secure and sustainable energy future (International Energy Agency, 2018).

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Literature Review

The process of strategic energy planning involves not only setting ambitious long-term goals but also continuously adapting to new technological advancements, market trends, and policy interventions (Krasniqi, 2019). The European Union (EU) has taken a leading role in this endeavour, using strategic energy planning to align national energy policies with broader European climate goals, as outlined in key frameworks like the European Green Deal and the Renewable Energy Directive (RED II). The emphasis on comprehensive planning ensures that countries can manage the complexities of transitioning to renewable energy while safeguarding energy security, economic competitiveness, and environmental sustainability (Ioannidis et al., 2022).

Strategic Planning, Leadership role and Vision in Energy Planning

Strategic energy planning is a proactive, long-term approach aimed at developing energy systems that meet social, economic, and environmental goals (Krasniqi & Elezaj, 2023). Unlike traditional, reactive energy policies focused on short-term supply-demand fluctuations, strategic planning emphasises sustained investment, foresight, and broad stakeholder engagement (Koirala et al., 2018). In Europe, strategic energy planning aligns national policies with EU climate objectives through structured elements like vision setting, scenario planning, stakeholder engagement, and evaluation (Leal & Azevedo, 2016). Vision setting, in particular, provides critical long-term direction for the energy sector (Sovacool & Geels, 2021).

Germany's Energiewende, launched in 2000, targets phasing out nuclear by 2022 and coal by 2038, aiming for 80% renewable electricity by 2050. Denmark's vision is to be fossil-fuel-free by 2050, with over 40% of current electricity needs met by wind power, focusing on energy efficiency and security.

Spain's Plan Nacional Integrado de Energía y Clima (PNIEC) 2021–2030 aims to reach 42% renewable energy by 2030, leveraging its abundant solar resources for substantial solar energy expansion.

Table 2. National Energy Visions in Germany, Denmark, and Spain

Country	Key Vision Elements	Renewable Energy Target (2030)	Long-term Goal (2050)
Germany	Phase-out of nuclear & coal, 80% renewables	65% renewables	Climate neutrality, 80% renewables
Denmark	Fossil fuel independence, focus on wind energy	100% fossil-free electricity	100% renewable energy
Spain	Focus on solar energy, 42% renewables by 2030	42% renewables	Significant reduction in carbon emissions

Global Perspective on Scenario Planning and Stakeholder Engagement

Scenario planning offers a flexible framework that helps countries adapt energy strategies as conditions shift, allowing them to anticipate challenges and opportunities.

Germany's Energiewende employs extensive scenario planning, with models assessing paths for a low-carbon system while phasing out nuclear and coal (Stremke & Schoebel, 2019). Denmark also integrates scenario planning, exploring routes to achieve 100% renewable energy by 2050.

In Spain, scenario planning leverages its solar potential. The Plan Nacional Integrado de Energía y Clima (PNIEC) includes scenarios for expanding solar power, with one aiming for 42% renewable energy by 2030.

Stakeholder engagement is crucial, as well as promoting inclusivity, transparency, and broad support for energy strategies.

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Table 3. Key Stakeholders in Energy Strategic Planning

Country	Government Bodies	Private Sector Stakeholders	Civil Society Involvement
Germany	Federal Ministry for Economic Affairs and Energy, State Governments	Energy companies, technology providers	Environmental NGOs, local communities
Denmark	Danish Energy Agency, Municipal Governments	Wind energy companies, offshore developers	Local communities, investors
Spain	Ministry for the Ecological Transition	Solar energy companies, investors	Local communities, environmental organizations

Research Methods

For the research purpose a mixed-method approach that combines both quantitative and qualitative research methods to gain a comprehensive understanding of complex phenomena. The study benefits from methodological triangulation, ensuring that findings are more robust and validated through multiple sources of evidence.

Research Design

The study adopts a **comparative case study design** to explore how different European countries implement leadership, policy, and innovation strategies. A **mixed-method approach** ensures comprehensive insights by integrating both quantitative and qualitative techniques. The focus is on understanding how leadership, policy, and innovation influence the effectiveness of these transitions.

