New Strategic Commodities

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Energy Industry Report

The Al-Attiyah Foundation

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INTRODUCTION

NEW STRATEGIC COMMODITIES

The rise of new energy systems and progressing transition to low-carbon energy sources draws attention to emerging strategic resources. These resources include critical minerals lithium, copper and rare earths required in renewable energy systems. They also include renewable resources, such as high-quality sites for wind, solar, geothermal and hydro power, and subsurface space for carbon dioxide storage.

New strategic resources have varying characteristics and are different in location and nature to oil and gas. How will these new commodities shape the energy transition, geopolitics, and trade?

Energy Industry Report

This research paper is part of a 12-month series published by The Al-Attiyah Foundation every year. Each in-depth research paper focuses on a prevalent energy topic that is of interest to The Foundation's members and partners. The 12 technical papers are distributed in hard copy to members, partners, and universities, as well as made available online to all Foundation members.

EXECUTIVE SUMMARY

- A transformation of the global energy system driven by renewables and low-carbon energy systems could introduce radical changes across the geopolitical landscape.
- The change in the global political landscape will force states to reposition themselves in the international system as they race to become global low-carbon energy leaders, lead to a relative decline in the influence of fossil fuel exporters, allow fossil fuel importers to improve their energy security, and create opportunities for certain countries to take advantage of their new energy endowment.
- Some of the metals and minerals used in renewable energy technologies, mainly rare earth elements, may be subject to a similar kind of competition, contest, and control as for fossil fuels.
- However, the geopolitics of new strategic resources will be quite different from that of oil and gas. Low-carbon resources are more varied and dispersed. Minerals are relatively easy to transport and stockpile, and do not lead to immediate crises if supplies are interrupted. The processing and manufacturing chains are as important or more than the extraction.
- The new energy landscape will be a result of a reconfiguration of strategic alliances and the geography of international trade. Key energy resources, both mineral and renewable will play a role alongside more dominant factors of geo-economics and technology.

THE FUTURE GLOBAL ENERGY SYSTEM

The uptake of renewable and other new energy systems has accelerated and increased in economic and technological feasibility. It is receiving an ever-stronger push from national and corporate policies, represented by 'net-zero' commitments by many leading economies, and scenarios from prominent bodies such as the International Energy Agency.

At the same time, there is considerable uncertainty surrounding the ongoing energy transition – it remains to be seen which technological innovations will accelerate this transformation. The early stage of the transformation means that limits – whether of minerals or suitable land – have not yet been major constraints.

The primary aspects that define the transformation of the global energy system are 1) the growth of renewable energy capacities and their supporting systems, 2) increasing electrification of end-user sectors, notably transport and 3) improvements in energy efficiency that enable economic growth with lower energy inputs.

Renewable energy generation is increasing at a faster rate than overall demand for electricity. In 2019, global renewable electricity generation increased by 14% from the previous year, whereas global electricity consumption increased by 1%, and electricity generation from fossil fuels decreased by 1% [i].

Renewable energy sources, mainly solar and wind, are the fastest growing sources of energy with solar generation increasing by 43% / year and wind generation increasing by 18% / year between 2009 – 2019. The impact of this extraordinary growth is mainly observed in the power sector where renewable energy sources account for 10% of the global electricity generation mix. Countries such as Germany, Spain and the United Kingdom generate more than a quarter of their electricity from renewable energy sources.

Electricity accounts for 19% of final energy consumption and its share is projected to grow as technological disruptions across various sectors and industries increase the electrification of end-use sectors. An example of this is the transport sector, which has shown early signs of disruptive acceleration. The increasing electrification of the transport sector is mainly due to the market acceptance of enabling technologies such as electric vehicles and battery storage systems, combined with the rapid cost reductions of solar PV and offshore wind generation.

In contrast to transport, renewable energy penetration across the residential, commercial, and industrial sectors is growing at a slower rate. Renewable energy technologies here remain well below the levels required to create a sustainable, less carbon intensive energy system. However, as well as electrification

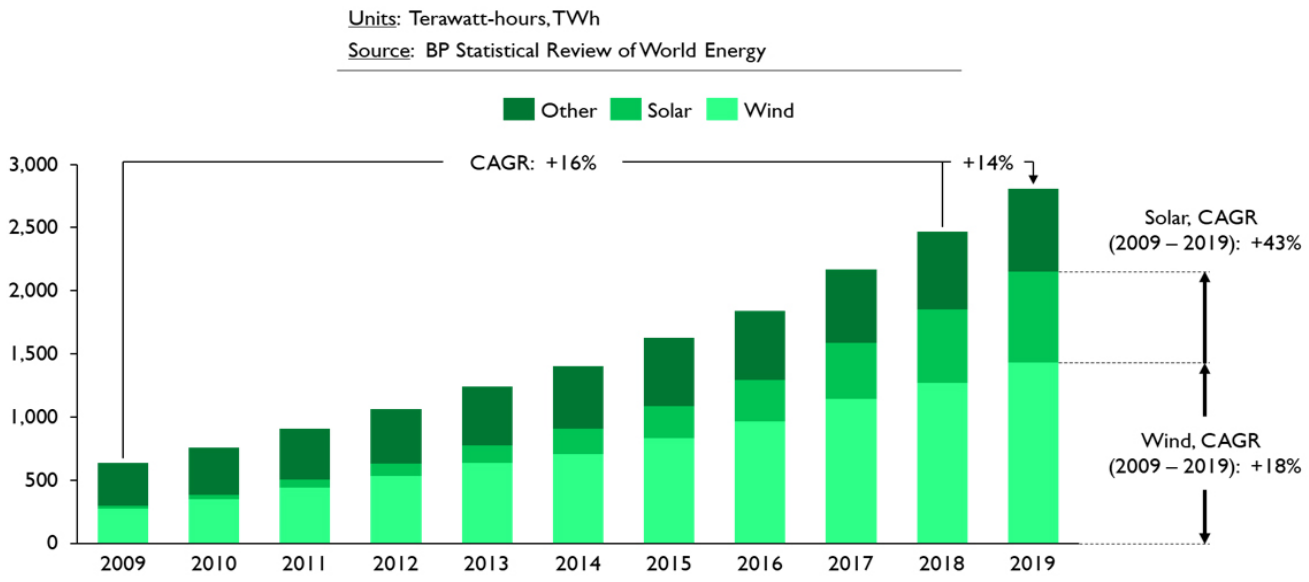
using low-carbon sources for demand such as residential and industrial heat, growth of renewables across these sectors could accelerate in the future with ongoing progressions in energy efficiency and biofuels developments.

