NEW ENERGY GEOPOLITICS SHAPED BY ENERGY TRANSITION: THE ENERGY BALANCE FOR RARE EARTH ELEMENTS AND CRITICAL MINERALS

ENERJİ DÖNÜŞÜMÜNÜN ŞEKİLLENDİRDİĞİ YENİ ENERJİ JEOPOLİTİĞİ: NADİR TOPRAK ELEMENTLERİNE VE KRİTİK MİNERALLERE YÖNELİK ENERJİ DENGESİ

Yazar

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Abstract

Energy transitions have affected world development historically. Energy transitions first started with the use of wood as a heating source reached renewable energy sources that are environmentally-friendly, safer and cleaner such as sun, wind, wave, biomass and, geothermal. Renewable energy sources and new energy technologies are leading tools in combating global warming and climate change. However, the energy transition causes new geopolitical tensions in terms of energy security. Inputs such as cobalt, lithium, germanium, tellurium, and neodymium are used for the production of wind tribunes and solar panels, for the construction of power plants, and products such as electric vehicles and energy storage units related to new energy technologies. These inputs are found in small quantities in certain countries, which therefore are called rare earth elements or critical minerals. The fact that critical minerals becomes one of the most important components of the energy transition leads to global competition regarding access to these resources. This study explains the new energy geopolitics specific to critical minerals, an important component of the so-called energy transition analyzes the global competition in production, export, and import of critical minerals as well as addressing the geopolitical approaches emerging in the axis of countries with mineral reserves.

Keywords: Critical Minerals, Rare Earth Elements, Lithium, Cobalt, Energy Transition, Renewable Energy, Energy Geopolitics.

Özet

Tarih boyunca enerji dönüşümleri dünyanın gelişiminde etkili olmuştur. Odunun bir ısı kaynağı olarak kullanımıyla başlayan enerji dönüşümü, günümüzde rüzgâr, güneş, dalga, biyokütle ve jeotermal gibi daha temiz, daha güvenli ve çevre dostu yenilenebilir enerji kaynaklarına uzanmıştır. Yenilenebilir enerji kaynakları ve yeni enerji teknolojileri, dünyanın karşı karşıya olduğu küresel ısınma ve iklim değişikliği tehlikesiyle mücadelede en önemli araçlardan bir haline gelmiştir. Ancak bu enerji dönüşümü enerji güvenliği açısından yeni jeopolitik gerginliklere de yol açmaktadır. Enerji santrallerinin oluşturulmasında, güneş panelleri ve rüzgar türbinlerinin üretiminde ve yeni enerji teknolojileri ile bağlantılı elektrikli araçlar ve enerji depolama birimlerinin üretiminde kobalt, lityum, germanyum, tellür ve neodyum gibi sadece belirli ülkelerde yoğunlaşan, az miktarda bulunan ve bu nedenle kritik mineralleri olarak adlandırılan girdilere ihtiyaç duyulmaktadır. Bu bağlamda kritik minerallerin enerji dönüşümünün en önemli bileşenlerinden biri haline gelmesi, bu kaynaklara erişim açısından küresel bir rekabetin yaşanmasına neden olmaktadır. Bu çalışmada, enerji dönüşümünün önemli bir bileşeni olan kritik mineraller özelinde ortaya çıkan yeni enerji jeopolitiği açıklanırken bunların üretimi, ihracatı ve ithalatı ekseninde oluşan küresel rekabet değerlendirilmekte ve bu minerallerin rezervlerine sahip ülkeler ekseninde gelişen jeopolitik yaklaşımlara yer verilmektedir.

Anahtar Kelimeler: Kritik Mineraller, Nadir Toprak Elementleri, Lityum, Kobalt, Enerji Dönüşümü, Yenilenebilir Enerji, Enerji Jeopolitiği.

1. INTRODUCTION

The world is going through transformation in the energy sector. This process has social, economic, technological, and geopolitical dimensions. The rapid developments in energy technologies, energy sustainability and efficiency, the preference of cleaner and safer renewable energy sources such as wind, sun, wave and hydroelectric in terms of environment constitute technological and social dimensions of the energy transition. Asian countries such as China, South Korea, and India which increase their trade volumes and energy demands have become the demand center of global energy markets. The fact that their energy demands rapidly increase by comparison with the United Kingdom (UK), the United States (US), Germany, and France reflect the economic and geopolitical dimensions of the energy transition. Whereas demand for oil and natural gas continues globally, the transition to renewable energy resources has also been accelerating. The production and the diversity of products related to renewable energy have been increasing.

The COVID-19 pandemic has proven that the energy consumption met with hydrocarbon resources such as oil, natural gas, and coal could adversely be affected by processes such as epidemics and natural disasters, and global prices of fossil fuels may follow an unstable and fluctuating course. The pandemic has proven the increase in the future utilization of renewable energy sources and related technologies will be faster than expected. This energy transition will further increase global competition about the renewable energy products.

Renewable energy resources require a very different infrastructure in terms of production and consumption and these resources are subject to a largely different process. Inputs such as cobalt, lithium, germanium, tellurium, and neodymium are employed in producing wind tribunes, solar panels, power plants and energy storage units of new energy technologies. These inputs are found in small quantities in certain countries, and, therefore, are ‘called critical minerals’ or ‘the rare earth elements’ (REE). Thus, risks in terms of energy security increase because supply of the critical minerals is not flexible and certain countries keep monopoly of production. Therefore, the minerals become one of the most important components of the energy transition leading to global competition.

Whilst fossil fuels were at the center of international conflicts throughout the 20th century, the nature and actors of this struggle for energy resources have been changing rapidly. Some minerals have already become a part of energy geopolitics, generally associated with oil, coal, and natural gas. Moreover, new energy geopolitics is emerging due to the technology and requirements of renewable energy sources.

This study explains the new energy geopolitics specific to critical minerals as an important component of the energy transition, while evaluating the global competition in production, export, and import of these minerals and addressing the geopolitical approaches emerging in the axis of countries with minerals reserves. By conducting the qualitative research method, I have benefitted from the statistics published by international institutions and companies operating in the field of energy and current academic publications related to the subject in this study.

2. ENERGY GEOPOLITICS AND ITS SECURITY APPROACH

Geopolitics has been introduced to the literature of International Relations (IR) combining "ge" meanining place, and land and "politike" which means politics in Greek.[1]

[1] Mehmet Öğütçü, *Yeni Büyük Oyun,* Doğan Kitap, İstanbul, 2017, p. 131.