Research Question

This research aims to explore how governance and innovation strategies shape the interplay between leadership at national and regional levels of policy and decision-making. Based on this, the research question in this case is:

RQ: How do leadership, strategic planning, policy, and innovation strategies impact the renewable energy transition in European countries?

Main variables

In order to answer the research question, a set of variables is analysed, including:

- Energy Policy Frameworks: national and regional legislation, regulatory incentives, subsidies, and carbon pricing mechanisms,
- Innovation Outputs: patent filings, research and development (R&D) expenditures, and technology,
- Leadership Metrics: political and institutional leadership, public-private collaborations, and governance models,
- Energy Transition Indicators: share of renewables in the energy mix, reductions in carbon emissions, energy efficiency improvements, EU energy targets (e.g., the European Green Deal goals).

Case Study Selection

The study focuses on a diverse set of countries with varying levels of progress and strategies in the energy transition to allow for comparative insights:

- Germany – A leader with ambitious renewable energy goals and extensive wind and solar capacity,
- Denmark – Known for innovation in wind energy and its highly integrated energy systems,
- Spain – Rapidly expanding solar infrastructure with supportive government incentives.

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Data Collection and Analysis

This research relies on secondary data from credible sources, including:

- Government policy documents (e.g., European Green Deal, national energy strategies),
- Reports from energy agencies (e.g., International Energy Agency, Danish Energy Agency),
- Journal articles and industry reports on renewable energy and strategic planning,
- Statistical energy data from national and European databases.
- A thematic analysis examines key dimensions:
- **Leadership and governance:** How political leadership and governance frameworks drive energy transitions,
- **Policy interventions:** The influence of national and EU-level policies on renewable energy goals,
- **Innovation and technology:** Adoption of technologies like energy storage and grid modernisation to handle renewable energy intermittency.

Ethical Considerations

- **This study ensures adherence to ethical research standards, including:**
- **Informed Consent:** Participants are asked for their consent to participate,
- **Confidentiality:** All personal data will be anonymised to protect participants' privacy.
- **Transparency:** The research process will follow open science principles, ensuring reproducibility and transparency in data collection and analysis.

Research Model

The research model integrates three core components: **Leadership, Policy, and Innovation**.

- **Leadership**: Encompasses government initiatives, public-private partnerships, and investment in innovation,
- **Policy**: Focuses on regulatory stability, consistent energy policies, and incentives,
- **Innovation**: Involves the adoption of energy storage technologies and smart grids.

Outcomes in this model are measured by:

- Renewable energy is shared in the national energy mix,
- Progress toward achieving climate neutrality by 2050,
- Levels of public support and stakeholder engagement in renewable energy projects.

Results and Discussion

This section dives into the comparative analysis of the strategic energy approaches taken by Germany, Denmark, and Spain as case study countries while also bringing in other European countries like France, the UK, and Poland as comparison cases.

Europe is at the forefront of the global transition to renewable energy, driven by a combination of ambitious national priorities and overarching EU climate and energy policies. The European Union (EU) has set a comprehensive framework through the European Green Deal, which aims to reduce greenhouse gas emissions by 55% by 2030 and achieve climate neutrality by 2050. By comparing and contrasting these different approaches, we can better understand how national contexts influence energy strategies and how Europe, as a whole, can achieve its climate objectives.

The case study of Germany: "The Energiewende"

Germany's Energiewende is one of the most ambitious and well-known energy strategies in the world. Initiated in the early 2000s, it aims to completely phase out nuclear power by 2022 and coal by 2038 while dramatically increasing the share of renewable energy, particularly wind and solar, in the country's electricity mix. Germany's long-term vision is to reduce greenhouse gas emissions by 55% by 2030 (compared to 1990 levels) and achieve climate neutrality by 2050. One of the key challenges Germany faces in its energy transition is grid stability. As the share of intermittent renewable energy sources like wind and solar increases, balancing supply and demand becomes more complex. Investments in energy storage technologies and smart grid solutions are crucial to addressing this

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challenge, as they allow excess renewable energy to be stored and dispatched when needed, ensuring a stable and reliable energy supply.