In the 20th century, global average energy consumption growth rate and the GDP growth were both ~3%[ii]. Primary energy demand is estimated to grow by 1% / year by 2040[iii]. However, energy efficiency improvements and the increasing deployment of renewable energy technologies, combined with deep electrification of end-uses, will overturn this long-term trend. They can offer the most effective way to achieve more than 90% of the carbon mitigation measures required to reduce energy related GHG emissions, which is required to meet the Paris Climate Agreement target[iv].

Fossil fuels have been the backbone of the global energy system, the economic growth narrative, and the modern consumer lifestyle since the early nineteenth century for coal and the mid-twentieth century for oil. As result of this, the geographic concentration of oil, gas, and coal reserves provided countries with significant leverage in terms of wealth and security, which ultimately helped shape the global geopolitical landscape. Key instances include the US supply of oil to the Western allies in the two world wars contrasted with Germany's and Japan's lack of petroleum. Oil revenues allowed the Soviet Union's economy to survive without reform much longer than it otherwise would have done, but contributed to its collapse when prices fell. And possession of the world's largest and lowest-cost reserves has helped make the Middle East one of the key strategic global regions, contributing to great wealth and power in some of its states but to conflict and economic failure in others.

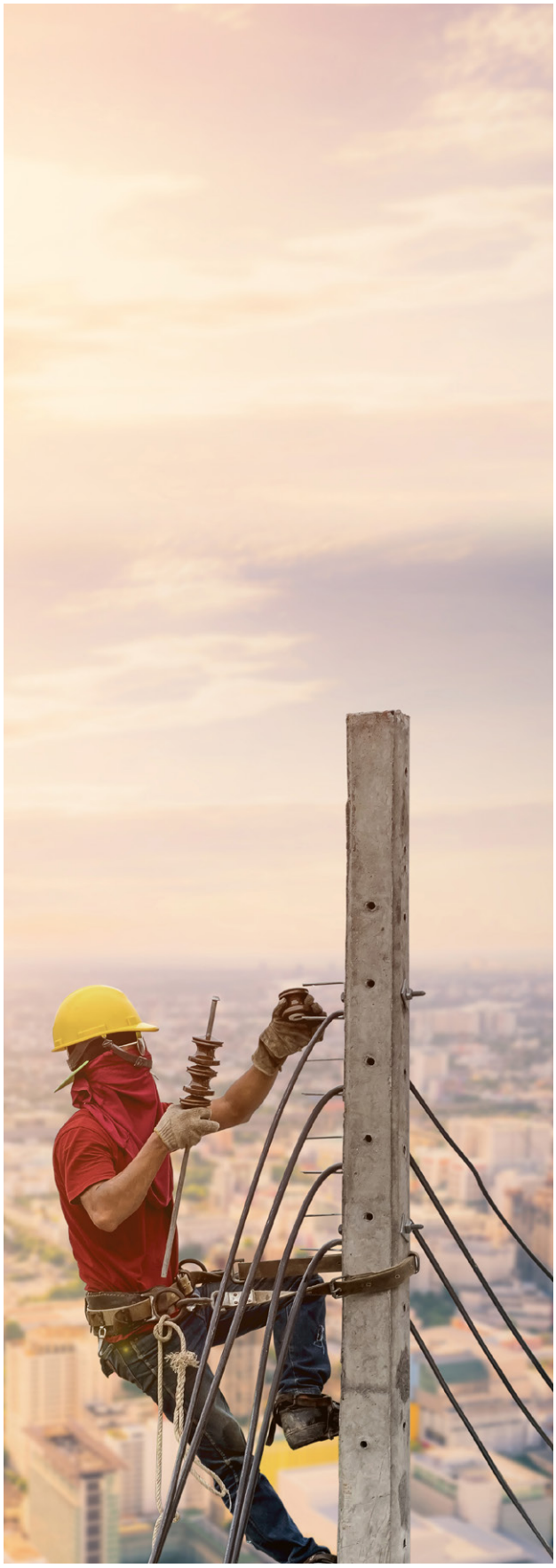
A transformation of the global energy system driven by renewables and other low-carbon energy systems could introduce radical changes across the geopolitical landscape. The differences between renewables and fossil fuels in terms of size, location and nature determine the geopolitical consequences.

