

Greenflation and the Global Energy Transition
Analyzing the Inflationary Pressures of Critical Minerals Demand

Balouz Mohamed

University of Relizane (Algeria), mohamed.balouz@univ-relizane.dz

 ORCID:<https://orcid.org/0009-0000-7453-3836>

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Abstract: This study examines the inflationary impacts of the global energy transition driven by rising demand for critical minerals like lithium, cobalt, and rare earth elements. As economies shift to low-carbon technologies such as EV batteries, wind turbines, and solar panels, supply chain constraints, geopolitical tensions, and underinvestment in mining have fueled "greenflation." Using a mixed-methods approach, this research assesses how mineral price volatility affects renewable energy markets and broader economic stability. Furthermore, the study highlights policy responses, including recycling, supply diversification, and sustainable mining technologies, as potential solutions to mitigate inflationary pressures. The findings suggest that without intervention, greenflation may hinder decarbonization efforts and economic sustainability. However, strategic investments and regulatory frameworks can help stabilize critical mineral markets, ensuring a balanced transition to clean energy.

Keywords: Greenflation, Energy Transition, Critical Minerals, Inflationary Pressures, Supply Chain Disruptions.

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Corresponding author: Balouz Mohamed, mohamed.balouz@univ-relizane.dz

1. Introduction

Due to the rapid changes in the climate, the energy transition around the world has relied heavily on minerals like lithium, cobalt, and rare earth elements, which are in high demand. The fossil fuel industry has renewed and, yet, made it essential for new technologies such as electric vehicles batteries, wind turbines, and solar panels to be created. The low-carbon economy has resulted in greenflation where inflation occurs due to constraints within the supply chain, geopolitical conflicts, and underinvestment in the mining and refining industry. Any investment that was made in market assets was based on the current price and, therefore, technology was created and revised under the achievable commodity price. Now, the energy transition is strengthening its grip on the economy further making it much more difficult to achieve economic and environmental sustainability.

As they affect the possibilities of global decarbonization strategies and economic growth, understanding the inflationary ramifications of certain minerals is important in scholarly work as well as policy formulation. Earlier works have looked into the supply and demand of different minerals, but very few have tried to ascertain the overarching impacts of greenflation during the broader energy transition. However, these previous studies lack an integrated framework that considers the increases in demand for specific minerals, inflation, rising energy demand, and subsequent policy responses. To formulate effective strategies for strengthening the resilience of clean energy supply chains, this research gap must be addressed.

This study, wishes to analyze the exemplary energy transition in order to determine the inflationary consequences resulting from the increased demand for specific minerals as well as explain their implications for the decarbonization of the global economy. The research addresses three key questions: **How much has the increased appetite for essential minerals impacted inflation within the renewable energy markets?**

In what ways do supply constraints together with geopolitical issues worsen greenflation?

What steps can be taken to alleviate these inflationary issues without making the transition to a sustainable energy economy overly complex?

This study employs a mixed-methods approach that integrates quantitative data analysis and qualitative policy evaluation to assess the inflationary impacts of rising demand for critical minerals in the context of the global energy transition.

2. Literature Review

The global energy transition towards low-carbon technologies has led to increased demand for critical minerals such as lithium, cobalt, and rare earth elements. This surge in demand has introduced inflationary pressures, often termed "greenflation," affecting both renewable energy markets and broader economic stability. Below is a literature review of academic articles and reports that explore these dynamics:

- **"Assessing the Fiscal Implications of Changes in Critical Minerals' Demand in the Low-Carbon Energy Transition" by Paola D'Orazio (2024):** D'Orazio examines how fluctuations in the demand for critical minerals impact the fiscal stability of resource-dependent economies. She introduces the **Fiscal Revenue Risk Index (FRRI)** to quantify the risks faced by emerging markets and developing economies (EMDEs) reliant on exports of lithium, cobalt, nickel, and rare earth elements. The study finds that as demand for these minerals is projected to increase up to sevenfold, countries may experience significant

revenue volatility, influenced by price fluctuations and supply chain uncertainties. While higher prices could benefit resource-rich nations, dependence on volatile markets poses fiscal sustainability challenges, particularly in the context of the global energy transition (D’Orazio, 2024).

