Geopolitics of Renewable Energies

1- Renewable Energy and the Reshaping of the Energy Map

Europe's shift from wood to coal in the eighteenth century accelerated the steps that led to the Industrial Revolution and defined its identity and shape. Later, the shift to oil transformed transportation, shortening distances and reengineering cities and industries. Similarly, it can be argued that the coming shift in energy sources will radically change the world of tomorrow. The rapid growth of renewable energy is likely to alter the power and influence of some countries and regions relative to others, redrawing the geopolitical map of the 21^{st} century.

Today, we stand on the threshold of a radical energy transition, the long-term implications of which are not limited to reorienting the global energy system toward sustainable energy sources, but may also extend to a redistribution of power within the current international order, which oil has helped engineer for decades. Researcher Meghan O'Sullivan, director of the Belfer Center for Science and International Affairs at the Kennedy School, spoke about the rapid growth of renewable energy and the impact of the energy transition on geopolitics, stating: "The chosen path will, in turn, impact geopolitics [...] We are talking about changing how we generate, store, transport, and use energy, reshaping the backbone of the global energy system [...]." O'Sullivan and her colleagues posed the question: How is renewable energy changing geopolitics? They provided their answer in 2017 in a paper outlining seven mechanisms through which renewable energy could reshape geopolitics:

- Cartels could develop around critical resources for renewable energy technologies;
- Renewables are the dominant source of investment capital, and associated technologies could become a source of international cooperation or competition between developed and developing countries;

- The spread of the resource curse, which could lead to a rise in renewable energy, where oil-producing countries benefit from access to high rents;
- The geopolitical complexity of electricity interconnections could create greater vulnerabilities for importing countries and increase dependency, leading to a reduced risk of conflict;
- Reducing gas and oil consumption may lead to political reform and economic diversification among fossil fuel producers, but it may also lead to political instability.
- Renewable sources will reduce the risk of conflict and instability.
- The shift in strategic influence between producers and consumers.

Wang et al., in their study titled "Impact of Different Geopolitical Factors on the Energy Transition: The Role of Geopolitical Threats, Geopolitical Acts, and Geopolitical Risks," presented an analysis using data from 39 countries and revealed that geopolitical risks (political, natural, and economic) disrupt the energy transition by restricting trade and investment flows, increasing price volatility and inhibiting investment opportunities in vulnerable regions. Therefore, the energy transition is linked to a geopolitical redistribution of power. These negative trends in the energy transition on geopolitics include:

• The competitive relationship between the United States and China, which dominates clean energy supply chains and controls critical minerals. If this dominance is exploited, it could slow the energy transition or make it more costly.

• The rise of so-called middle powers, including OPEC countries, which have already had an influence on climate talks. These countries, seeking independent foreign policies, could use arguments about economic fairness to slow the energy transition.

2- Renewable Energy and Alliance Diplomacy

Renewable energy is likely to reshape geopolitics, beginning with the emergence of new contexts of bilateral relations and multiple alliances, which will shift the center of gravity of energy dependence from global markets to regional networks. This is due to the efforts of oil-importing countries to develop their renewable energy sources and integrate their networks with those of neighboring countries, with the goal of eliminating the threat of fossil fuel supplies and, in return, accessing abundant energy throughout life. The renewable energy revolution emerged with technological advancements and has attracted international attention. This has been accompanied by the emergence of the concepts of "Regional Energy Hubs" and "Grid Communities," which involve the creation of regional and international alliances that enhance interconnectedness between countries, with positive effects on political stability. The shift toward renewable energy sources and the change in the geopolitical map do not mean the end of hegemony and influence. Power cuts between countries will become an important tool of foreign policy, strategically implemented in the same way as oil and gas sanctions. However, electricity trade tends to be more reciprocal than oil and gas trade. While gas flows in one direction from source to importer, electricity trade between countries flows in multiple directions. For example, a country generating solar energy exports energy to a group of neighboring countries. Indeed, several alliances have emerged on the international scene to support the deployment of renewable energy, such as the International Solar Alliance (ISA), the first intergovernmental organization based in India, emerging from a joint initiative initiated by France and India during the 21st session of the Conference of the Parties. In an unprecedented effort to benefit solar energy, Indian Prime Minister Narendra Modi said at the launch of this alliance: "The International Solar Alliance will play the role of OPEC in the future, and India hopes to establish deeper trade and political relations with the developing world through solar diplomacy." Based on the saying: *"No one bans the sun or cuts off its*