FIGURE 1 RENEWABLE ENERGY GENERATION



Firstly, fossil fuels are an energy stock that is permanently expended when used, whereas renewables are energy flows that are not permanently expendable – making them harder to disrupt. However, while fossil fuels are quite easily transported and stored, electricity (from renewables or other sources) is hard to transport over long distances or to store in quantity for long periods. Critical minerals, by contrast, can easily be both transported and stored. Secondly, although some areas have better renewable resources than others, unlike fossil fuels, most renewable energy resources are not concentrated in a specific geographic location. They are also more varied, with good locations for solar, wind, biofuels and hydroelectric not generally coinciding. This reduces risks associated with their supply and the importance of key maritime or land energy transit routes. Thirdly, renewable energy resources can be captured at any scale and integrated to any decentralised system, which could democratise energy generation. And finally, most renewable energy sources have low to zero marginal costs, have experienced steady cost reductions over recent years, and once installed, their costs are predictable, unlike the volatility of fossil fuel prices[v]. However, renewables are affected by daily and seasonal fluctuations and weather events.

Critical minerals are geopolitically different again. They are more varied and dispersed than fossil fuels, but some specific minerals are very concentrated, often in countries that are politically unstable or have a poor investment climate.



CHANGING POWER POLITICS LANDSCAPE

The ongoing energy transition and the subsequent rise in the share of renewables in the global energy mix will the change global political landscape by:

- forcing states to reposition themselves in the international system as they race to become leaders in the global renewable energy race;
- lead to a relative decline in the geopolitical influence exhibited by fossil fuel exporters;
- allow fossil fuel importers to improve their energy security and energy independence;
- and, allow certain countries to take advantage of their endowment of renewable energy generation, materials used in new energy systems, and / or renewable energy technologies to emerge as global renewable energy leaders and enhance their geopolitical influence.

A state's relative position in the international system, among many factors, includes having control and / or reliable access to energy resources, which is an important factor in protecting its national interests, enhancing its economic leverage, and projecting political influence abroad.

In the context of the geopolitical energy landscape, how different countries position themselves in the international systems among others is dependent on how they fare in the race to become technological and renewable energy leaders, counterbalancing their exposure to changes in the global fossil fuel sector.

The United States, China and Europe are at the forefront of the race to become renewable energy leaders. The US has fallen behind in the manufacturing of low-carbon energy systems and is relatively limited in mining and processing of critical minerals. However, US-based companies hold the most significant global market share in the innovation and development of new technologies with applications across the entire energy sector, including robotics, artificial intelligence, fourth-generation nuclear power, batteries, and electric vehicles (such as, Tesla and Lucid Motors). It also fares well on renewable energy deployment and resources, with strong wind, solar, hydroelectric, geothermal, and biofuel potential.

In comparison to countries across Europe and China that are highly dependent on fossil fuel imports, the US is the closest to energy self-sufficiency, albeit with a high exposure to the global fossil fuel sector as a result of its domestic shale revolution. Despite being well-positioned in the global renewable energy race it is also the world's largest producer of oil

and gas. This could be vulnerable to the shale sector's high decline rates, relatively high costs and political unpopularity with a proportion of the electorate.

By contrast, China is a leading global manufacturer of renewable energy technologies and components. The country's renewable energy sector is a larger recipient of investments than any other country – in 2019 it attracted US$ 86 bn[vi]. China is particularly strong in the manufacturing of solar photovoltaic systems and batteries. It is weaker, though, in wind turbines and electric vehicles. China stands to gain from the energy transition in terms of improving its energy security, given its reliance on oil and gas imports, much of which could be vulnerable to US naval blockade in the case of conflict. China is the world's leading miner and / or processor of most critical minerals, notably rare earth elements, copper, lithium, aluminium, tin, graphite, silver and others. This gives it a key position in new energy supply chains.

Across Europe, Germany leads the global race to become a technological and renewable energy leader. The country holds the largest number of renewable energy patents by any single European country, which currently stand at ~31,000. Denmark is strong in wind turbine manufacturing. Enel, Engie, Iberdrola, Siemens, and Vestas are leading developers and deployers of new energy systems.

Europe is the global leader in offshore wind deployment. However, it has lost most of its solar PV manufacturing to Chinese competition, and is similarly, concerned about losing its battery industry. European automakers are also trying to transition to manufacturing EVs, which are acquiring a strong market share in Norway, the Netherlands and elsewhere. Finally, Europe is concerned about its dependence on the import of critical mineral, and has developed a list of 29 of these substances[vii].

Russia's deployment of renewable energy, other than hydropower, is very weak. The country is beginning to increase its use of renewables, and in 2019, the sector attracted US$ 1.5 bn of investment, still lagging behind competitors. Russia has only belatedly begun developing a hydrogen strategy, and manufactures little in new energy systems. However, it is the most important miner and resource holder of critical minerals after China, particularly in aluminium, nickel, cobalt and platinum-group metals.

Moreover, it is also the most exposed to changes in the global fossil fuel sector. Russia is the second largest net exporter of oil after the Middle East and the largest exporter of gas. Russia's economy is more diversified than other oil and gas exporters in the Middle East but its slow progress in adapting to the energy transition poses a long-term challenge.

Other countries have secondary but still significant roles in the energy transition, whether as suppliers of key materials or systems, or markets. These include Japan, which is a leader in developing the use of hydrogen, Iceland as a pioneer of hydrogen, geothermal and carbon mineralisation, Indonesia in geothermal and biofuels, Kenya for geothermal energy, Turkey, South Africa, South Korea, Canada, Brazil and Australia.

Fossil fuel exporters (mainly OPEC members) that have traditionally projected their geopolitical influence as global exporters and suppliers of fossil fuels are also vulnerable to the ongoing energy transition. The transition will increasingly pressure global oil and gas prices, which impacts their fiscal budgets, subsequently forcing them to rethink their national priorities, strategies, and economic diversification plans.

