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Energy Transformation of the EU Defense Industry : A Study of France

Hafda Prima Agung[1*], Henny Saptatia Drajati Nugrahani[2]
Universitas Indonesia
Corresponding Author: Hafda Prima Agung hafda.prima@ui.ac.id

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A B S T R A C T

This study aims to determine the challenges of energy transformation in the EU Defense Industry, particularly those carried out by French. The French defense industry is adapting its operation to the EU's new energy policy, which include investment in green technologies, sustainable supply chain management, and adaptation to increasingly stringent environmental regulations. The energy transformation strategy in the French defense industry is important to explore because France is one of the major players in the global defense industry. The research method used is qualitative method with data is obtained through in-depth interviews, policy analysis, and case studies to understand the context, perceptions, and experiences of key actors related to policy implementation. This research uses Daniel Yergin's energy security theory to analyze the relationship between energy and security and the challenges faced in global energy transformation. In addition, this study uses the energy policy theory of Amory B. Lovins, to analyze, evaluate and implement energy transformation policies. Lovins, to analyze, evaluate and provide recommendations regarding energy transformation strategies in the context of the French defense industry. The study's findings is that the European Union has established an environmentally friendly strategi yon defense industry and France as one of the member states has implemented the practice in its national security defense operations. The conclusion the study is that EU energy policy has encouraged energy transformation in the French defense industry without undermining France's national defense progress

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INTRODUCTION

The European Union (EU) has been spearheading efforts to promote energy transformation and sustainability across diverse sectors, including defense. As part of this overarching initiative, member states such as France are witnessing significant shifts within their defense industries to adhere to the EU's energy policy objectives. This paper serves as a critical investigation into the intricacies of energy transformation within the French defense industry, offering invaluable insights into the complex processes involved in transitioning towards greener and more sustainable practices while upholding national security interests. In recent years, the EU has emerged as a frontrunner in advocating for energy transformation and sustainability on a global scale, underscoring the imperative of transitioning towards cleaner and more environmentally friendly practices (Widuto Agnieszka, 2023). This paradigm shift encompasses traditionally energy-intensive domains, notably defense, where member states like France face the pressing need to align their military capabilities with the ambitious energy policy goals set forth by the EU. Against this backdrop, this paper embarks on a comprehensive exploration of the challenges and strategies intrinsic to the energy transformation journey undertaken by the French defense industry. Through an in-depth analysis, the study aims to unravel the complexities and nuances involved, shedding light on the multifaceted dynamics at play. The EU defence industry faces major challenges in undertaking energy transformation as global demands to reduce carbon emissions and increase energy efficiency increase (Schaik, Ramnath, "Clingendael," & Initiative, 2022). Energy transformation in the defense industry not only affects operational and technological aspects, but also has implications for policy, economics and international relations ("Stratégie énergétique de défense," 2020).

France, as one of the major players in the global defense industry, is actively pursuing an energy transformation strategy to comply with EU directives while safeguarding its national security interests. In the article entitled "Energy Transition in France" we can get information about policies, challenges and innovations related to the energy transition in France (Lebrouhi, Schall, Lamrani, Chaibi, & Kousksou, 2022). In another journal entitled "Challenges for the Defense Industry Against the Background of Environmental, Social, Governance (ESG) Concepts" we can find out the challenges and opportunities faced by the defense industry in the context of the environment, social and governance (Mitkow, Antczak, & Roszkiewicz, 2022).

LITERATURE REVIEW

1. Energy Transformation in the Defense Industry

The French Ministry of Defense has been heavily involved in environmental protection and energy transition initiatives, which are part of the public sustainable development policy. They use the term "defense vert"/green defense to encompass measures that contribute to controlling and reducing the impact of defense institutions on the environment and, in some cases, combating climate change through mitigation measures (Ministère des armées, 2022). Traditionally, the defense industry has been characterized by high energy

consumption and a heavy reliance on fossil fuels to power various operations, including military vehicles, equipment, and facilities. However, in recent years, there has been increasing pressure on the defense sector to transition towards renewable energy sources and adopt more sustainable practices. This shift is primarily driven by several factors:

- Environmental Concerns: The detrimental impact of fossil fuel combustion on the environment, including air and water pollution, climate change, and habitat destruction, has prompted calls for the defense industry to reduce its carbon footprint and minimize ecological harm (Perera, 2018).
- Resource Constraints: Fossil fuel reserves are finite and subject to geopolitical tensions, making them vulnerable to supply disruptions and price fluctuations. As a result, there is growing recognition within the defense sector of the need to diversify energy sources and reduce dependence on finite resources (Bagus & Peña-Ramos, 2023).
- Operational Efficiency: Energy-intensive military operations, such as transportation, logistics, and base infrastructure, contribute significantly to overall operational costs. Transitioning to more energy-efficient technologies and practices not only reduces environmental impact but also enhances operational effectiveness and cost-effectiveness (Kim, 2024) .