Table 4. Key Milestones in Germany's Energiewende

Year	Milestone	Target
2011	Decision to phase out nuclear power	Complete by 2022
2020	45% of electricity from renewable energy	Reduce GHG emissions by 40% compared to 1990
2030	65% of electricity from renewable energy	Reduce GHG emissions by 55% compared to 1990
2050	80% of electricity from renewable energy	Climate neutrality (net-zero emissions)

Offshore wind farms have the potential to supply a significant portion of Germany's electricity needs, but they require substantial investments in infrastructure and transmission systems.

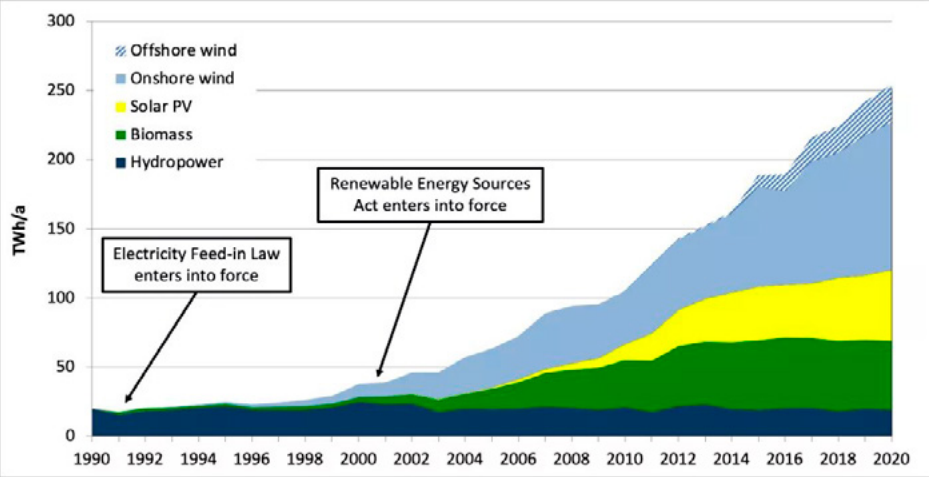

Figure 1. Growth of Renewable Energy Capacity in Germany (2000-2020)

The case study of Denmark: A Global Leader in Wind Energy

Denmark has established itself as a global leader in wind energy, with wind turbines supplying over 40% of the country's electricity needs. Denmark's energy strategy is among the most ambitious in Europe, with a goal of becoming fully independent of fossil fuels by 2050. Public support for wind energy in Denmark has been bolstered by policies that allow local communities to invest in wind energy projects, fostering a sense of ownership and reducing opposition to new developments.

Table 5. Wind Energy in Denmark (2010-2020)

Year	Onshore Wind Capacity (GW)	Offshore Wind Capacity (GW)	Total Wind Energy as % of Electricity
2010	3.9	0.9	25%
2015	4.2	1.5	38%
2020	4.7	2.4	43%

Additionally, Denmark's participation in the European electricity market allows it to trade surplus wind-generated electricity with neighbouring countries like Germany and Norway, further enhancing its energy security.

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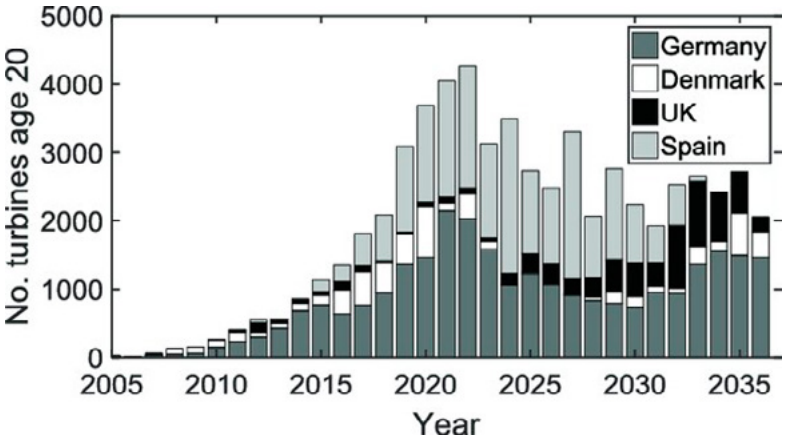

Figure 2. Comparison of Offshore Wind Energy Growth in different countries (2005-2035)

The case study of Spain: Solar Power Leadership

Spain has leveraged its geographic advantages to become one of Europe's largest producers of solar energy. The country's strategic energy plan (PNIEC) 2021-2030 sets ambitious targets for increasing the share of renewable energy in the energy mix to 42% by 2030, with solar energy playing a central role.