supply to us," this alliance aims to establish rules and standards that regulate solar energy for its rapid and widespread deployment in the 121 countries that enjoy high solar radiation. 83 countries have signed this agreement, including: Australia, Japan, the United Kingdom, the Netherlands, and Egypt. The preamble to the framework agreement states: "Cooperation is an unparalleled opportunity to achieve prosperity, security, and development for people," by working to deploy more than 1,000 gigawatts of solar energy and mobilize more than a trillion dollars from solar energy by 2030. Article Two of the agreement also emphasized the importance of international cooperation. There is another alliance, the Global Energy Alliance for People and Planet (GEAPP), which was established. Launched at the COP26 climate summit to accelerate investment in green energy and renewable energy solutions in developing countries, these alliances will not realistically match the power and influence of OPEC+ in the short term, but they could have a tangible impact in reducing global fossil fuel consumption. Regarding the development of new energy, there is the International Green Hydrogen Alliance (IGN2A), a non-profit organization that aims to promote renewable energy technologies. Even multinational companies have become interested in alliances to deploy renewable energy technologies. Google and others, in partnership with Sustainable Energy for All, are working to encourage companies and governments to join the coalition for carbon-free energy.

3- The second requirement: The potential geopolitical implications of the global energy transition.

The geographical concentration of fossil fuel reserves has helped some countries protect their national interests and maximize their economic and political influence. In comparison, countries without such assets have suffered for more than a century from the risks of supply chain disruptions and the threat of disruption. These factors have prompted them to seek alternative sources to protect their energy security. They have found renewable energy sources to be the most appropriate solution and strategic option to overcome this energy dilemma.

3.1 The Geopolitical Risks of the Global Energy Transition

The energy transition is accompanied by complex and indirect geopolitical implications that are difficult to control, given that we are in the early stages of this transition. Many researchers—particularly those who oppose the abandonment of fossil fuels—have attempted to outline the profound implications of the energy transition. A 2019 report issued by the Global Commission on Geopolitics, commissioned by the Director of the International Energy Centre and the International Renewable Energy Agency, stated in its introduction: “The accelerated deployment of renewable energy has unleashed a global energy transition that will have profound geopolitical consequences. Just as fossil fuels have shaped the geopolitical map over the past two centuries, the energy transition will alter the global distribution of power, relations between states, the risk of conflict, and the social, economic, and environmental drivers of political instability.” The reasons for the energy transition, according to the report, relate to the widespread availability of renewable energy resources, unlike fossil fuels, which are geographically concentrated in specific regions, and the world's ability to deploy them on a large scale. Francesco La Camera, Director-General of the International Renewable Energy Agency, stated: "The market has given the green light to the spread of renewable energy, with many cost-competitive technologies being introduced. Policymakers must now develop enabling frameworks that help accelerate climate-resilient investments. We must create a low-carbon energy system to maintain the target of global temperature rise. It is possible." The global energy transition could seriously impact fossil fuel-intensive sectors, especially in countries with relatively uncompetitive fossil fuel industries. Even in countries like China, which have led the energy transition, the enormous consequences of moving away from fossil fuels would have a significant impact on the national workforce in this sector. The most important risks resulting from the energy transition can be highlighted as follows:

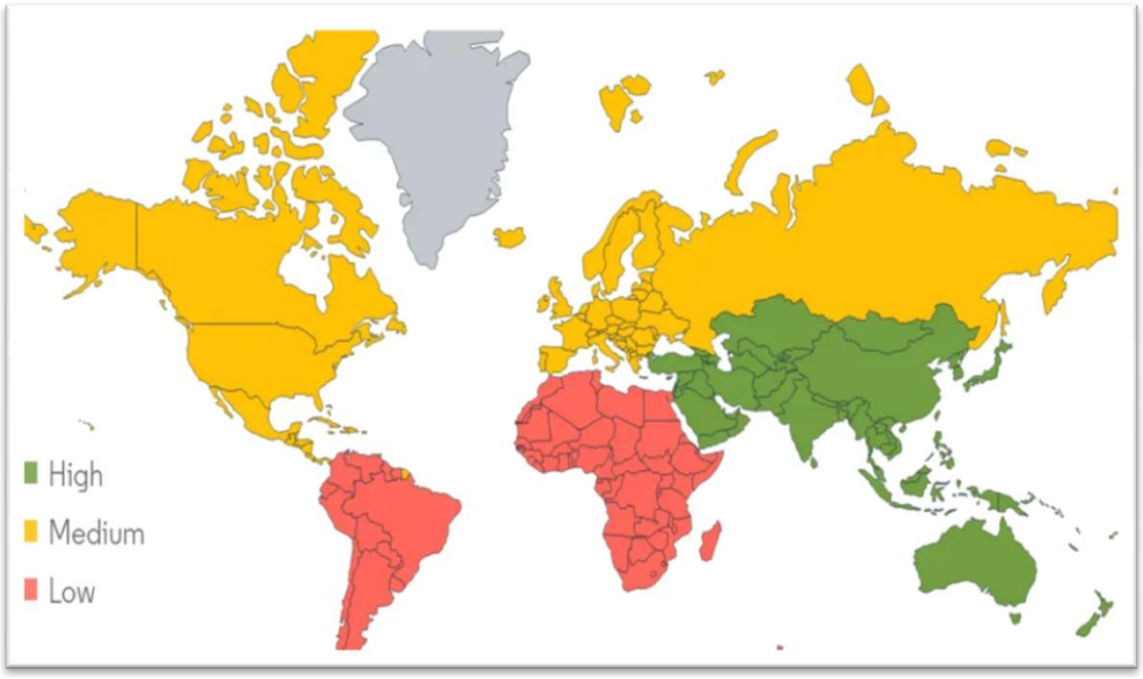
3.1. 1 First: Growing North-South divisions

Demand for fossil fuels is increasing in the Global South due to rapid demographic growth and economic development requirements, while countries in the North are moving towards diversifying their economies by developing renewable energy sources. It is not unlikely that clashes will occur between the two sides due to the significant divergence in strategies and implementation plans. The new division between developed and developing countries revolves around the roadmap and how to move forward to achieve a safe and just transition for all countries. The division is evident in the following:

• Disagreement over climate policies, including the transition from who is responsible for cumulative carbon dioxide emissions to who bears responsibility. The division is particularly evident when it comes to financing, as Western banks and financial institutions have halted financing for pipelines, ports, and other infrastructure related to hydrocarbon development.

• How quickly should developing countries proceed with the transition? This is the biggest dilemma for implementing carbon emissions targets by 2050. Some have warned against accelerating the transition, including Jean Pisani Ferry, a founder of Bruegel, the European economic research center. He pointed to the risks of accelerating the energy transition and its impact on the macroeconomy, saying, "It is unlikely to be benign, and policymakers should be prepared to make difficult choices." Furthermore, achieving the energy transition in a short timeframe poses an unprecedented risk to resources, as it requires mobilizing resources, talent, and capabilities. The consequences of failure or inaction are significant. • Developing countries with low and low-middle incomes per capita are difficult to prepare for or able to undertake the transition without regional and international support.

Map 1: Lithium-ion battery recycling market 2020-2025



The above global map shows South Asia's dominance in the global lithium-ion battery recycling market.

The global energy transition driven by renewable energy sources will have significant geopolitical implications. It will reshape relations between the countries of the North and the South, with technology as the divider between them. It will also lead to fundamental structural changes in economies that will be significantly different from the world built on fossil fuels after World War II. The structures and arrangements of international relations will change, and the influence of some countries, such as China, will increase thanks to its massive investments in renewable energy technologies and mining capacity. In contrast, countries that rely heavily on fossil fuel exports and fail to adapt to this transition will face multiple economic, political, and security risks, with a gradual loss of influence in their regional and international environment. It could also create a financial shock with dire consequences for their economies and political stability. Proponents of the Renewed Conflict Camp assert that the energy transition leads to the same conflicts caused by fossil fuels, or to new types of divisions. For example, Capllan Perez et al. argue that if the transition

to renewable energy sources occurs under conditions of continued global energy consumption, it will lead to new vulnerabilities. Raman, on the other hand, argues that renewable energy may take over the role played by fossil fuels and become a driver of international economic conflicts in the form of trade wars.