Examining the connection between countries' geographical features and policies, geopolitics began to evolve scientifically in the 20th century. It prioritizes geographical conditions in international conflicts as well as challenges and advantages provided by these geographical conditions.[2] In this context, certain geopolitical advantages of a country have not been sufficient to turn its geopolitical advantage into power. As for countries not having economic and political potential, such advantages became a threat, and resulted in the exploitation of those countries.[3]

The most obvious example for such a disadvantage had arisen in the field of energy at the international level; thus, the geopolitical approach for energy resources has begun to develop. In addition to its logistics and economic dimensions such as availability, reserve volume, transportation options, and market potential of the energy sources, energy geopolitics was developed as a political concept such as ensuring the control of energy supply and turning energy supply into a diplomatic weapon at the international level.[4]

The efforts of the globally dominant countries to control their energy resources and to extend their influence over countries having energy resources since the 20th century affected the development of energy geopolitics. In this regard, preferred as a fuel in production, transportation, and military fields, oil has gained a great effect on energy geopolitics. The UK, and then the US has shaped their global policies in a way dominating the oil-rich countries and geographies referring to foreign intervention options such as political coups, wars and international economic sanctions. The goal of the US to dominate the Middle East oil was stated in the US Department of State document dated 1945 with the following statements: "Saudi Arabian oil reserves are among the world's largest reserves… These reserves must be under our control for two reasons: on the one hand, to meet our depleted reserves, on the other hand, not to fall into unfriendly hands.".[5]

The control of Middle Eastern oil and natural gas was not sole purpose target for the US. Ensuring control and security of the transit countries and the strategic maritime areas such as straits and gulfs, which enable these sources to access the European countries, has also been important in terms of geopolitics. The US policy towards the Middle East was largely outlined in the Carter Doctrine. The fact that any power takes control of the Persian Gulf and the Strait of Hormuz enabling energy resources of Saudi Arabia, Iran, Iraq, the United Arab Emirates, Kuwait, and Qatar to reach the world energy markets by sea, would be considered as an attack for the vital interests of the US in the doctrine. To prevent losing the control of these strategic maritime areas, it has further been stated that the US would take all kinds of attempts, including military power.[6]

The US geopolitical approach has been one of the main causes for political instability, wars and crises in the Middle East countries with the richest reserves of the world in terms of oil and natural gas resources. In other words, oil and natural gas have constituted one of the leading causes for the Suez Crisis, the conflict between Arab countries and Israel, Iraq's invasion of Kuwait, the conflict within the Islamic countries, and the Gulf Crises accelerating fragmentation of Iraq. The international tension in the Eastern Mediterranean over the maritime

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[2] Hakkı İşcan,"Uluslararası İlişkilerde Klasik Jeopolitik Teoriler ve Çağdaş Yansımaları". Uluslararası İlişkiler Dergisi, 1(2), 2004, p. 49.
[3] Ibid, 49.
[4] Muazzez Harunoğulları, "Enerji Dağıtım Merkezi Perspektifinden Türkiye'nin Enerji Jeopolitiği", Mukaddime, 11(1), 2020, p. 182.
[5] Necdet Pamir,.*Enerjinin İktidarı,* Hayykitap, İstanbul, 2015, p. 73.
[6] Tayyar Arı, *Geçmişten Günümüze Orta Doğu: Siyaset, Savaş ve Diplomasi*, Dora, Bursa, 2014, p. 400.

jurisdiction areas is also one of the recent examples of the struggle for energy resources. These crises have turned into proxy wars of the regional and global actors.

3. ENERGY TRANSITION: RENEWABLE ENERGY SOURCES AND NEW ENERGY TECHNOLOGIES

The energy transition first started with the use of wood as a heat source, then changed into the wind and waterpower that drive the mills. This transition was also followed by the steam power that drives machines and then fossil fuels have been used as the primary energy sources in many sectors such as industry, transportation and defense.

The coal became the primary energy source of the Industrial Revolution that started in the 18th century, and was replaced by oil notably with the World War I. Although oil is the most intensive and commonly consumed energy source of the 20th century, alternative energy sources have also emerged. The nuclear technology race between the Eastern and Western blocs under the Cold War conditions caused the use of nuclear fuel as an energy source alongside the nuclear armament creating the balance of terror. In addition to oil and nuclear energy, natural gas has been widely used since the 1960s. Natural gas was preferred more because its greenhouse gas emission is low when compared to other fossil fuels' emissions. However, the more natural gas use in residences and industry and lesser in transportation sector could not prevent the increase in greenhouse gas emissions associated with oil and coal. Thus, increasing greenhouse gas emissions worldwide has become one of the most important factors causing global warming.

Triggered by global warming, global climate change has made countries conscious about the protection of the environment and the relationship between the human and nature shifted to cleaner energy resources. In this context, the Sustainable Development Goals were accepted by the United Nations (UN) in 2015 to create a low-carbon economy globally, and the Paris (Climate) Agreement was signed in 2016. Paris Agreement was approved by 196 countries has aimed to keep global warming rise below 2°C in the 21st century.[7] The UN members have been asked to take urgent action to combat climate change within the framework of the Sustainable Development Goals, and cleaner and appropriate energy has been called for all.[8] On the other hand, the dangers and risks associated with nuclear power plants like nuclear disasters and radioactive incidents have also been effective in the energy transition. The Fukushima nuclear accident in 2011 expedited the recent transition to renewable energy sources. Renewable energy sources that are safer and cleaner such as sun, wind, wave, and geothermal, have been preferred instead of fossil fuels, which cause environmental pollution.

The share of renewable energy sources in global energy consumption, including fossil fuels, nuclear energy, and hydroelectric, increased from 6.6% in 1990 to 10.2% in 2016[9] and 12.2% in 2019. On a global scale, renewable energy consumption in 2019 increased approximately 3.5 times compared to 2009.[10] According to the International Energy Agency estimates, this increase is expected to reach 19.3% by 2040. It is also estimated that there will be 4-7% shift from fossil fuel consumption to renewable energy consumption in the next 15-25

[7] United Nations. The Paris Agreement, 2020, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement, Accessed 01.04.2021

[8] Clare Church and Alec Crawford, "Minerals and the Metals for the Energy Transition: Exploring the Conflict Implications for Mineral-Rich, Fragile States". (Ed.), The Geopolitics of the Global Energy Transition, Springer, 73, 2020, p. 279.

[9] The International Energy Agency. Renewables, https://www.iea.org/fuels-and-technologies/renewables, Accessed 01.04.2021

[10] British Petroleum. Statistical Review of World Energy 2020, 69th Edition, p. 53.

years.[11] Accordingly, it is expected that the share of renewable energy in total primary energy consumption would rise to 63% by 2050, and the use of fossil fuels, which was 86% in primary energy consumption in 2015, also would decrease to 37% by 2050.[12] These estimates and the expected consumption rates indicate the speed and dimensions of the transition from fossil fuels to renewable resources worldwide.

Renewable energy is essentially used in the generation of the electricity, which is a secondary energy source. Renewable resources are among commonly used energy type in electricity generation. Their share in global electricity generation reached 26% in 2019.[13] Future projections indicate that the share would rise to 30% by 2024.[14]

Because of their accessibility under any conditions, wind and sun are the most widely used renewable energy sources in electricity generation. According to the global statistics published by the British energy company, British Petroleum, approximately 51% and 26% of the renewable energy production in 2019, excluding hydroelectricity, came from wind and sun, respectively. When compared to 2018 figures, solar and wind energy productions were increased by 24.3% and 12.6% in 2019, respectively.[15] The trend upwards accelerates the investments on energy infrastructure worldwide. With the investment, renewable energy capacity is projected to increase by 50% between 2019 and 2024. This increase equivalent to the United States' total installed power capacity today, would come almost %60 from solar energy and %25 from wind energy.[16]

China is the expected to receive the largest increase in the renewable energy capacity. It alone would meet 40% of global renewable capacity expansion by 2024. The US, India, and the European Union (EU), consisting of 27 member countries follow China.[17] In this context, while the EU sets its renewable energy target of 32% by 2030, India has targeted renewable energy production to 227 GW by 2027. China has also set the target for non-fossil fuel share in total energy demand to 20% by 2030.[18]

In recent years, the increase in the renewable energy use in the EU, China, and many other countries shows that these targets are not far. While renewable energy sources supplied 40% of electricity generation in Spain and Germany and 33% of electricity generation in the UK in 2018, China's electricity generation capacity from renewable sources reached 38% in the same year.[19] With its rapid transformation over the last few years, Chile has become one of Latin America's largest renewable energy markets. Morocco, a North African country, supplied 35% of its electricity demand from renewable energy sources in 2018.[20] The increase in generation indicates that the development of renewable energy worldwide is not limited