- **"A New Age of Energy Inflation: Climateflation, Fossilflation, and Greenflation" by Isabel Schnabel (2022):** Schnabel discusses how the transition to renewable energy sources contributes to "greenflation." She highlights that the increased demand for critical minerals, essential for technologies like EV batteries and wind turbines, has led to price surges in these commodities. Supply chain constraints and geopolitical tensions further exacerbate these inflationary pressures, potentially hindering decarbonization efforts (Schnabel, 2022).
- **"Greenflation, a Myth or Fact? Empirical Evidence from 26 OECD Countries" by Changwoo Chung and Jinsoo Kim (2024):** Chung and Kim provide empirical evidence on the unintended inflationary effects of the green transition, analyzing panel data from 26 OECD countries. Their findings indicate that while the green transition exerts upward pressure on headline inflation, the impact on core inflation remains insignificant. The study suggests that increased spending on green initiatives and heightened demand for critical minerals contribute to these inflationary trends (Changwoo & Jinsoo, 2024).
- **"Greenflation: The Energy Transition Will Prove Inflationary" by TD Bank (2022):** This report discusses how the energy transition is expected to lead to significant increases in demand for various commodities, particularly critical minerals like lithium, cobalt, and nickel. The analysis highlights that the production of electric vehicles and renewable energy infrastructure requires substantially more minerals than traditional technologies, leading to price surges and increased volatility in these markets (Hebner, Priest, & Varghese, 2022).

These studies collectively underscore the complex relationship between the global energy transition and inflationary pressures arising from increased demand for critical minerals. They highlight the necessity for strategic policy responses, including supply chain diversification, investment in sustainable mining practices, and the development of recycling technologies, to mitigate "greenflation" and ensure a balanced and sustainable shift towards clean energy.

2.1. Research Gap and Contribution

Although several studies (Schnabel, 2022; D’Orazio, 2024; Chung & Kim, 2024) have analyzed greenflation, most remain either theoretical or limited to specific OECD economies. Few works integrate economic, geopolitical, and environmental dimensions simultaneously, nor do they provide empirical illustrations of mineral price volatility.

This study contributes to the literature by:

- Providing a descriptive analysis of mineral price trends and their inflationary implications during 2010–2025.
- Framing greenflation within a comprehensive perspective that links supply-chain disruptions, geopolitical dependencies, and macroeconomic outcomes.
- Offering a set of policy-oriented solutions, thus bridging the gap between academic debate and applied policy frameworks.

2.2. Methodology

This study adopts a mixed-methods approach that combines descriptive statistics with a qualitative policy review. Secondary data were collected from international institutions such as the International Energy Agency (IEA), OECD, and World Bank commodity price databases.

- **Data:** Annual price series for lithium, cobalt, nickel, and rare earth elements (2010–2025), along with global inflation indicators (CPI).
- **Tools:** Descriptive statistical analysis, simple trend comparisons, and correlation coefficients between mineral prices and inflation.
- **Qualitative component:** A review of international policy reports to identify mitigation strategies (e.g., recycling, diversification).

This approach allows the paper to illustrate the link between critical mineral price volatility and macroeconomic inflationary pressures, while acknowledging the limitation of not applying advanced econometric modeling.

3. The Conceptual Framework

3.1. Definition of Greenflation

Greenflation refers to the inflationary pressures resulting from the transition to a green economy. This phenomenon is characterized by rising prices of raw materials and energy as economies shift towards sustainable energy sources and technologies (Gagey, 2024).

3.2. Definition of Global Energy Transition

The global energy transition is the ongoing process of shifting from a system predominantly based on fossil fuels to one that relies on renewable energy sources. This transition aims to reduce carbon emissions, combat climate change, and promote sustainable energy solutions worldwide (Biro, 2021).

3.3. Definition of Inflationary Pressures

Inflationary pressures are economic conditions that lead to an increase in the general price level of goods and services over time. These pressures can result from various factors, including increased production costs, higher demand, or supply chain disruptions (Olovsson & Vestin, 2023).

3.4. Definition of Critical Minerals

Critical minerals are raw materials essential for the manufacturing of advanced technologies, including those vital for clean energy transitions, such as batteries, wind turbines, and solar panels. These minerals are deemed critical due to their economic importance and the risks associated with their supply chain vulnerabilities (Rediker, Moniz, Wicks, & Gross, 2024).

