Post-Fossil Fuel Energy Security: Integrating Critical Materials into Europe's Single Energy Market

Michael Carnegie LaBelle, Central European University
Department of Environmental Sciences
Vienna, Austria
labellem@ceu.edu

Steffen Bettin, Austrian Academy of Sciences
Institute of Technology Assessment
Vienna, Austria

***Abstract*—Russia's invasion of Ukraine in 2022 reset European energy security perspective. The interdependence developed first with the Soviet Union then Russia broke. The knock-on effect questioned the interdependence with China as a key partner for the energy transition. If Europe's gas market was built with Russia, can Europe's zero-carbon economy be built with Chinese products? To assess a new energy security perspective the global interdependencies around critical raw materials need to be assessed. Europe's framing of energy security requires an expansion to include the unique features of low carbon technologies and resources. The passage of the Critical Raw Materials Act (CRMA) signals a new energy security age, one where selective trade partners contribute to European energy security. And European manufacturing capacity is integrated into the energy security framing. To explore this topic a research question is posed, 'Why should critical raw materials be accounted for in Europe's energy security and geopolitics?'**

***Index Terms*— energy security, critical raw materials, gas, geopolitics, energy markets**

I. Introduction

The premise of this article is a new energy security framing is born when geopolitics is no longer about marshaling militaries to protect oil – the lifeblood of the global economy. There is a structural shift in how *markets and geography* are organized with the plethora of critical raw materials necessary for the electrification of economies. Energy security changes when there is a decoupling of economic growth from the price of oil. An interdependent global economy is no longer constrained – or threatened – by oil flows [1].

Rather, as this article argues, a 'post-fossil geopolitics' emerges, which is more fractured and insecure as non-fossil *resources and technologies* become the new levers for geopolitical influence. Energy *security emerges as solidarity* between countries, rather than through globally integrated markets [2]. Assessing the shift to a post-fossil era can be done by drawing on three categories to assess new leverage points thereby redefining energy security. An assessment in critical raw materials in three areas exposes this new energy security in Europe: a) single energy market operations, b) energy solidarity, and c) technology and resources.

European fossil geopolitics were characterized by how the Single European Market (SEM) has worked to attract foreign companies and governments to "come and play" [3, p. 2]. They do this in the EU by accepting rules and regulations "to foster strategic goals in the near abroad and at the global level" [3, p. 2]. However, since Russia's 2022 invasion and the emergence of peak oil, there are warning signals that the era of interdependency is faltering. Not everyone should come and play. Tariffs are now applied on Chinese made electric vehicles and batteries in both the EU and the United States. To a certain extent, cooperation has increased between the EU and the US. Both are founding members of the Minerals Security Partnership which aims to develop a supply chain with selected countries [4], and which excludes China and Russia. However, with the new U.S. presidency beginning to pose a threat to supranational organizations such as the EU, these partnerships are anything but stable. This shift may also signal a potential return to an era where the importance of nation-states is reasserted, challenging the dominance of supranational cooperation.

Modern geopolitics was focused on fossil fuels and in particular, securing oil, and most recently securing gas [5, p. 2]. Expanding the concept of energy security to include renewable technologies updates the field to deliver a more nuanced account of inter-state activities. This translates to the strategic alignment of states to ensure sovereign decisions in a reorganized interdependent reframing of energy security. The term, 'post-fossil' demonstrates the lingering influence of the fossil fuel era, while a new era of electro or green-politics remains to take root [6].

The interlacing of energy security and geopolitics requires a joint reworking of how geopolitics are perceived. Geopolitics is about considerations for a world order [7, p. 8]. Writing in 2014, Dalby underscores it is "not the war plans of the great powers but their energy consumption plans" [7, p. 8]. However, in Europe, after Russia's 2022 invasion of Ukraine, geopolitics *is* about war plans *and* energy consumption. Energy security is more than securing raw materials and production of energy, but also controlling the demand. The securing of oil supplies or the generation and delivery of electricity are a traditional frame. But once a crisis hits, then demand reduction is essential.