The EU defence industry, particularly in France, faces major challenges in carrying out its energy transformation to meet its commitments to reduce carbon emissions and use renewable energy (Carole Marc-antoine, 2022). In response to these pressures, defense organizations worldwide are increasingly exploring alternative energy sources, such as solar, wind, hydro, and biomass, as well as adopting energy-saving technologies and practices, such as energy-efficient vehicles, LED lighting, and smart building systems. The main objective of this transformation is to reduce the environmental impact of fossil energy production and consumption and ensure energy security, reliability, accessibility, affordability and sustainability (Genc & Kosempel, 2023).

2. EU Energy Policy and Defense Industry

The European Union has set ambitious energy and climate targets as part of its broader strategy to combat climate change and promote sustainable development. These targets include reducing greenhouse gas emissions, increasing energy efficiency, and expanding the share of renewable energy in the overall energy mix (Clingendael et al., 2022). Within the defense sector, these EU energy policies are translated into specific initiatives aimed at:

- Minimizing Carbon Footprint: Defense organizations are encouraged to assess and reduce their carbon emissions by optimizing energy use, transitioning to renewable energy sources, and implementing carbon offsetting measures.
- Optimizing Energy Efficiency: Efforts are made to improve the energy efficiency of military equipment, vehicles, and infrastructure through the adoption of energy-efficient technologies, operational practices, and maintenance procedures.

- Fostering Innovation: The EU promotes research and development in green technologies and sustainable practices relevant to the defense sector, such as renewable energy systems, energy storage solutions, and advanced materials for lightweighting and efficiency improvements.

By aligning with EU energy policies, defense organizations can not only contribute to the EU's broader energy and climate objectives but also enhance their own resilience, competitiveness, and operational effectiveness in an increasingly resource-constrained and environmentally conscious world ("Stratégie énergétique de défense," 2020).

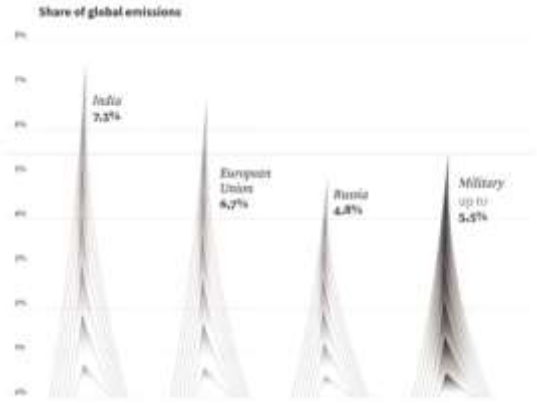

Figure 1. Contribution of Military in Global Emissions

Source: Research Paper Greening the Army ("Greening the armies ,," n.d.)

3. French Defense Industry and Energy Transformation

France, as one of the major players in the global defense industry, is actively pursuing energy transformation strategies to comply with EU directives while safeguarding its national security interests (Lovins, 1974). This involves:

- **Investments in Renewable Energy Technologies:** The French defense industry is investing in renewable energy technologies, such as solar panels, wind turbines, and biofuels, to power military installations, vehicles, and equipment. These investments not only reduce carbon emissions but also enhance energy security by diversifying energy sources and reducing reliance on imported fossil fuels. An article in Energy Policy (2021) shows that reliance on renewable energy increases national energy security, reducing its vulnerability to global energy crises and external energy supplies. France, with its investment in renewable energy in the defense sector, not only strengthens its military capabilities, but also increases the country's economic stability through a more independent energy source diversity that is not affected by global price fluctuations (Tarmizi & Muis, 2021).
- **Sustainable Supply Chain Management:** France is implementing sustainable supply chain management practices to ensure that the procurement and production of defense-related goods and services are conducted in an environmentally responsible manner. This includes promoting eco-friendly materials, reducing waste and emissions, and promoting ethical labor practices throughout the supply chain.
- **Adherence to Stringent Environmental Regulations:** France is adhering to stringent environmental regulations, both at the national and EU levels, to

minimize the environmental impact of defense activities. This includes compliance with emissions standards, waste management regulations, and environmental impact assessments for military projects and operations.