The country's focus on solar energy is not only driven by its abundant sunshine but also by the need to diversify its energy mix and reduce dependence on fossil fuel imports. Solar power offers a flexible and scalable solution to meet Spain's growing electricity demand while reducing greenhouse gas emissions.

Table 6. Growth of Solar Energy in Spain (2010-2020)

Year	Installed Solar PV Capacity (GW)	Share of Electricity from Solar Energy
2010	3.7	4%
2015	5.2	7%
2020	8.4	12%

Challenges in Strategic Energy Planning

Despite Europe's progress in transitioning to renewable energy, significant challenges remain, categorised into three main areas: grid stability, public support, and energy storage.

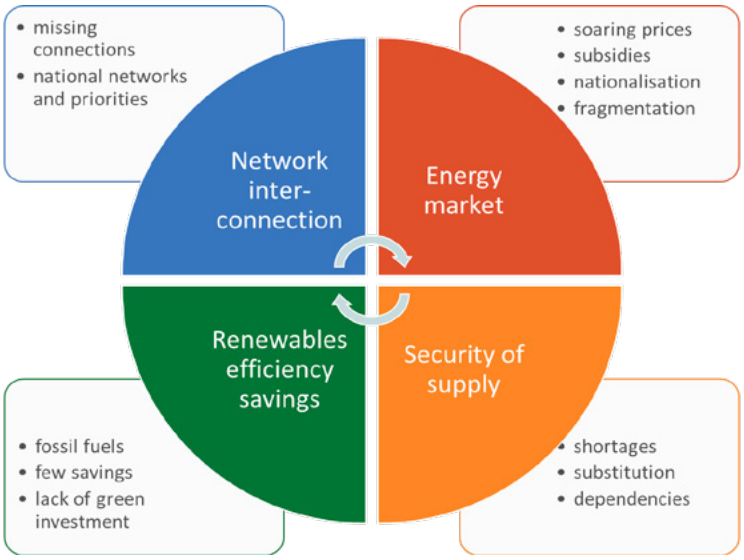

Figure 3. Challenges in Strategic Energy Planning Across Europe

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Grid Stability – One of the most pressing challenges facing Europe's energy transition is maintaining grid stability. To address this, Germany has invested heavily in energy storage technologies, such as hydrogen storage and smart grid solutions that optimise energy distribution and consumption.

Denmark, which also relies heavily on wind energy, has adopted a similar approach by investing in energy storage and interconnecting its electricity grid with neighbouring countries.

Spain faces a different challenge in terms of grid stability, as its solar energy generation peaks during the day and falls during the night. To overcome this, Spain is investing in large-scale battery storage systems and pumped hydro storage, which store excess solar energy during the day for use at night.

Public Support for Renewable Energy Projects – Public support is crucial for the successful implementation of renewable energy projects. To address this, Germany has shifted its focus to offshore wind energy, which faces less public resistance. Denmark's approach to public engagement offers valuable lessons. By involving local communities in wind energy projects and offering financial incentives for community investment, Denmark has built strong public support for renewable energy development. Spain's experience with regulatory instability in the early 2010s underscores the importance of consistent government policies in maintaining public and investor confidence.

Energy Storage Technologies – Energy storage is a critical component of the energy transition, as it allows excess renewable energy to be stored and used when needed.

Technological Innovations and Future Scenarios – Europe's energy transition is being shaped by a range of technological innovations that offer new opportunities for decarbonisation. Smart grids, artificial intelligence (AI), and the Internet of Things (IoT) are revolutionising the way energy is distributed and consumed, allowing for more efficient and flexible energy systems.

