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The Role of Geopolitics in the Energy Transition: Strategy for EU Competitiveness and the Role of Africa

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Abstract

The global energy transition is reshaping the foundations of international politics and economics. For the European Union (EU), the pursuit of carbon neutrality by 2050 represents not only an environmental imperative but also a strategic challenge at the intersection of sustainability, energy security, and economic competitiveness – the three vertices of the energy trilemma. This dissertation examines how the transition to renewable energy is altering global power dynamics, with particular focus on the role of critical raw materials (CRMs). China's dominance in CRM extraction and processing, combined with its strategic partnerships in Africa, places significant pressure on EU supply chains and industrial competitiveness. At the same time, Africa has emerged as both a crucial supplier of CRMs and a potential renewable energy producer, making its developmental trajectory central to the geopolitics of the transition. Using a mixed-methods approach – including document analysis, trade data, and expert insights – the study assesses the EU's vulnerabilities, opportunities for supply chain diversification, and prospects for strategic cooperation with Africa. The findings underline that securing CRMs and advancing electrification, are indispensable for Europe to strengthen resilience, maintain competitiveness, and contribute to a just and inclusive global energy transition.

Keywords: Energy transition; Energy trilemma; European Union; Critical raw materials; China; Africa; Geopolitics; Competitiveness

Resumo

A transição energética global está a redefinir os alicerces da política e da economia internacionais. Para a União Europeia (UE), a meta da neutralidade carbónica até 2050 representa não apenas uma exigência ambiental, mas também um desafio estratégico situado na intersecção entre sustentabilidade, segurança energética e competitividade económica – os três vértices do trilema energético. Esta dissertação analisa de que forma a transição para energias renováveis está a alterar as dinâmicas globais de poder, com especial atenção ao papel das matérias-primas críticas (MPC). O domínio da China na extração e no processamento destas matérias, aliado às suas parcerias estratégicas em África, exerce forte pressão sobre as cadeias de abastecimento e a competitividade industrial da UE. Ao mesmo tempo, África surge como fornecedor essencial de MPC e como potencial produtor de energia renovável, tornando o seu percurso de desenvolvimento central para a geopolítica da transição. Recorre-se a uma abordagem metodológica mista – incluindo análise documental, dados de comércio e contributos de especialistas – para avaliar as vulnerabilidades da UE, as oportunidades de diversificação das cadeias de abastecimento e as perspetivas de cooperação estratégica com África. Os resultados destacam que garantir o acesso a MPC e avançar com a eletrificação, são condições indispensáveis para que a Europa reforce a sua resiliência, mantenha a competitividade e contribua para uma transição energética global justa e inclusiva.

Palavras-chave: Transição energética; Trilema energético; União Europeia; Matérias-primas críticas; China; África; Geopolítica; Competitividade

Table of Contents

Chapter 1 – Introduction

The global energy landscape is in the midst of a transformative shift driven by the urgent need to combat climate change and reduce greenhouse gas emissions. Known as the energy transition, this shift seeks to replace fossil fuels with renewable energy sources such as wind, solar, and hydropower. For the European Union (EU), this transition is at the core of its economic and environmental strategy, aiming to achieve carbon neutrality by 2050, with key milestones set for 2030. The European Green Deal outlines these ambitions, underscoring the importance of renewable energy in ensuring sustainable development and long-term energy security.

However, the energy transition is not just an environmental or technological challenge but a geopolitical one. The shift toward renewables is reshaping global power dynamics, particularly due to the growing importance of critical raw materials (CRMs) necessary for renewable technologies like electric vehicles (EVs), solar panels, and wind turbines. China holds a near-monopoly on many of these CRMs, such as rare earth elements, cobalt and lithium, which places significant pressure on global supply chains. This dominance poses a strategic challenge to the EU's competitiveness and energy security, as it relies heavily on imports of these materials to power its green technologies. Moreover, Africa, rich in CRMs, has become a key player in this geopolitical competition, as both the EU and China seek access to its vast resources.

Therefore, it is timely and relevant in its focus on how the energy transition is fundamentally altering global power structures. The need to address climate change has intensified competition for renewable energy technologies and the raw materials required to produce them, making the energy transition an immediate global priority. For the EU, this study is critical to understanding and securing its position within this shifting landscape.

China's dominance in the supply of CRMs, particularly through extensive state-subsidized operations and control over African resources, directly threatens the EU's competitiveness in the renewable energy sector. The EU's path to carbon neutrality relies not only on the technological advancements outlined in the European Green Deal but also on securing raw materials and maintaining access to global markets. Meanwhile, Africa's role as both a resource supplier and a potential green energy producer positions it as a central figure in this

transition. Understanding and navigating these interconnected dependencies is essential for the EU to ensure sustainable progress and economic resilience.

As both the EU and China vie for access to African's critical resources, the EU faces growing challenges to its energy security, industrial competitiveness and geopolitical influence. This competition is reshaping international relations, with the EU, China, and Africa each pursuing distinct strategies that reflect broader shifts in global power dynamics. A central concern is how the EU can reinforce its position within the global energy transition while supporting Africa's developmental interests and strategic autonomy.

The overarching objective of this dissertation is to analyse how the energy transition is reshaping global geopolitics and to assess how the EU can maintain its competitiveness in this evolving landscape – particularly in relation to China and Africa.

To fulfil this aim, the dissertation will pursue the following specific objectives:

- To examine the extent to which the EU's renewable energy ambitions are constrained or enabled by geopolitical pressures, particularly concerning access to critical raw materials (CRMs).
- To analyse Africa's role in the global energy transition, both as a supplier of CRMs and as an emerging energy producer.
- To investigate the strategic rivalry between the EU and China in Africa, and the implications of China's dominance in resource extraction and clean technology manufacturing.
- To assess how the EU might reduce its dependency on external suppliers through supply chain diversification, technological innovation and trade partnerships.
- To evaluate how the EU can strengthen its partnership with African nations in a way that ensures mutual benefit, supports Africa's development objectives and contributes to a just and inclusive global energy transition.
- To explore how Africa can leverage its resource wealth to promote industrialisation and sustainable growth, aligning national development goals with the broader demands of the global energy system.

To address the research questions, this study adopts a mixed-methods approach, combining document and literature analysis, case studies, expert input, and data analysis. The focus lies on policy frameworks (EU, China, Africa), selected African case studies, and trade statistics, complemented by an expert interview to incorporate qualitative perspectives. This design enables a comprehensive examination of the geopolitical and economic dimensions of the global energy transition, while the methodological details will be developed in a dedicated section.

Understanding the intersections between energy, resources, and geopolitics is essential for developing policies that promote sustainability, economic growth, and global stability.

This dissertation contributes to the literature on energy geopolitics, offering insights into how emerging power dynamics are shaped by the shift toward renewable energy. It also sheds light on the role of Africa in the global energy transition, a topic that is often underexplored in geopolitical studies. This research is critical for multiple stakeholders, including policymakers, businesses, and international organizations. The energy transition is a transformative process that will have far-reaching implications for global economic and political power.

The dissertation is structured to systematically explore the relationship between the energy transition and the green industry, global geopolitics, and the EU's competitive strategy within this evolving landscape.

The theoretical framework, based on the concept of the energy trilemma, is outlined in Chapter 2. Chapter 3 then examines the concept of the energy transition, beginning with its definition and an exploration of its core components. The primary advantages of renewable energy, such as sustainability and emission reduction, are then highlighted, followed by a discussion of the limitations and challenges inherent in this shift. China's competitive edge in renewable technology production is also examined, emphasizing the pressure this places on the EU's industry.

The role of the energy transition in European competitiveness is assessed, where strengths and vulnerabilities within the EU's green energy sector are analysed. Particular attention is given to how technological innovation, trade policies, and industrial strategies affect its

market position. Geopolitical tensions resulting from the shift toward renewable energy are also addressed. The origins and drivers of these tensions are outlined, with a focus on the strategic interests and interactions among key global players, including the EU and China.

In Chapter 4, Africa's role as a supplier of raw materials and an emerging renewable energy producer is analysed. This examines how Africa's development objectives align with global energy needs, and how its resources influence EU–China dynamics in the energy transition.

Chapter 5 outlines the methodology, including the research process, the research problem and objectives, and the methods applied. Chapter 6 presents the results of the analysis. Chapter 7 synthesises the study's findings, offers strategic recommendations, and reflects on the study's scope and boundaries, concluding with suggestions for future research.

Chapter 2 – Theoretical Framework

2.1 The Energy Trilemma

This research adopts the energy trilemma as its central analytical framework. Traditionally defined by the World Energy Council as the challenge of balancing three objectives – energy security, environmental sustainability, and energy equity –, the trilemma has served as a widely recognized tool for evaluating national energy systems (World Energy Council, 2024).

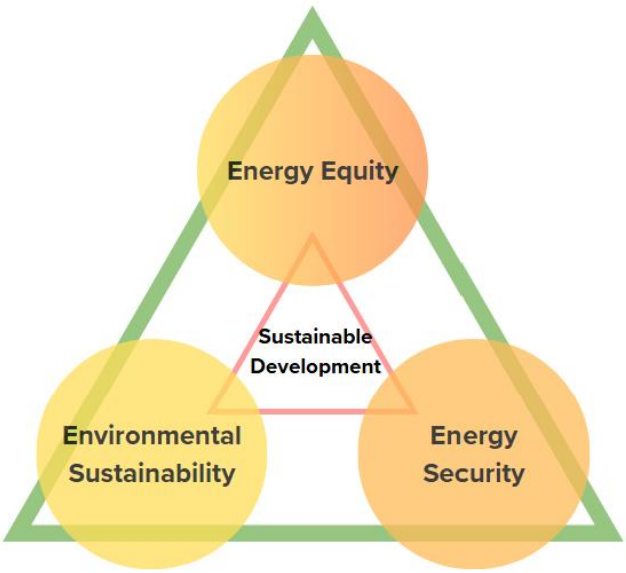

Figure 1 – Original energy trilemma

The concept is rooted in the work of the World Energy Council (WEC), established in 1923 as a neutral platform for international energy dialogue, and formalised at the first World Power Conference in London in 1924, which brought together experts from 40 countries (World Energy Council, 2023). Over the decades, the WEC expanded its role from convening debates to developing analytical tools. In 1995, it introduced the Energy Sustainability Country Index, which represented the first structured attempt to measure national performance across three key dimensions: the reliability of supply, the affordability of energy access, and the environmental implications of energy production and use.

In 2010, this initiative was formalised into the World Energy Trilemma Index, which transformed the trilemma from a conceptual model into a quantitative benchmarking framework assessing countries' ability to balance security, equity, and sustainability. The

subsequent 2012 World Trilemma Report elevated the framework to a global policy agenda. Since then, the Index has been updated annually, ranking more than 120 countries worldwide, and has become a reference tool for policymakers.

Each of the vertices captures a distinct policy concern. Energy security refers to the resilience of supply and the ability to withstand geopolitical or technical disruptions. Energy equity reflects the imperative of affordable and universal access to energy services, addressing both consumer affordability and social inclusion. Environmental sustainability encompasses reducing greenhouse gas emissions, promoting renewable energy deployment, and managing natural resources responsibly.

Balancing these objectives is the defining challenge of the trilemma. Progress on one dimension often creates tensions in another: expanding fossil fuel capacity may strengthen security and affordability but undermine sustainability, while rapid renewable deployment improves sustainability but can impose short-term costs or risks to stability. By framing these trade-offs, the World Energy Council presents the trilemma as a navigation tool rather than a formula for optimisation.

To contextualise the evolution of the energy trilemma, it is essential to understand past energy crises and how they shaped contemporary energy policy.

The energy crises of 1973, 1979, and the current global energy crisis share several commonalities, while also diverging due to evolving geopolitical, technological and economic contexts. All three crises were triggered by external shocks – unexpected geopolitical disruptions that destabilised energy markets. In 1973, the Yom Kippur War and the subsequent oil embargo by OPEC countries marked the beginning of the first oil shock, while the Iranian Revolution in 1979 caused further disruption to oil supplies (Covi, 2015).

At the same time, the 1970s also witnessed the first international debates on environmental concerns. The Club of Rome's report Limits to Growth (Meadows et al., 1972) acknowledged then recent concerns about man-made pollution and its impacts on the environment, marking an early recognition of the link between economic growth, resource use, and environmental degradation. From the 1990s onwards, these debates evolved further

with the publication of the first IPCC assessment reports. The 1992 IPCC report not only reflected the growth of concern but also formalised the use of terms such as climate change and sustainable development (IPCC, 1992), signalling the consolidation of the environmental dimension as a central pillar of the global energy agenda.

The consequence of these crises, which were centred around oil, has been the sudden and sharp increase in energy prices. These price surges have contributed to inflationary spirals, as energy costs feed into the production and transport of goods and services (Covi, 2015). In the present context, Russia's invasion of Ukraine, however, disrupted oil as well as gas flows, creating severe supply insecurity and leading to differentiated price impacts across fuel types and regions. Fuel prices surged: natural gas by approximately 180%, coal by around 130%, and oil by about 40% within two weeks (Adolfsen et al., 2022). While countries like the United States, Canada and the United Kingdom quickly imposed total bans on Russian energy imports, the EU remained significantly more exposed. In 2021, Russian exports to the EU accounted for 49% of its crude oil exports and 74% of its natural gas exports (IEA, 2022). This regional dependency intensified the impact of the supply shock across Europe, compared to other regions.

Price dynamics have affected energy consumption patterns in each case. In the 1970s, high oil prices led to energy conservation efforts, reduced demand and a shift toward alternative sources like coal and nuclear energy. These developments, coupled with improvements in efficiency, contributed to a relative decoupling of GDP from carbon emissions, as economic output continued to grow while emissions rose more slowly. IEA data shows that energy intensity (the amount of energy consumed per unit of GDP) declined by approximately 33% across IEA member countries between 1973 and 2000 (IEA, 2004). This was largely due to improvements in energy efficiency and shifts in the energy mix. In the European Union, the reduction was even greater, with a 40% decrease in energy used per unit of GDP achieved through a combination of energy efficiency policies, structural transitions toward service-based economies, and the substitution of oil with nuclear power and natural gas (IEA, 2004). This process of fuel switching was a cornerstone of Europe's strategy to reduce its dependency on oil and to diversify its energy portfolio.

An apparent slowdown in energy savings may be attributed to the rebound effect as discussed by Hart (2018). Over the last 150 years global energy intensity decreased only slightly. Hart (2018) argues that, as energy efficiency increases, there is a substitution towards more energy-intensive goods. The observed decline in momentum raised significant concerns for both environmental sustainability and energy security, as continued gains became harder to achieve. This stagnation in efficiency is consistent with resilience and energy security literature, as efficiency improvements are one of the main ways energy systems build flexibility: by lowering overall demand, reducing import dependence, and easing integration of variable energy sources. When these gains slow, systems face higher exposure to high-impact and unexpected disruptions (Cherp & Jewell, 2011; Gracceva & Zeniewski, 2014). This insight is relevant in the current context, where fluctuating prices and repeated supply disruptions are testing the robustness and adaptability of global energy infrastructures.

Similarly, the present crisis has led to shifts in residential and industrial energy use, accelerated energy efficiency measures and a renewed push for renewable energy integration. Yet, the structural readiness for substitution differs, as in the 1970s, alternatives were limited (Covi, 2015), whereas today, many economies have more diversified energy portfolios and access to clean technologies, although unevenly.

The ease of substitution also distinguishes the crises. In the 1970s, oil had limited substitutes in transport and industrial use (Covi, 2015), whereas today's energy systems, especially in electricity generation, have more flexibility to switch between fuels. Nonetheless, dependence on natural gas remains a constraint in Europe. The IEA's Laspeyres decomposition of CO_2 emissions and energy use provides sector-specific insights. In the transport sector, for instance, efficiency gains initially reduced energy consumption. However, these gains were partially offset by increased usage (IEA, 2004). This illustrates how behavioural factors, such as increased vehicle ownership and use, as well as infrastructure lock-ins (e.g., car-centric urban planning), can limit or reverse the expected benefits of technological improvements, thereby slowing broader systemic transformation.

The policy responses and energy options available to governments have expanded significantly. Today's responses extend beyond emergency mechanisms to encompass systemic reforms aimed at decarbonisation, including large-scale investment in renewables,

the development of green hydrogen, and securing critical raw material supply chains (IEA, 2021).

However, after 1990, the pace of energy savings markedly slowed down, raising concerns for both environmental sustainability and energy security. The IEA explicitly attributes this deceleration to growing systemic vulnerabilities: as improvements in energy intensity began to stagnate, countries in Europe and other IEA member states became exposed to energy price volatility and supply disruptions (IEA, 2004). This trend underscores the strategic importance of policies aimed at enhancing energy system resilience and diversifying energy sources in order to maintain economic and strategic stability in the face of external shocks.

The geographic distribution of impacts also differs. While the oil shocks affected most industrialized oil-importing countries (Covi, 2015), today's crisis affects Europe in particular. Meanwhile, many developing countries face heightened energy insecurity due to rising global fuel prices. Each crisis also carried significant macroeconomic repercussions. The 1970s were marked by high inflation and economic stagnation, with governments increasing public spending to mitigate social unrest and economic disruption (Covi, 2015). Today, inflation again coexists with economic uncertainty – and the globalised nature of supply chains means that energy shocks are rapidly transmitted across borders.

As with previous crises, there are short- and long-term winners and losers. Energy exporting countries often benefit in the short term due to higher revenues, while energy importers, including energy intensive industries, suffer the most immediate harm (Covi, 2015). In the long term, however, those able to restructure their energy systems and reduce dependencies, emerge more resilient.

All three crises prompted various degrees of international cooperation and policy innovation. In the 1970s it was the creation of the IEA and oil sharing agreements. Now, the current crisis has revived efforts at coordination, particularly withing the EU, which has implemented joint gas purchasing mechanisms and accelerated plans for energy sovereignty and climate neutrality. These shifts in governance and collective response mechanisms reveal a deeper transformation in how global energy challenges are conceptualised. Rather than addressing crises as isolated events, today's approach increasingly frames them withing a broader strategic logic: the evolving interpretation of the energy trilemma.

The IEA's report (2023) highlights that since 2022, the global energy crisis has exposed the fragility of fossil fuel-based systems and infrastructure and underscored the urgency of accelerating the clean energy transition. The report also accentuated that the energy trilemma intersects short-term market volatility with long-term structural transformation (IEA, 2023). The G7's recognition of net-zero targets by 2050 and the target to limit global warming to 1,5ºC requires navigating the trilemma with renewed coordination.