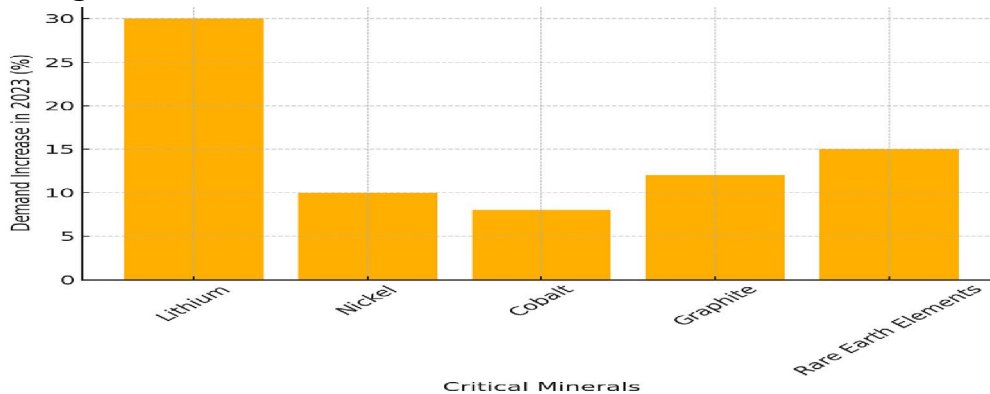
4. Rising Demand for Critical Minerals:

The increasing global reliance on clean energy technologies, electric vehicles, and digital infrastructure has intensified the demand for critical minerals. These minerals, including lithium, nickel, cobalt, graphite, and rare earth elements, play a vital role in energy storage, renewable energy systems, and advanced manufacturing. As economies transition towards low-carbon solutions, securing a stable and sustainable supply of these resources has become a strategic priority for governments and industries worldwide. The following table presents the percentage increase in demand for key critical minerals in 2023:

Table 01. Critical Minerals Demand Growth 2023 with Economic Insights

Critical Mineral	Demand Increase in 2023 (%)	Economic Insights
Lithium	30	Critical Minerals Demand Growth 2023 with Economic Insights.
Nickel	10	Critical Minerals Demand Growth 2023 with Economic Insights.
Cobalt	8	Lower demand growth due to reduced reliance in new battery technologies.
Graphite	12	Strong demand as a key material for battery anodes.
Rare Earth Elements	15	High demand driven by renewable energy applications and electronics.

Source : (IEA, 2024)

Figure 01. Growth Trends in Critical Minerals Demand for 2023

Source :Compiled by the researcher based on Table 01.

Considering the data presented in Table 01, it is evident that the demand for critical minerals in 2023 varied significantly. Lithium recorded the highest demand growth at 30%, followed by rare earth elements at 15% and graphite at 12%. Meanwhile, nickel and cobalt experienced relatively lower growth rates of 10% and 8%, respectively.

These findings highlight the accelerating demand for critical minerals, underscoring the inflationary pressures associated with greenflation and the global energy transition.

According to a 2023 report by the International Energy Agency (IEA) titled *The Role of Critical Minerals in Clean Energy Transitions*, if countries implement their announced energy and climate pledges, the demand for minerals used in clean energy technologies could more than double by 2030 and triple by 2040, reaching nearly 35 million tonnes annually (INTERNATIONAL ENERGY AGENCY, 2023).

This upward trend is largely driven by the accelerating adoption of electric vehicles (EVs) and the expansion of renewable energy infrastructure. For instance, the battery sector alone accounts for approximately 70% of the global demand for cobalt, underscoring the mineral's critical role in energy storage solutions (Statista, 2024).

Between 2017 and 2022, the demand for lithium tripled, while nickel and cobalt experienced demand increases of 40% and 70%, respectively (INTERNATIONAL ENERGY AGENCY, 2023).

Additionally, Wood Mackenzie, a global energy consultancy, estimates that copper demand could rise by 50% by 2040, while lithium demand could increase eightfold over the same period (Harris, 2024).

This sharp increase in critical minerals demand highlights the global shift toward clean energy technologies, emphasizing the need for significant investments in mining and refining to meet global climate goals.