Overall, France's commitment to energy transformation in the defense industry reflects its broader efforts to balance national security imperatives with environmental sustainability goals, contributing to the EU's vision of a greener, more resilient, and more secure future.

3. Theoretical Framework

1. Daniel Yergin's Energy Security Theory

Daniel Yergin's Energy Security Theory focuses on the complex interplay between energy resources, geopolitical dynamics, and national security (Yergin, Affairs, York, & Apr, 2006). Yergin argues that energy is not merely a commodity but a strategic asset that shapes international relations, economic stability, and military capabilities. According to this theory, energy security encompasses several key dimensions:

- **Supply Security:** Ensuring a reliable and uninterrupted supply of energy resources is essential for maintaining national security and economic stability. Vulnerabilities in energy supply chains, such as geopolitical conflicts, natural disasters, or disruptions in production or transportation, can have significant ramifications for national security.
- **Geopolitical Considerations:** Energy resources are often concentrated in specific regions of the world, leading to geopolitical competition and conflicts over access, control, and transit routes. Geopolitical tensions in energy-rich regions can escalate into broader geopolitical crises, affecting global stability and security.
- **Diversification and Resilience:** To mitigate the risks associated with energy dependence, nations seek to diversify their energy sources, suppliers, and transit routes. By reducing reliance on a single energy supplier or geopolitical hotspot, countries can enhance their energy resilience and security. In this regard, France is also working with research institutions to develop renewable energy technologies such as the hydrogen-based micro-UAV program (RAPACE). In addition, programs such as Poseidon, in collaboration with Italy, aim to utilize fuel cells on warships (Vivienne Machi, 2022).
- **Technological Innovation:** Advancements in energy technologies, such as renewable energy, energy storage, and energy efficiency, play a crucial role in enhancing energy security. Investing in innovative technologies can reduce dependence on fossil fuels, mitigate environmental risks, and strengthen national competitiveness. Hydrogen-based technology also increases operational flexibility due to its clean fuel properties and high durability, making it a strategic choice for long-haul operations (Bureau, 2022).

By applying Yergin's Energy Security Theory to the analysis of energy transformation efforts in the defense industry, researchers can assess how changes in energy policies, technologies, and geopolitics influence overall security considerations. This framework helps identify potential vulnerabilities,

opportunities, and strategic implications of energy transformation initiatives within the context of national defense and international relations.

2. Amory B. Lovins' Energy Policy Theory

Amory B. Lovins' Energy Policy Theory advocates for a holistic approach to energy policy, emphasizing the importance of efficiency, diversity, and decentralization in energy systems. Lovins argues that conventional energy policies often focus narrowly on increasing energy supply or reducing energy consumption without considering the broader social, economic, and environmental implications. Instead, he proposes a set of principles for designing effective energy policies:**Efficiency First:** Prioritizing energy efficiency measures, such as improving building insulation, upgrading industrial processes, and promoting energy-saving technologies, can deliver significant energy savings and cost reductions while reducing environmental impact.

- **Diversity and Redundancy:** Diversifying energy sources, technologies, and suppliers enhances resilience and reduces vulnerability to supply disruptions or price fluctuations. Embracing a diverse energy mix, including renewables, natural gas, nuclear, and clean technologies, can enhance energy security and mitigate risks.
- **Decentralization and Distributed Generation:** Decentralized energy systems, characterized by local generation, distribution, and consumption of energy, offer numerous benefits, including increased flexibility, reliability, and resilience. Encouraging distributed generation, such as rooftop solar panels and community microgrids, can empower communities, reduce transmission losses, and improve energy access.

By utilizing Lovins' Energy Policy Theory, researchers can evaluate the effectiveness of energy transformation policies within the French defense industry and identify opportunities for improvement. This framework emphasizes the importance of integrating energy efficiency, diversity, and decentralization principles into policy design and implementation, thereby maximizing the social, economic, and environmental benefits of energy transformation initiatives.

Overall, both Yergin's Energy Security Theory and Lovins' Energy Policy Theory offer valuable insights for analyzing and evaluating energy transformation efforts within the defense industry, providing a comprehensive framework for understanding the complex interrelationships between energy, security, and policy.