Table 8. Comparison of Renewable Energy Integration Challenges

Challenge	Germany	Denmark	Spain	France	UK	Poland
Grid Stability	High demand for grid updates	Interconnection with neighbors	Grid modernization needed	Nuclear safety, grid balancing	Need for integration with EU markets	Coal-dependent grid
Public Opposition	Wind farm opposition in rural areas	Community investment minimizes opposition	Improved investor confidence needed	Concerns over nuclear safety	Local opposition to wind projects	Resistance to coal phase-out
Energy Storage	Growing investment in hydrogen, batteries	Green hydrogen, smart grids	Focus on battery storage, pumped hydro	Exploring advanced nuclear solutions	Investment in large-scale storage	Limited development

Conclusions and Recommendations

The study of energy transitions in Germany, Denmark, and Spain highlights key lessons for aligning national energy policies with global climate goals. Below are the main insights and recommendations from each case.

Germany's Energiewende: Strengths and Challenges

Germany's Energiewende demonstrates the benefits and challenges of large-scale energy transitions. Its long-term carbon-neutral vision, including phasing out nuclear by 2022 and coal by 2038, underscores the value of ambitious policy frameworks. However, balancing long-term goals with practical, short-term solutions remains crucial. Future planning in Germany should prioritise energy storage, grid modernisation, and stronger public-private partnerships.

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Denmark's Wind Energy Success: A Model of Stakeholder Engagement

Denmark's wind energy success showcases the power of public-private collaboration and strategic planning. Its leadership in wind is driven by technological innovation and inclusive stakeholder engagement, which has minimised public opposition. Denmark's approach, involving citizen investment in wind projects and local input, fostered broad support. The key takeaway is that early investment, coupled with government support and strong stakeholder involvement, enhances renewable energy deployment.

Spain's Solar Power Leadership: Overcoming Regulatory Instability

Spain's solar strategy capitalises on its natural resources, making it a European leader in solar energy. Although regulatory instability initially posed challenges, recent reforms have created a more stable framework, revitalising the solar industry.

Cross-Cutting Lessons and Broader Implications for Europe and Beyond

The experiences of Germany, Denmark, and Spain reveal several key lessons for regions aiming to transition to low-carbon energy systems.

First, flexibility and adaptability in policy are crucial. Both Germany and Spain encountered challenges such as public opposition, regulatory instability, and grid infrastructure issues, underscoring the need for adaptable strategies.

Second, public engagement is vital. Denmark's approach shows that involving local communities in planning can build public support for renewables.

Third, technological innovation is essential for overcoming renewable energy challenges, particularly intermittency. All three countries have invested in energy storage to manage fluctuations in renewable generation.

Finally, regional cooperation enhances stability and security. Europe's interconnected market enables countries like Denmark and Germany to trade surplus renewable energy, supporting a steady supply.

These insights from Germany, Denmark, and Spain illustrate how energy strategies can balance sustainability, security, and economic competitiveness, providing valuable guidance for policymakers.

Recommendations

To lead the shift to sustainable energy effectively, fostering skilled leaders is essential. Key recommendations are:

- Leadership Development Programs: Provide specialised training for current and future leaders in energy.
- Cross-Sector Collaboration: Promote partnerships between government, industry, and academia.
- Policy Support: Advocate policies that encourage sustainable energy leadership development.
- Effective strategic planning is also critical:
- Integrate Long-Term and Short-Term Goals: Align sustainability objectives with immediate operational goals.
- Data-Driven Decision-Making: Use data analytics to support informed, strategic choices.
- Stakeholder Involvement: Engage diverse stakeholders like communities, experts, and policymakers.
- Innovation and technology drive sustainable energy progress:
- R&D Investment: Accelerate technology development.
- Technology Transfer Programs: Facilitate moving advanced technologies from research to market.
- Incentives for Adoption: Encourage uptake of new technologies with incentive programs.
- Finally, strong policy frameworks are essential:
- Policy Consistency: Maintain stable, long-term energy policies.
- Regulatory Flexibility: Craft adaptable regulations for evolving technology and market needs.
- Supportive Incentives: Develop incentives to encourage sustainable energy use.