4.1. Economic Challenges and the Impact of Greenflation:

The rising demand for these minerals reflects the ongoing phenomenon of greenflation, where increasing demand, coupled with supply constraints, drives up prices. This trend raises production costs for industries reliant on these materials, including electric vehicle manufacturing and renewable energy development. Policymakers and companies must address this challenge by adopting long-term investment strategies to secure stable supply chains. The following table summarizes the projected growth in demand for selected critical minerals by 2040:

Table 02. Projected Growth in Demand for Selected Critical Minerals by 2040

Mineral	Projected Demand Increase by 2040
Lithium	Over 40-fold
Graphite	20 to 25-fold
Cobalt	20 to 25-fold
Nickel	20 to 25-fold

Source: (INTERNATIONAL ENERGY AGENCY, 2023)

Looking ahead, if countries fully implement their announced energy and climate pledges, the demand for minerals vital to clean energy technologies is projected to more than double by 2030 and triple by 2040, reaching nearly 35 million tonnes annually (IEA, 2024).

Specifically, in a scenario aiming for net-zero emissions by 2050, the demand for lithium is expected to grow over 40 times by 2040, while graphite, cobalt, and nickel are anticipated to see demand increases of 20 to 25 times within the same period (Birol, 2021).

These projections highlight the escalating need for critical minerals, driven by the global transition towards sustainable energy solutions.

4.2. Key Minerals in Focus

The escalating global demand for critical minerals is primarily driven by their indispensable roles in modern technologies, particularly in energy storage systems. Lithium and cobalt are two such minerals that have garnered significant attention due to their applications in batteries and energy storage solutions.

- **Lithium:** Applications in Batteries and Energy Storage

Lithium-ion batteries have become the standard for a wide range of applications, including consumer electronics, electric vehicles (EVs), and grid energy storage, due to their high energy density and long cycle life. As of 2023, lithium-ion batteries account for over 80% of the more than 190 gigawatt-hours (GWh) of battery energy storage deployed globally (Sbaraglia, Maccioni, & Zedda, 2024, pp. 7-8).

The demand for lithium is expected to continue its upward trajectory. In 2022, about 60% of lithium demand was attributed to EV batteries, a significant increase from approximately 15% in 2017 (Falbo, Hinz, Leelasilapasart, & Pelizzari, 2021, pp. 5-6-7).

Projections indicate that if countries implement their announced energy and climate pledges, mineral demand for clean energy technologies could more than double by 2030 and triple by 2040, reaching nearly 35 million tonnes annually (Xu , et al., 2023, pp. 7-8).

- **Cobalt: Role in Battery Stability and Performance**

Cobalt is a critical component in many lithium-ion battery chemistries, particularly in the cathodes of batteries used for EVs and portable electronics. Its inclusion enhances battery stability, energy density, and longevity. In 2022, approximately 30% of cobalt demand was for EV batteries, up from around 10% in 2017 (COBALT INSTITUTE, 2025).

The importance of cobalt in batteries is underscored by its ability to improve thermal stability and prevent cathode degradation, which are essential for the safety and performance of high-energy-density batteries. However, concerns over supply chain sustainability, ethical sourcing, and cost have led to research into reducing cobalt content in batteries or developing cobalt-free alternatives (Stanford Advanced Materials, 2024).

4.3. Supply Constraints and Market Dynamics (Production Challenges):

4.3.1. Geographical Concentration: Analyze the distribution of critical mineral production. China dominates the production of many critical minerals, controlling a significant share of global output. For instance, China accounts for **98% of global gallium production, 78.9% of silicon, and 88.3% of magnesium**. Additionally, it is a leader in the production of rare earth elements and granite, highlighting the world's heavy reliance on Chinese supply chains (REUTERS, 2023).

This geographical concentration poses risks to global supply chains. Any disruption in Chinese production—whether due to political, economic, or environmental factors—could lead to significant price volatility and supply shortages.

Environmental and regulatory issues play a crucial role in shaping the mining industry. The environmental impacts of mining include soil erosion, water contamination, biodiversity loss, and chemical pollution of groundwater and surface water. Mining in wilderness areas can destroy ecosystems, in agricultural regions, it may reduce crop yields, and in urban environments, it contributes to noise and visual pollution (Liu, et al., 2021).

According to a 2019 report by Oxpeckers Investigative Environmental Journalism (Oxpeckers, 2019), 118 mines in South Africa were found to be polluting local rivers, inadequately testing for contamination, or otherwise compromising the country's waterways. Additionally, 115 mines were reported to be operating without proper water licenses, marking a significant increase from 2014, when 39 mines were found non-compliant. These violations pose threats to public health and biodiversity.