Fiscal budgets in countries such as Libya, Angola and Democratic Republic of Congo are highly exposed to oil and gas rents, which account for more than a quarter of their respective GDP. These countries lack the resilience to battle the changes in the global fossil fuel sector due to low per capita GDP, high debt burdens, and low sovereign reserves, along with undiversified economies and weak state capacity.

The oil and gas exporters of the GCC are much more resilient, given their significant sovereign reserves, financial capacity, high-quality infrastructure and stronger governance. Although fiscal budgets across the GCC countries are highly exposed to volatile oil and gas rents, in recent times these countries have recognised the new reality and embarked on ambitious plans to diversify their economies to boost the domestic share of low-carbon energy, including renewables and nuclear, improve energy efficiency and cut subsidies, and explore new technologies of hydrogen and carbon capture. Nevertheless, these approaches cannot replace hydrocarbon rents, and pose the GCC countries with major long-term challenges.

They also have to contend with political instability in their neighbourhood, along with state weakness in other Middle Eastern countries who are less able to cope with volatility in hydrocarbon earnings.

In comparison to the fossil fuel exporters, the transition to renewables allows fossil fuel importers to enhance their energy security. The increased deployment of low-carbon energy allows fossil fuel importers to have 1) greater energy independence and flexibility with lower political dependence on suppliers 2) reduced risks to disruptions in maritime or overland energy supply, 3) reduced exposure to oil and gas price volatility caused by political instability, terrorist attacks, and armed conflict across fossil fuel exporting countries, and 4) reduced import burden with improved trade balance.

Renewable energy generation may not allow fossil fuel importers to achieve full energy independence, however. They are still likely to rely on imports of manufactured energy systems as well as critical minerals. The seasonal variability of renewables means that

FIGURE 2: FOSSIL FUEL RENTS (OIL, GAS, AND COAL) AS A PROPORTION OF GDP, 2019

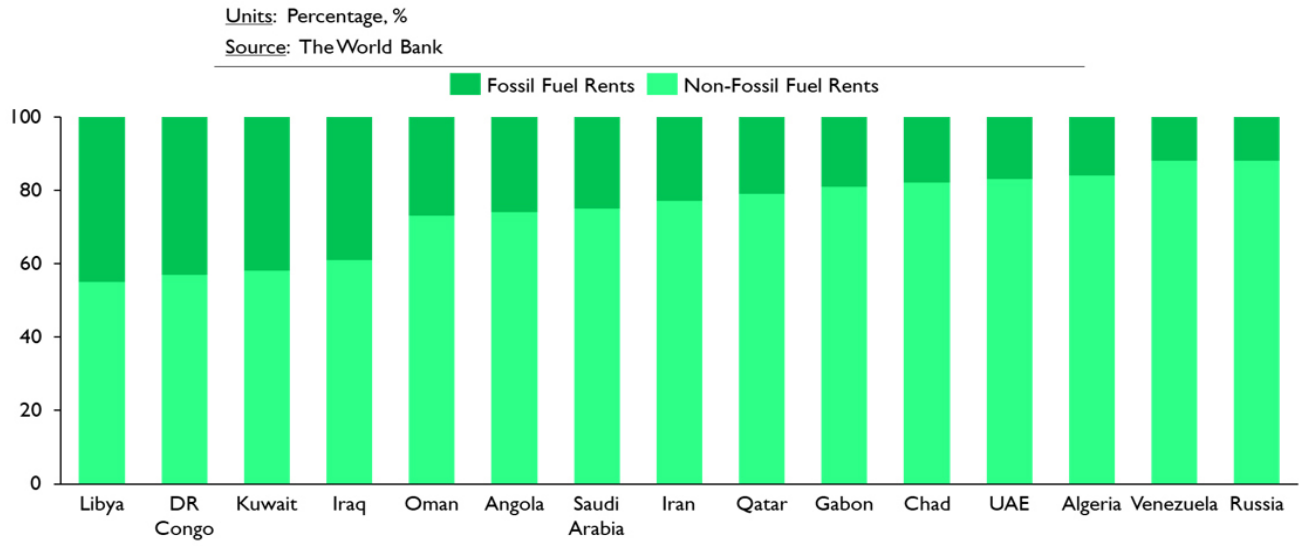
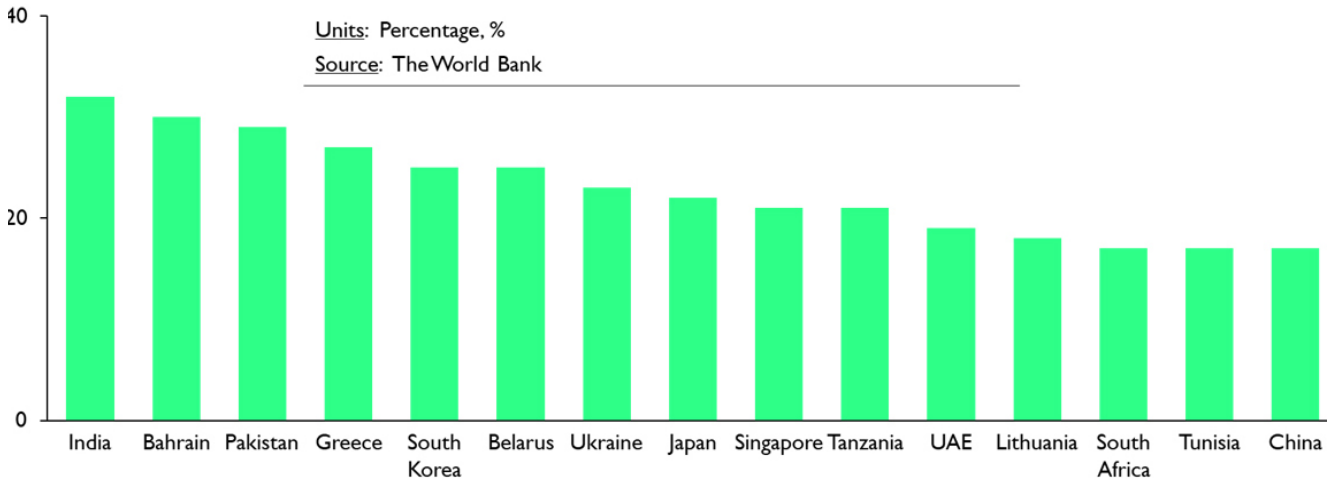