3. Intergovernmentalism Theory

What specific propositions about European integration does intergovernmentalism derive from these general rational-institutionalist assumptions and theories? Andrew Moravcsik proposes a three-stage analysis: domestic politics generate national preferences, intergovernmental negotiations generate substantive bargains, and governments pool and delegate state competences in common institutions to secure these substantive bargains. In its most concise form, Moravcsik’s argument is that “EU integration can be understood as a series of rational choices made by state leaders. These choices respond to

constraints and opportunities stemming from the economic interests of powerful domestic constituents, the relative power of individual states in the international system, and the role of institutions in strengthening the credibility of interstate commitments (Moravcsik 1998:18)"(Leuffen, Rittberger, & Schimmelfennig, 2022).

Intergovernmentalism Theory is one of the approaches in the study of European Integration that can be used to analyze Energy Transformation in the European Union Defense Industry. First, Dominance of Member States, According to this theory, European Union member states have primary control over supranational policies, including energy transformation and defense policies. Countries like France will prioritize their national interests, especially energy sovereignty and defense capacity. Second, Intergovernmental Negotiations as stated by Andrwe Moravscik intergovernmental negotiations or Joint policies in energy transformation in the defense sector tend to emerge from intergovernmental negotiations. France, as one of the countries with the largest defense industry in Europe, has a significant influence in determining the direction of European Union policy regarding green energy innovation for military needs. Third, Sovereignty and National Priorities, In the context of energy transformation, France prioritizes its national energy independence (such as dependence on nuclear power) to ensure its defense sector remains strong, even as the European Union promotes more collective energy transition targets. Application In the French case study, namely Energy Transformation in the Defense Industry, France places nuclear energy as the main source of military and industrial power.

METHODOLOGY

The methodology employed in this research is qualitative, facilitating a nuanced exploration of the energy transformation challenges within the French defense industry. Through qualitative methods, such as in-depth interviews, policy analysis, and case studies, the study endeavors to capture rich, contextualized data that elucidates the complexities of policy implementation and its implications.

In-depth interviews are conducted with key stakeholders involved in energy transformation initiatives within the French defense sector. These interviews provide valuable insights into the perspectives, experiences, and challenges faced by individuals directly engaged in shaping and implementing energy policies.

Policy analysis involves examining existing policies, directives, and regulations pertaining to energy transformation in the French defense industry. This analysis helps in understanding the regulatory framework, identifying gaps or inconsistencies, and assessing the effectiveness of current policies in driving sustainable practices.

Case studies are employed to delve deeper into specific instances or projects related to energy transformation within the French defense industry. By examining real-world examples, the study can glean practical insights, identify success factors, and uncover potential barriers to implementation.

Overall, the qualitative approach adopted in this research allows for a comprehensive understanding of the context, perceptions, and experiences of key actors involved in energy transformation efforts within the French defense industry. It enables the study to capture the intricacies of policy implementation and provide valuable insights for policymakers, industry stakeholders, and researchers.

The next stage is contextual analysis, a technique used to understand data in its broader context, such as policy, technology, or operational environment. This helps to place the findings within a relevant framework to provide a deeper understanding. This process is carried out by identifying the context, analyzing how the context influences the data and research findings, and integrating the findings with the context to provide a more complete understanding of the phenomenon being studied. For example, in the context of the European Union Energy policy: the researcher analyzes how the European Union energy policy influences the implementation of renewable energy in the French defense industry. Conducting a comprehensive data analysis technique will allow the researcher to identify themes, confirm findings through triangulation, and understand the data in a relevant context related to the energy transformation in the European Union defense industry, especially in France.

RESULTS AND DISCUSSION

The qualitative analysis delves into the insights gathered from in-depth interviews, policy analysis, and case studies, with a specific focus on the application of Daniel Yergin's energy security theory and Amory B. Lovins' energy policy theory. These theoretical frameworks provide a lens through which to understand the complexities of energy transformation within the French defense industry and its implications for national security and sustainability.

Interplay between Energy Resources, Geopolitics, and National Security.

Yergin's energy security theory underscores the intricate relationship between energy resources, geopolitical dynamics, and national security. Through in-depth interviews, stakeholders involved in energy transformation initiatives within the French defense industry provide valuable insights into how these factors intersect and influence each other. They discuss the strategic importance of energy resources, geopolitical tensions surrounding energy supply chains, and the implications for national security.