[11] Meghan O'Sullivan, Indra Overland and David Sandalow, "The Geopolitics of Renewable Energy", Center on Global Energy Policy Columbia University, Amsterdam Ave, 2017, New York, p. 5.
[12] Dolf Gielen, Francisco Boshell, Deger Saygin, Morgan Bazilian, Nicholas Wagner and Ricardo Gorini, "The Role of Renewable Energy in The Global Energy Transformation". Energy Strategy Reviews, 24, 2019, p. 41.
[13] The International Energy Agency. Renewables, https://www.iea.org/fuels-and-technologies/renewables, Accessed 01.04.2021
[14] The International Energy Agency. Renewables 2019: Analysis and Forecast to 2024, https://webstore.iea.org/download/direct/2854?fileName=Renewables_2019.pdf, Accessed 01.04.2021, p. 24.
[15] British Petroleum. Statistical Review of World Energy 2020, 69th Edition, p. 55.
[16] The International Energy Agency. Renewables 2019: Market Analysis and Forecast from 2019 to 2024, https://www.iea.org/reports/renewables-2019, Accessed 01.04.2021
[17] Ibid.
[18] Dolf Gielen, Francisco Boshell, Deger Saygin, Morgan Bazilian, Nicholas Wagner and Ricardo Gorini, "The Role of Renewable Energy in The Global Energy Transformation", p. 39.
[19] International Renewable Energy Agency (IRENA), Global Energy Transformation: a Road Map to 2050 (2019 edition). Abu Dhabi, p. 16.
[20] Ibid, p. 17.

exclusively to developed countries. Many developing countries also prefer renewable energy technologies. Moreover, the forecasts for emerging economies such as South Korea and India indicate that these countries would catch up with the developed Western countries in renewable energy with their increasing energy demands. It even creates the impression that they would surpass Western countries in terms of renewable energy capacity.

It is important to stress that energy transition is not limited to primary energy consumption. It has affected different sectors and services. There is a rapid transformation occurred in vehicles, one of the leading causes of global warming and environmental pollution due to operating with oil and natural gas. The number of electric vehicles classified as heavy and light used in personal and public transport are on the constant rise. Thus, electric vehicle sales exceed 2 million units in 2018, increasing by 58% compared to 2017. Electric vehicle sales in Norway increased by 40% in 2018, while nearly 5.6 million light electric vehicles were on the roads worldwide in the same year.[21] In 2018, around 425 thousand electric buses were used for public transport globally, of which 99% were in China.[22] In addition to light and heavy electric vehicles, the use of two/three-wheelers individual electric vehicles for transportation is rapidly expanding. It is estimated that there is a stock of 350 million electric two/three-wheelers across the globe, most of which are in China. In 2030, according to the Sustainable Development Goals, it is expected that electric vehicle stock across the globe (excluding two/three-wheelers) will reach 245 million units, more than 30 times the current amount.[23]

Table 1. Summary of Stocks in Society in the 'beyond 2 degree' (B2D) Scenario, 2015–2060.

	Stock in society (2015)	**Stock in society (2060)**	**Stock increase**
Personal vehicles: Battery electricity (million)	1.5	1,300	87,000%
Personal vehicles: Hybrid, plug-in hybrid and fuel cells (million)	14	710	5,000%
Electric bikes (million)	460	1,600	300%
Buses: Battery electric, hybrid, plug-in hybrid and fuel cell (million)	0	31	N/A
MFT and HFT: Battery electric, hybrid, plug in hybrid and fuel cell (million)	0	130	N/A
Wind power (GW)	430	4,200	1,000%
Solar photovoltaic (GW)	220	6,700	3,000%
Solar thermal (GW)	21	1,300	6,000%

[21] International Renewable Energy Agency (IRENA), Global Energy Transformation: a Road Map to 2050 (2019 edition). Abu Dhabi.

[22] Bloomberg. Why U.S. Cities Aren't Using More Electric Buses, 27.06.2019, https://www.bloomberg.com/news/articles/2019-06-27/why-china-is-winning-the-electric-bus-race , Accessed 01.04.2021

[23] The International Energy Agency. Global EV Outlook 2020, https://www.iea.org/reports/global-ev-outlook-2020#, Accessed 01.04.2021

Source: Manberger, Andre and Stenqvist, Björn. "Global Metal Flows in the Renewable Energy Transition: Exploring the Effects of Substitutes", Technological Mix and Development. Energy Policy, 119, 2018, pp. 226-241.

According to the scenario targeted to achieve the Paris Agreement's goals, Table 1 indicates the targeted stocks for various electric vehicle models and renewable energy infrastructures between 2015 and 2060.[24] Given that 196 countries ratified the Paris Agreement comply with the terms of the agreement, electric vehicle stocks and renewable energy capacity in the future will be higher than the figures presented above.

4. MINERALS FOR ENERGY TRANSITION, AND THE GEOGRAPHIC DISTRIBUTION AND SUPPLIER OPTIONS OF THESE COMMODITIES

Renewable energy resources and new energy technologies require a quite different infrastructure in terms of production and consumption processes compared to those of fossil fuels, since they are subject to a largely different process. Natural gas and oil are subject to processes from production to demand, including for example, transport through pipelines, liquification, gasification, and refinement. Wind power plants (WPP) converting wind power into electricity and photovoltaic solar power plants (SPP) converting sunlight into electricity are built on geographically suitable lands and maritime areas. Wind and sun are free and unlimited resources, and depending on their geographical conditions, countries access these sources with varying densities. In this respect, wind and sun differ from fossil fuels in terms of accessibility and availability. In other words, although countries have differences in terms of wind speed and intensity and the duration of receiving sunlight during the day, they have the opportunity to access these resources free of charge.

In addition to these geographical features, the supply and use of some strategic products, and technologies are required for WPP and SPP infrastructure. Wind and sun are intermittent sources. Therefore, solar panels and wind turbines converting both sources into electricity necessitate different technologies and infrastructures. SPP and WPP cannot generate electricity without daylight and suitable weather conditions. For this reason, wind and sun energy must be stored to provide an uninterrupted energy supply. Energy storage is also essential for the electric vehicle, which is an important part of the energy transition. In SPP, WPP, and electric vehicles, energy is stored in batteries/cells called lithium-ion batteries using lithium minerals. Cobalt and lithium are key minerals for electric vehicles, plants, and energy storage.[25] Therefore, depending on the speed of energy transition, the demand for cobalt and lithium is increasing rapidly across the globe. Energy storage demand is anticipated to expand exponentially over the next decades. Consequently, lithium demand of 270,000 metric tons of Lithium Carbonate Equivalent (LCE) in 2018 is anticipated to exceed 1,000,000 metric tons of LCE by 2025.[26] International Renewable Energy Agency (IRENA) also confirms this expectation. According to IRENA, the annual battery storage capacity in the global electricity market, which was 360 megawatts in 2014, is expected to reach 14,000 megawatts by 2023.[27] Cobalt prices, which

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[24] Andre Manberger and Björn Stenqvist, "Global Metal Flows in the Renewable Energy Transition: Exploring the Effects of Substitutes", Technological Mix and Development. Energy Policy, 119, 2018, p. 226-241.

[25] Bengt Johansson, "Security Aspects of Future Renewable Energy Systems–A Short Overview", Energy, 61, 2013, p. 602.