There is now a broader definition of energy security in a revised definition of geopolitics. For the fossil fuel era, this rested on an 'energy statecraft' [8] which ensured energy security through geopolitical relations. This was seen as providing a higher level of energy security through international alliances [1, p. 534], [9, p. 204]. While energy statecraft still lives, it is a broader practice of statecraft that deals with critical raw materials.

Since the height of Covid in 2021 and 2022 when supply chain interruptions prompted a rethink, and the subsequent 2022 Russian attack on Ukraine, energy security has a new dimension around renewable energy technologies. This means a revised energy security lens includes plans for *both* energy consumption and supply from both natural resources and technological components in a supply chain.

To uncover the outlines of post-fossil geopolitics and energy security the question is asked: 'Why should critical raw materials be accounted for in Europe's energy security and geopolitics?' Answering this question can lead to further scholarly and policy reframing as to how to provide security for an energy system reliant on critical raw materials. The next four section will examine the role of critical raw materials in energy markets along with resources and technologies deliver energy security.

II. Energy Markets

Geopolitics once treated oil as a scarce commodity marshaling military responses and wars in the Middle East. Both our modern economic and political systems and how foreign relations are conducted were dependent on fossil fuels. The geography of fossil fuels lends itself to spatial relations expressed through geopolitics. The location of oil and gas deposits are not often the same as the location of consumers. Geographical factors influence the geopolitics of energy, shifting from Middle East oil to gas flows from Russia to the EU (see [5, p. 2]).

After the 1973 oil crisis, this was epitomized by a second oil crisis in 1980, when the Carter Doctrine was issued by US President Jimmy Carter. This would protect the flow of oil through the Persian Gulf from Iranian threats of supply disruption. The securitization of Middle East oil supplies was assured and extended to the US military to guard the resource flow for the global economy. The second oil shock at the time of the Carter Doctrine militarizing the oil markets also set in motion the diversification of suppliers. The impact of these crises would change spatial relations in political, economic, and transport in global energy geopolitics for the next fifty years.

The impact of the Middle Eastern oil crisis was also felt in Cold War Europe. The 1970s and 1980s saw Soviet technology and resources expand to both Eastern and Western Europe. The pipelines for oil and gas were strung and nuclear power plants built; all to ensure European energy prices could diversify away from Middle Eastern oil prices. This expanding market also included North Sea and North African oil and gas feeding into the Single European Market. The Soviet Union and then Russia became a reliable supplier, buffering Europe from geopolitical turmoil.

In 2004, the Eastward expansion of the EU, bringing in the post-Communist countries, created a unified European market tightly integrated through a network of pipelines with oil and gas fields in Russia, Central Asia, and the Caspian Sea. The EU would become the holder of a dual-tracked geopolitical balancing the historical relations of Western and Eastern Europe with Russia. Unification of the divergent geopolitical relations by Member States would largely happen after Russia's invasion of Ukraine in 2022. Russian oil and gas were targeted with sanctions and diversification efforts. Russian gas, which once seemed irreplaceable, was replaced by LNG and a technology shift. The gas import capacity controlled by Russia was once Europe's Achille's heel [10]. However, by 2024 Europe largely decoupled from Russian supplies and geopolitical pressure.

One of the early outcomes of European decoupling from Russian oil and gas supplies was the ability to replace Russian gas and oil imports. In 2021, in the lead-up to Russia's 2022 invasion, gas and electricity prices in Europe increased 400% because Russia withheld gas from the European market and left storage facilities empty [refs]. The EU rejigged its electricity and gas market rules, reduced gas consumption, facilitated joint purchases of LNG, and sped up deployment of renewables and energy efficiency measures. These efforts were facilitated and accomplished at the Member State (MS) level, and were in addition to national measures of fuel switching and diversification. Germany, the most heavily impacted of MS increased output from coal power plants and began building LNG facilities and signing new contracts. In 2024 the results demonstrate Europe can survive without Russian energy resources.

The diversification efforts in both technology and resources reflect utilizing market forces to drive change. Limited supplies and higher prices push diversification. Relations which were once dominated by bilateral gas contracts between Russia and MS, gave way to market pricing. Thereby dulling the impact of utilizing energy as a weapon of war. Likewise, Middle Eastern oil went through a similar experience. After the 1970s oil crisis, the vertical integration of oil companies ended which previously was characterized by producers being locked into long-term contracts with consumers. Oil shortages, exacerbated by withholding oil by some members of OPEC in 1973, later reduced the use of bilateral contracts and opened up a more market-based solution, which emphasized available supply and incentive new producers [11, p. 22]. As global demand soared so did oil supplies.