Energy Resources:

Energy resources, such as oil, natural gas, coal, and renewables, are fundamental to the functioning of modern societies and economies. The power industries, transportation systems, and households, making them essential for national development and prosperity. The strategic importance of energy resources lies in their role as a critical input for economic growth and military capabilities. From a military perspective, energy resources are critical

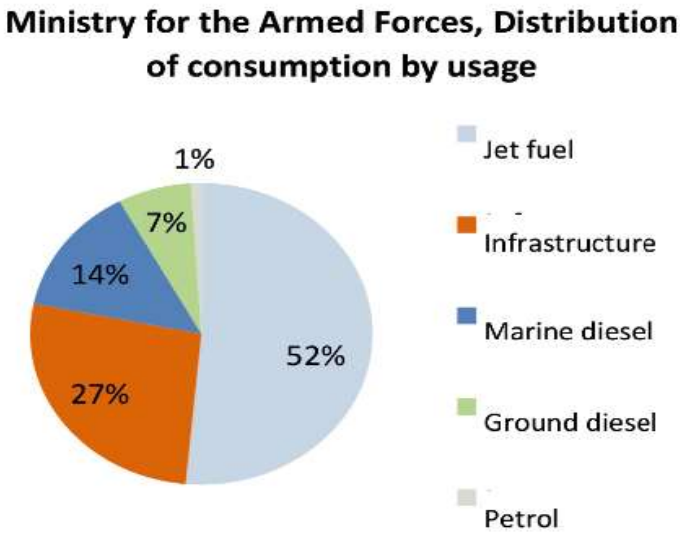

Figure 2. Fuel Consumption In French Armed Forces
Source : French Defence Energy Strategy 2020

Geopolitics: Geopolitical dynamics refer to the interactions and power struggles among nations on the global stage. These dynamics are heavily influenced by factors such as territorial disputes, resource competition, strategic alliances, and ideological differences. In the context of energy, geopolitics revolves around the control, access, and transit of energy resources. Nations often seek to secure access to energy sources such as oil, natural gas, and coal to fuel their economies and maintain their strategic interests. Geopolitical considerations also come into play in the construction and operation of energy infrastructure, such as pipelines, ports, and shipping lanes, which are critical for the transit of energy resources.

Moreover, ensuring the security of energy supply routes is essential for nations to safeguard their energy security. Disruptions to these routes, whether due to conflicts, piracy, or natural disasters, can have significant geopolitical and economic implications, affecting not only the countries directly involved but also the global energy market as a whole.

- National Security: Energy security pertains to the assurance of access to reliable and affordable energy resources that are essential for meeting domestic needs and supporting critical infrastructure. Without a stable and secure energy supply, a nation's economy may face disruptions, affecting key sectors such as industry, transportation, and agriculture. Moreover, ensuring access to energy resources is essential for maintaining social stability and meeting the basic needs of citizens, including heating, lighting, and transportation.

Military readiness also relies heavily on energy security, as modern armed forces are highly dependent on energy-intensive equipment and technologies. Adequate and reliable energy supplies are essential for powering military operations, logistics, and transportation systems. Therefore, any vulnerabilities in energy supply chains or dependence on imported energy

resources can undermine a nation's military capabilities and readiness to respond to security threats.

Dependence on imported energy resources or reliance on vulnerable supply routes can pose significant risks to national security. Vulnerabilities in energy supply chains, such as disruptions due to geopolitical conflicts, natural disasters, or cyberattacks, can have far-reaching consequences for a nation's economy, infrastructure, and overall security posture. Additionally, reliance on energy imports may expose a nation to external influence and manipulation by energy-exporting countries, potentially compromising its sovereignty and strategic autonomy. In the face of Russia's dependence on fossil fuels, France is pushing for diversification of energy sources and investment in green technologies, such as biorefineries and alternative fuels (Policy, 2022).

The European defence industry, including France, is also starting to adopt circular economy principles, such as the reuse and repair of materials, to reduce its overall environmental impact (Reis, 2022). Programs such as the Incubation Forum for Circular Economy in European Defence (IF CEED) highlight the importance of data sharing to improve material footprint and transparency in supply chains, with better traceability systems, militaries can ensure the materials they use have minimal environmental impact, as well as comply with regulations such as the waste framework directive (Eda.europe.eu, 2023). For example, the French Ministry of the Armed Forces has implemented projects such as hybrid tactical vehicles and infrastructure renovation to reduce carbon emissions. These steps demonstrate France's efforts to strengthen energy security, reduce dependence on fossil fuels, and encourage innovation in green technologies in the military