To address these challenges, governments worldwide enforce strict environmental laws, requiring mining companies to rehabilitate damaged areas and adopt sustainable practices. These regulations, while essential for environmental protection, can increase production costs and limit mining expansion, leading to supply constraints and inflationary pressures on critical minerals.

4.3.2. Environmental and Regulatory Factors in Mining: Environmental concerns and stringent regulations significantly impact mining activities worldwide. Mining operations are often associated with adverse environmental effects, including habitat destruction, water contamination, and biodiversity loss. To mitigate these impacts, many countries have implemented rigorous environmental regulations.

***United States:** In the United States, mining projects are subject to comprehensive environmental reviews under laws such as the **National Environmental Policy Act (NEPA)**. NEPA requires federal agencies to assess the potential environmental impacts of their actions before making decisions. This includes preparing **Environmental Impact Statements (EIS)** to evaluate potential environmental consequences before a project is approved. NEPA ensures that all branches of government consider the environment properly before proceeding with any federal action that significantly affects environmental quality (EPA, 2024).

***Argentina:** In Argentina, mining activities require an **Environmental Impact Study (EIS)** in accordance with **Law No. 24,585**, enacted in 1995 to amend the Mining Code and incorporate environmental provisions. This law introduces new environmental protections, ensuring that mining projects adhere to sustainability standards. The regulation mandates environmental monitoring, impact assessments, and mitigation measures before mining projects can proceed (IEA, Growth in global electricity demand is set to accelerate in the coming years as power-hungry sectors expand, 2025).

While these regulations are crucial for environmental protection, they can lead to **increased operational costs and extended timelines for mining projects**, potentially constraining the supply of critical minerals needed for the global energy transition.

4.3.3. Price Volatility: Over the past two decades, annual trade in energy-related critical minerals has surged from approximately \$53 billion to \$378 billion (Mimouni & Avérous, 2024). This substantial growth reflects increasing global demand, supply constraints, and geopolitical influences. Key minerals such as lithium, cobalt, nickel, and rare earth elements have experienced significant price volatility due to shifts in supply and demand, technological advancements, and policy changes. Below is a summary of historical price trends and influencing factors for these minerals:

Table 03. Historical Price Volatility of Key Critical Minerals and Influencing Factors

Mineral	Historical Price Trends	Influencing Factors
Lithium	Prices have experienced substantial fluctuations, with significant increases in recent years due to rising demand for electric vehicle (EV) batteries.	The surge in EV production has driven demand for lithium-ion batteries, leading to price increases. Supply chain challenges and limited production capacity have also contributed to price volatility.
Cobalt	Prices reached an all-time high of \$95,250 per metric ton in March 2018 but have since decreased, trading at \$24,300 per metric ton as of January 2025.	Market dynamics are heavily influenced by supply chain risks, particularly in the Democratic Republic of the Congo (DRC), which is the world's largest producer. Geopolitical factors and competition from producers in other countries, such as China, also impact prices.
Nickel	Prices reached an all-time high of \$54,050 per metric ton in May 2007. As of January 2025, nickel is trading at \$15,790 per metric ton.	Price fluctuations are linked to geopolitical factors, including export restrictions from key suppliers, and changes in global demand, particularly from the stainless steel and battery industries.
Rare Earth Elements	Prices have experienced volatility, with notable increases in 2010 and more recently in 2024.	Price fluctuations are often linked to China's market dominance and trade policies, as China is a major producer of rare earth elements. Geopolitical tensions and changes in export policies can significantly impact global prices.

Source: (INTERNATIONAL ENERGY AGENCY, 2023), (Trading Economics, 2025), (Economic, 2025), (Science History Institute, 2025)

These price volatilities underscore the complex interplay of market demand, supply chain dynamics, and geopolitical factors influencing the critical minerals essential for the global energy transition.

Table 04. Evolution of Critical Mineral Prices (2010–2025)

Year	Lithium (USD/ton)	Cobalt (USD/ton)	Nickel (USD/ton)	Rare Earth Index (base=2010)
2010	5,000	35,000	21,000	100
2015	6,500	28,000	15,000	120
2020	9,000	33,000	13,000	160
2022	17,000	81,000	24,000	240
2025	14,000	24,300	15,790	210

Source: Compiled by the author, from (INTERNATIONAL ENERGY AGENCY, 2023), (Trading Economics, 2025)

As shown in Table 4, lithium prices almost tripled between 2010 and 2022 before partially correcting in 2025, while cobalt peaked dramatically in 2018. Such volatility has transmitted to downstream industries, especially EV batteries, thereby reinforcing inflationary pressures on consumer prices.