FIGURE 3:FOSSIL FUEL IMPORTS AS A PROPORTION OF ALL IMPORTS, 2019



international trade of electricity, biofuels and perhaps hydrogen will be important.

Furthermore, a key feature of the changing global political landscape induced by the ongoing energy transition is the rise of new renewable energy leaders. These leaders could be 1) renewable energy technology innovators, 2) large renewable energy producers (or electricity producers), and / or 3) or countries endowed with significant metals and minerals resources that are used across the renewable energy value chain.

Countries endowed with a high technical resource for renewable energy stand to achieve the greatest if they export their electricity generated through regional grid connections or hydrogen. Countries such as Australia, Chile, Morocco and Saudi Arabia are among those with the best combination of solar and wind resources. The Atacama Desert in Chile has a long-term annual average global horizonal irradiation (GHI) that ranges between 730 kWh / m^2 – 2,556 kWh / m^2 and the south-western region of Saudi Arabia has a solar resource of 2,045 kWh / m^2– 2,410 kWh / m^2[viii]. Smaller states such as Bhutan, Nepal and Tajikistan have the potential to export hydropower, helping balance their neighbours' renewable generation. Norway already plays this role in Europe.

The ongoing energy transition also provides countries endowed with a large metals and minerals resource an opportunity to emerge as new renewable energy leaders. Some countries operate a near-monopoly on these materials. The Democratic Republic of Congo accounts for 64% of the global supply of cobalt, Australia produces 53% of lithium, and China contributes 60% of graphite and 63% of rare earth elements (REE)[ix]. Some such countries carry geopolitical concerns, either because they may be subject to domestic political stability, labour unrest, corruption and similar problems, or because they may seek to leverage their resources for political reasons, as discussed below.

As the race for leadership heats up, the geopolitical landscape could see certain countries dominating technologies, energy generation, and / or supply of metals and minerals, which monopolises innovation, restricts supplies, and distorts markets. Countries that are dependent on imports will further voice their arguments for fair trade and a rules-based international trading system. Yet the structure of the global energy trade flows will still be far from the market dominance enjoyed by fossil fuel producers over the last two centuries given the abundant nature and varied geography of renewable energy resources.

Hence, the impact of the ongoing transition from fossil fuels to renewables will change the global political landscape no less than the transition to coal and steam during the Industrial Revolution of the 19th century and the transition to oil and gas during the 20th century.

FIGURE 4: GLOBAL RARE ELEMENT (REE) AND LITHIUM MINES, DEPOSITS, AND OCCURRENCES,2019

Source: British Geological Survey

RECONFIGURATION OF STRATEGIC ALLIANCES AND GEOGRAPHY OF TRADE

As the ongoing energy transition changes the global political landscape, it will also reconfigure strategic alliances, multilateralism, and the geography of international trade.

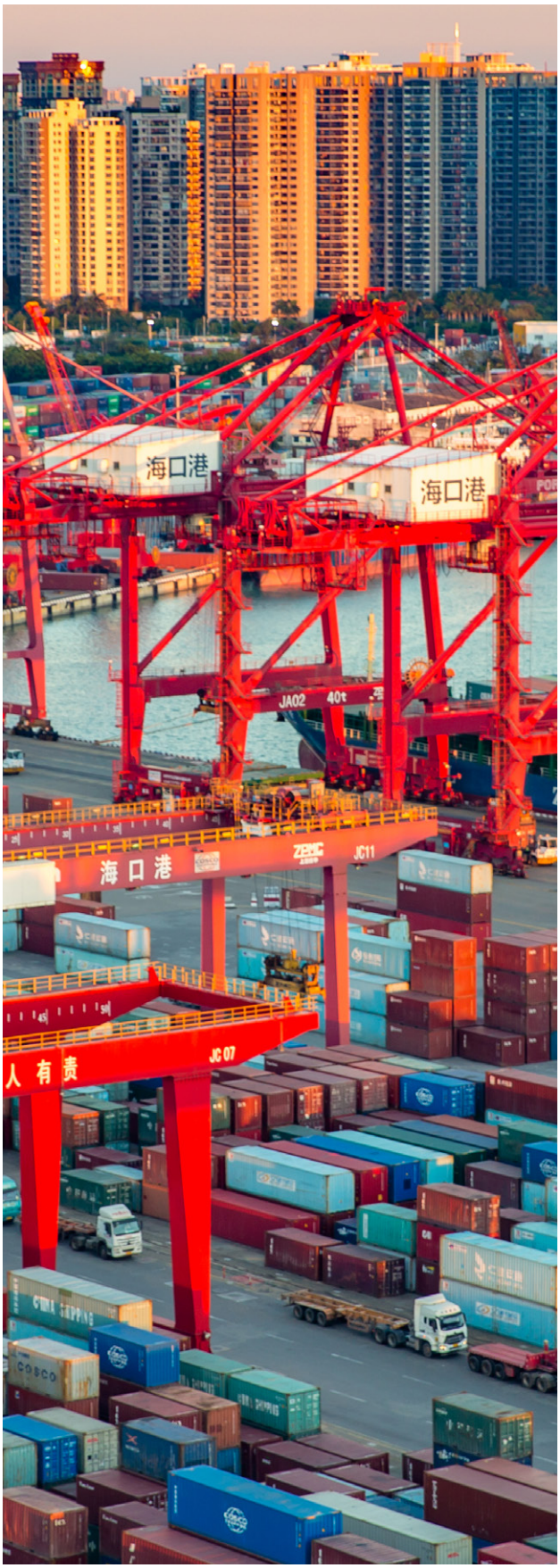
If fossil fuels continue to lose market share to renewables and other non-fossil systems, strategic alliances that were previously forged on control and access to reliable source of fossil fuel supply could lose their rationale. This will impact the role of energy organisations, notably OPEC and the OPEC+ framework with Russia and others. The bilateral relationship between the US and Saudi Arabia, already seen as less necessary for Washington because of the rise of shale oil output, could undergo a further downgrade.