3.1.2 The Escalation of Competition Between the Great Powers

The energy transition is one of the most important strategic issues that will exacerbate tensions, particularly within the US-Russia-China strategic triangle. This is despite the United States demonstrating resilience against any attempts to challenge its dominance over the global energy system, which it has helped shape under the shadow of oil geopolitics since the end of World War II. While China controls the supply chains for minerals, the United States, its multinational corporations, and its financial institutions control the oil and gas markets, maritime routes, and transit zones. This is not to mention the imposition of the currency (the US dollar) and the establishment of the Inflation Reduction Act, which includes massive support and incentives for investment in renewable energy sources. Great power competition influences technology choices, commercial companies, and the global agreements that can be reached. The scramble among great powers will lead to the emergence of competing poles for greater interests and profits. China has become a leader in all aspects related to electricity and renewable energy technologies, and OECD countries are leading in hydrogen production, carbon capture, and bioenergy. Signs of competition will also emerge around batteries, a key pillar of the energy transition, based on their ability to maintain a balance between supply and demand in the renewable energy sector. Therefore, China has also sought to dominate the battery storage industry, with 93 large lithium-ion battery cell factories. CATL alone controls 30% of the global electric vehicle battery market and is expected to have 140 factories by 2030, while Europe will have 17 factories and the United States 10. The map below shows the locations of lithium-ion battery recycling markets.

3.1. 3 Arming Mineral Exports

Most industries today rely on oil from the Middle East and Central Asia. Gradually, attention will turn to the Democratic Republic of the Congo, Australia, Chile, and Indonesia to produce cobalt, copper, lithium, and nickel, essential for the energy transition. Consequently, countries will become dependent on these countries. The late Chinese leader Deng Xiaoping foresaw the future when he said in 1997: “Rare earths will become more important than Middle Eastern oil and will give China a great status.” Just as oil and gas exporting countries derived their power to influence and play an active role in the international system by controlling energy exports and their price range, the scene could be repeated again with countries seeking to control the supply chains of minerals and rare earths, which are a pivotal element in generating renewable energy. This is why China realized the geopolitical importance of rare earths thirty years ago. Its dominance over rare earths is not only based on what is known as the “geography of reserves.” Rather, its dominance is due to its exploitation of its relatively low-cost labor force and lax environmental laws to gain a competitive advantage in the global market. In addition, it signed exploration contracts for these minerals in countries rich in them, extracting and processing them, and then exporting them to the rest of the world. This is why China views monopolizing the supply chains of important minerals as an integral part of China’s energy security strategy, and it may have been born out of Chinese interest. Critical minerals have faced several crises, the first of which was the cobalt crisis of 1978 following the outbreak of conflict in the country's Katanga province, which caused a global shortage of cobalt. In 1990, the Chinese government declared rare earth minerals a strategic reserve, preventing foreign investors from extracting them. Prior to 2003, most joint ventures required foreign investors to obtain approval from the Ministry of Foreign Trade and Economic Cooperation. The Chinese monopoly also allowed minerals to be used as a weapon. For example, in 2010, China suspended its shipments of rare earths to Japan due to a dispute over disputed islands. This

decision led to a decrease in supply and a rise in prices in the markets. In 2021, amid its trade war with the United States, China announced restrictions on the production and export of 17 rare earth minerals, which, as previously mentioned, are essential for the production of F-35 aircraft, electric vehicles, and wind turbines. China is the world's leading supplier of garium (80%), germanium (80%), indium (48%), and metallic silicon (66%). It also holds 69% of the world's graphite and 45% of hard rock lithium refining volumes. China plays a leading role not only in the supply of raw materials but also in material processing (cathodes and anodes) and in the development of electrodes, separators, and e-cells. Complaints against China's export restrictions on rare earths and other raw materials filed before the World Trade Organization's dispute settlement bodies over the past decade, as well as some foreign investment disputes over rare earths and the rush to deep-sea mining for these minerals, are just a few examples of the beginning of the conflict. This assumes that the more control one country has over the supply chain for a particular raw material, the greater the risk of potential blockages and flow disruptions. The International Energy Agency predicts that the world will transition from a "fuel-intensive energy system to a mineral-intensive energy system," with competition between Big Oil companies shifting to competition between Big Shovels. With China's continued monopoly, several complaints filed before the WTO's dispute settlement bodies over the past decade, as well as some foreign investment disputes over coordination on rare earths and the rush to deep-sea mining, represent the beginning of the conflict over raw materials. This assumes that the greater the control one country has over the supply chain for a particular raw material, the greater the risk of potential blockages and flow disruptions.