The literature on geopolitics in a post-fossil fuel era are seen as either perpetuating existing geopolitical power structures or reducing geopolitical tensions [12], [13, p. 4] [82]]. Fossil fuel geopolitics rely on a global interconnected market irrespective of political leanings and political systems. Economics is first. However, the transition away from economic dependency on fossil fuels, for both consumers and producers, can feed into "a destabilizing effect on global security" due to efforts for exporters to keep market share, and the "emergence of new types of interdependence among states" [13, p. 8]. It is this new type of interdependency that may buck traditional fossil fuel relations, characterized by neoliberal economics, which integrated the global economy since the 1970s.

The energy transition is altering what resources and technologies are delivered. Shipping lanes are seeing more LNG cargo, and the development of a global supply chain for renewable energy technologies underpinned by the delivery and processing of critical raw materials. Energy security is no longer about the delivery of fossil fuels and electricity, but the resources and components for a zero-carbon energy system.

The components for renewable energy become part of an extended energy security paradigm. The supply chain includes resource extraction to processing and manufacturing facilities. Critical raw materials that go into battery technologies, solar PV and more generic devices utilizing copper, aluminum, and cobalt are just some resources that a low and zero-carbon future will rely on. The complex supply chains, including microchips and processing facilities, emerge as interlinkages between raw resource supplies and the devices that deliver energy services. If energy security in the 1970s extended from the wellhead to the gas pump, then dominant renewable technologies would also require a new geographic perspective for energy security.

III. Security and Solidarity

"What lies in ruins are not only Ukrainian cities but also many of our basic security assumptions. For decades, many said that economic inter-dependence was the ultimate source of security." Ursula von der Leyen, The President of the European Commission, [14]

Energy security rests on the concept of energy sovereignty and in turn, rests on the ability to choose whether a country is independent or interdependent with other countries. "Energy sovereignty is defined by a state's ability to control its energy policy to secure its energy system against multidimensional threats" [2, p. 4]. Protection against threats may prompt countries to align themselves into energy security pacts. In 2022 and 2023, the EU and its MS finally came around to a common energy security perspective that saw Russia as a threat, thereby invoking an 'energy sovereignty' mechanism of the Lisbon Treaty detailing the functioning of the EU and its energy market [2, p. 4]. The joint purchase of gas and the proposed joint purchase of critical raw materials point to greater European interdependency and solidarity.

Energy solidarity emerges as an essential ingredient to Europe's energy security. It is built into the foundation of the European project on the common foundation of justice, values, and morals [2, p. 4]. Therefore, energy solidarity is a prerequisite for the EU's single energy market to work. Interdependency did not die after 2022, but energy sovereignty and solidarity re-emerged as essential protection against external threats. The interdependency and the dependency on Russian resources von der Leyen speaks about were based on economic interests keeping the peace. However, the definition of interdependency "means mutual dependence" [1, p. 534]. Mutual dependence forms a reciprocal relationship [15, p. 8]. However, for security to be assured, then economic interests are not enough, but a solidarity expressed through morals and values between allies emerge as the ingredient for security in energy interdependency.

Market solidarity is necessary to improve energy security. Energy security is a threat multiplier so holds an outsized impact on the economy and for society. Therefore, it is a political issue as to how to organize markets to produce a secure energy system where sovereignty is not threatened by external actors.

Energy interdependency produces a faster and cheaper energy transition [16] countries do not have to possess all their energy resources. However, rather than understanding the rise of energy independence vs. interdependency (as traditionally framed), there is an acknowledgment that a nation can't go it alone. Therefore, countries develop an alliance for energy resources and technologies. The next section will begin to identify how alliances may be organized.

IV. Resources and Technologies

For Europe, the largest challenge is the extraction and processing of critical materials necessary for the energy transition. There are strong movements within the EU to foster domestic European production and processing capacity. The passage of the Critical Raw Materials Act (CRMA) at the EU level demonstrates the political impetus behind a push for a greater self-sufficiency[17]. It is doing this through enacting regulations outlining short-term goals necessary to improve the security of supplies for critical raw materials.