Since its establishment in 1960, OPEC has exhibited enormous resilience in coordinating and unifying the oil policies of its member countries and ensuring the stabilisation of the oil market in light of price shocks and conflicts among its members. Amid the structural changes in global energy markets, Qatar's decision to leave the group in 2018 to pursue an independent strategy highlights the challenges OPEC faces. In addition to this and despite opposing geopolitical priorities, the rapprochement between Saudi Arabia and Russia has led to the formation of OPEC+ in order to stabilise global oil markets, initially to counter US shale oil output, then to deal with the demand collapse of the COVID-19 pandemic in early-mid 2020. OPEC has thus already reinvented itself; it may have to do so again to help its members decarbonise and adjust to a world of lower oil rents.

The Gas Exporting Countries Forum (GECF), based in Doha, Qatar, is less established than OPEC but could perhaps play a similar role for gas, which is also coming under increasing climate challenge.

Multilateral initiatives under the UN Framework Convention on Climate Change (UNFCCC), leading to the Kyoto Protocol and the Paris Agreement on climate change (2015), provide a platform for countries to rethink energy diplomacy and consider new energy alliances. There are numerous potentially relevant institutions, some multinational, some containing corporate and academic members, some focused more on policy and others on investment or technology development. These include the International Renewable Energy Agency (IRENA), the Global Carbon Capture and Storage Institute (GCCSI), the Hydrogen Alliance, the International Geothermal Alliance, Mission Innovation, the Desertec Industrial Initiative, the Oil & Gas Climate Initiative, and others. But perhaps the geopolitically most consequential international cooperations are China's Belt and Road Initiative (BRI), and the recently announced G7 counterpoint[x]. The BRI has a number of objectives and motivations, including securing and deepening Chinese trade routes, including energy. It has been criticised, though, for an overly heavy focus on coal power to the exclusion of renewable energy (most of its renewable energy component is big hydropower, which is also environmentally damaging). By contrast, the G7 plan is intended to be low carbon, but details on the finance available are still limited.

As the ongoing energy transition shifts strategic alliances and international relations, it will also reconfigure international trade through new connections. The global renewable energy trade currently consists of three types of commodities, 1) renewable energy technologies, components, and materials, 2) electricity interconnections and grids, and 3) renewable energy fuels such as hydrogen.



CHINA WILL BE THE LARGEST CONTRIBUTOR TO GLOBAL GAS DEMAND GROWTH

As Figure 5 shows, the global markets for energy and other key minerals are still dominated by fossil fuels and precious metals: oil, gas and LNG, coal and gold. The common industrial metals, iron, aluminium and alumina, and copper, come next. Note this excludes use within countries (non-exported), which would likely increase the role of fossil fuels even further given that much oil and gas, and most coal, is used domestically. Fossil fuels amounted in 2019 for almost $2 trillion of trade, the major industrial metals (in ore or raw form, excluding processed metals) for $310 billion, and all the other illustrated commodities, including electricity, for just over $170 billion (a few minor metals and ores would boost this total slightly; it is mostly composed of electricity, palladium, zinc, silver and nickel).

Unlike the global trade of fossil fuels, renewable energy trade will consist of countries specialising in production based on their comparative advantage as a combination of resource quality, technology and financing (dissimilar to fossil fuels where resource rents are based primarily on natural endowment).

Due to the high costs of transporting electricity or hydrogen over long distances, and the wide distribution of renewable potential, they will only generate very limited rents. The main rent may be from the production of energy-intensive secondary commodities, such as ammonia, steel and aluminium, which can be transported easily. This pattern is already observed in the global aluminium industry, which is based in areas with cheap electricity.