[26] Teague Egan, "Beating China at the Lithium Game - Can the US Secure Supplies to Meet Its Renewables Targets, 18.02.2020, https://www.utilitydive.com/news/beating-china-at-the-lithium-game-can-the-us-secure-supplies-to-meet-its/572307/, Accessed 01.04.2021

[27] Nejat Tamzok, Kömür mü arayalım lityum mu?, 25.06.2018, https://www.enerjigunlugu.net/komur-mu-arayalim-lityum-mu-dr-nejat-tamzok-27794yy.htm, Accessed 01.04.2021

were USD 60,000 per tonne in 2017, are expected to increase to USD 100,000 per tonne by 2030.[28]

Minerals used for renewable infrastructures and new energy technologies are not limited to lithium and cobalt. Many minerals are also needed to build wind and solar energy systems and to produce energy storage units and electric vehicles. It is required for many metals and minerals such as tellurium, ruthenium, and indium for solar cells used in solar panels and neodymium for wind turbines.[29]

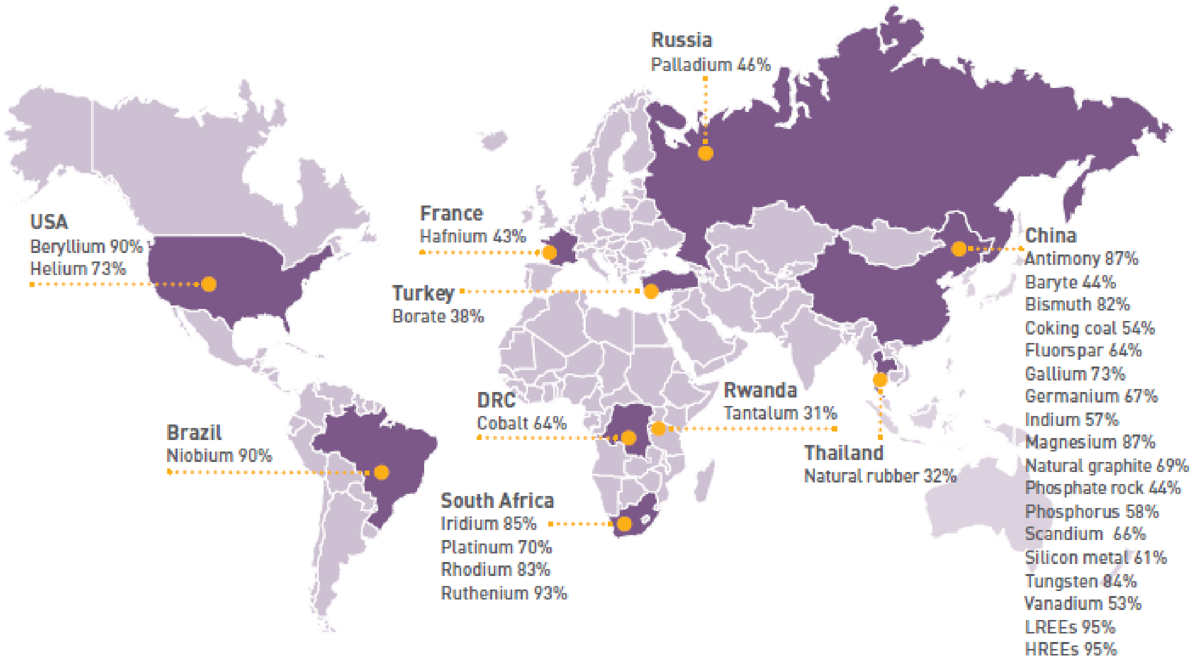
Table 2. Metals and Minerals Used in Renewable Energy Production and Technologies and Energy Storage, and the Biggest Producers

Mineral Commodities	**Used In**	**Biggest Producers**
Beryllium	Wind energy	Brazil, China, Madagascar, Mozambique, Portugal
Cobalt	Batteries, energy storage, electric vehicles	The Congo, Biggest refiner China
Gallium	Solar power systems	Biggest refiner China
Germanium	Solar power systems, fiber-optic cables	Canada, China, Finland, the Congo
Indium	Solar power systems	China (50%), Belgium, Canada, Japan, South-Korea
Graphite	Battery technology, electric vehicles	China (67%), India, Brazil
Lithium	Battery technology	China, Australia
Niobium and Tantalum	Energy storage	Brazil (90%), Canada
Rare Earth Elements	Clean energy applications	China (90%), Australia
Selenium	Solar power systems	Japan (51%), Belgium, Canada, Japan and the United States
Tellerium	Solar power systems	China, Sweden
Vanadium	Battery technology	China, Russia, South Africa

Source: Marju Körts, "The Strategic Importance of Rare Earth Minerals for NATO, EU and The United States and its Implications for the Energy and Defense Sectors", pp. 24-40.

[28] Clare Church and Alec Crawford, "Minerals and the Metals for the Energy Transition: Exploring the Conflict Implications for Mineral-Rich, Fragile States", p. 288.
[29] Bengt Johansson, "Security Aspects of Future Renewable Energy Systems–A Short Overview", Energy, 61, 2013, p. 602.

Figure 1. Countries Accounting for the Largest Share of Global Rare Metals and Minerals Supply



Source: Marju Körts, "The Strategic Importance of Rare Earth Minerals for NATO, EU and The United States and its Implications for the Energy and Defense Sectors", pp. 24-40.

Table 2 and Figure 1 indicate REEs and critical minerals used for energy transition and countries accounting for the largest share of the production of these minerals. Given the table and figure, China is in the dominant position in terms of reserve volume, production amount, and export potential of REEs. It has the largest proven reserves of REEs and is also the largest consumer and exporter of REEs.[30] It alone reached the top of the market by performing 97% of REE production globally in 2010 and 2011. Although China's share in production declined to 70-80%, thanks to new producers, it maintained its leadership in the REEs market over the last 10 years.[31] China, which has technological superiority in processing and separating REEs, has supplied more than 90 percent of the world demand in past decades.[32]

However, China has a supply problem in some minerals; its national production cannot meet its national demand. For this reason, it imports a large amount of mineral, which causes price and demand fluctuations in the REE, lithium and cobalt market. For example, China, a country rich in lithium reserves, is the largest lithium importing country in the world at the same time. In 2015, China's share in global lithium production was 7%, and its share in global lithium consumption was 50%.[33] The gap between China's production and consumption has caused significant fluctuations in lithium prices. The rapid increase in China's electric vehicle production caused lithium carbonate's price to rise from 43,000 Yuan / t at the beginning of

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[30] Marju Körts, "The Strategic Importance of Rare Earth Minerals for NATO, EU and The United States and its Implications for the Energy and Defense Sectors", (Ed.) Energy Security: Operational Highlights, The NATO Energy Security Center of Excellence, 2020, p. 26.

[31] March Schmid, "Rare Earths in the Trade Dispute Between the US and China: A déjàVu", Intereconomics, Leibniz Information Centre for Economics, 2019, p. 380.

[32] Ibid, p. 380.

[33] Han Hao, Zzongwei Liu, Fuquan Zhao, Yong Geng and Joseph Sarkis, "Material Flow Analysis of Lithium in China. Resources Policy, 51, 2017, p. 100.