4.3.4. Factors Influencing Prices: The price volatility of critical minerals is influenced by a complex interplay of factors, including geopolitical tensions, supply chain disruptions, technological advancements, regulatory policies, and macroeconomic conditions. Below is an overview of these factors:

Geopolitical Tensions :

- Trade Restrictions and Export Controls (Saefong, 2024).
- Regional Conflicts (Guardian News, 2025).

Supply Chain Disruptions :

- Pandemic-Related Challenges (Moerenhout, Lee, & Glynn, 2023).
- Natural Disasters

Technological Advancements & Market Demand :

- Increased Demand for Clean Energy Technologies (IEA, Reliable supply of minerals, 2025).
- Development of Alternative Materials (Home, 2024).

Regulatory & Environmental Policies :

- Environmental Regulations
- Government Incentives (Bikales, 2024).

Macroeconomic Factors:

- Global Economic Conditions
- Supply Constraints (Moerenhout, Lee, & Glynn, 2023)

Speculative Trading:

- Impact on Commodity Prices (Robles, Torero, & Braun, 2009).
- Market Volatility (Intercontinental Exchange, 2025).

4.4. Inflationary Impacts on the Global Economy

4.4.1. Cost Pass-Through to End Products : The escalating demand for critical minerals essential to the global energy transition has led to significant price increases, which, in turn, affect the costs of end products such as electric vehicles (EVs) and renewable energy infrastructure. This section examines how rising mineral costs influence the pricing of EVs and the expenses associated with solar panels and wind turbines.

Electric Vehicles (EVs): Impact of Increased Mineral Costs on Pricing

The production of EV batteries relies heavily on critical minerals like lithium, cobalt, nickel, and graphite. Recent surges in the prices of these minerals have directly impacted battery production costs. For instance, between 2015 and 2021, the cost of EV battery packs decreased by 65%; however, this trend has recently reversed, with a 10% increase in battery pack prices globally in 2022. This rise is partly attributed to the escalating costs of minerals used in battery cathodes, which now constitute approximately 22% of the total battery pack cost (Moerenhout, Lee, & Glynn, 2023).

According to (Spiller, Kannan, & Toman, 2024):

- Raw material costs now make up **50-70%** of total battery costs, an increase from **40-50% five years ago**.
- A **doubling** of lithium or nickel prices could lead to a **6% increase** in battery costs.
- If both lithium and nickel prices doubled simultaneously, it could negate the expected cost reductions associated with battery production scaling.

These increased production costs are often passed on to consumers, resulting in higher retail prices for EVs.

Higher vehicle costs may slow down EV adoption, hindering efforts to reduce greenhouse gas emissions in the transportation sector.

Broader Economic Implications : The rising demand for critical minerals essential to clean energy technologies has led to significant price increases, which have broader economic implications. This section examines how these escalating mineral costs contribute to overall inflation rates, as measured by the Consumer Price Index (CPI), and discusses potential monetary and fiscal policy responses to mitigate these inflationary pressures.

Consumer Price Index (CPI): Contribution of Rising Mineral Costs to Overall Inflation Rates

The Consumer Price Index (CPI) is a key indicator that measures the average change over time in the prices paid by consumers for a basket of goods and services. Increases in the costs of critical minerals can indirectly influence the CPI by raising production costs for goods that rely on these materials, such as electronics, vehicles, and renewable energy technologies.

A study by the Centre for Economic Policy Research (Pinto, Pescatori, Stuermer, & Wang, 2024), found that a 10% increase in copper prices leads to a 0.2 percentage point rise in both headline and core inflation within 12 months, with effects peaking around two to three years after the shock, reaching 0.5 percentage points for headline and 0.3 percentage points for core inflation.

Similarly, the International Energy Agency (IEA) reports (Dhir, Buisson, & Kim, 2025), that sharp spikes in critical mineral prices can drive up the cost of both batteries and electric vehicles, potentially slowing the pace of electrification and causing significant economic consequences.