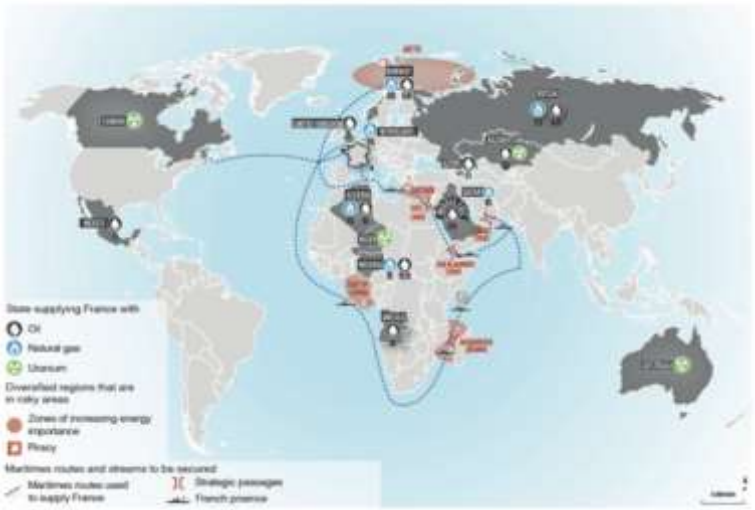

Fig 3. France’s Energy Dependence : Diversification of Import Routes and Sources

Source : French Defence Energy strategy 2020

- **Intersection and Influence**: Through in-depth interviews, stakeholders involved in energy transformation initiatives within the French defense industry provide valuable insights into how energy resources,

geopolitics, and national security intersect and influence each other. They discuss the strategic importance of energy resources for military operations, highlighting the need for secure and reliable energy supplies to support defense activities. Additionally, stakeholders analyze geopolitical tensions surrounding energy supply chains, including competition for resources, geopolitical rivalries, and potential disruptions to energy supply routes. They also assess the implications of these dynamics for national security, emphasizing the importance of proactive measures to mitigate risks and ensure energy resilience. France also collaborates with research institutions and international partners to develop green technologies, such as hydrogen and renewable energy, and participates in multilateral agreements such as the Paris Agreement to ensure a just and sustainable global energy transition (Pastukhova, Pepe, & Westphal, 2020).

The findings underscore the intricate relationship between energy resources, geopolitics, and national security within the context of energy transformation initiatives in the French defense industry. By examining these interconnections, stakeholders gain valuable insights into the complexities and challenges associated with ensuring energy security while safeguarding national interests in an increasingly uncertain geopolitical landscape.

Impact on Overall Security Considerations and International Relations.

In-depth interviews allow stakeholders to elucidate how energy transformation initiatives within the French defense industry impact broader security considerations and international relations. Stakeholders may discuss how efforts to enhance energy efficiency, reduce dependence on fossil fuels, and adopt renewable energy technologies contribute to enhancing energy security and geopolitical stability. Additionally, they explore how these initiatives influence France's position within the international community and its relationships with other countries.

Enhancing Energy Security: In-depth interviews with stakeholders provide insights into how energy transformation initiatives contribute to enhancing energy security within the French defense industry. Stakeholders may discuss efforts to improve energy efficiency, reduce dependence on fossil fuels, and adopt renewable energy technologies as critical components of enhancing energy resilience and reducing vulnerability to supply disruptions. By diversifying energy sources and increasing self-sufficiency, these initiatives strengthen France's ability to withstand external shocks and ensure continuity of military operations, thereby contributing to overall security considerations. Overall, this green initiative can create new jobs, strengthen the position of the French defense industry, and contribute to energy and climate security (European Defence Agency, 2012)

Table 1. Summary of Energy Security Issues in the World
Source: Energy And Security (Adrian Cotasaenz, 2023)

Energy sector and its significance	Energy security concerns and the population affected	
	Shorter term	Longer term
Oil (125 countries, 5.9 billion)*	>75% import dependency (**3 billion**) consumption growth >5%/year (**1.8 billion**)	Reserves/Consumption <15 years (**1.7 billion**)
Gas (78 countries, 2 billion)*	>75% import dependency (**650 million**)	Reserves/Consumption <16 years (**780 million**)
Coal (45 countries, 4.5 billion)*	>80% import dependency (**300 million**)	
Nuclear (21 countries, 1.3 billion)**		Average age of nuclear power plants >25 years (**1.9 billion**) Start of last plant construction >20 years (**1.4 billion**)
Hydro (58 countries, 1.5 billion)***	Low diversity (one or two major dams) (**730 million**)	
Electricity (all countries)	>50% dependency on imported fossil fuels (**600 million**) low diversity (one or two fuel sources) (**450 million**)	annual demand growth >6%/year and/or access rate <60% (**4.2 billion**)
Transport	>50% dependency on imported fuels (**4.9 billion**)	annual consumption growth >8% (**1.7 billion**)
Industry (>25% of GDP in 60 countries; 4.5 billion)	>50% dependency on imported fuels (**800 million**)	
Residential and commercial (all countries)	>50% dependency on imported fuels (**500 million**)	Reliance on traditional biofuels for >80% of the residential sector energy (**700 million**)
Cross-sectoral energy supply (all countries)	>50% overall import dependency (**700 million**) low diversity of PES (one or two dominant sources) (**1 billion**) cost of energy imports >20% of export earning (**2.5 billion**); cost of energy imports >10% of GDP (**200 million**)	energy intensity >50% of world average (**400million**) consumption growth >6% (**1.8 billion**) consumption per capita <30 GJ/year (**3 billion**)