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Addressing Social and Economic Impacts

The transition to sustainable energy must address its social and economic implications. Key recommendations include:

- Inclusive Growth Strategies: Create approaches that ensure equitable distribution of sustainable energy benefits.
- Community Engagement: Involve communities impacted by energy transitions to understand their concerns and needs.
- Education and Training: Invest in programs to equip the workforce with the skills needed in the sustainable energy sector.
- Global energy challenges necessitate international cooperation, with recommendations such as:
- Joint Research Initiatives: Encourage participation in collaborative research to tackle global energy issues.
- Harmonization of Standards: Work towards aligning energy standards and regulations internationally.
- Effective, sustainable energy strategies require robust monitoring and evaluation mechanisms. Key recommendations are:
- Establish Key Performance Indicators (KPIs): Define clear KPIs to assess the success of sustainable energy initiatives.
- Regular Reporting: Implement systems for regular reporting to enhance transparency and accountability.
- Feedback Mechanisms: Create avenues for stakeholder and public input to improve strategies.

Novelty and Contribution to Existing Research

This research makes a unique contribution to the literature on renewable energy transitions by integrating leadership, policy, and innovation within a multi-country European framework. Unlike studies that isolate aspects like policy design or innovation, this paper connects these areas to understand their combined impact on energy transitions. Key contributions include:

- Interdisciplinary Integration: This study examines leadership, policy, and innovation together, showing how their interactions shape energy outcomes, unlike prior work that treats these areas separately.
- Cross-National Comparison: The research systematically compares multiple European countries with diverse energy strategies, identifying best practices and challenges often overlooked in single-country studies.
- Inclusion of Leadership Metrics: This study introduces underexplored leadership metrics—such as government effectiveness and institutional commitment—to assess their effects on policy, stakeholder engagement, and innovation.
- Methodological Innovation: Using a mixed-method approach that combines policy reviews, quantitative data, and interviews, the study offers a richer perspective than single-method research.
- Focus on the European Green Deal: Situated within the policy shifts driven by the European Green Deal, the study examines how countries align with EU climate targets, providing early evidence on progress toward 2030 and 2050 goals.
- In summary, this paper advances knowledge by providing an integrative, multi-country, and leadership-focused analysis of renewable energy transitions, offering actionable insights for policymakers and industry stakeholders in Europe.

Limitations

This study's findings are specific to Europe, with limitations including:

- Data Availability: Incomplete or inconsistent datasets in some countries may affect comparability.
- Subjectivity in Qualitative Data: Interviewees' personal biases may influence findings, though triangulation helps mitigate this.
- Cultural Differences: Variability in leadership and policy frameworks across countries may complicate direct comparisons.
- Future research could apply this framework to non-Europeans, especially developing regions, to assess the scalability of these strategies in different contexts.

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OCENA STRATEGICZNYCH PODEJŚĆ DO TRANSFORMACJI ENERGETYCZNEJ: PRZYWÓDZTWO, POLITYKA I INNOWACJE W KRAJACH EUROPEJSKICH

STRESZCZENIE: Cel: W niniejszym dokumencie zbadano strategiczne wyzwania związane z przejściem na energię odnawialną w różnych krajach UE przy jednoczesnym zmniejszeniu emisji gazów cieplarnianych. Metodologia/podejście: W badaniu wykorzystano studia przypadków do analizy polityk krajowych, zaangażowania interesariuszy i roli UE, w szczególności w ramach Europejskiego Zielonego Ładu. Wyniki: Niemcy borykają się z problemami stabilności sieci, Dania przoduje w partnerstwach publiczno-prywatnych, a Hiszpania skutecznie wykorzystuje swoje zasoby słoneczne. Ograniczenia/implikacje badań: Przyszłe badania mogłyby zbadać skalowalność tych strategii w innych regionach. Implikacje praktyczne: Wyniki oferują praktyczne spostrzeżenia dla regionów przechodzących na niskoemisyjne systemy energetyczne. Implikacje społeczne: Włączające zaangażowanie interesariuszy jest niezbędne do zminimalizowania sprzeciwu społecznego wobec projektów energii odnawialnej. Oryginalność/wartość: Niniejsze badania wnoszą nowe spostrzeżenia do literatury na temat przejść na energię odnawialną poprzez integrację strategii przywództwa, polityki i innowacji w ramach porównawczych, wielonarodowych ram europejskich.

SŁOWA KLUCZOWE: przywództwo, innowacja, przejście na energię, planowanie strategiczne

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