The World Energy Trilemma Report 2024 confirms this perspective by positioning the trilemma as a navigation framework for managing the trade-offs between energy security, equity and environmental sustainability (World Energy Council, 2024). The report stresses that balancing these objectives is essential for building robust energy systems capable of withstanding geopolitical and systemic shocks. In this sense, the Trilemma Index offers a comparative lens across 126 countries, revealing critical regional divergences – particularly in Europe, Africa and China.

While the energy related CO2 emissions temporarily declined during the 2020 pandemic, they rebounded in 2021. Demand for coal and oil reached all-time highs, while the IPCC's findings reveal that climate change is inflicting severe damage on ecosystems and disproportionately impacting vulnerable communities. In 2022, the war in Ukraine acted as a catalyst for energy supply disruptions, notably in natural gas and oil markets, as mentioned. The sudden supply cuts of gas flows to Europe led to historic price surges in natural gas and coal, leading the IEA to activate emergency oil stock releases. Simultaneously, OPEC+ tightened the global oil market – and the geopolitical instability in the middle east, responsible for over one-third of the world's seaborne oil trade, further increased supply vulnerabilities. These events have brought the need for a modernised and comprehensive energy security agenda into focus, particularly as the global energy system undergoes a fundamental transformation such as this.

In Europe, the energy trilemma is predominantly shaped by the post-Ukraine crisis dynamics. While many countries rapidly moved to cut ties with Russian gas (except Hungary), this reorientation came with costs. The continent managed to restore energy security though alternative gas import sources and LNG rerouting, which came at the expense of energy

security due to soaring prices. Moreover, the increased use of coal and other traditional sources in 2022 and early 2023, temporarily undermined environmental sustainability. These trade-offs required state interventions and led to debates over electricity market reforms and energy sovereignty. The World Energy Trilemma Report notes that Europe is now focused on achieving a more resilient and self-reliant energy system – one that is able to integrate renewable energy at scale while remaining technologically independent and socially equitable (World Energy Council, 2024).

The shift toward clean energy technologies introduces a new set of geopolitical risks related to supply chain concentrations. The production and refining of critical minerals remain highly concentrated in a few countries – particularly China, which also leads in clean technology manufacturing. This dependency increases vulnerability to political leverage, export restrictions and market disruptions. The IEA emphasizes that the global clean energy transition will not succeed unless supply chains are diversified and rendered more resilient (IEA, 2023). China's dominance is highlighted by the World Energy Trilemma report as well, noting that the geographical concentration of clean energy supply chains poses a systemic risk. Although China plays a key role in scaling up clean technologies, its outsized influence has prompted Western economies to prioritise technological independence and diversify sources and manufacturing bases. The dependence on China intensifies the trilemma's geopolitical dimension, as access to essential materials and technologies becomes a strategic vulnerability (World Energy Council, 2024).

The IEA outlines the potential of clean energy technologies to address all three dimensions of the trilemma. The report states that, for instance, between 2021 and 2023, the EU saved 100 billion EUR in electricity costs thanks to renewable energy installations or around 230 TWh of more expensive fossil fuel generation. Furthermore, clean energy investments surpassed fossil fuel investments for the first time in 2023 with 1.8 trillion USD invested. This figure, however, remains below the estimated four trillion required to be invested annually by 2030 to reach the net-zero pathway target (IEA, 2023).

A key insight is that the transition must be global, including emerging and developing economies which currently attract a disproportionally low share of investments. Two thirds of these investments are concentrated in China, with Africa accounting for less than 2%. The

report estimates that 28 billion USD would be needed to catalyse sufficient private investment in Africa by 2030 (IEA, 2023).

Africa presents a critical test case for the global energy trilemma, as the WET Report 2024 emphasizes that the continent is facing rising energy demand and pressing security challenges while also advancing in its renewable energy targets. Despite infrastructure gaps and limited access to financing, African countries are increasing clean energy investments and regional integration initiatives. However, the tension between expanding energy equity and achieving environmental sustainability remains unresolved. The report points out that accomplishing a just energy transition in Africa requires significant support from international partners (World Energy Council, 2024), which aligns with the IEA's call for mobilising private capital and investing in Africa's grid and clean technology infrastructure to avoid a deepening global investment imbalance.

To mitigate the systemic risk posed by the energy trilemma, the IEA outlines a set of policy priorities and strategic interventions aimed at ensuring a secure and inclusive energy transition. One of them is being aware of traditional energy security threats such as oil supply disruptions which require robust frameworks to ensure stability. Additionally, there is the need for coordinated action across energy demand and supply, as the transition depends on synchronised infrastructure deployment and consumption shifts, supported by smart and resilient electricity grids capable of integrating various renewable energy sources (IEA, 2023). Energy efficiency is outlined as well. Doubling the rate of energy efficiency improvements is essential for easing consumer cost burdens and strengthening resilience, as well as reducing GHG emissions. Investment patterns, though, remain a concern, as clean energy investments are still insufficient and unevenly distributed and increase the risk of long-term carbon lock-in.

It also highlights the need for maintaining a reliable and flexible electricity system as the global energy mix shifts toward variable renewable sources. This includes investments in batteries, demand-side response mechanisms and an adaptable grid infrastructure, necessary to ensure secure power supplies. A successful decarbonisation of the economy also depends on low-emission technologies besides renewables, such as heat pumps, carbon capture

technologies and hydrogen-based systems, in order to address emissions in hard-to-abate sectors.

Finally, the IEA underlines the importance of building resilient and diversified clean energy supply chains. The current geographic concentration of clean technology manufacturing and critical material extraction heightens the vulnerability of the energy transition to supply disruptions and geopolitical interference. According to the IEA, adhering to ESG standards is essential to mitigating these risks, in addition to increased recycling shares and innovation investments – tools the agency deems essential to supporting and achieving supply chain diversification and resilience (IEA, 2023).

Both institutions agree on the idea that an effective response to the energy trilemma must be contextual and inclusive, tailored to regional strengths and vulnerabilities. The World Energy Trilemma Index, now in its 15th year, provides a comparative framework for identifying best practises and systemic gaps. It complements the IEA's policy roadmaps by offering practical insights on how high-ranking countries in both the Trilemma Index and the World Economic Forum's Energy Transition Index integrate energy equity, security and sustainability through strong institutional frameworks and diversified strategies.

Both reports illustrate that managing the energy trilemma is not a matter of technical optimisation alone. Rather, it demands structural transformation, resilient governance, inclusive financing tools and strategic cooperation – particularly across regions such as Europe, Africa and in managing a strategic interdependence with China. These regions are not only vulnerable to systemic shocks, but also serve as testing grounds for how secure, sustainable, and economically competitive systems can be developed under evolving geopolitical conditions.

Given the heightened geopolitical tensions, the race for technological leadership and critical raw material dependencies, this study draws on an adapted interpretation of the trilemma seen in Figure 2, which incorporates economic competitiveness as a core concern, replacing energy equity. As stated in the International Agency's (IEA) 2023 report to the G7 leaders, the trilemma has evolved in its framing and this shift reflects a broader prioritisation of global competitiveness, with increasing emphasis on supply chain resilience, technological leadership and strategic autonomy (IEA, 2023). These priorities are embedded in recent EU

strategies such as the Green Deal Industrial Plan, the Net-Zero Industry Act and various critical raw material and trade frameworks, which aim to secure Europe's position in the evolving green economy.

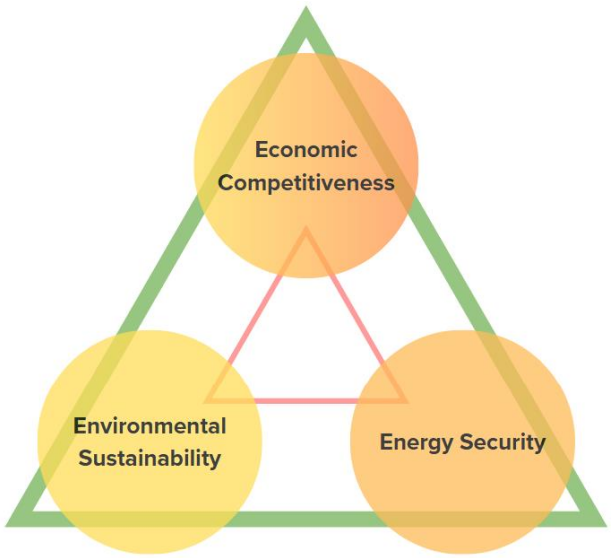

Figure 2: Adapted energy trilemma

By structuring the analysis around this framework, the study aims to provide a comprehensive understanding of how these three dimensions interact with the broader geopolitical landscape. Specifically, it allows for a critical examination of the European Union's efforts to assert and maintain competitiveness in a rapidly evolving green economy, while addressing climate targets and securing reliable access to critical resources. In doing so, the trilemma serves as a conceptual tool to assess the EU's strategic positioning vis-à-vis China's expanding influence in the global green economy.

Chapter 3 – The energy transition in the EU

3.1 European Energy and Environmental Policies: a historical background

The present only makes sense when the past is understood. Therefore, the historical background of EU energy policies, its response to the energy trilemma, and key legislative initiatives like the Net-Zero Industry Act and the Green Deal Industrial Plan will be explored firstly.

The European Union (EU), as we know it today, was born from a profound desire for peace, stability, and economic recovery following the devastation of World War II. Over the decades, this vision expanded to encompass environmental protection and energy policy, shaping the EU into a global leader in sustainable development.

After World War II, Europe faced widespread destruction, fractured economies, and deep mistrust among nations. Leaders like Jean Monnet and Robert Schuman proposed unifying key industries to ensure economic interdependence, thus preventing future conflicts. This idea materialized in 1951 with the creation of the European Coal and Steel Community (ECSC), bringing together six nations - Belgium, France, Germany, Italy, Luxembourg, and the Netherlands. By managing coal and steel resources jointly, these nations laid the groundwork for economic cooperation (European Union, n.d.-a).

The success of the ECSC led to the Treaty of Rome in 1957, which established the European Economic Community (EEC) and the European Atomic Energy Community (EURATOM). These treaties aimed to create a common market and foster collaboration in the peaceful use of nuclear energy, reflecting the growing recognition of shared economic and energy challenges (European Union, n.d.-a).

The 1970s oil crisis was a turning point for Europe's energy policy. Triggered by geopolitical tensions like the Yom Kippur War, OPEC's oil embargo exposed Europe's dependence on external fossil fuel supplies. This crisis caused severe price spikes, economic disruption, and shortages, compelling European nations to prioritize energy security, efficiency, and diversification. Nuclear power gained prominence as an alternative energy source, and the groundwork was laid for exploring renewable energy (European Union, n.d.-b).

Simultaneously, environmental awareness grew. The First Environmental Action Programme (EAP) was launched in 1973, marking the EU's first coordinated effort to address transboundary environmental issues. It focused on pollution control and prevention, introducing principles like "polluter pays" and environmental integration into other policy areas (Hey, 2005).

The ambitions of the EAP evolved through subsequent iterations. The Second EAP (1977-1981) expanded the scope to include air quality and industrial pollution, reflecting the growing understanding of environmental risks. By the Third EAP (1982-1986), the focus shifted to integrating environmental concerns into other sectors, such as agriculture and transport. The Fourth EAP (1987-1992), coinciding with the Rio Earth Summit, introduced the concept of sustainable development, emphasizing biodiversity protection and resource efficiency (Hey, 2005).

The Fifth EAP (1993-2000) marked a significant milestone as it coincided with the establishment of the European Union through the Treaty of Maastricht. It integrated environmental goals with economic and social policies, laying the foundation for sustainable growth. By the Sixth EAP (2002-2012), climate change became a central focus, supporting landmark initiatives like the Emissions Trading System (ETS). The Seventh EAP (2014-2020) aligned with the EU's 2020 climate and energy targets, emphasizing the circular economy, low-carbon growth, and global partnerships. The forthcoming Eighth EAP (2021-2030) builds on the European Green Deal, prioritizing climate neutrality, resilience, and a broader sustainable agenda (Hey, 2005).

During the 1980s, European integration deepened. The Single European Act (1986) established environmental protection as an official policy area, allowing the EU to legislate on cross-border environmental issues. This marked a critical shift from national policies to coordinated European efforts (European Union, n.d.-c).

The 1990s brought transformative changes. The Treaty of Maastricht (1992) formalized the European Union, significantly expanding its competencies, including environmental protection. Sustainability was enshrined as a key EU goal, enabling ambitious climate and energy initiatives (European Union, n.d.-d).

The EU also emerged as a global leader in climate diplomacy. It played a pivotal role in negotiating the Kyoto Protocol, the first legally binding international treaty to reduce greenhouse gas emissions. Despite challenges – such as the U.S. withdrawal and delays in ratification by Russia – the EU exceeded its reduction targets, solidifying its reputation in global climate governance (Walsh, 2004). The Protocol entered into force in 2005 and set binding emission reduction targets for 37 industrialized countries and economies in transition, including the EU. These countries committed to an average 5% reduction in emissions from 1990 levels during the first commitment period (2008–2012).

The Doha Amendment (2012) evolved the Kyoto Protocol by extending its commitment period from 2013 to 2020 (UNFCCC, 2012). Under the Doha Amendment, participating countries committed to reducing emissions by at least 18% below 1990 levels (UNFCCC, 2012) – more ambitious than the first period's targets. It also introduced updated commitments for Annex I Parties, specifying new individual targets for those that agreed to participate alongside a revised list of greenhouse gases to be reported and amendments to several articles of the Protocol (UNFCCC, 2012). The Amendment marked a shift in the composition of the Parties involved, introducing more stringent targets in light of the urgency surrounding climate action.

In addition, the Doha Amendment extended the Protocol's flexible market-based mechanisms, such as international emissions trading, the Clean Development Mechanism (CDM), and Joint Implementation (JI) (UNFCCC, 2012), which allowed countries to meet their targets more cost-effectively. These mechanisms also encouraged green investment in developing countries, stimulating the transition to cleaner technologies. The Amendment further supported the Adaptation Fund, which finances climate adaptation projects in developing countries (UNFCCC, 2012). Contributions to the fund were expanded to include proceeds from international emissions trading and joint implementation, in addition to CDM project activities (UNFCCC, 2012). These updates strengthened the Protocol's enforcement mechanisms, ensured continued climate financing, and reinforced global cooperation in addressing climate change.

In 2007, the EU adopted the Strategic Energy Technology (SET) Plan to accelerate clean energy innovation and align with long-term climate targets. This plan aimed to reduce carbon emissions, improve energy efficiency, and expand renewable energy technologies. It was

updated in 2023 to reflect the EU's strengthened climate objectives and the evolving policy landscape (European Commission, 2023).

The European Green Deal, launched in 2019, represents the EU's most ambitious environmental framework. It seeks to make Europe the first climate-neutral continent by 2050. Encompassing initiatives such as the Circular Economy Action Plan and the Just Transition Mechanism, the Green Deal integrates environmental sustainability with social and economic equity (European Commission, 2019).

In 2023, the Green Deal Industrial Plan and the Net-Zero Industry Act were introduced to enhance the EU's clean technology manufacturing base and reduce reliance on imports of critical raw materials. These policies aim to secure supply chains, foster green investment, and ensure that the EU remains competitive in the global energy transition (European Commission, 2023-a; European Parliament & Council of the European Union, 2024).

3.2 The Energy Transition

The energy transition is at the core of the European Union's strategy to address the global climate crisis while ensuring economic and social sustainability. This transition, defined as the shift from fossil fuels to renewable and low-carbon energy systems, represents a profound transformation in energy production, consumption, and infrastructure (European Commission, 2006). For the EU, the energy transition is not only an environmental necessity but also a strategic opportunity to achieve energy security and enhance competitiveness in the rapidly expanding global green technology market (European Commission, 2006). Framing this ambition, the European Commission's Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy articulates the need for a unified approach that addresses import dependence, price volatility and climate change while drawing on the EU's leadership in renewables to reinforce both security of supply and economic competitiveness

The EU's efforts to drive the energy transition are framed within the context of the adapted energy trilemma, balancing environmental sustainability, energy security, and economic competitiveness. Each of these dimensions presents its own set of challenges, particularly as the EU faces competition from global actors like China. The Union's success in navigating

this transition depends on its ability to develop robust legislative frameworks, foster ambitious international partnerships, and take coordinated action towards achieving its climate goals, including like carbon neutrality by 2050.

In the following sections, the challenges and opportunities associated with the energy transition will be examined and discussed, with a focus on how the EU can leverage its strengths to overcome obstacles and seize potential benefits of this transformation.

3.2.1 Challenges

The EU's energy transition faces significant obstacles that must be overcome to maintain its leadership in the global green economy. The challenge of energy security remains paramount, particularly as the EU integrates renewable energy sources like wind and solar, which are intermittent by nature. To mitigate the variability of these sources and ensure a reliable energy supply, the EU needs to modernize its electricity grid and invest in smart grids and storage technologies. These investments are crucial; without them, both energy stability and the EU's economic future face significant risks.

Recent crisis – most notably the supply shock caused by Russia's 2022 invasion of Ukraine – demonstrate that decarbonisation and supply security can be advanced simultaneously. The gas-supply disruption of 2009 and the annexation of Crimea in 2014 exposed institutional fragmentation in the EU's external energy policy, which limited the integration of climate and security objectives. These responses were largely security driven, with the institutional fragmentation hindering coordinated action across climate and energy domains. In both cases, responses focused primarily on infrastructure expansion and diversification, with limited attention to decarbonisation. In contrast, the Union's 2022 response integrated climate and energy-security objectives, deploying incentives for renewables, efficiency gains and demand-reduction to bolster resilience while staying on course with its climate goals (Giuli & Oberthür, 2023).

Furthermore, the EU's dependency on critical raw materials exposes it to potential disruptions in supply chains (Giuli & Oberthür, 2023). These materials are largely controlled by a few countries, many of which have geopolitical interests that may not align with the

EU's. This creates vulnerabilities that the EU must address by securing alternative sources, investing in recycling, and potentially expanding domestic extraction and processing.

The EU's bureaucratic structure further complicates its ability to respond quickly to these challenges. The decision-making process, while designed to ensure broad consensus, can result in delays in the implementation of urgent policies. This institutional inertia, combined with the Union's desire to remain economically competitive creates tension that slows down policy integration and obstructs progress in the green transition (Giuli & Oberthür, 2023). As global competitors like China ramp up investments in green technologies, the EU faces the dual challenge of streamlining its regulatory processes while ensuring that its policies do not place excessive burdens on its industries. These inefficiencies could undermine the EU's industrial competitiveness in the rapidly evolving green economy.