Policy Responses: Potential Monetary and Fiscal Policies to Mitigate Inflationary Pressures

To address the inflationary pressures arising from increased critical mineral costs, policymakers can implement both monetary and fiscal measures, as shown in the following table:

Table 05. Monetary and Fiscal Policy Responses to Mitigate Inflationary Pressures from Critical Minerals Demand in the Global Energy Transition

Policy Measure		Description
Monetary Policy:		
Interest Adjustments	Rate	Central banks can modify interest rates to influence economic activity. Raising interest rates can help cool an overheating economy and curb inflation by reducing consumer spending and business investment.
Quantitative (QE)	Easing	In situations where traditional monetary tools are less effective, central banks may engage in QE by purchasing financial assets to increase the money supply and encourage lending and investment. This approach can help stabilize the economy during periods of deflationary pressure.
Green Easing	Quantitative	Central banks could implement green QE by purchasing green bonds or climate bonds, thereby directing funds towards environmentally sustainable projects and supporting the green transition.
Green Operations	Refinancing	Central banks can offer favorable refinancing terms to financial institutions that provide loans for green projects, incentivizing investments in sustainable initiatives.
Fiscal Policy		
Government and Taxation	Spending	Adjusting government expenditures and tax policies can influence aggregate demand. For instance, reducing public spending or increasing taxes can help cool demand-pull inflation. Conversely, during economic downturns, increased government spending and tax cuts can stimulate demand.
Subsidies and Support for Critical Mineral Production	Support	Governments can provide subsidies or tax incentives to encourage domestic production of critical minerals, thereby reducing reliance on imports and mitigating supply chain vulnerabilities. The U.S. Inflation Reduction Act of 2022, for example, includes provisions to boost domestic production of clean energy components and critical minerals.
Public Investment in Infrastructure	Investment in Infrastructure	Investing in infrastructure projects, such as transportation and energy, can enhance the efficiency of critical mineral supply chains, potentially lowering costs and mitigating inflationary pressures.
Strategic Stockpiling		Establishing reserves of critical minerals can provide a buffer against supply disruptions and price volatility, ensuring stable supply and prices.
International Agreements	Trade	Engaging in trade agreements with countries rich in critical minerals can secure supply chains and reduce costs associated with imports, thereby alleviating inflationary pressures.
Recycling and Circular Economy Initiatives		Promoting the recycling and reuse of products containing critical minerals can reduce demand for newly mined materials, easing pressure on supply and prices.

Source: (US DEPARTMENT OF ENERGY, 2022), (FISCAL MONITOR: CLIMATE CROSSROADS: FISCAL POLICIES IN A WARMING WORLD, 2023), (OECD, 2024)

4.5. Mitigation Strategies

To address the challenges posed by rising critical mineral costs, various mitigation strategies can be implemented. These strategies focus on enhancing resource efficiency, promoting recycling, and adopting sustainable alternatives to reduce dependency on limited mineral supplies.

4.5.1. Recycling and Circular Economy : Implementing recycling and circular economy practices can significantly reduce reliance on newly mined critical minerals. By reusing materials and improving resource efficiency, these strategies help mitigate supply constraints and environmental impacts. As shown in the following table:

**Table 06. Mitigation Strategies for Greenflation:
The Role of Recycling and Circular Economy in Reducing Critical Mineral Demand**

Section	Sub-Section	Details
Recycling and Circular	Potential Impact	Recycling plays a crucial role in reducing the demand for newly mined critical minerals by implementing circular economy strategies.
	IEA Projections	According to the International Energy Agency (IEA), scaling up recycling could reduce the need for new mineral supply by 25% to 40% by mid-century. Copper and cobalt mining needs could be reduced by 40%, while lithium and nickel could see a 25% reduction by 2050.
	Current Recycling Rates	Less than a third of the 60 critical metals studied have an end-of-life recycling rate above 50%. 34 of these metals have a recycling rate below 1%, highlighting a significant opportunity for improvement.
	Technological Advancements	New recycling technologies, such as plasma separation techniques, have been proposed to enhance rare earth element recycling, providing more sustainable solutions.

Source: (Jefferies, 2025), (IEA, Recycling of Critical Minerals -Strategies to scale up recycling and urban mining A World Energy Outlook Special Report, 2024)

4.5.2. Diversification of Supply Sources : To mitigate the inflationary pressures arising from the heightened demand for critical minerals, it is imperative to diversify supply sources. This can be achieved through the identification of emerging mining locations and the advancement of mining technologies.