> *"The targets of the CRM Act are very specific regarding domestic production and dependence on dominant foreign suppliers, namely, it stipulates that by 2030, the EU will cover at least 10% of the EU's annual consumption for extraction at least 40% of the EU's annual consumption for processing at least 25% of the EU's annual consumption for recycling from domestic sources. Furthermore, the EU will source no more than 65% of the Union's annual consumption of any strategic raw material at any stage from a single third country."[18, p. 4]*

As it were, a modern renewable energy system depends on various technologies, not only wind and PV as the most prominent generating technologies, but also various batteries, electrolyzes, and other means of storage as well as inverters, cables, transformers, etc. to distribute electricity, as well as heat pumps etc. to use electricity for heating and cooling. Moreover, as all of this is controlled by digital devices, the world of smart grids etc. tends to require various controlling devices with chips etc. Thus, all of this tends to depend on multiple technologies, requiring various materials that require various raw materials.

Further action is being taken to foster more production of renewable energy components. The European Solar PV

Industry Alliance (ESIA) aims for 30 GW of solar PV production capacity by 2030. In addition, there is the Net-Zero Industry Act (NZIA), with a target of the EU's solar PV manufacturing capacity meeting at least 40% of annual deployment needs by 2030. The act includes measures like accelerated permitting and market access facilitation through non-price criteria in public procurement and renewable energy auctions [19]. Figure 1 demonstrates the low manufacturing capacity in the EU compared to China, India, the United States and the rest of the world.

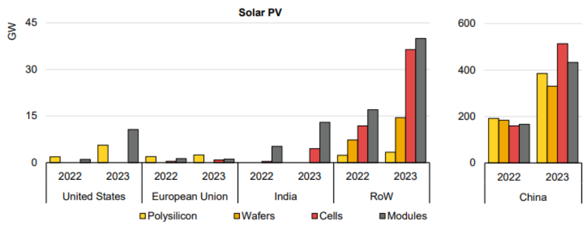

Figure 1: Net manufacturing capacity additions for solar PV, wind and battery components by country/region, 2022-2023 Source: [20, p. 39]

The lack of domestic manufacturing capacity results in high imports. Figure 2 demonstrates Europe's high dependency on imported technologies. Only wind power is an export to other countries while solar panels, battery systems and heat pumps are imported. Nonetheless, there are policy and entrepreneurial attempts to start a European battery ecosystem. As identified, the expectations were higher for more political support [21].

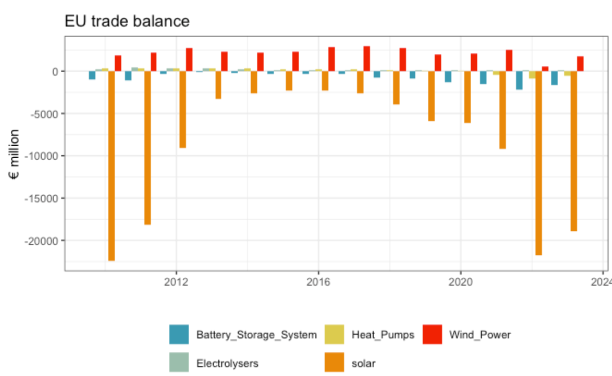

Figure 2: EU trade balance in selected renewable based energy technologies. Source: Eurostat trade data -Authors' compilation [22]

To foster breathing room or shelter domestic markets from (Chinese) competition the United States and the EU imposed tariffs against Chinese electric vehicles in 2024. This should be seen as both protective for jobs and to enable European car manufacturers to catch up [23]. The leverage points are shifting to boosting domestic resources and technology necessary for a post-fossil energy system.

In the market for critical raw materials and technologies for renewable energy, there is currently no discernible risk premium. Overall, the prices for renewable technologies are decreasing, while those for raw materials remain relatively constant. However, the disruption of supply chains during the COVID-19 pandemic led to short-term price increases for critical raw materials in the renewable energy sector. At present, the supply of raw materials meets the demand. Occasionally, there is an oversupply of raw materials, rendering investments in raw materials (mining, refining, etc.) particularly risky. There is a rising geographical concentration towards a few countries dominance of the materials supply chain for renewable energy technologies and the associated critical raw materials, with China the leader for control of the resources and technologies [18], [20], [24].