Notes: PES – primary energy sources;

Numbers in brackets indicate the number of people who live in countries with the indicated energy security conditions;

* – more than 10% in total energy supply; ** – more than 10% in electricity generation; *** – more than 20% in electricity generation

- Geopolitical Stability: Stakeholders may also explore how energy transformation initiatives influence geopolitical stability and dynamics at the international level. By reducing reliance on imported fossil fuels and mitigating geopolitical risks associated with energy supply chains, France can enhance its geopolitical resilience and reduce vulnerability to external pressure. Additionally, investments in renewable energy technologies may foster cooperation and partnerships with other countries, promoting stability and dialogue in regions with strategic importance for energy resources.
- Position in the International Community: In-depth interviews allow stakeholders to discuss how energy transformation initiatives shape France's position within the international community and its relationships with other countries. By demonstrating leadership in sustainable defense practices and renewable energy adoption, France can enhance its reputation as a responsible global actor committed to addressing environmental challenges and promoting security cooperation. These initiatives may also contribute to France's soft power and influence in international forums, strengthening diplomatic ties and strategic partnerships with like-minded nations.
- Contributions to International Relations: Through discussions on energy transformation initiatives, stakeholders may highlight the role of energy policy in shaping broader international relations and cooperation. By aligning defense strategies with energy sustainability goals, France can foster dialogue and collaboration on shared security and environmental objectives, promoting trust and confidence among allies and partners.

These initiatives may contribute to building resilience against common threats, fostering regional stability, and advancing collective security interests within the international community. Public engagement and international cooperation are key to ensuring effective implementation and long-term sustainability of this policy (Clingendael et al., 2022).

The findings underscore the multifaceted contributions of energy transformation initiatives within the French defense industry to enhancing energy security, promoting geopolitical stability, shaping France's international image, and fostering cooperation and trust in international relations. Through these efforts, France strengthens its position as a responsible global actor committed to addressing pressing security and environmental challenges.

Navigating Challenges of Transitioning Towards Greener Practices.

Stakeholders share their experiences and perspectives on the challenges encountered in transitioning towards greener practices while balancing national security imperatives. They discuss technological barriers, budget constraints, regulatory challenges, and organizational resistance faced during the implementation of energy transformation initiatives, For the defense sector, this means that France, within the framework of the policy, must utilize renewable energy technologies in their defense operations (Stephanie Barna, Daniel Feldman, Elżbieta Bieńkowska, Thomas Reilly, 2024). Through these discussions, stakeholders provide valuable insights into the complexities of navigating the transition towards sustainability within the defense sector.

- Technological Barriers: Stakeholders often highlight technological barriers as one of the primary challenges in transitioning towards greener practices. This includes the development and adoption of advanced renewable energy technologies, energy-efficient systems, and sustainable supply chain solutions tailored to the unique requirements of defense operations. Stakeholders may discuss the need for research and development efforts, collaboration with technology providers, and investments in innovation to overcome these barriers.
- Budget Constraints: Budgetary limitations pose significant challenges to implementing energy transformation initiatives within the defense sector. Stakeholders may discuss competing priorities for limited resources and the need to demonstrate the cost-effectiveness and long-term benefits of green technologies and practices. Strategies such as prioritizing investments, seeking external funding sources, and optimizing resource allocation may be explored to address budget constraints while advancing sustainability goals.
- Regulatory Challenges: Regulatory complexities and compliance requirements present obstacles to the adoption of greener practices within the defense industry. Stakeholders may discuss navigating a complex regulatory landscape, including environmental regulations, procurement policies, and security standards, which may impact the selection and implementation of sustainable solutions. Collaboration with regulatory authorities, advocacy for supportive policies, and

streamlining of regulatory processes may be necessary to address these challenges effectively.