In addition, the transition to green energy will lead and has already caused economic displacement in sectors reliant on traditional fossil fuels. For such communities and workers, the shift to cleaner energy sources will require reskilling programs and social support to ensure a just transition. Without these efforts, the EU risks deepening social inequality and losing public support for its green policies.

These challenges are both institutional and economic in nature – navigating these issues will require not only overcoming the bureaucratic complexities of the EU's decision-making process but also ensuring that its industries remain competitive while securing a sustainable and inclusive future.

3.2.2 Opportunities

While the EU faces significant challenges in its energy transition, these can also be viewed as opportunities to strengthen its energy systems, enhance economic competitiveness, and lead the global green transition. A central element of this pathway is the electrification of the energy system, since Europe lacks substantial fossil fuel resources and electricity can be generated from renewable sources. Decarbonisation by 2050 therefore depends on the electrification of final demand, particularly in sectors such as transport. This shift, however, increases the EU's dependence on critical materials required for renewable technologies and electrified mobility, highlighting both the vulnerabilities and the opportunities inherent in the

transition. By leveraging its existing resources and capabilities, the EU can address these issues and shape a sustainable future.

To address the challenge of energy security, the EU has the opportunity to create a transnational energy system by further integrating energy infrastructure across member states. This would allow for optimized energy distribution, reducing reliance on external suppliers and ensuring greater resilience in disruptions. A unified electricity grid capable of incorporating renewable energy sources and smart grid technologies would help the EU ensure a stable supply while integrating growing energy demands from electric vehicles and other energy-intensive sectors. Energy resources could be distributed more efficiently, contributing to grid stability and thus improving energy security across the region. This objective has also been pursued through instruments such as the Trans-European Energy Networks (TEN-E) and the Projects of Common Interest (PCIs), which aim to strengthen cross-border infrastructure, though their alignment with long-term climate objectives has varied over time (Giuli & Oberthür, 2023).

As part of the green transition, the EU has the opportunity to ensure that local communities directly benefit from locally produced clean energy. With one of the largest climate budgets globally – including the Recovery and Resilience Facility, which allocates over one third of its €723 billion to green measures – the EU could direct significant investments into renewable energy projects and infrastructure modernization (European Commission, 2024).

These investments would not only accelerate the transition but also create economic growth and job opportunities in the green economy. By providing financial support to local energy projects, the EU could foster social equity, ensuring communities hosting green energy infrastructure, such as wind farms or solar parks, receive profits from energy generation, which would ensure that economic benefits of the transition are distributed equitably. A model similar to Alaska's oil dividend system, where revenues from natural resources are shared with local communities could be applied. By integrating such measures, the EU could not only address economic displacement from traditional industries but also foster public support for the transition, making it more inclusive and sustainable in the long term. This approach would give communities a stake in the green economy and ensure that the transition is just and beneficial to all.

In line with its financial strength, the EU has the chance to set global standards in areas like eco-design and energy efficiency. By using its regulatory power to create high standards for sustainable products and technologies, the EU could shape the global market, driving global adoption of green practices (European Commission, 2006). The Brussels Effect, which describes the phenomenon in which companies worldwide adopt EU standards to access the European market, would allow the EU to push green innovation on a global scale. This regulatory leadership would solidify the Union's role as a key player in global sustainability.

The EU is also well positioned to foster technological innovation in energy systems. By investing in energy storage, smart grids, and green hydrogen, the EU could accelerate breakthroughs in clean technologies. For example, innovations like sodium-ion batteries, which are being explored as alternatives to lithium-ion batteries, could reduce the EU's reliance on critical raw materials and improve energy resilience. As discussed by Innocenti et al. (2024), the potential of these alternative solutions is significant, not only for reducing material dependencies but also for enhancing the EU's energy security. Further advances in clean energy technologies would not only support the EU's internal market but could also strengthen the Union's global position in green technologies (European Commission, 2006), ensuring its economic competitiveness in a rapidly expanding global market.

Finally, the EU could play a significant role in supporting the energy transition in Africa. As the continent's energy demand is increasing rapidly, the EU could partner with African countries to accelerate renewable energy adoption and create job opportunities through green energy projects (European Commission, 2006). This collaboration would not only contribute to global sustainability goals but also open up new markets for the EU. By focussing on energy infrastructure development and capacity building, the EU could help Africa leapfrog traditional energy systems and move directly to clean energy solutions, fostering geopolitical alliances and ensuring that both regions benefit from a shared, sustainable future.

3.3 Geopolitical Tensions over CRMs

The objective of limiting global warming to 1.5ºC, as established by the Paris Agreement, requires an unprecedented transformation of global energy systems. NASA (2024) states that the last ten years were the warmest on record, with the Earth being around 1.47ºC warmer

in 2024 when compared to the preindustrial average. Attaining the 1.5-degree Celsius target requires a peak of global greenhouse gas emissions by 2025, a reduction of 43% by 2030 and net zero CO2 by the 2050s (IPCC, 2022). Accomplishing this presupposes the full decarbonization of electricity production, widespread electrification of energy end-use sectors such as transport and heating and the expansion of low-carbon hydrogen through electrolysis. According to McKinsey (2024), global electricity consumption could more than double—rising from around 28,000 TWh in 2023 to between 64,000 and 79,000 TWh by 2050—depending on the pace of the energy transition. This sharp rise reflects accelerating electrification in transport, expanding digital infrastructure (notably data centres and artificial intelligence), and the expected scale-up of green hydrogen, which could grow from under 1 million tonnes today to approximately 179 million tonnes per year by mid-century. Accompanying this shift is the need for a massive expansion of electricity networks. The global power grid, currently at about 75 million kilometres in length, would need to grow to roughly 200 million kilometres by 2050 to meet demand and integrate renewable sources, requiring transmission and distribution investments to triple (McKinsey, 2024).

However, such forecasts are subject to significant uncertainty. For instance, the World Energy Council (2013) projected that electricity generation could grow from approximately 21,500 TWh in 2010 to between 48,000 and 54,000 TWh by 2050, depending on the scenario—implying a 123% to 150% increase. The higher projection reflects a future driven primarily by market forces and consumer-led innovation, where decentralised technologies and economic growth stimulate rapid electrification. The lower projection is based on a more coordinated global pathway, where strong governance, sustainability goals, and long-term planning shape energy system development. These diverging trajectories illustrate how structural assumptions—ranging from economic models and political will to societal preferences—can significantly influence expectations about future electricity demand.

The realisation of these targets depends on the availability of CRMs such as lithium, cobalt, copper, nickel, graphite and other rare earth elements. Currently, clean energy applications account for approximately 55% of total lithium demand, 30% of cobalt, 25% of rare earth elements, and 15% of copper and nickel (IEA, 2024). As a result of this rising pressure, extraction of these minerals has grown considerably: lithium output increased fivefold between 2010 and 2022, while nickel and cobalt production roughly doubled in the same

period. Between 2020 and 2022 alone, lithium production rose by 80%, nickel by 35%, and cobalt by 40%. Despite these gains, demand growth has consistently outpaced supply, leading to severe market tensions—illustrated by a more than fivefold surge in international lithium prices between early 2020 and 2022. Looking ahead, even if all currently announced projects come to fruition, supply in 2030 would still cover only around 65% of projected lithium demand, 80% of nickel, 85% of cobalt, and 90% of copper needs under the Net Zero Emissions Scenario (IEA, 2024).

Geopolitical tensions are intensifying energy security concerns due to the high concentration of mining, processing, and manufacturing of critical raw materials and clean technologies in a few countries—especially China. China dominates global refining of lithium, cobalt, and rare earths, and produces over 80% of key clean technologies like solar panels and EV batteries (IEA, 2024). This creates vulnerabilities to political disruptions.

Adding to this complexity is the fragmented nature of global mineral supply chains. Mining, metallurgy, manufacturing, and consumption frequently take place in entirely different regions. In the case of copper, it has been observed that raw concentrates are largely mined in Latin America, refined in Asia, and used in downstream manufacturing processes mainly in China (IRP, 2020). This spatial disconnection created logistical bottlenecks and increase geopolitical risks, particularly as copper is indispensable for electrification infrastructure and clean energy systems (IRP, 2020).

In response, countries are pushing to localise supply chains, which may improve resilience but risk undermining global trade efficiency. Deployment remains uneven: from 2015 to 2022, China and advanced economies accounted for over 95% of EV and heat pump sales, and nearly 85% of solar and wind capacity additions (IEA, 2024).

Geopolitical leverage over CRMs is becoming increasingly evident. China's temporary suspension of rare earth exports to Japan in 2010, triggered by a maritime border dispute, demonstrated how dominance over critical raw material supply chains can be used as a tool of coercion in international politics (IRP, 2020). Similarly, resource-rich countries are asserting control over their mineral wealth by restricting exports of unprocessed materials in order to stimulate their domestic industries. Indonesia offers a prominent example: in 2012,

the government introduced export quotas and taxes n a range of unprocessed metal ores – including nickel, tin and copper – with the explicit aim of encouraging local processing and developing a downstream manufacturing sector. These policies, later tightened in 2014 and again in 2020, were designed to ensure that raw materials contributed to national development rather than being exported cheaply and processed abroad (IRP, 2020).

This form of resource nationalism, amplified during commodity booms, has significant geopolitical implications. By deterring foreign investment and tightening global supply, such measures heighten volatility in already strained CRM markets. As countries begin to realise the strategic vulnerabilities embedded in global value chains, diversification of sourcing becomes not just an economic objective but a geopolitical imperative.

In this context, the European Union's dependence on a small number of suppliers – most notably China – has become a matter of strategic concern. In 2024 total global reserves of rare earth minerals were 90 million tonnes, with the biggest global reserves being 140 million tonnes in 2013 (Statista, 2025). It is estimated that China's reserves alone amounted to 44 million tonnes in 2024 (Statista, 2025a) and that the country produced around 270000 tonnes in the same year, nearly 70 % of the global total (Statista, 2025b). The second largest producer – the US – extracted around 45000 tonnes (Statista, 2025a).

According to Eurostat, the European Union imported 12900 tonnes of rare earths in 2024. Figure 3 depicts the quantities of rare earths imported by the EU in tonnes, in a time span of ten years.

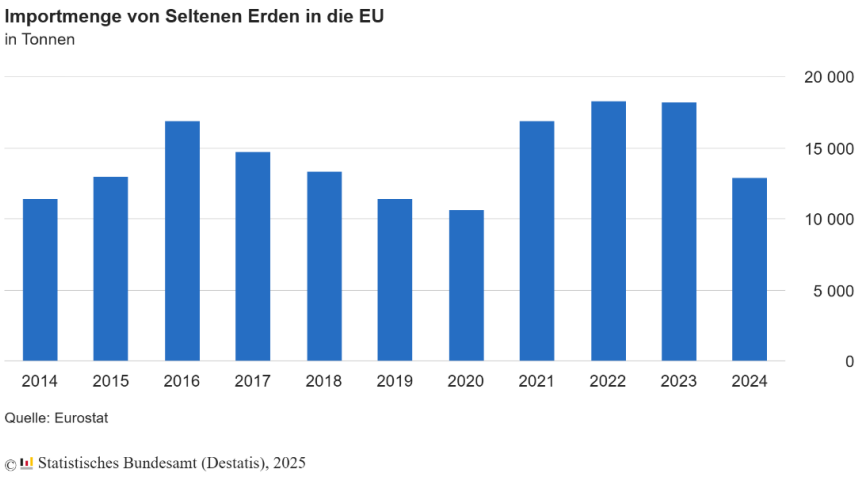

Figure 3 - EU Rare Earth Imports (Statistisches Bundesamt, 2025)

In the same year Germany accounted for 5200 tonnes alone – 40,3% of the total share, a reduction from 5900 tonnes in the previous year. From the EU's 12900 tonnes of imports, 6000 tonnes, or 46,3 %, came from China. Russia, in second place, accounted for 3700 tonnes which amount to 28,4%. Given the sanctions and the war in Ukraine, one fourth of total imports seems like too high a share. Figure 4 shows the quantities Germany imported from 2016 to 2021, in tonnes as well.

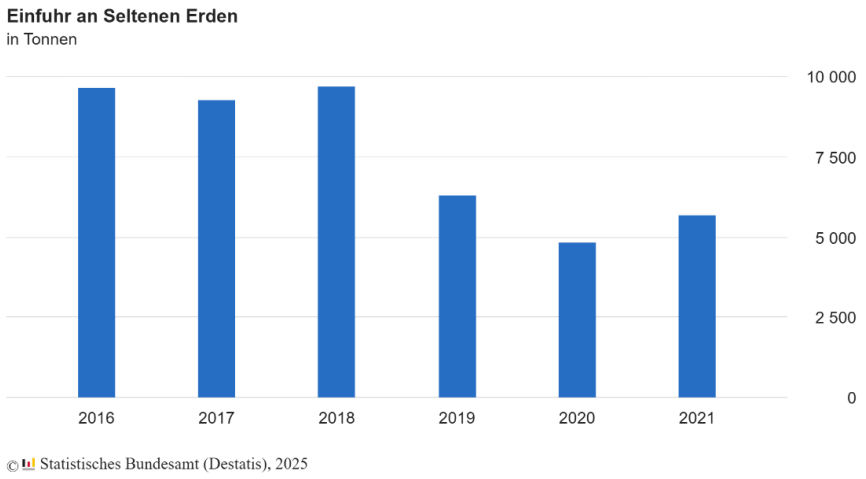

Figure 4 - Germany's Rare Earth Imports (Statistisches Bundesamt, 2025)

However, these percentiles represent the total of the seven materials classified as rare earths by the EU (European Parliament & Council of the European Union, 2024a). When looked at more closely, China's share of imports to the EU rises significantly. In 2024 97,7% of Neodymium, Praseodymium and Samarium, and 99,3% of Cer and Lanthanum came from the country. It should also be noted that import countries like Austria and Estonia do not extract but process rare earths and that their origin cannot be traced, but likely are from China, Russia or Malaysia (Statistisches Bundesamt, 2025). Germany's share of Lanthanum, Neodymium, Praseodymium, Cerium and Samarium originating in China was 75% in 2024.

Nonetheless, strategies aimed at diversifying supply chains must contend with the reality that investment in mineral exploitation is far from evenly distributed. According to the International Resource Panel (IRP, 2020), between 1991 and 2015, Canada and Australia attracted average exploitation investments of USD 118 and 125 per km² per year, respectively. In contrast, Africa, with comparable geological potential, received only USD 36

per km² per year. This metric, reflecting the annual amount of exploration capital invested per square kilometre of land, serves as an indicator for how attractive and secure a region in perceived by investors. The disparity is not geological but institutional, stemming from persistent infrastructure deficits, regulatory uncertainty, limited geological data, and elevated political risks (IRP, 2020). Without addressing these underlying constraints, policy efforts to diversify supply sources may remain aspirational rather than effective.

It is due to the strategic importance of rare earths to the EU that the union decided to limit the demand per one country of import to 65% until 2030. Supply sources are to be diversified to reduce dependencies. Other objectives are to fortify in-house production and extraction and to bolster recycling shares (Statistisches Bundesamt, 2025).

The materials considered strategic and critical by the EU are as follows (table 1). Strategically important materials are those which are relevant for the green and digital transitions and for defence and aerospace purposes. To be categorized as such, they must be irreplaceable components in strategic technologies, required in significant volumes, and associated with globally growing demand.

List of strategic raw materials	bauxite/alumina/aluminium, bismuth, boron — metallurgy grade, cobalt, copper, gallium, germanium, lithium — battery grade, magnesium metal, manganese — battery grade, graphite — battery grade, nickel — battery grade, latinum group metals, rare earth elements for permanent magnets (Nd, Pr, Tb, Dy, Gd, Sm, and Ce), silicon metal, titanium metal, tungsten
List of critical raw materials	Antimony, arsenic, bauxite/alumina/aluminium, baryte, beryllium, bismuth, boron, cobalt, coking coal, copper, feldspar, fluorspar, gallium, germanium, hafnium, helium, heavy rare earth elements, light rare earth elements, lithium, magnesium, manganese, graphite, nickel — battery grade, niobium, phosphate rock, phosphorus, platinum group metals, scandium, silicon metal, strontium, tantalum, titanium metal, tungsten, vanadium.

Table 1 - Strategic and critical materials (European Parliament & Council of the European Union, 2024a)

As dependencies become more visible, especially in light of geopolitical instability and the lessons from the COVID-19 pandemic, both the EU and its member states have begun to translate strategic CRM policy into concrete initiatives. While the EU sets overarching goals such as diversification, in-house-capacity-building, and recycling, the operationalisation of these goals varies by country. Germany, for instance, has launched a dedicated financial mechanism to reduce exposure to supply risks. Elisabeth Braw (Braw, 2024) reports that Germany has set up a €1 billion fund managed by the KfW. Its purpose is to lessen the country's vulnerability to supply-chain disruptions by helping German companies monetarily through loans and equity investments, focussing on mining, processing and recycling said raw materials (KfW, 2024). According to Braw (2024), before the 2020 pandemic, dependencies were seen as efficient outcomes of globalization and specialisation. However, as dependencies became visible through personal protective equipment (PPE) shortages during the pandemic, perspectives changed, making over-reliance on single countries appear dangerous.

China's near monopoly on CRM supply chains and the rising geopolitical tensions have heightened strategic anxieties across industrial and defence sectors. The pandemic revealed the fragility of global dependencies, prompting governments to consider worst-case-scenarios – particularly the risk of China restricting access to critical raw materials. It is due to China's dominance in rare earth supply chains, that the US Department of Defense, faced with heavy reliance on China for those materials, has launched an initiative to establish a fully domestic "mine-to-magnet" supply chain by 2027. The objective of the initiative is to ensure national security and industrial resilience by reshoring every step of the production process – from mining to processing to magnet manufacturing (U.S. Department of Defense, 2024).

The urgency becomes clearer when considering the amount of rare earths required for electronic warfare capabilities, propulsion systems, targeting precision and communications. A single F-35 fighter jet requires around 408kg of the materials, a Virginia-class submarine

around 4100kg. They are also necessary for drones and missiles, as well as radar and sonar systems (U.S. Department of Defense, 2024).

Despite this demand, the United States currently operates only one rare earth mine, which falls short of meeting military demand. Through the Manufacturing Capability Expansion and Investment Program (MCEIP), the Department of Defense invested roughly $470 million to expand the current mine, build a second, establish domestic alloy and magnet production, and fund research into alternative extracting methods such as coal ash and acid mine drainage (U.S. Department of Defense, 2024). These efforts aim to reduce strategic vulnerabilities by building a resilient, self-sufficient, and competitive domestic supply chain.