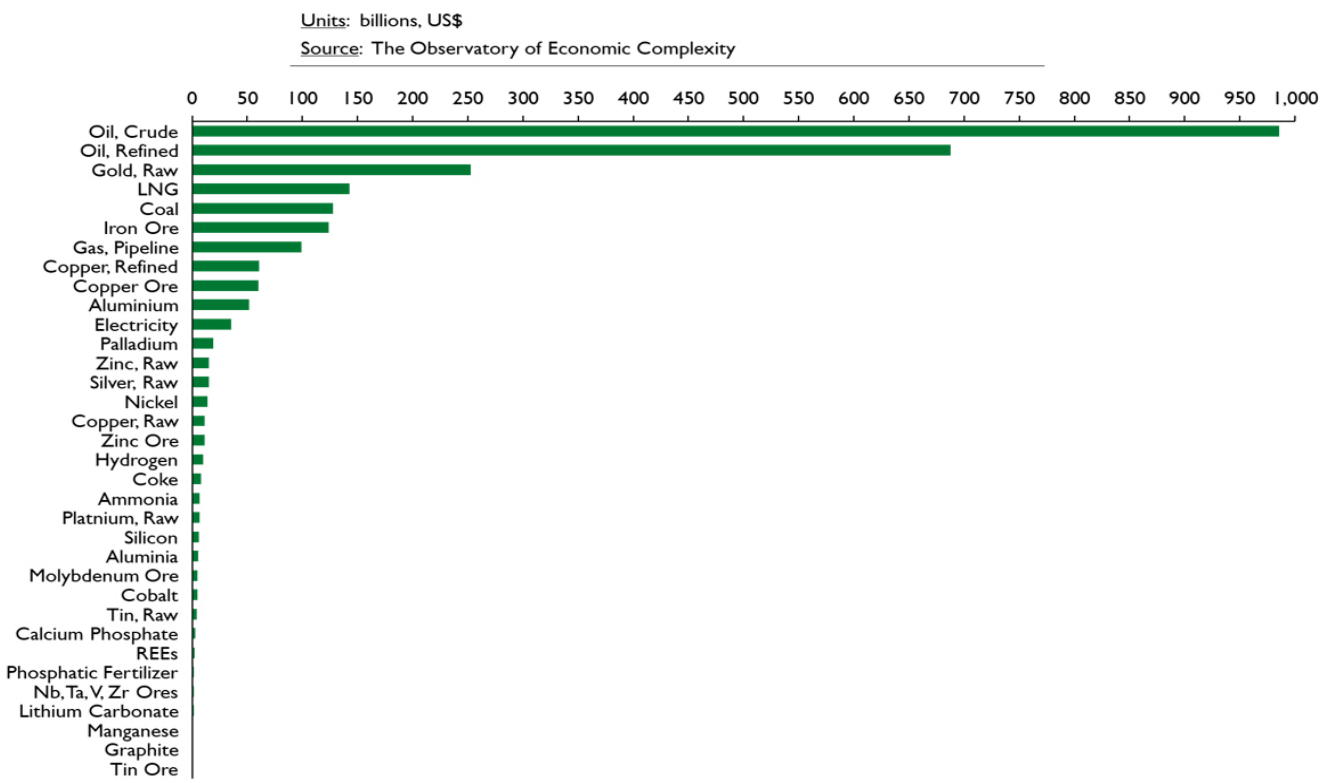
These characteristics suggest that critical material producers will find it very difficult to establish an effective cartel in the path of OPEC for oil. Indeed, there has been no international gas cartel (the Gas Exporting Countries' Forum, GECF, has never tried to set production or export levels or prices). The Intergovernmental Council of Copper Exporting Countries (set up in 1967 and dissolved in the 1990s) and the Association of Natural Rubber Producing Countries (established 1970) were not successful in cutting output or raising prices significantly. As critical minerals are different, are not all found in the same countries, and

have substitutes, it will be challenging to set up an effective cartel. The most likely scenario would be a single powerful country, such as China, Russia or the US using its dominance in one or a few critical minerals, either as seller or buyer, as part of trade or diplomatic pressure against another country. Russia has indeed played this role at times in gas against some Central Asian and eastern European countries.

In the future, electricity connectivity and regional interconnections will complement a country's land, sea, and air communications. Electricity infrastructure will be considered an important component of national security and its significance will grow as new transmission, distribution, storage, and interconnections are introduced.

In 2015, the State Grid Corporation of China, which is China's largest state-owned power and utilities corporation, proposed a global electricity network called the Global Energy Interconnection (GEI) that connects all the continents of the world with high-voltage, direct current (DC) undersea transmission cables for 'green' electricity. Along with other infrastructure projects such as the Belt and Road Initiative (BRI), the GEI highlights China's two strategic intentions. Firstly, the country intends to diversify its energy supplies from strategic maritime energy routes such as the Strait of Hormuz, the Strait of Malacca, South China Sea, and East China Sea. And secondly, China views infrastructure diplomacy as a crucial element of geopolitical power and influence in 21st century, similarly to how the US viewed the protection of important maritime energy shipping routes as an element of global hegemony in the 20th century.

FIGURE 5: WORLD EXPORTS OF ENERGY AND OTHERS STRATEGIC MINERALS,2019



CHANGING NATURE OF CONFLICTS

In the past fossil fuels were the primary link between energy, international security, and conflict risk as the control of oil and gas resources led at times to political unrest, territorial disputes, economic volatility and interventions by global powers concerned with securing their supply chain.

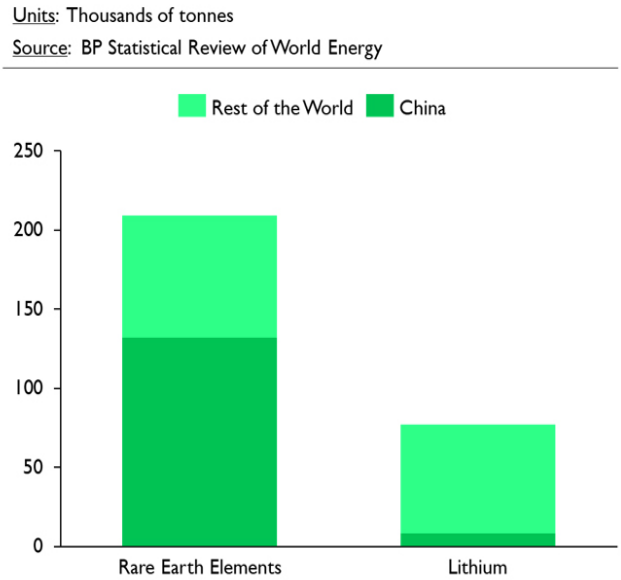
The increasing penetration of renewables should reduce the worst impacts of climate change, itself a strong driver of conflict. Yet, some of the key new energy metals and minerals could themselves be contested.