Alternative Mining Locations : The global distribution of critical minerals is undergoing significant shifts as new regions emerge as potential suppliers. For instance, the Lithium Triangle, encompassing parts of Argentina, Bolivia, and Chile, is renowned for its substantial lithium reserves (Davis , 2020, pp. 1-2-3). Notably, Argentina is poised to increase its lithium production, potentially surpassing Chile by 2027 (Quinn , 2023).

In Africa, countries like Namibia and Tanzania are gaining attention for their untapped critical mineral resources. These nations offer opportunities to diversify supply chains and reduce dependence on traditional mining regions (Ritchie & Rosado, 2024).

Table 07. Emerging Global Mining Locations for Critical Minerals

Region	Notable Developments
Australia	Australia is a leading producer of lithium, with significant reserves contributing to the global supply.
Guinea	Guinea holds the largest bauxite reserves globally, essential for aluminum production.
Indonesia	Indonesia produced half of the global nickel output in 2023, becoming a major player in the nickel industry.
United States	The U.S. has approved new lithium projects, such as the Rhyolite Ridge mine in Nevada, to reduce dependence on foreign sources.

Source: (Ritchie & Rosado, 2024), (Melas, Faitatzoglou, Michail, & Artemiou, 2024, p. 10)

Investment in Mining Technologies : Advancements in mining technologies are pivotal in enhancing extraction efficiency and minimizing environmental impacts. Innovations such as bioleaching utilize microorganisms to extract metals from low-grade ores, offering a more sustainable alternative to traditional methods.

Additionally, the integration of automation and digitalization in mining operations has led to improved safety, increased productivity, and reduced environmental footprints. Technologies like remote sensing and real-time data analytics enable precise resource assessment and efficient extraction processes. And Table 7 illustrates the following:

Table 08. Technological Innovations in Mining for Sustainable Extraction

Technology	Description
Bioleaching (Biomining)	Utilizes microorganisms to extract metals from ores, offering a more sustainable alternative to traditional methods.
Electrodialysis for Lithium Extraction	An innovative technique that extracts lithium from brine without extensive water usage, potentially reducing reliance on traditional methods.
Automation and Digitalization	Incorporating automation and digital tools in mining operations improves safety, productivity, and environmental sustainability.

Source: (Financial Times, 2025), (Baker Hughes, 2025), (Eldomiaty, Azzam, El Kolaly, Dabour, & Anwar, 2025, p. 9), (Tommerdahl, 2025, pp. 4-5)

The technological advancements presented in Table 08 highlight key innovations that contribute to enhancing mining efficiency, reducing environmental impacts, and ensuring long-term sustainability in the extraction of critical minerals.

5. Conclusion

This article has shown that the global energy transition generates significant inflationary pressures due to rising and volatile prices of critical minerals. The empirical evidence from 2010–2025 illustrates how lithium, cobalt, nickel, and rare earths have become central drivers of "greenflation."

The key finding is that unchecked mineral price volatility may delay the adoption of renewable technologies and raise the costs of decarbonization. However, strategic policies—such as recycling, diversification of supply, and investment in sustainable mining—can mitigate these risks.

The paper's main contribution lies in integrating economic, environmental, and geopolitical perspectives to highlight the urgency of coordinated global responses. Future research should deepen the quantitative dimension by applying econometric models and regional case studies, especially in resource-dependent economies.

Contribution, Limitations, and Future Prospects:

This study contributes to the existing literature by offering an integrated framework that evaluates the interplay between mineral demand, inflationary trends, and energy policy. And highlights the broader macroeconomic and policy implications of critical mineral inflation. It also provides a comprehensive assessment of mitigation strategies, including recycling, supply diversification, and investment in sustainable mining technologies.

However, despite these contributions, the study has certain limitations:

1. **Data Constraints** – The research relies on projections from international agencies, which are subject to revisions based on evolving market conditions.
2. **Geopolitical Uncertainty** – Future disruptions, such as trade policies or geopolitical conflicts, could alter supply chain dynamics in unpredictable ways.
3. **Technological Advancements** – The study does not fully account for emerging battery technologies that may reduce reliance on certain minerals, which could reshape the inflationary landscape.

Future research should explore the long-term sustainability of mineral supplies, assess the role of circular economy initiatives, and investigate how technological innovations in battery production might mitigate price volatility.

Additionally, expanding this analysis to include regional impacts—such as how different economies are affected by mineral price inflation—could provide deeper insights into policy responses.

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