As awareness of this security shift grows in the EU, a new geopolitical thinking starts to become more prominent. This is apparent inn the classification of critical raw materials. While the origins of that approach go back to 2009, now with the CRMA, they become ever more pertinent. Additionally, the dependency on currently needed raw materials and the risks involved regarding their reliability of supply drives the onshoring of resource extraction and manufacturing. Internationally, this also includes assess countries of origin and their governance situation, substitutability as well as impact on Europe's economy. The CRMA now extended to so-called strategic raw materials that focuses on raw materials that are likely to be in short supply in the future (e.g. copper). Thus, the EU starts to anticipate a risk premium, thereby expanding how energy security is assessed and priced.

V. Conclusion: A New Security Through Solidarity

Energy security within a global interdependent market changes when risk premiums are applied to new areas. A new geopolitical framing emerges when the full supply chain, from resource extraction to manufacturing, is added. Energy security changes because the practice of interdependency shifts from globally interlaced interdependent markets in resources and technologies. Neoliberal economics with the most efficient cost structure gives way to a national security pricing structure. There is now an acknowledgment for secure supply chains from selective countries of origin. Applying selective interdependency in policies and market operations changes assessments of energy security and the practice of energy statecraft to facilitate a new energy geopolitics.

This rational emerges as justification to answer the research question of, 'Why should critical raw materials be accounted for in Europe's energy security and geopolitics?' If Dalby's statement that "energy consumption plans" matter more than war plans, than the growth of renewable energy technologies matter to satisfy consumption of economies and societies. The stagnation of fossil fuels is not due to stagnation in demand, but the rise of other generation sources – renewables. Energy statecraft therefore emerges as a tool to secure the flow of critical raw materials just as oil and gas secured the fossil-fuel era.

The integration of resources and renewable energy technologies require a broader scope of analysis. Understanding that politicians are already utilizing energy statecraft through geopolitical relations to secure their national energy systems, requires the academic literature to catch up to this reframing of energy security. Critical raw materials fill the energy demand gap that fossil fuels no longer occupy.

However, it is important to acknowledge the broader geopolitical shift from fossil fuels to critical raw materials for Europe. Rather than participating in an interdependent international oil and gas market, the critical raw materials market emerges as one of selection with an ability to pay a risk premium. While current market prices indicate no risk premium, the recent allowance of the use of tariffs as a tool in energy statecraft, points towards the development of a security premium. Selective interdependency emerges as a more secure way of sources for a post-fossil energy system.

The EU is recognizing the limitations of energy and economic interdependence as a means to provide security [14]. The EU's CRM Act begins to address the lack of resources and ability to manufacture renewable technologies. The EU's Single Energy Market provides a space for gas, oil and electricity to be sold and bought. However, just as the joint purchase of gas emerged as an EU policy response to high gas prices, joint action represented through energy solidarity is required to effectively foster an EU wide market for critical raw materials and European manufacturing capacity for renewable technologies. The pursuit of a new energy security enables the emergence of selective interdependency as a means to create a new European energy security paradigm.

References

[1] M. C. LaBelle, "Energy as a weapon of war: Lessons from 50 years of energy interdependence," *Global Policy*, vol. 14, no. 3, pp. 531–547, Jun. 2023, doi: 10.1111/1758-5899.13235.

[2] M. C. LaBelle, "Breaking the era of energy interdependence in Europe: A multidimensional reframing of energy security, sovereignty, and solidarity," *Energy Strategy Reviews*, vol. 52, p. 101314, Mar. 2024, doi: 10.1016/j.esr.2024.101314.

[3] A. Goldthau and N. Sitter, "Soft power with a hard edge: EU policy tools and energy security," *Review of International Political Economy*, vol. 22, no. 5, pp. 941–965, Feb. 2015, doi: 10.1080/09692290.2015.1008547.