2015 to 129,000 Yuan / t at the end of the year. This price increase only in one year has made manufacturers perceive the importance of a sustainable supply of lithium.[34]

In addition to China, many countries have great potential for critical minerals production and reserves. For example, niobium used in energy storage is produced mostly in Brazil, and %90 of beryllium used in wind turbines is produced in the US. On the other hand, the Democratic Republic of Congo (DRC) has half of the world's proven cobalt reserves, and this country is expected to meet around 70% of the global cobalt supply by 2020.[35] Of the proven lithium reserves, are 34% in Bolivia, 31% in Chile, 13% in China, 8% in the US, 6% in Argentina, 3% in Australia,[36] and the leading producer and exporter of lithium are Australia and Chile.[37] When the global reserve distribution of critical minerals is evaluated on a global scale, 6 countries consisting of Australia, DRC, Brazil, China, Chile and Russia alone have 66% of cobalt reserves, 52% of nickel reserves, 33% of copper reserves, 84% of lithium reserves, 33% of silver reserves, and 70% of other REEs reserves.[38]

5. NEW ENERGY GEOPOLITICS FOR RARE EARTH ELEMENTS AND CRITICAL MINERALS

Separation and production of REEs and minerals by certain countries, and countries holding the majority of lithium and cobalt reserves brings up new geopolitical risks about energy security. According to some research for critical minerals, these sources pose a supply risk threatening energy security. Some studies also argue that critical minerals supply does not pose a critical risk for the energy transition. Energy transition depends more on research in the field of innovation and technology. The researchers are effective in creating alternative products to some minerals that are monopolized by certain countries.[39] For instance, due to alternative minerals, the preferability of minerals such as neodymium, germanium, and tellurium in energy transition has been decreasing in recent years. On the other hand, the majority of minerals have a recyclable structure. Moreover, the decrease in the recycling costs in the future is expected to increase the supply of mineral.[40]

Despite these expectations, even if the expected success in recycling may be achieved, the supply of lithium and cobalt will be at critical levels by 2060.[41] The countries having alternative REEs and minerals, experiencing political tensions, economic instability, civil war, regional and political conflicts, and shaking by fragility and corruption causes the imbalance of supply and demand, which made them remain on the agenda. It is assumed that the risk of energy security will increase, and new geopolitical tensions will be experienced in terms of REE and minerals.

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[34] Ibid, p. 100.

[35] Marju Körts, “The Strategic Importance of Rare Earth Minerals for NATO, EU and The United States and its Implications for the Energy and Defense Sectors”, p. 26.

[36] The Lithium Market, Fox Davies Capital, 01.09.2013 http://doc.xueqiu.com/1497add8471193fc2e583642.pdf, Accessed 01.04.2021

[37] Basudev Swain, “Recovery and Recycling of Lithium: a Review”. Separation and Purification Technology, 172, 2017, p. 390.

[38] Andre Manberger and Bengt Johansson, “The Geopolitics of Metals and Metalloids Used for the Renewable Energy Transition”, Energy Strategy Reviews, 26, 2019, p. 5.

[39] Indra Overland, “The Geopolitics of Renewable Energy: Debunking Four Emerging Myths” Energy Research & Social Science, 49, 2019, p. 37.

[40] Ibid, p. 37.

[41] Clare Church and Alec Crawford, “Minerals and the Metals for the Energy Transition: Exploring the Conflict Implications for Mineral-Rich, Fragile States”, p. 283.

Table 3. Mineral Reserves in States With High Fragility and High Corruption

Mineral	Global reserves located in a **fragile** or **very fragile state**	Global reserves located in states perceived to be **corrupt** or **very corrupt (%)**
Bauxite and Alumina	44	68
Chromium	55	100
Cobalt	70	70
Copper	41	41
Graphite	73	100
Iron	42	60
Lead	49	49
Lithium	21	34
Manganese	66	86
Molybdenum	70	72
Nickel	42	59
Rare Earths	58	94
Selenium	76	76
Silver	52	52
Tellurium	67	67
Tin	69	84
Titanium	57	62
Zinc	52	59

Source: Clare Church and Alec Crawford, "Minerals and the Metals for the Energy Transition: Exploring the Conflict Implications for Mineral-Rich, Fragile States", p. 287.

Table 3 indicates the global reserve percentages of REEs and minerals located in countries shaken by corruption and fragility. According to the table, 28% of bauxite and aluminum reserves are in Guinea, a very fragile country, %66 of cobalt reserves are in DRC, a very fragile and very corrupt country, all of the chromium and graphite reserves are in other countries that are an either corrupt or very corrupt.[42] According to the Corruption Perception Index published by Transparency International in 2017, most of the minerals listed in the table are located in countries with corruption or very corruption.[43]

The unstable political environment caused by these negative conditions prompts these countries' natural wealth to be targeted by different interest groups. The rebel groups, which easily find a field of activity in fragile and unstable countries, try to seize the natural wealth of countries they target to finance their activities.[44] Notably, the developments in South American

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[42] Clare Church and Alec Crawford, "Minerals and the Metals for the Energy Transition: Exploring the Conflict Implications for Mineral-Rich, Fragile States", p. 283.
[43] Ibid, p. 288.
[44] Ibid, p. 288.

and African countries rich in mineral reserves are remarkable. For example, the DRC had to struggle with wars and occupations in Africa for many years and still felt the effects of these crises. The country's cobalt reserves constitute one of the main income sources of separatist groups and militia armed organizations that want to seize the country. Hence, these organizations cause political crises in Katanga, where most of the country's cobalt reserves are located.[45]

South American countries such as Chile, Argentina, and Bolivia are also fragile and unstable countries with the richest lithium reserves globally, thus they are described as “the lithium triangle”. These countries take precautionary measures against foreign interventions despite their fragility and instability. While Bolivia was rocked by a coup in 2019, local communities in Chile have blocked mines in the Atacama to protest social inequality and environmental degradation caused by mining. In Argentina, grappled with deep economic crises, the change of government is also expected to affect new projects and lithium supply negatively.[46] The opposition and rebel groups target mines and facilities while economic crises shake reserve-rich countries, and political instabilities increase the risk of critical minerals supply worldwide. This causes trouble to energy markets and Western countries are also dependent on these products.

The new energy balance in critical minerals has been increasingly becoming strategic for major economies such as China, the US, the EU, and Japan while this balance also creates diplomatic tensions among them. China desires to use REEs for national production rather than exporting to add value to its own economy, and hence it limited its quota of REEs exports to 40% in 2010.[47] This policy of China is substantially shaping the new energy balance. When considering the interdependence between the US and China in terms of REEs imports and exports, this energy balance is recognized. Although the US, which has significant REEs and mineral reserves, imports approximately 80% of its REEs demand from China because the US cannot produce enough to meet the national demand.[48] Thus, China forces the US to acknowledge that it can use this dependency on imports as a counter trump in the ongoing trade dispute between the two countries since 2018. China reminds us that the option to limit REE exports is on the agenda whenever possible. This supply security risk originating from China causes a structural market problem for Western countries.[49]

This pressure factor was tested in China's diplomatic crisis with Japan in 2010. Japan's arrest of the captain of a Chinese fishing boat around the Senkaku Islands turned into a diplomatic crisis between the two countries. With the escalation of tension, China stopped the export of REEs as a sanctioning tool against Japan.[50] This venture of China has been defined internationally as a "rare earths weapon”. The US warned the countries that are dependent on China's exports. Germany stated that it would bring critical minerals issue to the agenda of the G20 summit, and the EU Trade Commissioner defined China's restrictive policy as a violation of international trade law.[51]

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[45] Marju Körts, “The Strategic Importance of Rare Earth Minerals for NATO, EU and The United States and its Implications for the Energy and Defense Sectors”, p. 27.
[46] Sophia Kalantzakos, “The Race for Critical Minerals in an Era of Geopolitical Realignments”. Italian Journal of International Affairs, 55(3), 2020, p. 4.
[47] Ibid, p. 4.
[48] Marju Körts, “The Strategic Importance of Rare Earth Minerals for NATO, EU and The United States and its Implications for the Energy and Defense Sectors”, p. 27.
[49] Ibid, p. 27.
[50] Jeffrey D. Wilson, “Whatever Happened to the Rare Earths Weapon? Critical Materials and International Security in Asia”. Asian Security, 14(3), 2018, p. 364.
[51] Ibid, p. 364.