3.2 The Resource Curse and Clean Energy Wars

Throughout history, major powers have leveraged their dominance over oil resources and the routes leading to them. Former US President Carter established a doctrine that will likely endure for decades to come: imposing a military and political presence in the Middle East, the Caspian Sea, and Central Asia, regions with enormous fossil energy potential. This doctrine has enabled the shaping of energy markets and their management. However, the security dilemma is that these regions are witnessing protracted conflicts that have, in many cases, led to the disruption of oil supply chains, thus creating a global crisis. With the escalation of concerns, Western countries have been forced to shift to renewable energy sources to achieve their energy security. Can it now be said that the penetration of renewable energy technologies into global markets and the ability of all countries to access energy have ended Western strategies and, with them, wars over natural resources? The global energy transition will impact interstate relations and potentially alter the balance of power, making Graham Allison's Thucydides Trap all the more important. Allison's theory posits that major shifts in the balance of power often trigger global conflict. Even the mere fear of the rise of new powers at the expense of oil producers can be enough to trigger conflict. The first signs of conflict will be that mineral revenues fund armed groups and fuel forced labor and other gross human rights abuses, along with corruption. Sierra Leone and Angola are prominent examples, where diamond mines were a major incentive for rebel groups to engage in violence and looting during the civil war. Even outside Africa, armed groups are exerting pressure to control rare minerals and resources in Venezuela and Colombia. The world is concerned about the effects of fragility, conflict, and violence in key producing regions and their impact on energy transitions. Identifying fragile states rich in minerals and metals is crucial to the energy transition. Minerals are critical to the development and deployment of renewable energy technologies. Given the historical link between minerals and conflict, it is essential to identify future

scenarios for the energy transition. If critical minerals are essential to the transition to a carbon-free energy system, it is necessary to identify the levels of fragility and corruption in mineral-rich states and the impact of these levels on mineral supply chains. This will provide a deeper understanding of conflict risks, their causes, and their implications for future energy transition policies.

Minerals	Mineral reserves in fragile or very fragile country %	Mineral reserves in a corrupted or very corrupted condition%	Minerals	Mineral reserves in fragile or very fragile country %	Mineral reserves in a corrupted or very corrupted condition%
Bauxite and alumina	44	68	Iron	42	60
Chrome	55	100	Lead	49	49
Cobalt	70	70	Lithium	21	34
Copper	41	41	Manganese	66	86
Molybdenum	70	72	Selenium	76	76
Nickel	42	59	Silver	52	52
Rare earths	58	94	Tin	69	84
Zinc	52	59	Titanium	57	62

The table above illustrates the demand for strategic minerals for renewable energy deployment technologies. It shows that most of the minerals are located in regions with high levels of fragility and corruption in Central Africa, Southeast Asia, Central America, and parts of South America. It shows that 100% of chromium and graphite reserves are located in countries that are either corrupt or highly corrupt.

The relationship between "critical" minerals and the deployment of renewable energy technologies is characterized by tensions. These interdependencies/indirect risks require action to mitigate their occurrence, including:

- Expanding current resource supplies: Mining projects take 15 to 20 years, along with updating geological surveys and improving international data exchange.

- Reducing pressure on international supply: Accelerating technology development, improving material efficiency, and increasing recycling could reduce cumulative demand by 2050 by 20–60% for most materials. The main danger is that new energy systems will emerge slowly, making them marginally impacted not only by environmental problems but also by the severe social and economic repercussions that can accompany the energy transition. Therefore, societies have little time to begin charting a path toward sustainable energy and adapting to the new energy race.