In parallel, the U.S. is also extending its strategic position abroad. Under the Defense Production Act, countries like Australia, Canada, and the United Kingdom have been designated as domestic sources of critical minerals, making them eligible for U.S. funding (Burton, 2024). In 2024, the U.S. extended support to two Australian-listed rare earth projects with up to $850 million in funding. Despite declining global prices, which have negatively impacted both Western and Chinese producers, officials argue that building a robust, non-Chinese rare-earth industry is essential to address and correct current market imbalances and ensure long-term stability and resilience in the global supply chain (Burton, 2024).

The United States is thus pursuing a diversification strategy to close critical gaps in processing and magnet manufacturing, recognising that no domestic or allied source can currently meet both defense and commercial demand. These large-scale investments are not only designed to reduce strategic vulnerabilities but also to accelerate innovation, including the development of alternative extraction methods from waste materials. By fostering a resilient, secure, and self-sufficient supply chain, the U.S. aims to regain competitiveness in the rare earth industry.

In sum, critical raw materials are no longer mere economic inputs. They are strategic assets. Their access determines not only the pace of the energy transition, but also the geopolitical autonomy of entire regions. While the EU prioritises regulatory cohesion and industrial resilience, countries like the U.S. opt for vertical integration and militarised supply security.

These diverging strategies underscore that CRM governance will be central to the international order emerging from the green transition.

3.4 Energy Transition and European Competitiveness

As stated above, Germany's import shares within the European Union are considerable, which is why it deserves a more profound analysis, representative of the EU.

According to Deloitte (2024) Germany imports raw materials majorly as processed primary products instead of ores, oxides or concentrates. Focussing on the three most used materials and intermediate products – Lithium and lithium-ion batteries, silicon/semiconductors, cobalt and cobalt mat – it concluded that the industrial sectors that rely on these contribute 79% to the gross value added of the manufacturing industry. Among them is the automotive industry with 23%, plant and mechanical engineering industry with 15% and metal production with 12%. In case of a non-availability (such as supply failures or interruptions) of these three raw materials and pre-products, up to four-fifths of the industrial production or 20% of the German GDP would be negatively affected (Deloitte, 2024).

In the case of cobalt oxide and hydroxide, the USA (45%), the Democratic Rebublic of Congo (23%) and Finland (11%) are the main global exporters. Germany, however, imports predominantly from Finland (84%), followed by Belgium (7%) and Italy (5%) – all European countries. This intra-European sourcing reflects regulatory alignment and strategic cooperation, as well as shorter transport routes. Yet, as mentioned above, the EU is to limit import rates to 65% per country of origin and material until 2030, which means Finland's imports will have to decrease (Deloitte, 2024). The USA's and DRC's export capacity are not being used and could represent an opportunity in the matter.

Cobalt matte shows this more clearly. While the DRC accounts for 89% of global exports, Germany sources the product from Canada (17%), Belgium (16%) and the USA (15%), with more than half of the imports classified as "other", probably intermediate processing countries. Again, the import countries are partners to the EU, nevertheless, Deloitte (2024) proposes raw material agreements with the DRC to diversify the supply. If properly

regulated, such partnerships could contribute to stability and development in the African country, provided that revenues are transparently reinvested into local communities.

For silicon, global exports are dominated by China (57%), Norway (17%) and Brazil (17%). Germany, though, imports 58% from Norway, 15% from France and 14% from Brazil. These import countries represent relatively resilient and diversified sources. Still, Deloitte (2024) warns that Norway's share should be monitored for potential overreliance and suggests the expansion of German domestic silicon reserves and recycling capacities.

In lithium-ion batteries, China leads with 41% of global exports, followed by Japan with 21% and South Corea (16%). Germany imports 41% from China but also draws on Poland (23%) and Hungary (19%), reflecting a growing intra-European battery manufacturing capacity. However, the input materials for the batteries are most probably not European. Germany does not currently import from Japan or South Corea – a clear gap considering their leading market roles and partnership status. The company recommends increasing imports from these countries and supporting nearshoring to Poland, Hungary and the Czech Republic. Dependencies could also be reduced by investing in alternative storage technologies (Deloitte, 2024).

As for lithium carbonate, Chile dominates the exports with 61%, followed by Argentina (17%) and China (7%). Along the years Chile has lost parts of its import share to Germany to China, which is why 47% are imported from Chile and 24% from China, as well as 17% from the US. Argentina, the second largest global exporter, currently only supplies 1%. Deloitte (2024) proposes increasing imports from Argentina and countries like France and the UK, besides seeking trade agreements with South American countries. To reduce vulnerabilities over the long term, the evaluation of domestic (European) lithium extraction and processing is recommended.

Across all materials, Deloitte stresses the importance of diversifying suppliers, strengthening partnerships and developing domestic processing capacities. Imports from Argentina, the U.S., and other underrepresented partners should be increased, overreliances avoided.

The demand for critical raw materials such as lithium, cobalt and silicon is expected to rise by 2030, driven by the electrification and digitalisation transitions. Lithium demand is projected to increase by a factor of 18, cobalt by a factor of 5. The need for semiconductors (and thus silicon) is expected to double. This surge is primarily due to the expansion of electric mobility, battery storage and the growing reliance on digital infrastructure and electronics. If supply capacities do not keep pace with rising demand, the report warns of potential shortages and significant bottlenecks. In the case of cobalt alone, a supply gap of up to 40% could emerge by the end of the decade (Deloitte, 2024). These developments underscore the urgency of implementing the recommended mitigation strategies to secure access to essential materials in the long term.

Chapter 4 – Africa's Role in the Energy Transition

With over 30 percent of the world's known reserves of key minerals such as cobalt, lithium, and rare earth elements, Africa has become an essential player in the development of green technologies, including electric vehicles, wind turbines, and solar panels (United Nations Economic Commission for Africa (UNECA, 2024). However, despite this wealth of resources, the continent has historically played a subordinate role in the global supply chain, primarily as an exporter of raw materials with little involvement in industrial processing or high-value manufacturing. This historical pattern, rooted in colonial economic structures, has persisted long after independence, shaping Africa's present-day economic landscape and its position within global markets (Easterly & Levine, 1995).

As global competition over CRMs intensifies, Africa finds itself caught between competing economic powers, particularly the European Union (EU) and China. While China has established itself as the dominant force in Africa's mining sector through long-term investment strategies under the Belt and Road Initiative (BRI), the EU has recently attempted to counterbalance this influence with the launch of the Global Gateway Investment Package, a framework designed to promote infrastructure investment and sustainable resource partnerships (European Commission, 2025). The increasing rivalry between these global actors highlights Africa's strategic importance in the energy transition but also raises concerns over whether the continent will continue to be treated as a mere supplier of raw materials, or whether it can leverage its resource wealth to achieve meaningful industrialization and economic sovereignty (Beuter et al., 2025).

Historically, Africa's economic trajectory has been dictated by external forces, with limited agency over its own development. During the colonial period, European powers structured African economies around extractive industries, building infrastructure designed not for local development but for the efficient export of raw materials to metropolitan centres. This system, largely unchallenged in the early post-independence period, resulted in an economic model that prioritized resource extraction over industrial diversification, leaving many African nations heavily dependent on volatile commodity markets and foreign direct investment (Helleiner, 1970). In more recent decades, African governments have attempted to restructure economic policies to encourage greater local value addition and industrialization, but progress has been uneven. Structural Adjustment Programs (SAPs)

imposed by international financial institutions in the late 20th century further constrained industrial growth, forcing many African economies to liberalize resource sectors, often to the benefit of multinational corporations rather than domestic industries (NEPAD, 2018).

The ongoing energy transition presents an opportunity for Africa to break away from this historical dependency by repositioning itself as not only a supplier of CRMs but also an active participant in the global green economy. The African Union's Agenda 2063, a strategic framework for the continent's long-term economic and social transformation, explicitly highlights the need to move beyond raw material exports toward higher-value industrial production and regional economic integration (African Union, 2015). The success of this vision depends on the implementation of policies that encourage local refining and manufacturing, the development of intra-African trade networks through initiatives such as the African Continental Free Trade Area (AfCFTA), and the establishment of partnerships that prioritize Africa's long-term development goals rather than perpetuating extractive relationships with foreign powers.

4.1 Africa's Resources

Africa holds a central yet structurally marginalized position in the global energy transition. The continent is rich in critical materials essential for decarbonisation technologies but remains trapped in low-value segments of global supply chains (IRP, 2020). The Democratic Republic of Congo (DRC) provides a compelling case study of this paradox. Holding a dominant share of global cobalt extraction and substantial copper deposits, the DRC is indispensable to global clean energy supply chains. Yet, it remains one of the poorest and most institutionally fragile states in the world. Its mining sector is dominated by artisanal and small-scale mining (ASM), and foreign companies, with limited capacity for domestic refining or processing. This illustrates how geological endowment alone does not translate into economic development when structural governance weaknesses and extractive foreign investment models persist (IRP, 2020). The DRC's experience reflects a broader pattern where resource flows generate external profits without translating into sustainable local gains.

Between 1986 and 1994, cobalt mine production in the DRC fell from over 33,000 tonnes to just 800 tonnes, following the collapse of state-owned mining firms, underinvestment in equipment and maintenance, and the deterioration of transport and electricity infrastructure.

In contrast, production increased by 50% during the Shaba I and II conflicts (1977-1979) and expanded sevenfold between 1996 and 2003, a period that coincides with the First Congo War (1996-1997) and the Second Congo War (1998-2003). These trends indicate that output was resilient during political and military crises, but vulnerable to structural economic breakdown. It raises the possibility that the sustained or increased production observed during the wars helped finance the wars themselves, trading mining concessions for military support and resources (Gulley, 2022; UN Security Council, 2002). As such, the main drivers of production disruption have historically been infrastructural fragility, electricity shortages, and economic disintegration – not conflict per se.

While demand for critical materials is increasing globally, African countries remain largely excluded from downstream segments such as refining and component manufacturing due to limited infrastructure and institutional integration (IRENA, 2023). In the DRC and Zambia, cobalt is almost exclusively mined as a by-product of copper, meaning that extraction decisions are dictated by copper market dynamics rather than cobalt-specific demand. When cobalt recovery is not economically viable, it is simply discarded. Throughout most of the 20th century, cobalt was systematically discarded as waste, as copper recovery was prioritized and cobalt was not considered economically valuable. This practice resulted in the accumulation of high-cobalt-content tailings and slag across mining sites in the DRC. From the 1990s to the 2010s, these cobalt-rich slag piles, once considered worthless, became highly profitable extraction sites for both industrial and artisanal operators, illustrating how mineral value is shaped by technological and market shifts rather than geological scarcity alone (Gulley, 2022).

In line with the broader pattern of exclusion from downstream segments already discussed, the DRC's attempts to increase domestic processing capacity have had limited success. Although the government adopted export bans on unprocessed ores and introduced in-country transformation requirements, the measures have had little structural impact. After peaking at 5,200 tonnes in 1999, refinery output declined sharply, falling to 600 tonnes by 2007 and remaining below 150 tonnes per year from 2016 onward (Gulley, 2022). The main constraint includes unreliable electricity supply, high operational costs, and a lack of reinvestment in refining infrastructure. The country's production model then shifted toward intermediate processing at mine sites: large-scale operators began converting ores into crude

cobalt hydroxide, a form that reduces shipping costs and is better suited for refining abroad. Since 2012, this intermediate has overtaken concentrate production, and the vast majority is exported to China for further processing into battery-grade cobalt chemicals. While this model allows for marginally greater value retention than raw ore exports, it continues to externalise most of the economic benefits and limits the development of domestic industrial capacity (Gulley, 2022).

The case of the DRC is not unique. Despite its geological abundance, the African continent continues to attract limited investment in exploration, infrastructure and industrial capacity. Between 1991 and 2015, Africa attracted only a fraction of the capital that flowed into mineral-rich regions such as Canada and Australia, receiving less than a third of the exploration spending. This investment disparity has been linked to structural factors, such as political instability, regulatory fragmentation and the costs associated with inadequate infrastructure (IPR, 2020). Transport networks, port systems and energy access remain unreliable or underdeveloped, particularly in landlocked or remote areas where the mines are localised. In addition to these domestic barriers, the global mining and processing landscape is dominated by a few actors reinforcing existing asymmetries – such as Glencore, China Molybdenum, Eurasian Resources Group –, and the long lead times for new facility development further consolidate Africa's peripheral role in global supply chains (IRENA, 2023).

Foreign dominance over cobalt extraction in the DRC is reinforced not only by structural barriers to domestic processing, but also by the regulatory and institutional environment in which mining takes place. While liberalisation of the sector since the early 2000s has supported continuous growth in cobalt output, the investment climate remains shaped by legal unpredictability, weak enforcement, and fragmented oversight. Foreign ownership of cobalt-producing assets is typically structured through joint ventures with the state, in which Gécamines holds minority shares. However, successive waves of contract renegotiations, revisions to the mining code, and abrupt fiscal shifts have introduced significant uncertainty.

In 2018, the Congolese government revised the national mining code and reclassified cobalt as a "strategic substance," prompting a sharp increase in royalty rates from 2% to 10%. Royalty payments function as a percentage of the gross value of extracted minerals and are

owed to the state regardless of company profitability. The designation of cobalt as "strategic" allowed the government to apply the highest possible rate permitted under the revised legislation. In addition, a 50% "super-profit" tax was introduced on windfall earnings, defined as profits exceeding 25% above the projections established at the time of the mining license. These fiscal reforms were designed to capture a larger share of the sector's rising revenues amid global cobalt price surges. However, they also led to a sharp decline in investor confidence and contributed to the withdrawal of several Western firms from the DRC's cobalt sector. In their place, Chinese, Kazakh, and Dubai-based companies gained increased dominance, reflecting a broader shift toward non-Western capital in a context of legal uncertainty and limited state oversight (Gulley, 2022).

This shift in the investor landscape has not only altered ownership structures but also reinforced patterns of extractive dependency. Chinese firms, in particular, have consolidated control over both extraction and export routes, positioning themselves as dominant actors across the cobalt supply chain. Their increasing involvement in the DRC's mining sector has implications that go beyond economics, reshaping geopolitical alignments and further entrenching the country's role as a supplier of unrefined strategic minerals (Gulley, 2022).

The interplay between infrastructure deficits, fiscal instability, and foreign dominance has direct implications for Africa's role in global supply chains. While Africa is a major exporter of raw materials, value addition is conducted outside the continent. In countries like the DRC and Zambia, more than 90% of extracted cobalt and copper is exported (IRP, 2020). This structural dependence on external processing reinforces Africa's role as a supplier of raw inputs while obstructing industrial learning and economic development. Local beneficiation is rare and that domestic supply chains are either weak or absent (IRP, 2020). The global concentration of refining capacity in East Asia and a few OECD countries – including China, Japan, and South Korea – creates asymmetrical dependencies that limit African exporters' bargaining power and expose them to the volatility of commodity markets and reinforces dependence on external actors (IRENA, 2023).

The institutional environment remains fragmented. National authorities often operate in insolation from local governance structures and community engagement is limited or absent. This disconnect weakens public trust, fosters social conflict and limits oversight. These gaps

not only enable elite capture and allow informal extractive activity to flourish in ecologically sensitive or socially vulnerable areas (Boafo & Arthur-Holmes, 2025). Elite capture prevents revenues from both ASM and formal mining from being channelled into broader public development, reinforcing patterns of inequality and external dependence. In countries such as Ghana and Zimbabwe local political elites and security forces have profited from unsanctioned mining operations, thereby undermining formal oversight and diverting rents away from community welfare (Boafo & Arthur-Holmes, 2025). Regulatory enforcement is inconsistent, and the lack of clearly defined institutional responsibilities contributes to ineffective governance (IRP, 2020). Ghana, for instance, has taken steps to clarify institutional responsibilities and improve oversight, but such efforts remain uneven across the continent. In this context, ASM has expanded as an informal survival strategy. While it provides income to millions, it often takes place in unregulated conditions, without basic protections or environmental safeguards. The result is a widespread loss of state revenue and heightened vulnerability for those working in the sector. In this context, the fragility of oversight frameworks extends beyond broader social and environmental risks. Extractive operations in ecologically sensitive areas or regions inhabited by Indigenous communities can lead to land conflicts and environmental degradation when environmental and legal protections limited. According to IRENA (2023), approximately 54% of global nickel, 50% of lithium, and over 40% of copper reserves are located on or near Indigenous lands, intensifying the risk of rights violations and contested land use.

Attempts to improve governance through international transparency mechanisms have had mixed outcomes. Standards such as the Extractive Industries Transparency Initiative (EITI) and the OECD Due Diligence are intended to increase accountability, yet their developmental effectiveness has been questioned (IRP, 2020). These frameworks tend to be externally imposed, and reflect the regulatory preferences of consumer countries, rather than the institutional capacities or development priorities of the states. In practise, they risk excluding informal actors, placing administrative burdens on already overstretched institutions, and reinforcing elite capture of revenues from the extractive sector. Global supply chain expectations – such as traceability requirements, reporting obligations, and certification standards – presume high institutional capacity and administrative resources. However, in many African resource-extracting countries, institutional and technical capacity remains limited, generating a disconnect between global compliance norms and local

implementation capabilities. Externally designed compliance frameworks often overlook these constraints, leading thus to procedural complexity, poor enforcement and reduced legitimacy. This gap is especially problematic where institutions lack clarity in mandates, staff, or infrastructure, thereby reinforcing implementation bottlenecks and undermining trust in governance processes (IRENA, 2023).

Illicit financial flows (IFFs) have also been identified as a major obstacle to development (IRP, 2020). In resource-rich counties such as Nigeria, the scale of these flows exacerbates fiscal fragility and undermines the state's capacity to reinvest revenues in social development. In some years, IFFs from Africa have exceeded the total volume of official development assistance. This capital flight deprives governments of the resources needed to invest in education, infrastructure, and healthcare – and it weakens the fiscal foundations of the state. Corruption and lack of transparency deepen these challenges and reinforce patterns of external dependence.