Another crisis that gives the impression that China may not be a reliable supplier country was also experienced between the EU and China. According to the EU Commission's inspection, the real value of the price of solar panels imported from China was 88% more expensive than the normal selling price.[52] Thus, in 2013, the EU imposed anti-dumping on the imports of solar panels and solar cells procured from China, citing the very high import prices. Similarly, China imposed anti-dumping on wine imports from the EU countries and threatened to initiate an investigation against luxury car imports from Europe.[53]

China's strategy to turn REE exports into a diplomatic weapon has caused serious concerns for Japan, Australia, the US, and the EU. It has forced these countries to take various commercial and legal measures. To investigate how to handle possible future limitations in the procurement of critical materials, the Trilateral Conference on Critical Materials, with Canada and Australia's participation, was organized by Japan, the US, and the EU.[54] While Japan, the world's largest consumer of REEs, defines the restrictions as an invisible tsunami, the US, whose defense industry's supply chain is dependent on China's mineral oxides, initiated dispute proceedings at the World Trade Organization against China's restrictions on three elements in 2012.[55] After the supply crisis, Japan embarked on a search for supplier countries that could be China's alternative for REEs imports and signed a long-term supply agreement with Australian mining company, Lynas Group.[56] In 2016, the EU expanded its anti-dumping measures to China's export to the EU via Malaysia and Taiwan.[57] Australia, which realizes the most intensive mineral production globally following China, signed a strategic partnership agreement with India to supply REEs resources in 2019 to break China's superiority in the REE supply chain.[58] While Lynas Group decided to process the minerals at a facility in Texas in partnership with the Pentagon, another Australian company, Syrah, settled to establish a production line in the US state of Louisiana to transform graphite into the active anode material used in electric vehicles outside China.[59]

Global tensions regarding critical minerals are not only caused by China. The US, accusing China imposing trade restrictions and embargoes, have undertaken similar initiatives reminiscent of its past interventions in the Middle East. In this regard, due to the endangerment of its commercial interests, there is strong evidence that the US organized the coup in Bolivia with the world's largest lithium reserves. The government of Evo Morales, who had ruled Bolivia for many years, first signed a long-term agreement with China to produce lithium mines in 2019, and canceled the agreement with the German-based mining company, ACI Systems Alemania, due to the protests by the Bolivian people. After a week from his decision, Morales

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52 Yu Chen, “EU - China Solar Panels Trade Dispute: Settlement and Challenges to the EU”, European Institute for Asian Studies, 2019, Brussels, p. 1.
53 Ibid, p. 2.
54 Smith Karen Stegen, “Heavy Rare Earths, Permanent Magnets, and Renewable Energies: an Imminent Crisis”, Energy Policy, 79, 2015, p. 4.
55 Jeffrey D. Wilson, “Whatever Happened to the Rare Earths Weapon? Critical Materials and International Security in Asia”. Asian Security, 14(3), 2018, p. 365-366.
56 Teufel J. Dreyer, “China’s Monopoly on Rare Earth Elements-and Why We Sould Care”, Foreign Policy Research Institute, 07.10.2020, https://www.fpri.org/article/2020/10/chinas-monopoly-on-rare-earth-elements-and-why-we-should-care/2020, Accessed 01.04.2021
57 Sergey Paltsev, “The Complicated Geopolitics of Renewable Energy. Bulletin of the Atomic Scientists, 72(6), 2016, p. 394.
58 Eryk Bagshaw, “Australia's Race Against China's Rare Earths Weapon” The Sydney Morning Herald, 13.09.2020, https://www.smh.com.au/world/asia/australia-s-race-against-china-s-rare-earths-weapon-20200825-p55p8s.html, Accessed 01.04.2021
59 Ibid.

was overthrown by a civilian coup.[60] Evo Morales, who had to leave the country, claimed that their partnership with China and Russia to extract lithium mines disturbed the US. It was claimed to be a US-backed coup aimed at seizing the control of Bolivia's enormous lithium resources.[61] The fact that ACI Systems Alemania is one of the companies supplying lithium-ion batteries to Tesla,[62] one of the leading electric vehicle manufacturers based in the US, has strengthened the claim that the power behind the impact is the US.

The REE and critical mineral reserves on earth are found in maritime areas in addition to land regions. In this context, the concentration of reserves on the seabed around the controversial Exclusive Economic Zone (EEZ) and islands causes international tensions. One of these geopolitical tensions has been experienced between Japan and China. After the crisis with China in 2010, Japan budgeted 240 million US dollars to develop REE resources. Moreover, 83 million US dollars was allocated to research the potential of deep-sea mining to extract REEs.[63] Japan detected REE in the EEZ of Okinotorishima and Minamitorishima islands that Japan claims to be its own in the Pacific Ocean. This discovery soon triggered diplomatic tension between Japan and China.[64] After Japan's announcement in 2010 that it would build sea walls on these islands, in return, China declared that Okinotorishima is not an island but just a rock and cannot have its own EEZ. Thus, it opposed Japan's research for minerals in the seabed.[65] While the discussions between these two countries remain, Japan officially protested China's unauthorized seabed research around Okinotorishima in 2018 as a response to China’s conducting research on critical minerals in the same region.[66]

Another area of geopolitical competition regarding REE reserves is Greenland, which is an autonomous region connected to Denmark in the north of the Atlantic Ocean. The region is estimated to contain significant REE reserves. Kvanefjeld, located in the south of Greenland, has nine REE deposits, which are considered one of the largest reserve areas worldwide.[67] This potential of Kvanefjeld has opened a new competition area for China and the US and has led both countries to a race for mining investments in the region. China is establishing research stations to explore the region's wealth while developing diplomatic relations with Greenland on the one hand, and concentrates its investments in the Kvanefjeld region on the other. China's national mining company is involved in the Kvanefjeld (Kuannersuit) uranium project in Southern Greenland, and the Citronen Fjord zinc project in Northern Greenland.[68] In addition

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[60] Peter Koenig, “China-Bolivia- A lithium deal no more?”, Center for Research on Globalization, 2019, https://www.globalresearch.ca/china-bolivia-lithium-deal-no-more/5695530 , Accessed 01.04.2021

[61] AlJazeera, Morales Claims US Orchestrated Coup to Tap Bolivia’s Lithium, 25.12.2019, https://www.aljazeera.com/news/2019/12/25/morales-claims-us-orchestrated-coup-to-tap-bolivias-lithium, Accessed 01.04.2021

[62] eeNews Europe, German Secure Access to World’s Largest Lithium Deposit, 06.12.2018, https://www.eenewseurope.com/news/gaermany-secures-access-worlds-largest-lithium-deposit, Accessed 01.04.2021

[63] March Schmid, “Rare Earths in the Trade Dispute Between the US and China: A déjàVu”, p. 382.

[64] Ting, H. Ming and Seaman, John. “Rare Earths: Future Elements of Conflict in Asia?”, Asian Studies Review, 37(2), 2013, p. 247.

[65] Ibid, p. 247.