- Organizational Resistance: Organizational resistance, including cultural norms, institutional inertia, and resistance to change, can impede efforts to transition towards greener practices within defense organizations. Stakeholders may discuss the importance of leadership commitment, stakeholder engagement, and change management strategies to overcome resistance and foster a culture of sustainability. Building awareness, providing training, and incentivizing participation can help cultivate a shared understanding and commitment to sustainability goals across the organization.

The findings highlight the multifaceted nature of challenges faced in transitioning towards greener practices within the defense sector. Stakeholders recognize the need for concerted efforts to address technological, budgetary, regulatory, and organizational barriers to effectively advance sustainability goals while balancing national security imperatives.

Overall, in-depth interviews serve as a valuable tool for unpacking the complexities of energy transformation within the French defense industry through the lens of Yergin's energy security theory. By capturing stakeholders' perspectives and experiences, these interviews provide nuanced insights into how energy considerations intersect with broader security dynamics and influence international relations.

Policy Analysis: Policy analysis, guided by Amory B. Lovins' energy policy theory, adopts a comprehensive perspective on energy policy within the French defense industry.

- Holistic Approach to Energy Policy: Lovins' energy policy theory advocates for a holistic approach to energy policy, focusing on efficiency, diversity, and decentralization. Through policy analysis, existing policies and regulations related to energy transformation within the French defense industry are evaluated against these principles. The analysis considers how policies address energy efficiency measures, promote renewable energy adoption, and encourage sustainability practices across the defense sector.
- Emphasis on Efficiency: Lovins' theory prioritizes energy efficiency as a key component of effective energy policy. Policy analysis assesses the extent to which existing policies within the French defense industry promote energy efficiency measures, such as the use of advanced technologies, optimization of energy consumption, and reduction of energy waste. The analysis identifies areas where policies effectively incentivize energy efficiency improvements and areas where further enhancements are needed.
- Promotion of Renewable Energy Adoption: Lovins' theory underscores the importance of diversifying energy sources and promoting renewable energy adoption. Policy analysis examines how existing policies incentivize the integration of renewable energy technologies, such as solar, wind, and bioenergy, into defense infrastructure and operations.

The analysis evaluates the effectiveness of policies in accelerating the deployment of renewable energy solutions and reducing reliance on fossil fuels. For example, projects in Renewable Acceleration Areas will experience accelerated licensing procedures, reducing administrative barriers. The revised directive also strengthens sustainability criteria for bioenergy and introduces new rules for forest biomass, ensuring that energy production from this source is compatible with EU biodiversity and carbon storage objectives (Commission, 2023).

- Consideration of Sustainability: Lovins' theory emphasizes the importance of sustainability in energy policy, including environmental, social, and economic dimensions. Policy analysis evaluates how existing policies within the French defense industry address sustainability goals, such as reducing carbon emissions, minimizing environmental impact, and enhancing resilience to climate change. The analysis considers the broader implications of energy policies for national security, strategic resilience, and long-term sustainability.

Overall, policy analysis through the lens of Lovins' energy policy theory provides a framework for evaluating existing policies and regulations related to energy transformation within the French defense industry. By assessing the extent to which policies align with principles of efficiency, diversity, and decentralization, policymakers can identify opportunities to enhance energy policy and drive sustainable practices across the defense sector.

CONCLUSION

The findings of this study underscore the importance of energy transformation in the EU defense industry, particularly within the French context. Despite challenges, such as technological barriers and geopolitical considerations, the EU's energy policy framework has incentivized progress towards greener and more sustainable defense practices. By leveraging theoretical insights from Yergin and Lovins, policymakers can further refine energy transformation strategies and ensure alignment with broader security objectives. Ultimately, this research contributes to ongoing efforts to enhance energy security, environmental sustainability, and national defense capabilities within the EU and beyond.

This paper provides a comprehensive analysis of the challenges and opportunities associated with energy transformation in the EU defense industry, with a specific focus on the French perspective. By integrating theoretical frameworks, empirical evidence, and policy insights, it offers valuable insights for policymakers, industry stakeholders, and researchers interested in advancing sustainable practices within the defense sector.

For further study Based on the findings of this study, there are several recommendations for further research to deepen the understanding of energy transformation in the European defense industry: a case study of France, especially in relation to energy transformation and its impacts. Suggestions for further research include three main aspects, namely developing research focus,

adding more diverse methodologies, and conducting long-term studies to observe more comprehensive changes over time.

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