Ultimately, the prevailing extractive model is characterised by economic disconnection (IRP, 2020). Mineral wealth is exported, and the gains remain externalised. Without structural reforms – both domestic and international – Africa's current position risks becoming further cemented. To break from this model, institutional capacity must be strengthened, and African actors must be integrated into higher value stages of the supply chain. Although, for instance, South Africa is institutionally more advanced than other African counties, also in terms of energy infrastructure, such examples remain the exception rather than the rule (IRP, 2020). For long-term inclusive growth, the continent must transition from raw material extraction to active participation in refining, processing, and technological development within global supply chains (IRENA, 2023). Otherwise, the continent will remain a resource provider without a stake in the benefits of the global energy transition. As Boafo & Arthur-Holmes (2025) caution, Africa risks becoming both the backbone and the casualty of the global sustainability agenda – indispensable for the supply of minerals yet excluded from benefits of green industrialisation.

4.1.1 China's Influence in Africa

From the early colonial period through industrialization and into the modern era, Europe's development was deeply tied to its economic dependence on Asia, the Americas, and Africa. Without the large-scale extraction of resources and labour from these continents, the prosperity and global status of Europe would look very different today.

In the present, Europe portrays itself as a changed actor — one that seeks to promote human rights, sustainability, and fair trade. But this moral position is complicated by Europe's loss of global dominance. Following the Second World War, global leadership shifted to the United States and the Soviet Union. Since the end of the Cold War, this bipolar structure has dissolved, giving rise to a more fragmented multipolar order has. Among the most notable actors in this landscape is China — a country that has transformed from a position of exploitation to one of assertive global power.

The People's Republic of China has undergone a dramatic transition over the past decades. From the late 1940s through the 1970s, Chinese foreign policy was characterized by support for revolutionary movements and the export of communist ideology. As documented by John F. Copper, China began to extend foreign aid as early as 1949, using it as a tool to support allied governments and promote ideological alignment. This included the funding of major wars — in Korea and Vietnam — as well as support for a wide range of liberation struggles across the Global South (Copper, 2016).

In the 1980s, however, this policy shifted. China turned inward, focusing on economic development and reform, suspending many of its international aid efforts. It began to receive foreign assistance itself, including from international institutions and Western investors. This phase laid the groundwork for China's modernization and rapid economic growth, heavily supported by investment from the West and overseas Chinese networks (Copper, 2016).

In the 1990s and early 2000s, once the foundations of growth had been laid, China re-entered the global stage — this time as an investor. What had once been framed as ideological "aid" was now rebranded as foreign direct investment. This economic engagement rapidly outpaced that of many Western donors and development agencies, particularly in resource-rich but capital-poor regions such as Sub-Saharan Africa (Copper, 2016).

In many African states, particularly those affected by European colonialism and structural adjustment, China's return was initially welcomed. Unlike the former European powers, China had no colonial legacy in Africa. Its approach was seen as non-intrusive, fast, and pragmatic, offering funding without the complex and often politically sensitive conditions imposed by Western donors. This gave Chinese investment a unique appeal — especially in countries seeking alternatives to the austerity-driven reforms of the IMF and World Bank (Copper, 2016).

This strategic reorientation allowed China to expand its global influence while securing access to essential raw materials. African governments gained capital and infrastructure, while China gained access to critical natural resources — including copper, cobalt, and coltan — all indispensable for high-tech industries and, later, the global energy transition.

While the partnership was framed as "win-win," China's engagement also contributed to the re-entrenchment of extractivist economic structures. Instead of fostering local processing capacity, industrial diversification, or sustainable value creation, many deals focused on raw material extraction and long-term export agreements. In some cases, they even reinforced corruption, conflict dynamics, or environmental degradation — especially where state capacity was weak and transparency lacking (Boafo & Arthur-Holmes, 2025; IRP, 2020).

China's role as a development partner in Africa was first formally institutionalized through the Forum on China-Africa Cooperation (FOCAC), with the 2006 summit marking a pivotal moment. At the time, China portrayed itself as a champion of post-colonial solidarity, highlighting principles such as national sovereignty, non-interference, and peaceful coexistence. This positioning resonated strongly across African capitals, where frustration with Western conditionality was widespread. By appealing to African nationalism and historical grievances against former colonial powers, China cultivated political goodwill and legitimacy. Its emphasis on "aid without conditions" distinguished it from Western donors, even as its projects often reinforced extractive structures and lacked transparency (Copper, 2016).

The 2024 FOCAC summit, in contrast, reflected a more assertive and strategically coordinated Chinese agenda. The new 2025–2027 Beijing Action Plan outlined ten key

programs that go far beyond the rhetoric of solidarity. These programs target industrialization, the expansion of Chinese-led free trade zones, police and military training, and the deepening of political and legal alignment between China and African countries. They also explicitly promote the adoption of China's governance model and the global diffusion of Chinese-led initiatives such as the Global Security Initiative, Global Development Initiative, and Global Civilization Initiative (Nantulya, 2025). These mechanisms serve China's global ambition to create parallel structures of influence, secure multilateral support in forums like the United Nations, and deepen economic and political interdependencies that reinforce its status as a global power. China's ability to advance its global ambitions increasingly depends on African support in multilateral institutions like the United Nations. Just as China promotes its governance model in bilateral partnerships, it also seeks to shape global norms around sovereignty, state-led development, and noninterference — often positioning these as alternatives to Western liberalism. In 2017 and 2020, African countries largely backed Chinese-sponsored resolutions at the UN Human Rights Council that reflected these values, including language drawn from Xi Jinping Thought (Nantulya, 2023). This alignment has triggered concern among civil society actors, who warn that such efforts may undermine the universality of human rights and weaken global accountability mechanisms. In response, some African voices have called for a clearer strategy grounded in African Union norms and strengthened by civil society engagement to safeguard the continent's long-standing multilateral commitments (Nantulya, 2023).

Yet behind this global alignment lies a pattern of concentrated, bilateral engagement that limits African participation and reinforces China's control. This evolution also reflects a shift from symbolic diplomacy toward transactional, state-centred engagement, characterized by bilateral arrangements with limited African input (Neema, 2024). While earlier FOCAC cycles emphasized solidarity, the 2024 summit highlights China's preference for tightly controlled, bilateral implementation, often minimizing African agency in the design and governance of projects.

China's engagement is also deeply embedded in material goals — particularly access to strategic minerals and control over infrastructure. In recent years, Chinese companies have acquired major assets in the Democratic Republic of the Congo (DRC), including cobalt and copper operations in Kolwezi, as well as lithium ventures in Zimbabwe and Mali. These

investments are accompanied by expanded control of African logistics, including railways and ports in Tanzania, Nigeria, Egypt, and beyond. Such infrastructure not only facilitates the export of raw materials but also integrates African production into Chinese-dominated supply chains. The implementation of these large-scale investments is often accompanied by a lack of local participation, with project planning and execution remaining largely within Chinese institutional frameworks. African policymakers have raised concerns about their limited influence in negotiations and oversight, especially in sectors critical to national development such as energy and transportation. This asymmetry reinforces a pattern where African economic agendas are shaped externally and subordinated to China's industrial and geopolitical objectives (Neema, 2024). In the DRC specifically, Chinese firms oversee extraction, processing, and transport — creating a vertically integrated system with limited local participation or upgrading potential (Gulley, 2022; Nantulya, 2025).

This dynamic also contributes to the expansion of informal economies, especially artisanal and small-scale mining (ASM). While ASM remains a vital source of income for millions, its proliferation is tied to global demand — particularly from China, whose companies are among the largest purchasers of ASM-sourced cobalt. The broader context includes infrastructure-for-resources agreements that often bypass environmental safeguards and labour protections. In this light, ASM is not simply a survival strategy, but part of a broader extractive model shaped by external actors. In regions like southern DRC, unregulated mining has been linked to land degradation, pollution, and exploitative labour practices — including child labour (Boafo & Arthur-Holmes, 2025). In key mining regions such as Kolwezi, Chinese-led extractive operations have triggered growing resentment due to environmental degradation, displacement, and the perceived absence of benefit-sharing mechanisms. Tensions between local communities and Chinese operators have escalated in some areas, highlighting the fragile social contract underpinning extractive partnerships that lack robust local governance and accountability structures (Neema, 2024).

Despite these imbalances, African actors are increasingly seeking to assert their interests. The New Partnership for Africa's Development (NEPAD) has been tasked with coordinating the implementation of 30 cross-border infrastructure projects outlined under the 2024 FOCAC framework. However, clarity is still lacking regarding project prioritization, co-financing, and governance standards. In parallel, independent African policy networks — such as the

Chinese in Africa/Africans in China (CA/AC) Network and the Africa-China Reporting Project — are advocating for stronger financial transparency, policy coherence, and the systematic tracking of FOCAC commitments. China's engagement also extends beyond economics into the discursive sphere, where it has invested heavily in shaping the narrative landscape of Africa-China relations. Media training initiatives, journalist exchange programs, and the expansion of Chinese-backed outlets across the continent have been promoted under the guise of South–South cooperation. However, these efforts risk limiting critical discourse by promoting one-sided representations of investment outcomes and discouraging scrutiny of negative externalities (Neema, 2024). Proposals have emerged to route Chinese financing through African multilateral institutions such as the African Development Bank, thereby increasing accountability and aligning Chinese-funded projects with African development priorities (Nantulya, 2025). These layered dynamics — infrastructural expansion, extractive control, and narrative influence — reveal a model that privileges Chinese strategic goals over African developmental autonomy (Neema, 2024).

The DRC continues to illustrate the paradox at the heart of Africa-China relations. On one hand, it is indispensable to the global energy transition due to its unparalleled cobalt reserves. On the other, it remains locked into extractive patterns that limit domestic industrial development. As Africa's most mineral-rich country, the DRC also exemplifies how Chinese control over both formal and informal supply chains — including ASM — reshapes local political economies while offering little in terms of value addition or long-term sustainability. The outcome of the current FOCAC cycle will largely depend on whether African governments succeed in translating demands for market access, industrial diversification, and sovereign policy space into enforceable reforms — or whether these aspirations are again subordinated to China's evolving global strategy.

Some African governments are beginning to act on these aspirations through regional industrial policies. A key example is the DRC–Zambia agreement to strengthen their mineral value chains by jointly developing infrastructure, sharing technical expertise, and cooperating on the production of electric vehicle (EV) batteries for export to European and other industrialized economies (Africa Center for Strategic Studies, 2025). This initiative reflects a strategic effort to move beyond raw material extraction and enter higher stages of the global value chain. However, progress has been limited. Both countries face persistent bottlenecks,

including unreliable electricity, poor transport infrastructure, and limited domestic markets for high-tech goods such as EVs. Equally critical are gaps in human capital and industrial capabilities, particularly in fields such as metallurgy, chemical engineering, and advanced manufacturing. Even when policies mandating local processing are in place, like Zimbabwe's lithium refinement requirements, structural limitations often reduce them to symbolic gestures — as local firms lack the capacity to implement them effectively. This disconnect underscores a broader problem: many African countries are attempting to industrialize without the necessary technological base or long-term investment in skills, institutions, and infrastructure. Addressing these constraints will require a fundamental shift in how mineral wealth is governed. It calls for better domestic policy coherence, stronger transparency and oversight mechanisms, and external partnerships that prioritize value addition, institutional strengthening, and sustainable development — rather than simply securing access to raw materials (Africa Center for Strategic Studies, 2025).

4.1.2 Africa-Europe Cooperation: Toward Sustainable Value Creation

As highlighted previously, China's engagement in Africa is increasingly characterised by bilateral arrangements and norm-altering partnerships that often marginalise African agency and weaken multilateral governance standards. This approach stands in stark contrast to the values-based strategy promoted by the European Union (EU) and is reflected in frameworks such as the African Union's Agenda 2063 and the African Mining Vision, which emphasise sustainable development, transparency, value addition, and inclusive governance in the natural resource sector (Acheampong, 2024).

The EU presents itself as a normative power in international affairs, and its approach to cooperation in the area of critical raw materials (CRMs) builds on shared principles with the African Union (AU). These include respect for human rights, the protection of environmental and social standards, and a commitment to rules-based, fair trade. By promoting Environmental, Social and Governance (ESG) criteria, transparency, and local capacity-building, the EU offers a model that diverges sharply from China's state-centric and transactional mode of engagement. As discussed in section 4.1.1, China's approach frequently sidelines civil society actors and emphasises political non-interference, which risks undermining democratic accountability and long-term development planning. In contrast,

the EU's values-based model appears more aligned with Africa's stated aspirations for structural economic transformation (Acheampong, 2024).

Within this evolving landscape, African states are not passive recipients of external investment but are increasingly redefining their position within global CRM supply chains. A growing number of governments have introduced export bans on unprocessed materials and implemented local beneficiation requirements aimed at retaining a greater share of value domestically. For instance, Zimbabwe's ban on unprocessed lithium exports in 2022 contributed to a tripling of lithium-related revenues within a year. Similarly, Ghana is strategically leveraging its lithium resources to develop local processing capacity through public-private partnerships (Acheampong, 2024). These cases reflect an increasing convergence between EU policy goals and African strategies to move up the value chain and foster industrial development, as further discussed in section 3.4 on European competitiveness and resilience.

To effectively support this trajectory, EU cooperation must go beyond ensuring access to raw materials and actively promote investment in midstream and downstream segments of CRM value chains. This includes activities such as refining, precursor production, and battery component manufacturing. Recent studies indicate that these operations may in fact be cost-effective when based in Africa, particularly where renewable energy sources are available. For instance, cobalt refining in the Democratic Republic of Congo (DRC) – powered by hydroelectricity – presents an opportunity to both feed European supply chains and contribute to job creation and industrialisation at the local level (Acheampong, 2024).

One notable example of this regionalised, integrated approach is the Lobito Corridor, a major infrastructure initiative connecting resource-rich areas of Angola, Zambia, and the DRC to Atlantic export terminals. Co-financed by the EU and the United States, the project aims to do more than facilitate mineral exports. Its broader objective is to foster regional industrial clusters and upgrade shared logistics and transport infrastructure, thereby enabling value creation closer to the source (Acheampong, 2024).

In terms of policy instruments, the EU has signed Memoranda of Understanding (MoUs) on CRM cooperation with countries such as Namibia, Zambia, the DRC, and Rwanda. While

these agreements express political intent and establish frameworks for dialogue, they often lack specificity regarding which stages of the value chain the EU is willing to co-develop. Clarifying these strategic priorities, especially regarding co-financing for local refining and manufacturing, would enhance alignment between European industrial policy and Africa's economic objectives (Acheampong, 2024).

A central pillar of this cooperation is the promotion of ESG standards and transparency mechanisms. Instruments such as the EU's Corporate Sustainability Reporting Directive (CSRD) aim to ensure that European firms maintain high social and environmental standards in their overseas operations. Such frameworks not only respond to African calls for responsible investment but also help strengthen the "social licence to operate" of foreign firms in African communities, contributing to trust-building and conflict prevention (Acheampong, 2024).

However, it must be acknowledged that ESG compliance frequently entails higher operational costs, which may place EU-based firms at a competitive disadvantage compared to companies from countries with looser regulatory requirements such as China. As noted in section 3.4, this raises concerns over the EU's competitiveness in international CRM markets. To address this challenge, the EU should expand access to financial support mechanisms, including concessional loans, export credits, and de-risking tools, in order to encourage ESG-compliant investment without eroding industrial competitiveness (Acheampong, 2024).

In this regard, the Minerals Security Partnership (MSP) is of particular importance. Launched by the United States and supported by the EU and other G7 partners, the MSP aims to diversify global CRM supply chains, promote environmental and social safeguards, and incentivise investment in sustainable production in resource-rich countries. Despite its inclusive rhetoric, African participation in MSP governance remains limited, which risks repeating past patterns of exclusion and undermining local ownership. Including African governments and regional organisations in the MSP's strategic direction would be a crucial step toward embedding African priorities within global governance frameworks for critical resources (Acheampong, 2024).

In conclusion, the EU's cooperation with Africa on CRMs holds the potential to advance both sustainable supply security for Europe and industrial development for African economies. However, realising this potential requires moving beyond rhetoric to concrete, inclusive, and adequately financed strategies. Unless European engagement clearly avoids reproducing the extractive dynamics of the past under a new guise, the credibility and long-term success of its values-based model will remain in question.

Chapter 5 – Methodology

5.1 Process

This study adopts a mixed-methods approach to comprehensively examine the geopolitical and economic dimensions of the energy transition, integrating both secondary data analysis and primary research through expert interviews. Given the intricate interconnection between energy security, industrial competitiveness, and global trade, this methodological framework ensures a multi-layered investigation into critical raw material (CRM) supply chains, policy frameworks, and stakeholder strategies.

The research follows a three-pronged approach, consisting of (1) an extensive document and data analysis of trade flows, industrial strategies, and policy frameworks; (2) a case study analysis focusing on cobalt mining in the Democratic Republic of Congo (DRC); and (3) an interview with one expert. This combination of methodologies provides a comprehensive foundation for mapping vulnerabilities in global CRM supply chains, evaluating diversification opportunities, and assessing the economic and geopolitical implications of resource extraction, trade dependencies, and evolving power dynamics.

This integrated approach ensures a balanced examination of the energy transition's geopolitical and economic dimensions. Given the nature of the research, which explores the intersection of resource dependency, policy frameworks, international competition, and industrial strategies, a singular methodological approach would be insufficient. The integration of policy analysis, trade data evaluations, case studies, and expert perspectives allows for a more robust, data-driven, and contextually rich understanding of the forces shaping the EU's, China's, and Africa's roles in the global energy transition.

5.2 Research problem and objectives

Based on the literature review conducted, the research problem can be stated as:

> How is the energy transition reshaping global geopolitics and how can the EU maintain its competitiveness in this evolving landscape – particularly in relation to China and Africa?

To answer the research question, the following objectives were specified:

- To examine the extent to which the EU's renewable energy ambitions are constrained or enabled by geopolitical pressures, particularly concerning access to critical raw materials (CRMs).
- To analyse Africa's role in the global energy transition, both as a supplier of CRMs and as an emerging energy producer.
- To investigate the strategic rivalry between the EU and China in Africa, and the implications of China's dominance in resource extraction and clean technology manufacturing.
- To assess how the EU might reduce its dependency on external suppliers through supply chain diversification, technological innovation and trade partnerships.
- To evaluate how the EU can strengthen its partnership with African nations in a way that ensures mutual benefit, supports Africa's development objectives and contributes to a just and inclusive global energy transition.
- To explore how Africa can leverage its resource wealth to promote industrialisation and sustainable growth, aligning national development goals with the broader demands of the global energy system.

5.3 Methods

Several methods were used to collect data, namely the analysis of public documents and datasets, as well as one in-depth interview with an expert.