[66] Thinsanka Siripala, Japan Slams China for Unauthorized Research Around Okinotori Island, The Diplomat, 08.01.2019, https://thediplomat.com/2019/01/japan-slams-china-for-unauthorized-research-around-okinotori-island/, Accessed 01.04.2021

[67] Patrik Andersson, Jesper Zeuthen and Per Kalvig, “Chinese Mining in Greenland: Arctic Access or Access to Minerals ?”. (Ed.), Arctic Yearbook 2018, Special Section: China & the Arctic, Akureyri, Iceland; Northern, p. 110.

[68] Camila Sørensen, “China is in the Arctic to Stay as a Great Power: How China’s Increasingly Confident, Proactive and Sophisticated Arctic Diplomacy Plays into Kingdom of Denmark Tensions”, (Ed.), Arctic Yearbook 2018, Special Section: China & the Arctic, Akureyri, Iceland: Northern, p. 48.

to mining, China aims to increase the security of energy investments in the region by investing in naval bases and airports that can increase its military presence in the region.[69]

China's initiatives in diplomacy, energy and economy in Greenland prompted the US, which also has an airbase in the region. In 2017, the US Department of Commerce presented the Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals, aiming to create an alternative supply chain for REE outside China.[70] In 2019, the US signed a memorandum of understanding with the Greenland government to help develop the region's natural wealth, including REEs.[71] By taking further step, the then American President Donald Trump made a statement, shocking the world public opinion, that they wanted to buy Greenland.[72]

6. CONCLUSION

Historically, energy transition starting with the transition from wood and coal consumption has shifted towards renewable energy sources such as wind, sun, wave, and geothermal. In this transformation process, the most preferred energy sources used to be oil and natural gas, which are still the most consumed fuels today. In the last two centuries, oil and natural gas met Western countries' energy demand, especially the US. Therefore, Western countries have made intense diplomatic, military, political, and economic efforts to control and supply oil and natural gas resources, which have an asymmetrical distribution worldwide. These efforts, generally leading the military aspect, have led to wars, conflicts, coups, and crises, especially in the Middle East.

For fossil fuels, the dimensions of the struggles starting in the 20th century between the countries are changing with renewable energy sources and new energy technologies. The supply of critical minerals such as lithium, copper and cobalt are critical to the success of the energy transition, and in combating global warming and climate change, and ensuring energy supply security. Accordingly, the advantages of energy diversity and sustainability provided by renewable energy resources would only be felt when the supply of these elements and minerals provided safely and uninterrupted, at an adequate level and affordable costs.

The REEs and critical minerals have become a part of the ongoing global struggle for energy sources for decades. This struggle between the minerals producing, exporting, and importing countries creates new energy geopolitics in terms of energy security. However, in the new energy geopolitics for critical materials, historical behaviors and attitudes of the countries have not changed. During the 1973 oil crisis, embargoes, astronomical price increases and production restrictions imposed by oil-producing Arab countries against consumer countries are used by elements and minerals producing and exporting countries in the energy transition. Thus, REEs and critical minerals have become the new energy weapon used by producing and exporting countries, and the oil weapon of the 20th century has turned into critical minerals weapon in the 21st century. This weapon increases the risk of energy supply security for countries going through the energy transition and depending on the REE and minerals supply. The risk of the supply security threatens countries with constantly developing renewable energy

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[69] Jackie Northam, Greenland is not for Sale. But it has Rare Earth Minerals America Wants. NPR, 24.11.2019, https://www.npr.org/2019/11/24/781598549/greenland-is-not-for-sale-but-it-has-the-rare-earth-minerals-america-wants, Accessed 01.04.2021

[70] March Schmid, “Rare Earths in the Trade Dispute Between the US and China: A déjàVu”, p. 382.

[71] U.S. Department of State. Joint Statement on U.S.-Greenland MOU and Hyperspectral Survey, 06.06.2019, https://www.state.gov/joint-statement-on-u-s-greenland-mou-and-hyperspectral-survey/, Accessed 01.04.2021

[72] The Guardian. Trump Confirms He is Considering Attempt to Buy Greenland, 18.08.2019, https://www.theguardian.com/world/2019/aug/18/trump-considering-buying-greenland, Accessed 01.04.2021

infrastructures such as the US, Japan, Germany and Australia, and those countries with high element and mineral demand in many areas such as automotive, aviation and defense.

The main players shaping the new energy geopolitics are not only consuming Western countries and producer Middle Eastern countries as was the case in the 20th century. Countries with the rapidly increased use of renewable energy, such as China, South Korea, and India, are now the strong players of the new energy geopolitics. In particular, China is the strongest country in terms of the volume of REE reserves, production, importing and exporting in the market. In addition to its own reserves, it also invests in REE mines in other countries.

China has tried to turn its advantage in REEs producing and exporting into an energy weapon in international politics. In this respect, for China, the biggest rival is the US, which is heavily dependent on China for the supply of REE. The REE and critical minerals have become an instrument of the trade war triggering a global competition between the US and China. The US is establishing international collaborations and using international organizations to ensure the REEs supply security, and create an REEs supply chain that may be an alternative to China across the world. To balance China's power, the US aims strategic investments to the production centers and mines of REEs and mineral outside the country. Furthermore, by not giving up its old habits as in the Middle East, it tries to control the countries with REEs and minerals by attempting foreign interventions.

Despite China and the US being the leading countries for a long time, there are many other countries that have rich REE and mineral reserves. However, most of these countries are fragile or corrupt with corruption, political instability, internal conflict and economic problems. Therefore, this makes these countries increasingly open to external intervention by Western countries. Some initiatives bearing the traces of external intervention are taking place as happened in Bolivia.

Taken together, the discussions take us to this conclusion that the elements and minerals era today is becoming as important as the oil age, which triggered wars, coups, rebellion and foreign interventions during the 20th century. It can be claimed that elements and minerals would be one of the reference points for shaping international relations and international cooperation in the 21st century, and that the new energy geopolitics to have emerged in this context would be one of the sources of diplomatic tensions, trade wars, and global competition. It can also be concluded that the new energy geopolitics shifts from the Middle East to the Asia Pacific and Southern American countries, and as well as to a limited number of countries in Africa and Europe, where the elements and minerals are produced or its reserves are concentrated.

BIBLIOGRAPHY

AlJazeera, Morales Claims US Orchestrated Coup to Tap Bolivia’s Lithium, 25.12.2019, https://www.aljazeera.com/news/2019/12/25/morales-claims-us-orchestrated-coup-to-tap-bolivias-lithium, Accessed 01.04.2021

Andersson, Patrik, Zeuthen, Jesper and Kalvig, Per. “Chinese Mining in Greenland: Arctic Access or Access to Minerals ?”. (Ed.), Arctic Yearbook 2018, Special Section: China & the Arctic, Akureyri içinde (102-117). Iceland; Northern.

Arı, Tayyar. Geçmişten Günümüze Orta Doğu: Siyaset, Savaş ve Diplomasi, Dora, Bursa, 2014.

Bagshaw, Eryk. “Australia's Race Against China's Rare Earths Weapon” The Sydney Morning Herald, 13.09.2020, https://www.smh.com.au/world/asia/australia-s-race-against-china-s-rare-earths-weapon-20200825-p55p8s.html, Accessed 01.04.2021

Bloomberg. Why U.S. Cities Aren't Using More Electric Buses, 27.06.2019, https://www.bloomberg.com/news/articles/2019-06-27/why-china-is-winning-the-electric-bus-race, Accessed 01.04.2021

British Petroleum. Statistical Review of World Energy 2020, 69th Edition.

Chen, Yu. "EU - China Solar Panels Trade Dispute: Settlement and Challenges to the EU", European Institute for Asian Studies, 2019, Brussels.