[4] U.S. Department of State, "Minerals Security Partnership," United States Department of State. Accessed: Nov. 01, 2024. [Online]. Available: https://www.state.gov/minerals-security-partnership/

[5] M. Blondeel, M. J. Bradshaw, G. Bridge, and C. Kuzemko, "The geopolitics of energy system transformation: A review," *Geography Compass*, vol. 15, no. 7, p. e12580, Jul. 2021, doi: 10.1111/gec3.12580.

[6] D. Boyer, *No More Fossils*. University of Minnesota Press, 2023. Accessed: Sep. 13, 2024. [Online]. Available: https://www.jstor.org/stable/10.5749/jj.6737806

[7] S. Dalby, "Rethinking Geopolitics: Climate Security in the Anthropocene," *Glob Policy*, vol. 5, no. 1, pp. 1–9, Feb. 2014, doi: 10.1111/1758-5899.12074.

[8] P. Högselius, *Energy and Geopolitics*, 1st ed. London: Routledge, 2018. doi: 10.4324/9781315177403.

[9] A. Cherp and J. Jewell, "The three perspectives on energy security: intellectual history, disciplinary roots and the potential for integration," *Current Opinion in Environmental Sustainability*, vol. 3, no. 4, pp. 202–212, Sep. 2011, doi: 10.1016/j.cosust.2011.07.001.

[10] D. Gros and F. Shamsfakhr, "Global energy price inflation with a European twist," Nov. 2022, [Online]. Available: https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/733997/IPOL_IDA(2022)733997_EN.pdf

[11] P. Stevens, "Oil Markets," *Oxford Review of Economic Policy*, vol. 21, no. 1, pp. 19–42, 2005.

[12] I. Overland, "The geopolitics of renewable energy: Debunking four emerging myths," *Energy Research & Social Science*, vol. 49, pp. 36–40, Mar. 2019, doi: 10.1016/j.erss.2018.10.018.

[13] R. Vakulchuk, I. Overland, and D. Scholten, "Renewable energy and geopolitics: A review," *Renewable and Sustainable Energy Reviews*, vol. 122, p. 109547, Apr. 2020, doi: 10.1016/j.rser.2019.109547.

[14] U. von der Leyen, "Keynote speech by the President: GLOBSEC Forum 2024," European Commission - European Commission. Accessed: Nov. 14, 2024. [Online]. Available: https://ec.europa.eu/commission/presscorner/detail/en/speech_24_4481

[15] R. O. Keohane and J. S. Nye, *Power and Interdependence*, Second edition. New York: Longman, 1989.

[16] J. Jewell *et al.*, "Comparison and interactions between the long-term pursuit of energy independence and climate policies," *Nat Energy*, vol. 1, no. 6, p. 16073, Jun. 2016, doi: 10.1038/nenergy.2016.73.

[17] European Commission, "Critical Raw Materials Act." Accessed: Feb. 12, 2025. [Online]. Available: https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en

[18] L. Tercero Espinoza and et al., "The role of R&I in ensuring a safe and sustainable supply of critical raw materials in the EU," *European Parliment Research Services*, May 2024.

[19] European Commission, "European Solar Charter." Accessed: Feb. 12, 2025. [Online]. Available: https://energy.ec.europa.eu/topics/renewable-energy/solar-energy/european-solar-charter_en

[20] International Energy Agency, "Energy Technology Perspectives 2024 – Analysis," IEA. Accessed: Feb. 10, 2025. [Online]. Available: https://www.iea.org/reports/energy-technology-perspectives-2024

[21] European Court of Auditors, "Special report 15/2023: The EU's industrial policy on batteries," European Court of Auditors. Accessed: Feb. 12, 2025. [Online]. Available: http://www.eca.europa.eu/en/publications/sr-2023-15

[22] Eurostat Trade Data, "EU Trade Balance." 2024.

[23] A. Hancock and E. White, "EU presses ahead with tariffs on Chinese electric vehicles," *Financial Times*, Oct. 30, 2024. Accessed: Feb. 12, 2025. [Online].

Available: https://www.ft.com/content/c8e27f70-358b-48ea-a23e-3100319af459
[24] European Commission. Joint Research Centre., *Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU: a foresight study.* LU: Publications Office, 2023. Accessed: Feb. 13, 2025. [Online]. Available: https://data.europa.eu/doi/10.2760/386650