The literature review, presented in Chapter 2, was conducted through document, dataset, and case study analysis. The document and data analysis involved a comprehensive review of policy documents and industry reports to examine existing strategies, synergies, and gaps in global energy transition policies. The primary goal was to understand the overarching policies that drive the economic and geopolitical strategies of key global actors. Key documents included the *European Green Deal*, the *Critical Raw Materials Act*, and the *Net-Zero Industry Act*, which define the EU's industrial and resource security strategies, sustainability ambitions, and global competitiveness objectives. African policy frameworks such as *Agenda 2063* were also analysed, alongside selected analytical reports, including UNECA, IRENA,

and the Africa Center for Strategic Studies (2025), to provide perspectives on governance frameworks, value addition potential, and Africa's strategic role in the critical raw materials sector.

To quantify the economic dimensions of the energy transition, trade and production data on CRMs were analysed using publicly accessible datasets from the International Energy Agency (IEA), Statista, and Destatis. This analysis mapped global CRM supply chain vulnerabilities and assessed the degree of import dependency among key actors, particularly the EU. It also identified trade diversification opportunities for the EU to reduce reliance on external suppliers, particularly China, and assessed Africa's position as a strategic supplier.

Additionally, the economic impacts of proposed CRM strategies were evaluated, considering market fluctuations, investment patterns, industrial trends, and production capacities. By combining trade flow statistics with policy analysis, the research provided a data-driven perspective on the economic and industrial factors shaping global energy governance.

A comparative case study approach was employed, focusing on the Democratic Republic of Congo (DRC), the world's largest producer of cobalt, a key mineral in lithium-ion battery production. This case study examined China's control over the DRC's cobalt sector, the geopolitical and economic dependencies resulting from this dominance, and the potential for local value addition and industrialisation. Through this analysis, the geopolitical, economic, and industrial implications of resource extraction and trade dependencies were assessed, alongside the ways in which African nations can navigate global competition while fostering local development and retaining agency over their natural resources.

5.3.1 In-depth interviews

To complement documentary analysis and trade data evaluations, an in-depth interview was conducted with one expert. A non-probabilistic by judgement sampling method was used to choose the experts, which included 3 specialists in energy policy, geopolitics, and African development. This qualitative input will enrich the analysis and provide real-world insights into the challenges and strategies associated with the energy transition. Questions posed are presented in table 2. Although these 3 experts were contacted, the interview was conducted with only one.

Table 2 - Objectives and questions posed to experts

Objective	Question
To examine the extent to which the EU's renewable energy ambitions are constrained or enabled by geopolitical pressures, particularly concerning access to critical raw materials (CRMs).	1. What do you see as the EU's key strengths or comparative advantages in advancing its renewable energy goals on a global scale? 2. Where do you identify internal vulnerabilities or structural weaknesses that could hinder the EU's green transition? 3. Are there emerging geopolitical trends that could benefit the EU's clean energy strategy? 4. In your opinion, what are the most significant geopolitical threats (e.g., supply disruptions, dependence on foreign actors) to the EU's energy security?
To analyse Africa's role in the global energy transition, both as a supplier of CRMs and as an emerging energy producer.	5. What strengths does the African continent offer in terms of renewable energy potential and critical raw material supply? 6. What limitations—technical, institutional, or financial—currently prevent African countries from fully benefiting from the global energy transition? 7. What opportunities exist for Africa to move beyond resource extraction toward value creation and energy production? 8. What risks could arise if Africa remains primarily a resource supplier in the green economy?
To investigate the strategic rivalry between the EU and China in Africa, and the implications of China's dominance in resource extraction and clean technology manufacturing.	9. Where do you see the EU having more credibility than China in its engagement with African nations? 10. In your view, what has held the EU back compared to China in terms of securing influence and access to resources in Africa? 11. Are there diplomatic or strategic openings the EU could leverage to rebalance the playing field? 12. How could China's dominance in mineral processing and technology supply chains undermine the EU's strategic position?
To assess how the EU might reduce its dependency on external suppliers through	13. What internal EU capacities (e.g., R&D, industry, policy instruments) can support supply chain resilience?

supply chain diversification, technological innovation and trade partnerships.	14. What structural bottlenecks limit the EU's ability to diversify its supply of critical raw materials (CRMs)? 15. What role can new technologies or international trade agreements play in reducing dependency? 16. Which external factors pose the greatest risk to securing stable and diversified supply chains?
To evaluate how the EU can strengthen its partnership with African nations in a way that ensures mutual benefit, supports Africa's development objectives and contributes to a just and inclusive global energy transition.	17. What are the strengths of the EU's current approach to cooperation with African partners? 18. Where does the EU risk falling short in aligning its agenda with Africa's development goals? 19. How can the EU and African states build partnerships that foster industrialisation, not just extraction? 20. What risks could jeopardise the creation of mutually beneficial relationships in the green transition?
To explore how Africa can leverage its resource wealth to promote industrialisation and sustainable growth, aligning national development goals with the broader demands of the global energy system.	21. What strengths can African nations leverage to promote green industrialisation? 22. What are the key weaknesses in current economic or governance frameworks that limit this potential? 23. What concrete opportunities exist for African states to move up the clean energy value chain? 24. How might geopolitical dynamics or global market shifts threaten Africa's ambitions for sustainable growth?

Chapter 6 – Results and Discussion

This chapter presents the results of the in-depth interview conducted with Pedro Miguel Ponte e Sousa, Lecturer in Politics and International Relations at the Department of Law, Portucalense University (UPT), and researcher at the Portuguese Institute of International Relations (IPRI). He is currently pursuing a PhD in Global Studies at NOVA University of Lisbon (NOVA FCSH), focusing on the relationship between globalization (and global governance) and foreign policy in Southern Europe (Portugal, Spain, Italy, and Greece). He holds a master's degree in History, International Relations and Cooperation from the University of Porto (FLUP), with a dissertation on the continuity and changes in Portuguese foreign policy since 1999, and a bachelor's degree in Languages and International Relations from the same institution. His scientific work spans political studies, comparative politics, international relations, and global studies, with particular interest in foreign and security policy, foreign policy analysis, diplomacy, political globalization, global governance, and the European Union. He has published more than twenty scientific articles and book chapters, presented his work at numerous national and international conferences, and is a regular foreign affairs analyst in the media, including Porto Canal, CNN Portugal, RTP3, Público, Expresso, Antena 1, and TSF.

Each table in this chapter corresponds to one interview question and the respective answer provided by the expert. As outlined in section 5.3.1, the questions are grouped into sets of four, with each set addressing one of the thesis' analytical objectives. For each answer, a brief analysis is provided to identify how the expert's perspective aligns or diverges from the academic literature discussed in earlier chapters.

First objective: To examine the extent to which the EU's renewable energy ambitions are constrained or enabled by geopolitical pressures, particularly concerning access to critical raw materials (CRMs).

Table 3 - Question 1

Question 1	Interviewee #1
What do you see as the EU's key strengths or comparative advantages in advancing its renewable energy goals on a global scale?	First, it has, up to this day, **strong regulatory and institutional capacities**, enabling the development of ambitious targets and robust climate governance mechanisms, such as the European Green Deal and the Fit for 55 package.
	Second, the EU leads in **technological innovation** in renewable energy, particularly in offshore wind, solar photovoltaics, and green hydrogen, supported by world-class research institutions.
	Additionally, the **scale of the EU's internal market** provides critical mass for investment, allowing for cost reductions.

The expert identifies three main strengths of the European Union in advancing its renewable energy goals: strong regulatory and institutional frameworks (e.g. the European Green Deal and Fit for 55), technological leadership in offshore wind, photovoltaics, and green hydrogen, and the large internal market, which enables cost reductions and attracts investment.

This view corresponds with sections 3.1, 3.2.2, and 4.1.2 of the thesis. The emphasis on institutional strength aligns with the argument that the EU's regulatory capacity enables long-term strategic planning and global standard-setting, as discussed in European Commission (2006, 2024) and Acheampong (2024). The reference to technological leadership reinforces the analysis of innovation potential in section 3.2.2 and reflects the EU's clean tech ambitions. The internal market's role in creating investment scale supports the thesis' use of the Brussels Effect to explain how EU regulations influence global practices.

Literature by Giuli & Oberthür (2023) further supports the claim that the EU integrates climate and energy policy effectively. Overall, the expert's perspective confirms the thesis argument that the EU's comparative advantage lies in institutional coherence, technological capacity, and regulatory influence.

Table 4 – Question 2

Question 2	Interviewee #1
Where do you identify internal vulnerabilities or structural weaknesses that could hinder the EU's green transition?	One major issue is the **asymmetry among Member States** in terms of economic capacity, infrastructure, and energy dependency, particularly between Western and Eastern Europe. This creates uneven implementation and political friction over the pace and cost of decarbonization.
	Additionally, the EU remains **reliant on imported critical raw materials** for renewable technologies, exposing it to external supply shocks. Local opposition to renewable energy infrastructure also delay progress.
	Moreover, the **rise of far-right and populist forces** across Europe threatens political consensus around climate policies, challenging the long-term stability of the green agenda.
	Finally, the **EU's lack of a consistent climate diplomacy** diminishes its role as a normative power, creating limitations for a just and sustainable energy transition amid increasing geopolitical pressures.

The expert identifies several structural weaknesses that could hinder the EU's green transition. First, significant asymmetries between Member States—in terms of economic capacity, infrastructure, and energy dependency—create uneven implementation and political friction over the pace and cost of decarbonisation. Second, the EU's continued reliance on imported critical raw materials exposes it to supply chain vulnerabilities. Local resistance to renewable energy infrastructure is also noted as a recurring obstacle to timely implementation. Additionally, the rise of far-right and populist forces across Europe threatens political consensus around climate policy, placing long-term stability of the green agenda at risk. Finally, the lack of a consistent climate diplomacy undermines the EU's credibility as a normative power and limits its ability to promote a just and sustainable energy transition.

These observations correspond with key arguments in sections 3.2.1, 3.3, and 4.1.2 of the thesis. The concerns about CRM dependency align with analyses by the IEA (2024), IRP (2020), and Deloitte (2024). The emphasis on institutional and political fragmentation supports the findings of Giuli & Oberthür (2023). Moreover, the critique regarding climate diplomacy directly echoes the thesis' conclusion on the EU's weakened external influence.

Overall, the response confirms that the EU's internal vulnerabilities—both structural and political—pose significant risks to the success and legitimacy of its green transition strategy.

Table 5 – Question 3

Question 3	Interviewee #1
Are there emerging geopolitical trends that could benefit the EU's clean energy strategy?	First, the rise of **critical-mineral diplomacy** —especially with resource-rich regions like Africa, Latin America, and Central Asia— allows the EU to diversify away from dominant suppliers.
	Second, **strategic energy partnerships** via Global Gateway and alliances with North African and Gulf states (e.g. Morocco, Tunisia, Egypt, and the GCC) enable investments in green hydrogen, solar, and wind infrastructure, enhancing both supply security and geopolitical influence.
	Third, the **push for pan-European interconnectivity** and supergrids, strengthens internal resilience and optimizes renewable sharing across borders.

The expert identifies three emerging geopolitical trends that could support the EU's clean energy strategy. First, the rise of critical mineral diplomacy offers opportunities to diversify supply chains by deepening partnerships with resource-rich regions such as Africa, Latin America, and Central Asia. Second, strategic energy alliances under the Global Gateway initiative and bilateral agreements with North African and Gulf states—including Morocco, Tunisia, Egypt, and the GCC—are enabling large-scale investments in green hydrogen, solar, and wind infrastructure, thus reinforcing both energy security and geopolitical leverage. Third, the growing emphasis on pan-European energy interconnectivity and supergrids is seen as a way to enhance internal resilience and facilitate cross-border renewable energy integration.

These insights align with several core arguments in the thesis, particularly in sections 3.2.2, 3.3, and 4.1.2. The diversification of critical raw material supply chains reflects the EU's strategy to reduce strategic dependencies discussed in Deloitte (2024) and IRP (2020). The role of infrastructure diplomacy under Global Gateway is directly linked to Acheampong (2024) and supports the EU's values-based model outlined in section 4.1.2. Finally, the

mention of supergrids corresponds with the EU's internal infrastructure goals discussed in 2.3.2, reinforcing the thesis' framing of resilience and strategic integration as key to the EU's global competitiveness.

Table 6 – Question 4

Question 4	Interviewee #1
In your opinion, what are the most significant geopolitical threats (e.g., supply disruptions, dependence on foreign actors) to the EU's energy security?	One of the most significant geopolitical threats to the EU's energy security is its ongoing **dependence on foreign actors** for critical raw materials and clean energy technologies, namely rare earths, solar panels, and batteries. This **creates structural vulnerabilities to supply disruptions and political coercion.**
	Additionally, the EU's increasingly confrontational stance toward Russia—intensified by the war in Ukraine and resulting in the severing of most fossil fuel ties—has forced a rapid and often costly diversification of energy sources. While necessary, this shift exposes the EU to **new dependencies**, including LNG imports from the U.S. and Gulf states, which come with their own geopolitical strings.
	At the same time, instability in regions targeted for renewable energy cooperation—such as North Africa and the Sahel—poses **risks to infrastructure and supply reliability.**
	These factors, combined with **fragmented external energy governance within the EU**, heighten the bloc's exposure to strategic shocks during its green transition.

The expert identifies the EU's continued reliance on foreign actors for critical raw materials and clean energy technologies as a major geopolitical threat. This includes dependence on rare earths, batteries, and solar panels, which exposes the Union to supply disruptions and external coercion. The shift away from Russian energy, accelerated by the war in Ukraine, has replaced one dependency with others—notably LNG imports from the U.S. and Gulf states. Instability in renewable energy partner regions, such as North Africa and the Sahel, further jeopardises long-term cooperation. Finally, fragmented external energy governance within the EU is viewed as a structural vulnerability.

These threats correspond directly to arguments developed in sections 3.3 and 3.2.1 of the thesis. The concern over foreign control of raw material supply chains is addressed through detailed data on CRM concentration and import dependencies, particularly regarding China, Russia, and the DRC. The thesis, drawing on IEA (2024) and IRP (2020), demonstrates how this dependency creates strategic exposure. The expert's point about new dependencies following the Russia crisis mirrors the analysis of shifting energy ties post-2022 in Giuli & Oberthür (2023). The identified governance fragmentation also aligns with the thesis' emphasis on the EU's lack of coherent external energy policy, which undermines its resilience. The reference to instability in North Africa connects to section 4.1.2, where geopolitical risks in CRM-producing regions are discussed in relation to infrastructure security and partnership credibility. Overall, the response reinforces the thesis' claim that energy security challenges are not only external but also embedded in the EU's institutional limitations and geopolitical repositioning.

Second objective: To analyse Africa's role in the global energy transition, both as a supplier of CRMs and as an emerging energy producer.

Table 7 – Question 5

Question 5	**Interviewee #1**
What strengths does the African continent offer in terms of renewable energy potential and critical raw material supply?	Africa offers substantial strengths in **both renewable energy potential and the supply of critical raw materials** essential for the global energy transition. The continent is endowed with some of the world's best solar exposure, vast untapped wind resources (particularly in North and East Africa), and abundant hydropower potential, positioning it as a **future powerhouse for clean energy production**, including green hydrogen.
	Additionally, Africa **is rich in critical minerals** such as cobalt (notably in the Democratic Republic of Congo), lithium, graphite, manganese, **and rare earth elements**—resources vital for batteries, solar panels, and wind turbines.

	These assets not only offer **opportunities for domestic industrialization and electrification** but also position Africa as a strategic partner for countries and blocs like the EU. Africa's resource wealth could be a **cornerstone for both its own development and the global decarbonization agenda**.

The expert highlights two main strengths of the African continent in the context of the global energy transition: its exceptional renewable energy potential and its abundance of critical raw materials. Africa is described as having some of the best solar irradiation in the world, significant wind resources in North and East Africa, and extensive hydropower capacity. Together, these assets create strong conditions for green hydrogen production and long-term clean energy development. On the resource side, the continent holds large reserves of key materials such as cobalt, lithium, graphite, manganese, and rare earth elements, all essential for battery production and renewable energy infrastructure.

These observations align directly with chapter 4 and section 4.1.1 of the thesis. The expert's focus on cobalt in the DRC reflects detailed analysis in Gulley (2022) and IRP (2020), which discuss both the scale and fragility of cobalt production. The emphasis on renewable potential corresponds with findings in IRENA (2023), which position Africa as an emerging clean energy hub, especially in solar and hydropower. The expert's reference to Africa's strategic relevance echoes the thesis argument that the continent is not only a supplier of raw materials but also a potential partner in industrial development and decarbonisation. This confirms the thesis' core claim that Africa's assets, if coupled with the right governance and investment structures, can support both continental development and the broader global energy transition.

Table 8 – Question 6

Question 6	Interviewee #1
What limitations—technical, institutional, or	Technically, many **nations lack the infrastructure for large-scale renewable energy deployment**, including grid capacity, energy storage, and interconnectivity, which limits integration and distribution.

financial—currently prevent African countries from fully benefiting from the global energy transition?	Institutionally**, weak governance, regulatory uncertainty, and limited technical expertise** can deter investment and slow project implementation.
	Foreign interference, political instability, and political coercion further complicate long-term planning and undermine public trust.
	Financially**, high perceived risks** lead to limited access to affordable capital, with many countries facing unfavourable lending terms, debt distress, or donor dependency.
	As a result, despite abundant resources, **Africa risks remaining a supplier of raw materials for foreign green industries rather than reaping broader socio-economic benefits from the energy transition.**

The expert highlights that African countries face technical, institutional, and financial constraints in advancing their role in the global energy transition. These include underdeveloped energy infrastructure, weak regulatory systems, political instability, limited technical capacity, and restricted access to affordable financing. As a result, Africa risks remaining a provider of raw materials without broader industrial or economic gains.

These observations are consistent with the analysis in sections 4.1 and 4.1.1. The lack of infrastructure, including grid interconnectivity and industrial processing facilities, is addressed in IRENA (2023), which outlines structural barriers to renewable deployment and midstream industrial development. The expert's reference to governance and institutional limitations reflects challenges described in Boafo & Arthur-Holmes (2025) and Gulley (2022), particularly regarding the DRC, where foreign firms control both extraction and processing. This limits the ability of national authorities to implement regulatory oversight or ensure domestic value creation.

Financial constraints, including high investment risk and dependency on external funding, are addressed in UNECA (2024). These dynamics reduce Africa's ability to attract long-term investment aligned with local development goals. The expert's assessment supports the thesis argument that without targeted reforms and regional industrial strategies, Africa's structural position in global value chains will remain peripheral.