Church, Clare and Crawford, Alec. "Minerals and the Metals for the Energy Transition: Exploring the Conflict Implications for Mineral-Rich, Fragile States". (Ed.), The Geopolitics of the Global Energy Transition, Springer, 73, 2020, pp. 279-304.

Dreyer, J. Teufel. "China's Monopoly on Rare Earth Elements-and Why We Sould Care", Foreign Policy Research Institute, 07.10.2020, https://www.fpri.org/article/2020/10/chinas-monopoly-on-rare-earth-elements-and-why-we-should-care/2020, Accessed 01.04.2021

eeNews Europe, German Secure Access to World's Largest Lithium Deposit, 06.12.2018, https://www.eenewseurope.com/news/gaermany-secures-access-worlds-largest-lithium-deposit, Accessed 01.04.2021

Egan, Teague. "Beating China at the Lithium Game - Can the US Secure Supplies to Meet Its Renewables Targets, 18.02.2020, https://www.utilitydive.com/news/beating-china-at-the-lithium-game-can-the-us-secure-supplies-to-meet-its/572307/, Accessed 01.04.2021

Gielen, Dolf, Boshell, Francisco, Saygin, Deger, Bazilian, Morgan, Wagner, Nicholas and Gorini, Ricardo. "The Role of Renewable Energy in The Global Energy Transformation". Energy Strategy Reviews, 24, 2019, pp. 38-50.

Hao, Han, Liu, Zzongwei, Zhao, Fuquan., Geng, Yong, and Sarkis, Joseph. "Material Flow Analysis of Lithium in China. Resources Policy, 51, 2017, pp. 100-106.

Harunoğulları, Muazzez. "Enerji Dağıtım Merkezi Perspektifinden Türkiye'nin Enerji Jeopolitiği", Mukaddime, 11(1), 2020, pp. 177-211.

İşcan, İ., Hakkı. "Uluslararası İlişkilerde Klasik Jeopolitik Teoriler ve Çağdaş Yansımaları". Uluslararası İlişkiler Dergisi, 1(2), 2004, pp. 47-79.

International Renewable Energy Agency (IRENA), Global Energy Transformation: a Road Map to 2050 (2019 edition). Abu Dhabi.

Johansson, B. "Security Aspects of Future Renewable Energy Systems–A Short Overview", Energy, 61, 2013, pp. 598-605.

Kalantzakos, Sophia. "The Race for Critical Minerals in an Era of Geopolitical Realignments". Italian Journal of International Affairs, 55(3), 2020, pp. 1-16.

Koenig, Peter. "China-Bolivia- A lithium deal no more?", Center for Research on Globalization, 2019, https://www.globalresearch.ca/china-bolivia-lithium-deal-no-more/5695530 , Accessed 01.04.2021

Körts, Marju. "The Strategic Importance of Rare Earth Minerals for NATO, EU and The United States and its Implications for the Energy and Defense Sectors", (Ed.) Energy Security: Operational Highlights, The NATO Energy Security Center of Excellence, 2020, pp. 24-40.

Manberger, Andre and Johansson, Bengt. "The Geopolitics of Metals and Metalloids Used for the Renewable Energy Transition", Energy Strategy Reviews, 26, 2019, pp. 1-10.

Manberger, Andre and Stenqvist, Björn. "Global Metal Flows in the Renewable Energy Transition: Exploring the Effects of Substitutes", Technological Mix and Development. Energy Policy, 119, 2018, pp. 226-241.

Northam, Jackie. Greenland is not for Sale. But it has Rare Earth Minerals America Wants. NPR, 24.11.2019, https://www.npr.org/2019/11/24/781598549/greenland-is-not-for-sale-but-it-has-the-rare-earth-minerals-america-wants, Accessed 01.04.2021.

Overland, Indra. “The Geopolitics of Renewable Energy: Debunking Four Emerging Myths” Energy Research & Social Science, 49, 2019, pp. 36-40.

O’Sullivan, Meghan, Overland, Indra and Sandalow, David, “The Geopolitics of Renewable Energy”, Center on Global Energy Policy Columbia University, Amsterdam Ave, 2017, New York.

Öğütçü, Mehmet. Yeni Büyük Oyun, Doğan Kitap, İstanbul, 2017.

Paltsev, Sergey. “The Complicated Geopolitics of Renewable Energy. Bulletin of the Atomic Scientists, 72(6), 2016, pp. 390-395.

Pamir, Necdet. Enerjinin İktidarı, Hayykitap, İstanbul, 2015.

Schmid, March. “Rare Earths in the Trade Dispute Between the US and China: A déjàVu”, Intereconomics, Leibniz Information Centre for Economics, 2019, pp. 378-384.

Siripala, Thinsanka. Japan Slams China for Unauthorized Research Around Okinotori Island, The Diplomat, 08.01.2019, https://thediplomat.com/2019/01/japan-slams-china-for-unauthorized-research-around-okinotori-island/, Accessed 01.04.2021

Sørensen, Camila. “China is in the Arctic to Stay as a Great Power: How China’s Increasingly Confident, Proactive and Sophisticated Arctic Diplomacy Plays into Kingdom of Denmark Tensions”, (Ed.), Arctic Yearbook 2018, Special Section: China & the Arctic, Akureyri, Iceland: Northern, pp. 43-58.

Stegen, Karen Smith. “Heavy Rare Earths, Permanent Magnets, and Renewable Energies: an Imminent Crisis”, Energy Policy, 79, 2015, pp. 1-8.

Swain, Basudev. “Recovery and Recycling of Lithium: a Review”. Separation and Purification Technology, 172, 2017, pp. 388-403.

Tamzok, Nejat. Kömür mü arayalım lityum mu?, 25.06.2018, https://www.enerjigunlugu.net/komur-mu-arayalim-lityum-mu-dr-nejat-tamzok-27794yy.htm, Accessed 01.04.2021

The Guardian. Trump Confirms He is Considering Attempt to Buy Greenland, 18.08.2019, https://www.theguardian.com/world/2019/aug/18/trump-considering-buying-greenland, Accessed 01.04.2021

The International Energy Agency. Global EV Outlook 2020, https://www.iea.org/reports/global-ev-outlook-2020#, Accessed 01.04.2021

The International Energy Agency. Renewables, https://www.iea.org/fuels-and-technologies/renewables, Accessed 01.04.2021

The International Energy Agency. Renewables 2019: Analysis and Forecast to 2024, https://webstore.iea.org/download/direct/2854?fileName=Renewables_2019.pdf, Accessed 01.04.2021

The International Energy Agency. Renewables 2019: Market Analysis and Forecast from 2019 to 2024, https://www.iea.org/reports/renewables-2019, Accessed 01.04.2021

The Lithium Market, Fox Davies Capital, 01.09.2013 http://doc.xueqiu.com/1497add8471193fc2e583642.pdf, Accessed 01.04.2021

Ting, H. Ming and Seaman, John. “Rare Earths: Future Elements of Conflict in Asia?”, Asian Studies Review, 37(2), 2013, pp. 234-252.

United Nations. The Paris Agreement, 2020, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement, Accessed 01.04.2021

U.S. Department of State. Joint Statement on U.S.-Greenland MOU and Hyperspectral Survey, 06.06.2019, https://www.state.gov/joint-statement-on-u-s-greenland-mou-and-hyperspectral-survey/, Accessed 01.04.2021

Wilson, D., Jeffrey. “Whatever Happened to the Rare Earths Weapon? Critical Materials and International Security in Asia”. Asian Security, 14(3), 2018, pp. 358-373.