Table 9 – Question 7

Question 7	Interviewee #1
What opportunities exist for Africa to move beyond resource extraction toward value creation and energy production?	**Investing in local renewable energy industries and fostering regional cooperation**. Yet, despite the abundant renewable resources and potential for value creation, Africa faces significant obstacles in moving beyond resource extraction toward energy production.
	One major challenge is the limited genuine interest from many Western states and multinational corporations, which often prioritize resource extraction over supporting local industrialization or energy autonomy, perpetuating neocolonial dynamics.
	Additionally, deep-seated difficulties in cooperation among African states—such as fragmented policies, competing national interests, and weak regional integration—hinder the development of coordinated energy markets and large-scale infrastructure projects.
	Financial constraints, governance issues, and technological dependence further exacerbate these problems.
	Consequently, without a fundamental shift in both external partnerships and internal political will, Africa risks remaining primarily a supplier of raw materials, missing out on the socio-economic benefits of the global energy transition.

The interviewee identifies opportunities for Africa to move beyond its traditional extractive role by developing local renewable energy industries and strengthening regional cooperation. However, these opportunities are constrained by persistent structural challenges. Western actors and multinational corporations often prioritise access to raw materials over long-term industrial development, reinforcing asymmetric partnerships and limiting African value addition. Internally, fragmented policy environments, weak institutional coordination, and regional rivalries impede the establishment of integrated energy markets and shared infrastructure. Financial risks, governance limitations, and technological dependence further hinder progress.

These points directly support arguments developed in sections 3.3, 4.1.1, and 4.1.2. As noted in UNECA (2024) and the IRP (2020), African countries receive significantly less investment in critical raw materials compared to countries like Australia and Canada, despite holding vast resource potential. Investors perceive Africa as a high-risk environment due to regulatory uncertainty and political instability, which deters funding for midstream and downstream industrialisation.

Moreover, as highlighted by Acheampong (2024), while the EU promotes ESG standards and transparency, its CRM partnerships often stop short of financing local manufacturing and refining stages. The interviewee's comments affirm the thesis conclusion that without more equitable investment models and stronger regional governance, Africa risks remaining trapped in extractive dependency.

Table 10 – Question 8

Question 8	Interviewee #1
What risks could arise if Africa remains primarily a resource supplier in the green economy?	Economically, the **continent could become trapped in a cycle of dependency and underdevelopment**, as profits and value-added activities are largely captured by foreign companies, **limiting job creation and industrial growth locally**.
	Politically, this may **exacerbate inequalities and fuel social unrest**, as communities see little benefit from resource extraction despite environmental and social costs.
	Environmentally, intensified mining and extraction activities could **lead to degradation, biodiversity loss, and water scarcity**, undermining long-term sustainability.
	Geopolitically, Africa's marginalization in global clean energy value chains might **weaken its bargaining power and deepen external dependencies**, perpetuating asymmetric relationships with major powers and constraining its ability to influence the trajectory of the global energy transition.

The expert warns that if Africa continues to act primarily as a supplier of raw materials in

the global green economy, the continent faces four key risks. Economically, it may remain stuck in a cycle of dependency, with profits and value-added activities captured externally, undermining job creation and industrial development. Politically, limited local benefits from extractive activities could intensify social unrest and inequality. Environmentally, the expansion of mining operations could lead to ecological degradation, including water scarcity and biodiversity loss. Geopolitically, Africa's marginal role in clean energy value chains risks reinforcing dependency and limiting the continent's influence in global energy governance.

These concerns are strongly reflected in sections 4.1 and 4.1.2. The thesis outlines how African countries risk reproducing historical extractivist patterns unless industrial diversification and regional value creation are prioritised. As discussed in IRP (2020) and Boafo & Arthur-Holmes (2025), intensified mining — particularly in countries like the DRC — often causes environmental degradation and socio-economic instability. Neema (2024) and Nantulya (2025) further highlight how China's vertically integrated supply chains in Africa marginalise local agency and restrict industrial upgrading. The interview thus reinforces the thesis' argument that Africa's structural exclusion from value-added processes poses long-term risks for development, sovereignty, and sustainability.

Third objective: To investigate the strategic rivalry between the EU and China in Africa, and the implications of China's dominance in resource extraction and clean technology manufacturing.

Table 11 – Question 9

Question 9	Interviewee #1
Where do you see the EU having more credibility than China in	The EU is somewhat **focused on promoting governance standards, human rights, and sustainable development frameworks**, at least rhetorically. Its engagement often emphasizes **transparency, environmental protections, and conditionality tied to democratic reforms**, which can appeal to segments of African civil society and international observers.

its engagement with African nations?	However, this credibility is limited by the EU's inconsistent application of these principles and its own history of neocolonial economic practices and unequal partnerships.
	Moreover, the EU's slower, smaller-scale investments make it less visible and sometimes less effective on the ground compared to China's rapid infrastructure projects.
	Therefore, while the EU may try to claim some normative superiority in certain areas, this does not always translate into stronger influence or trust among many African governments focused primarily on tangible development outcomes.

In the interview, the expert noted that the EU is perceived to have greater credibility than China in some areas of its engagement with African countries, particularly due to its rhetorical emphasis on governance standards, environmental protections, human rights, and transparency. However, the expert also pointed out that this normative credibility is undermined by inconsistent application of these principles and the EU's limited visibility compared to China's rapid infrastructure development.

In section 4.1.2, Acheampong (2024) presents the EU as promoting Environmental, Social, and Governance (ESG) standards and human rights, which aligns with the expert's view. The authors agree that this values-based approach may be more appealing to African civil society actors and international observers. However, they also acknowledge the EU's operational limitations, including smaller-scale investments and vague commitments in CRM cooperation, which limit its impact—consistent with the expert's critique.

Nonetheless, the thesis findings also portray a more critical picture of China. In section 4.1.1, China's engagement is described as reinforcing extractive structures, limiting African agency, and promoting bilateral deals with little transparency (Neema, 2024; Nantulya, 2025). These political and structural issues—absent from the expert's comparison—suggest that while the EU's credibility may be imperfect, China's approach is equally, if not more, problematic in terms of long-term developmental impact.

Table 12 – Question 10

Question 10	Interviewee #1
In your view, what has held the EU back compared to China in terms of securing influence and access to resources in Africa?	The EU suffers from **fragmentation** among its member states, leading to inconsistent policies and diluted diplomatic efforts, whereas China operates with a centralized and coherent strategy.
	The EU's historical ties to Africa are burdened by a legacy of colonialism and unequal economic relations, which breed distrust, while China's narrative of non-interference and South-South cooperation appeals politically to many African leaders.
	Finally**, funding constraints** limit the scale and **speed** of EU investments, reducing its ability to compete with China's often larger, more flexible financial commitments.

The expert highlights three reasons for the EU's comparative weakness in Africa: institutional fragmentation, historical colonial distrust, and limited financial capacity. In contrast, China is presented as a strategically coherent actor offering rapid, visible investments and a narrative of non-interference.

The first point aligns with the thesis. In section 4.1.2, Acheampong (2024) discusses how internal fragmentation, diverging national priorities, and overlapping mandates constrain the EU's ability to engage Africa strategically. This confirms the expert's claim.

The second point — that the EU's colonial legacy undermines trust — is not addressed in the thesis. The focus remains on current institutional and economic dynamics, without analysing historical perceptions or legitimacy.

The third point — that the EU lacks financial capacity — is directly contradicted. Chapter 4 (European Commission, 2023; IRENA, 2023) affirms that the EU has the largest climate and energy funding capacity globally. The problem is identified instead as slow disbursement, administrative burdens, and restrictive conditionality.

Finally, the thesis offers a critical analysis of China's model. Section 4.1.1 (Neema, 2024; Boafo & Arthur-Holmes, 2025) portrays China's bilateral approach as weakening African

agency and transparency, in contrast to AU frameworks like Agenda 2063 and NEPAD. While the expert stresses China's strengths, the thesis underlines the risks and dependencies this approach creates.

Table 13 – Question 11

Question 11	Interviewee #1
Are there diplomatic or strategic openings the EU could leverage to rebalance the playing field?	One opportunity lies in **deepening genuine partnerships based on mutual benefit and respect**, moving beyond conditionality towards co-designed development initiatives that address African priorities like energy access, industrialization, and climate resilience.
	Strengthening support for regional integration efforts could also help create larger, more cohesive markets attractive for sustainable investment.
	The EU might capitalize on growing global concerns about debt sustainability and social impacts of China's projects by positioning itself as a partner **promoting transparent, accountable financing and environmental safeguards**.
	However, the EU must overcome internal fragmentation and bureaucratic inertia to present a unified, agile front capable of competing effectively with China's streamlined diplomacy.

The expert suggests that the EU could rebalance its position in Africa by fostering co-designed development partnerships, supporting regional integration, and presenting itself as a more transparent alternative to China's debt-heavy model. However, success depends on overcoming internal fragmentation and slow bureaucratic procedures.

These views are largely supported in the thesis. In section 4.1.2, based on Acheampong (2024), the EU is encouraged to prioritise value creation, African industrialisation, and infrastructure investments aligned with regional strategies such as the Lobito Corridor. The need to strengthen regional cooperation and develop cohesive energy markets is also emphasised. Section 4.1.1 supports the expert's implicit critique of China, using Neema (2024) and Boafo & Arthur-Holmes (2025) to expose the negative impacts of China's opaque, bilateral lending practices. The thesis suggests the EU can offer an alternative model,

grounded in transparency and African frameworks like Agenda 2063, though this is framed more in normative than geopolitical terms.

Finally, the expert's remark on EU bureaucratic delays and fragmentation is directly reflected in the thesis. Section 4.1.2 identifies institutional overlap and lack of strategic coherence as critical barriers to effective EU action.

Table 14 – Question 12

Question 12	Interviewee #1
How could China's dominance in mineral processing and technology supply chains undermine the EU's strategic position?	China's dominant position in mineral processing and clean technology supply chains has accelerated the global energy transition by scaling up production and driving down costs for critical components like batteries, solar panels, and electric vehicles.
	This scale and efficiency have made renewable technologies more accessible worldwide, including for the EU, which benefits from competitive prices and the availability of key materials that might otherwise be scarce or more expensive.
	Moreover, China's investments in infrastructure and manufacturing capacity have contributed to the rapid diffusion of green technologies, indirectly supporting EU climate goals.
	China is an essential global supplier and partner in the shared challenge of decarbonization
	For the EU, the pragmatic approach could be to engage constructively with China to improve supply chain transparency, environmental standards, and fair-trade practices, leveraging interdependence rather than seeking complete decoupling.
	For decades, the EU largely **neglected the development of a coherent and robust industrial policy focused on strategic autonomy in critical sectors**, relying instead on globalized supply chains and market liberalization. It was only when the EU escalated geopolitical tensions with

	Russia and China and began framing these countries as threats that it rushed to assert its industrial sovereignty
	This reactive approach, driven more by political rivalry than by a clear-eyed assessment of economic and technological dependencies, means the bloc is now playing catch-up—facing **structural weaknesses** that could have been addressed much earlier.
	A more proactive, principle-driven industrial strategy, grounded in sustainability and resilience rather than confrontation, might have better served Europe's long-term interests and reduced its current vulnerabilities.

The expert argues that China's dominance in mineral processing and green tech has helped scale up renewable deployment and lower global costs, indirectly supporting EU climate objectives. However, the EU's failure to develop an industrial policy earlier—combined with a reactive turn toward sovereignty following geopolitical tensions—has left it playing catch-up. The expert suggests that instead of decoupling, the EU should engage China to promote higher standards and fair practices.

The thesis confirms several elements of this view. In section 3.4, the EU's historical over-reliance on external suppliers and market liberalism is addressed (Deloitte, 2024), with Germany highlighted as a case study of under-diversified trade in batteries and solar components. In section 4.1.1, authors such as Neema (2024) and Boafo & Arthur-Holmes (2025) emphasise China's central role in mineral processing and technology supply chains, though they focus more on the risks and asymmetries than on benefits.

The expert's proposal for constructive engagement does not appear in the thesis, which instead discusses China as a strategic rival (section 3.3) and focuses on Europe's need to secure alternative supply chains and reduce dependencies. Similarly, the critique of the EU's current approach as overly politicised is not reflected in the thesis, which frames current initiatives like the Net-Zero Industry Act and Green Deal Industrial Plan as necessary structural responses to a changing geopolitical environment.

Fifth objective: To evaluate how the EU can strengthen its partnership with African nations in a way that ensures mutual benefit, supports Africa's development objectives and contributes to a just and inclusive global energy transition.

Table 15 – Questions 17 – 20

	Question	Interviewee #1
17	What are the strengths of the EU's current approach to cooperation with African partners?	• governance standards, human rights, and sustainable development frameworks • transparency, environmental protections, and conditionality tied to democratic reforms • normative superiority
18	Where does the EU risk falling short in aligning its agenda with Africa's development goals?	• inconsistent application of principles • slow, small-scale investments • prioritize resource extraction over industrialisation"
19	How can the EU and African states build partnerships that foster industrialisation, not just extraction?	• co-designed development initiatives • energy access, industrialization, and climate resilience • regional integration efforts
20	What risks could jeopardise the creation of mutually beneficial relationships in the green transition?	• resource extraction despite environmental and social costs • limited benefit for local communities • foreign green industries rather than reaping broader benefits

The expert indicated that these four questions had already been addressed in previous answers, specifically in relation to EU–Africa partnerships, industrialisation, and the risks of extractive models. His earlier statements emphasized the EU's rhetorical strengths—such as its commitment to governance, transparency, and environmental safeguards—which can bolster its credibility among civil society actors and international observers. This assessment

aligns with the thesis (section 4.1.2), where the EU's values-based approach is articulated through frameworks like the African Mining Vision, Agenda 2063, and initiatives such as the Global Gateway (Acheampong, 2024). However, the expert also pointed out that the EU's slow, fragmented, and conditional engagement falls short of Africa's stated development goals, particularly regarding energy access and industrialisation. These concerns are shared by Boafo & Arthur-Holmes (2025), Neema (2024), and UNECA (2024), who argue that African actors seek co-designed partnerships that enable value addition and long-term socio-economic transformation. The thesis similarly advocates for regional integration and projects like the Lobito Corridor, suggesting that cooperation should prioritise shared benefits over extraction. The expert's warning—that failure to move beyond extractive dynamics could entrench dependency, fuel inequality, and marginalise Africa geopolitically – is also supported by Gulley (2022) and the thesis analysis in chapter 4 and section 4.1. These implications reinforce the necessity of recalibrating EU engagement to prevent the reproduction of structural asymmetries in the green transition.

Questions 13 to 16 and 21 to 24 were chosen not to be answered by the expert (fourth and sixth objective).

Chapter 7 - Conclusion

7.1 Main findings

Considering the first objective, which examines the extent to which the EU's renewable energy ambitions are constrained or enabled by geopolitical pressures, the findings highlight both enabling conditions and structural limitations. The EU's regulatory strength, exemplified by instruments like the Green Deal, its leadership in renewable technologies, and the size of its internal market represent key strengths. However, internal asymmetries between Member States, political fragmentation, and a lack of consistent climate diplomacy weaken its coherence and responsiveness. At the geopolitical level, continued dependencies on critical raw material imports expose the EU to external shocks, while opportunities lie in new supply chain partnerships and infrastructure integration. Both the expert and the thesis underscore these dynamics, identifying structural vulnerabilities and areas for strategic diversification.

Regarding the second objective, Africa's role in the global energy transition is marked by significant potential and systemic constraints. The continent's strengths include abundant solar, wind, and hydropower resources, as well as rich deposits of critical raw materials like cobalt, lithium, and rare earths. Nevertheless, inadequate infrastructure, governance deficits, and restricted access to capital continue to hinder large-scale energy deployment and domestic value creation. Opportunities exist in fostering regional integration and industrial development, yet the persistent threat is that Africa may remain locked in extractive roles. These conclusions are strongly supported by both the expert responses and the thesis analysis, including a detailed case study on the Democratic Republic of Congo.

Concerning the third objective, which investigates the EU–China rivalry in Africa and the implications of China's dominance in clean energy supply chains, the thesis and expert views largely converge. China's coherent state-led strategy, rapid project delivery, and large-scale funding have given it a comparative advantage, while the EU suffers from internal fragmentation and slower implementation. However, the thesis also emphasizes the environmental, social, and geopolitical risks associated with Chinese practices—such as conditionality and limited transparency—which the expert does not stress as strongly. While

the EU lacks speed, it may leverage its normative frameworks and values-based initiatives, such as Global Gateway and ESG standards, to build more sustainable long-term partnerships.

Relating to the fifth objective, the evaluation of how the EU can strengthen its partnership with African nations reveals both potential and limitations. The expert and thesis both emphasize that equitable cooperation must be based on mutual priorities, including energy access, industrialisation, and climate resilience. The EU's promotion of governance standards and transparency offers a potential comparative advantage, but its inconsistent application and limited presence on the ground weaken credibility. The thesis further argues that partnerships must go beyond extractivism and align with frameworks such as the African Mining Vision to ensure long-term developmental gains.

In terms of EU Supply Chain Diversification and Innovation (Objective 4), the main conclusions indicate that while the EU has made progress in identifying strategic dependencies and outlining policy responses—such as the Net-Zero Industry Act and CRM Act—its efforts remain largely reactive. The thesis identifies as strengths the EU's capacity to regulate, invest, and coordinate initiatives like the Green Deal Industrial Plan. However, weaknesses persist in industrial policy coherence, particularly in scaling domestic production and processing of critical materials. Opportunities lie in fostering innovation in battery technologies and circular practices, while strategic threats include intensified global competition, particularly from China, and underdeveloped mining and refining capacity within Europe.

Industrialisation and sustainable growth in Africa (Objective 6) remain hindered by structural constraints across governance, infrastructure, and financing. The thesis highlights Africa's strong resource base and renewable energy potential as foundational strengths. However, weaknesses include fragmented regulatory frameworks, limited cross-border cooperation, and the absence of robust local industrial ecosystems. Opportunities are identified in the development of regional value chains, ESG-compliant investment frameworks, and transcontinental corridors like the Lobito Corridor. Key threats involve Africa remaining locked in a raw material export role, environmental degradation from unregulated extraction, and continued marginalisation in global value chains dominated by external actors.

Overall, the findings reaffirm the continued relevance of the adapted energy trilemma as an analytical framework for understanding the EU's position in the global energy transition. On environmental sustainability, the EU's ambitious regulatory frameworks and leadership in renewable energy technologies stand out as key enablers, though they remain constrained by external dependencies on critical raw materials and the environmental risks embedded in global supply chains. Regarding energy security, persistent import reliance, infrastructure gaps in both Europe and Africa, and the dominance of external actors in resource processing underscore vulnerabilities that require targeted diversification and investment strategies. Finally, in terms of economic competitiveness, the EU's regulatory capacity, internal market scale, and potential for innovation represent strategic strengths, yet fragmented industrial policies and slower implementation rates hinder its ability to compete with state-driven rivals such as China. These interlinked challenges and opportunities highlight the need for integrated policy responses that address all three pillars of the trilemma simultaneously, ensuring that progress in one dimension does not come at the expense of another.

7.2 Recommendations

Building on the findings of this thesis, several recommendations are essential to strengthen the EU's position in the global energy transition and ensure that cooperation with African partners delivers genuine mutual benefit.

Firstly, the EU must urgently address internal fragmentation that weakens its capacity to act decisively on the green transition. Political rivalries, diverging national priorities, and bureaucratic inertia slow implementation and dilute the impact of strategic initiatives. The decision-making process needs to be streamlined, cutting down excessive administrative burdens and enabling faster mobilisation of funds for strategic projects.

Second, the EU must establish mechanisms that protect long-term climate and energy transition policies from political reversals, particularly in the event of far-right or populist electoral victories. Once adopted, key frameworks should be shielded from dismantling, ensuring continuity and credibility in the EU's commitment to decarbonisation.

Third, the EU needs to end its inconsistent strategic action on critical raw materials. Reliance on third-country processing – particularly in China – has left Europe exposed to the risk of targeted export restrictions and political coercion. While the Critical Raw Materials Act's 65% diversification rule by 2030 is an important safeguard, it should not be applied in a way that penalises imports from trusted and politically aligned partners where alternative sourcing options are either limited or strategically disadvantageous. Instead, the EU should rapidly expand domestic and allied processing capacity, establish strategic reserves, and hardwire intelligent, flexible diversification into its trade and investment strategies.

Fourth, the EU must reinforce its global position through credible, values-driven engagement – backed by tangible action, not just rhetoric. At a time when U.S. policy can be dismissive toward Europe, the EU must demonstrate its strength and autonomy as the world's largest integrated economic bloc. This includes delivering on its commitments to Africa by supporting industrialisation, technology transfer, and fair trade, setting itself apart from competitors whose engagement undermines governance and environmental standards.

Finally, anticipating the weaponisation of critical resources, the EU must integrate resilience planning across its supply chains. This means scenario-based stress testing, diversifying logistics routes, and forging binding strategic partnerships that lock in supply security. These safeguards are essential to protect both the EU's economic competitiveness and the stability of its green transition.

7.3 Limitations

The scope of this thesis was deliberately Europe-centred, reflecting its primary objective of examining the EU's strategic position within the global energy transition. This framing necessarily shapes the perspective of the analysis and, while African agency is addressed, the body of literature consulted contains a greater share of Western academic and policy sources. This imbalance is partly due to the distribution of available publications in the field, and it limits the extent to which African-led academic, institutional, and civil society perspectives could be incorporated.

Empirical evidence was based on a single expert interview, selected for its direct relevance and depth of expertise. While this provided a focused and analytically rich integration of qualitative insights, it also constitutes a limitation, as the findings inevitably reflect the perspective of one individual. A broader set of interviews, particularly with African policymakers, regional organisations, and industry stakeholders, would have enabled greater triangulation and a more diversified range of viewpoints.

In terms of data, the research integrates authoritative sources such as the IEA and IRENA to analyse CRM import flows, trade dependencies, and resource reserves. However, no original quantitative modelling or independent calculations of trade flows were conducted. As a result, the quantitative dimension complements but does not independently generate findings; the analysis remains primarily qualitative.

Finally, the conclusions reflect the geopolitical and economic conditions prevailing at the time of writing. The global energy transition is characterised by rapid developments, including new trade agreements, evolving industrial strategies, and shifting geopolitical alignments. These changes—particularly in the wake of the war in Ukraine and ongoing US–China tensions—are likely to influence the dynamics analysed in this thesis and may require future updates to maintain analytical relevance.

7.4 Future research

Building on these limitations, there are multiple directions in which future research could develop. Expanding the empirical base through additional interviews—particularly with representatives from African governments, regional organisations, and local industries—would allow for a more balanced and multi-layered understanding of Africa's role in the global energy transition. Integrating a greater proportion of African-led academic and policy perspectives would further strengthen the analysis of equitable partnerships and local agency.

From a data perspective, future work could incorporate more extensive quantitative methods, such as independent modelling of CRM trade flows, scenario analysis, or the use of datasets like UN Comtrade. Such approaches would allow for a more detailed evaluation of economic vulnerabilities, diversification strategies, and supply chain resilience. Combining

these methods with qualitative assessments could generate a richer, mixed-methods perspective on the geopolitical and economic dimensions of the transition.

Given the fast-evolving global context, continued research over time could track how EU–Africa–China relations adapt to changes in industrial policy, trade regulations, and market dynamics. Monitoring developments such as new trade agreements, regional infrastructure projects, and policy shifts in both the EU and African partner states would ensure that analysis remains relevant and reflects current realities.

Future research could place greater emphasis on the intersection between political and economic factors. Examining how political rivalries, shifting alliances, and domestic policy changes—such as the rise of governments with differing views on climate or trade—affect long-term strategies could help in designing frameworks resilient to policy reversals. This would also support the development of safeguards ensuring that commitments made under current sustainability and partnership frameworks are upheld over time, even amid changing political landscapes.

References

Acheampong, T. (2024). *From mines to markets: How Africa and Europe can become green industry partners of choice*. European Council on Foreign Relations. Retrieved 18.07.25, from https://ecfr.eu/publication/from-mines-to-markets-how-africa-and-europe-can-become-green-industry-partners-of-choice/

Adolfsen, J. F., Kuik, F., Schuler, T., & Lis, E. (2022). *The impact of the war in Ukraine on euro area energy markets*. European Central Bank. https://www.ecb.europa.eu/press/economic-bulletin/focus/2022/html/ecb.ebbox202204_01~68ef3c3dc6.en.html

Africa Center for Strategic Studies (2025). *Africa's Critical Minerals at a Critical Juncture*. Africa Center For Strategic Studies. Retrieved 27.06.25, from https://africacenter.org/spotlight/africas-critical-minerals-at-a-critical-juncture/

African Union (2015). Agenda 2063: The Africa we want. https://au.int/sites/default/files/documents/36204-doc-agenda2063_popular_version_en.pdf

Andrew L. Gulley (2022). One hundred years of cobalt production in the Democratic Republic of the Congo. Resources Policy, Volume 79. https://doi.org/10.1016/j.resourpol.2022.103007

Beuter, P., Hofmeyr, J., Gabadadze, L., Bhuee, R., Gnanguênon, A. (2025). Mapping Africa's Green Mineral Partnerships. Geopolitics & Geoeconomics. APRI. https://doi.org/10.59184/rp025.01

Boafo, J., Arthur-Holmes, F. (2025). Sustainability transition paradox: Emerging dimensions of illegal artisanal and small-scale mining of critical minerals in Africa. Resources Policy, Volume 108. https://doi.org/10.1016/j.resourpol.2025.105673.

Braw, E. (2024). *Germany is hardening its supply chains against Chinese control*. Foreign Policy. Retrieved 07.04.25, from https://foreignpolicy.com/2024/10/10/germany-china-supply-chains-de-risking-globalization/

Burton, M. (2024*). US on track to establish domestic rare earths supply chain for defence, official says*. Reuters. Retrieved 07.04.25, from https://www.reuters.com/markets/commodities/us-track-establish-domestic-rare-earths-supply-chain-defence-official-says-2024-05-22/

Cherp A, Jewell J. (2011). The three perspectives on energy security: intellectual history, disciplinary roots and the potential for integration. Current Opinion in Environmental Sustainability. DOI:10.1016/j.cosust.2011.07.001

Copper, J. F. (2016). China's Foreign Aid and Investment Diplomacy, Volume III

Covi, G. (2015). Puzzling Out The First Oil Shock: History, Politics and the Macroeconomy in a Forty-Year Retrospective. History of Economic Thought and Policy. DOI:10.3280/SPE2015-002004.

Deloitte (2024). *Wie abhängig ist Deutschland von kritischen Rohstoffen? Trends, Risiken und Alternativen*. Retrieved 27.03.25, from https://www.deloitte.com/content/dam/assets-zone2/de/de/docs/industries/energy-resources-industrials/2024/Supply_Chain_Pulse_Check_Vertiefungsanalyse_2024_Deloitte_DE.pdf

Easterly, W., & Levine, R. (1995). Africa's Growth Tragedy: A Retrospective, 1960-89. Policies and Ethnic Divisions. *The Quarterly Journal of Economics*, *112*(4), 1203–1250. http://www.jstor.org/stable/2951270

European Commission (2006). *Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Al27062

European Commission (2019). *The European Green Deal. https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF*

European Commission (2023). *Communication on the revision of the Strategic Energy Technology (SET) Plan. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0634&qid=1698315020718*

European Commission (2023-a). *A Green Deal Industrial Plan for the Net-Zero Age. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52023DC0062*

European Commission (2024). *Recovery and Resilience Facility*. Retrieved 14.07.25, from https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility_en

European Commission (2025). EU-Africa flagship projects. Global Gateway. https://international-partnerships.ec.europa.eu/document/download/ed505ccf-18ef-4fe9-816b-587d28f10633_en?filename=infographics-global-gateway-flagship-projects-2025-eu-africa_en.pdf

European Parliament & Council of the European Union (2024). *Regulation (EU) 2024/1735 of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724. Official Journal of the European Union*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32024R1735

European Parliament & Council of the European Union (2024a). *Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020. Official Journal of the European Union*. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202401252

European Union (n.d.-a). History of the European Union 1945-59. *European Union.* Retrieved 24.11.24, from https://european-union.europa.eu/principles-countries-history/history-eu/1945-59_en

European Union (n.d.-b). History of the European Union 1970-79. *European Union*. Retrieved 24.11.24, from https://european-union.europa.eu/principles-countries-history/history-eu/1970-79_en

European Union (n.d.-c). History of the European Union 1980-89. *European Union*. Retrieved 24.11.24, from https://european-union.europa.eu/principles-countries-history/history-eu/1980-89_en

European Union (n.d.-d). History of the European Union 1990-1999. *European Union*. Retrieved 27.11.24, from https://european-union.europa.eu/principles-countries-history/history-eu/1990-99_en

Giuli, M., & Oberthür, S. (2023). *Third time lucky? Reconciling EU climate and external energy policy during energy security crises*. *Journal of European Integration*, 45(3), 395–412. https://doi.org/10.1080/07036337.2023.2190588

Gracceva F, Zeniewski P. (2014). A systemic approach to assessing energy security in a low-carbon EU energy system. Applied Energy, Volume 123, Pages 335-348. https://doi.org/10.1016/j.apenergy.2013.12.018.

Hart, R. (2018). Rebound, directed technological change, and aggregate demand for energy, Journal of Environmental Economics and Management, Volume 89, Pages 218-234. https://doi.org/10.1016/j.jeem.2018.03.002.

Helleiner, G. K. (1970). Development policies for Africa in the 1970s. *Canadian Journal of African Studies / Revue Canadienne des Études Africaines, 4*(3), 285–303. https://www.jstor.org/stable/484063

Hey, C. (2005). EU environmental policies: a short history of the policy strategies. Environmental Science, Political Science. https://www.semanticscholar.org/paper/EU-Environmental-Policies-%3A-A-short-history-of-the-Hey/445ef8210932ca2b848b8d8b0d46072b592d97ae
https://www.defense.gov/News/News-Stories/Article/Article/3700059/dod-looks-to-establish-mine-to-magnet-supply-chain-for-rare-earth-materials/

IEA (2004). Oil Crises & Climate Challenges: 30 years of Energy Use in IEA Countries. https://iea.blob.core.windows.net/assets/9049fd65-2d4d-4b94-acd0-9e978c9ffcfd/OilCrisesandClimateChallenges30YearsofEnergyUseinIEACountries.pdf

IEA (2021). Net Zero by 2050: A Roadmap for the Global Energy Sector. https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

IEA (2022). Energy Fact Sheet: Why does Russian oil and gas matter? Retrieved, from https://www.iea.org/articles/energy-fact-sheet-why-does-russian-oil-and-gas-matter License: CC BY 4.0

IEA (2023). Overcoming the Energy Trilemma: Secure and Inclusive Transitions. IEA report to G7 leaders. https://iea.blob.core.windows.net/assets/29875a66-aebe-49aa-a2b1-d0824db302c2/OvercomingtheEnergyTrilemma_SecureandInclusiveTransitions.pdf

IEA (2024). Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach 2023 Update. https://iea.blob.core.windows.net/assets/8ad619b9-17aa-473d-8a2f-4b90846f5c19/NetZeroRoadmap_AGlobalPathwaytoKeepthe1.5CGoalinReach-2023Update.pdf

Innocenti, A., Beringer, S., & Passerini, S. (2024). Cost and performance analysis as a valuable tool for battery material research. *Journal of Energy Storage*. https://doi.org/10.1038/s41578-024-00657-2

IPCC (1992) Climate Change: The IPCC 1990 and 1992 Assessments. https://www.ipcc.ch/site/assets/uploads/2018/05/ipcc_90_92_assessments_far_full_report.pdf

IPCC (2022). *The evidence is clear: the time for action is now. We can halve emissions by 2030*. Retrieved 03.03.25, from https://www.ipcc.ch/2022/04/04/ipcc-ar6-wgiii-pressrelease/

IRENA (2023), Geopolitics of the energy transition: Critical materials, International Renewable Energy Agency, Abu Dhabi. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Jul/IRENA_Geopolitics_energy_transition_critical_materials_2023.pdf

IRP (2020). Mineral resource governance in the 21st century: Gearing extractive industries towards sustainable development. United Nations Environment Programme. https://www.researchgate.net/publication/342153969_Mineral_Resource_Governance_in_the_21st_Century_Gearing_extractive_industries_towards_sustainable_development

KfW (2024). *KfW establishes raw materials fund*. KfW. Retrieved 23.05.25, from https://www.kfw.de/About-KfW/Newsroom/Latest-News/Pressemitteilungen-Details_824192.html

Meadows, D. H., Meadows, D. L., Randers, J., Behrens III, W. W (1972). https://collections.dartmouth.edu/ebooks/meadows-limits-1972.html?_gl=1*19pchs8*_ga*MTEzOTI0MTExMS4xNzU3Njg5OTk3*_ga_X6T5RM37EZ*czE3NTc2ODk5OTckbzEkZzAkdDE3NTc2OTAwMDYkajUxJGwwJGgw#epubcfi(/6/2[front_cover]!/4/1:0)

McKinsey (2024). Global Energy Perspective 2024. Retrieved 30.05.25, from https://www.mckinsey.com/industries/energy-and-materials/our-insights/global-energy-perspective

Nantulya, P. (2023). *Africa's Interests in Strengthening the United Nations System.* Africa Center For Strategic Studies. Retrieved 27.06.25, from https://africacenter.org/spotlight/africa-interests-strengthening-united-nations-system/

Nantulya, P. (2025). *What to Expect from Africa-China Relations in 2025.* Africa Center For Strategic Studies. Retrieved 27.06.25, from https://africacenter.org/spotlight/africa-china-relations-2025/

NASA (2024). *Global Surface Temperature*. Climate Change: Vital Signs of the Planet. Retrieved 17.04.25, from https://climate.nasa.gov/vital-signs/global-temperature/?intent=121

Neema, C. G. (2024). *What FOCAC 2024 Reveals About the Future of China-Africa Relations.* Carnegie Endowment for International Peace. Retrieved 05.07.25, from https://carnegieendowment.org/research/2024/11/what-focac-2024-reveals-about-the-future-of-china-africa-relations?lang=en

Nepad (2018). *Strategic Priorities*. Retrieved 06.06.25, from https://www.nepad.org/strategic-priorities

Statista (2025). *Reserves of rare earths worldwide from 2010 to 2024.* Retrieved 20.05.25, from https://www.statista.com/statistics/271874/rare-earths-global-reserves/

Statista (2025a). *Reserves of rare earths worldwide as of 2024, by country.* Retrieved 20.05.25, from https://www.statista.com/statistics/277268/rare-earth-reserves-by-country/

Statista (2025b). *Mine production of rare earths worldwide in 2024, by leading country.* Retrieved 20.05.25, from https://www.statista.com/statistics/268011/top-countries-in-rare-earth-mine-production/

Statistisches Bundesamt (2025). *Ein Großteil der importierten Seltenen Erden kamen 2024 aus China.* Retrieved 20.05.25, from

https://www.destatis.de/DE/Presse/Pressemitteilungen/2025/04/PD25_N019_51.html?templateQueryString=seltene+erden+

U.S. Department of Defense (2024). *DOD looks to establish 'mine-to-magnet' supply chain for rare earth materials*. Retrieved 15.04.25, from https://www.defense.gov/News/News-Stories/Article/Article/3700059/dod-looks-to-establish-mine-to-magnet-supply-chain-for-rare-earth-materials/

UN Security Council (2002). Final report of the Panel of Experts on the Illegal Exploitation of Natural Resources and Other Forms of Wealth of the Democratic Republic of the Congo. https://www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/DRC%20S%202002%201146.pdf

UNECA (2024). *Africa's critical mineral resources, a boon for intra-African trade and regional integration*. Retrieved 06.06.25, from https://www.uneca.org/stories/africa%E2%80%99s-critical-mineral-resources%2C-a-boon-for-intra-african-trade-and-regional-integration

UNFCCC (2012). *Doha Amendment to the Kyoto Protocol*. United Nations Framework Convention on Climate Change. https://unfccc.int/files/kyoto_protocol/application/pdf/kp_doha_amendment_english.pdf

Walsh, N. P. (2004). Russian vote saves Kyoto protocol. *The Guardian*. https://www.theguardian.com/world/2004/oct/23/society.russia

World Energy Council (2013). World Energy Scenarios: Composing energy futures to 2050. https://www.worldenergy.org/assets/downloads/World-Energy-Scenarios_Composing-energy-futures-to-2050_Full-report1.pdf

World Energy Council (2023). *Our History*. Retrieved 01.09.25, from https://www.worldenergy.org/centenary/our-history

World Energy Council (2024). World Energy Trilemma Index 2024: Evolving with Resilience and Justice. "Used by permission of the World Energy Council." https://www.worldenergy.org/assets/downloads/2024_World_Energy_Trilemma_Full_Report_FINAL.pdf?v=1741883446