The negative externalities associated with the changing landscape of critical mineral extraction increase the risk of three types of conflicts. They are, 1) violent conflicts in resource-holding countries with weak governance system, where resource earnings incentivise and fund conflict, 2) competition among states over key commodities, and 3) the weaponisation of these metals and minerals across international trade disputes.

The largest reserves of metals and minerals required for renewable technologies are found in countries that have poor governance systems, weak institutions and rule of law, which often results in violent conflicts. Like the resource curse of several fossil fuel producers, these countries typically experience corruption and violence by belligerent groups that compete for control of the wealth-generating mining sector. However, given the lower rents from mining as compared to hydrocarbons, it does not appear to distort the entire domestic economy in the same way.

An example of such a country is the Democratic Republic of Congo. The DRC produces 53% of the global supply of cobalt, which is a key input raw material in the production lithium-ion-based batteries that are used in electricity grids and electric vehicles. The country's mining sector and wealth has led to the creation of more than 70 armed groups, large-scale human rights violations, and displaced millions of people [xi]. The country's security internal security could further escalate as demand for cobalt increases.

FIGURE 6: GLOBAL MINE PRODUCTION OF REE AND LITHIUM,2019



Furthermore, as demand for metals and minerals increases, so does the competition for "global commons", such as the Arctic Ocean and South China Sea, contested maritime territories that may contain significant resources.

As the Arctic ice-sheets retreat, the Arctic Ocean further opens for shipping and hydrocarbon and mineral exploration, which drives countries that claim regional territory to assert their argument more forcefully. This has

already been seen with Chinese investment in Greenland, which has deposits of rare earths and uranium, and Russia's aggressive moves to claim Arctic Ocean seafloor and construct military bases, observation posts and ports.

Across the South China Sea, China has increasingly violated sovereign maritime claims to ocean floors by surrounding

countries, which has escalated disputes and tensions, with the objective of establishing control of metals and minerals under the ocean floor. China is increasingly developing deep-sea mining capabilities[xii].

And finally, any country's hegemony or near-monopoly over the extraction of these metals and minerals will create a weaponisation effect of resources across international trade disputes. China produces 63% of the global supply of rare earth elements (REE).

REEs are 17 metals that a that have unique characteristics, such as magnetism, luminescence, and strength. Contrary to their name they are not rare! They are found under the earth's crust and are relatively abundant. However, these metals are highly scattered and are typically found with other metals and mineral deposits, which makes them difficult to mine and separate.

China's near monopoly over the supply of REE is of such economic importance that it is highly centralised and tightly controlled. For example, one Chinese firm, Tianqi Lithium, through its acquisition of a Chilean mining company, Sociedad Química y Minera (SQM), controls ~50% of the global supply of lithium. [xiii] China is also trying to consolidate firms to control the manganese market[xiv]. In response, the US has tried to encourage its allies to step up mining of REEs and other critical minerals, develop its processing capacity, take government stakes in some key minerals' firms, and research unconventional sources of such materials.

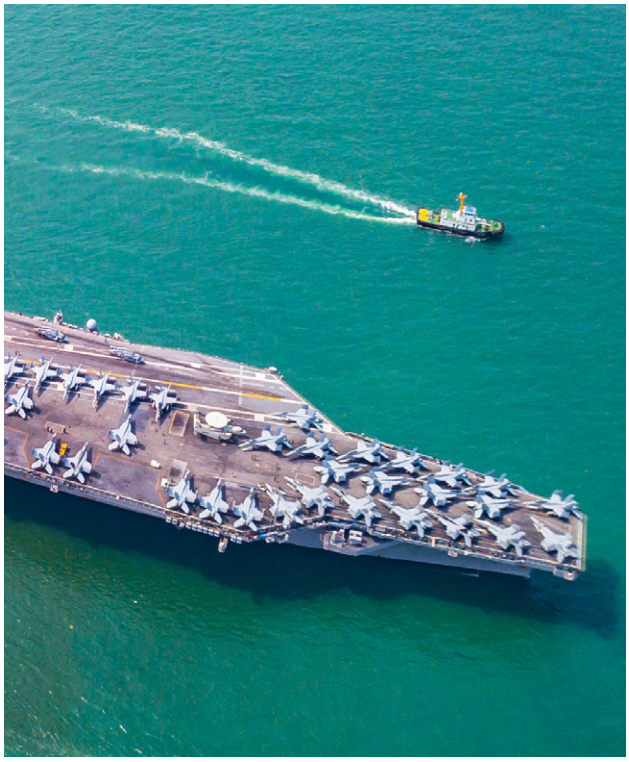
COMPETITION FOR RARE EARTH MATERIALS: THE US – CHINA TRADE WAR

In the 20th century, competition for natural resources has been typically focused on a secure and reliable supply of oil and gas. However, future conflicts may be focused on the competition for natural resources that are used across various renewable energy technologies. An example of such a resource are rare earth elements (REE), which are an important input raw material used in the production of solar panels, wind turbines, energy storage systems, and electric vehicles.

The US was the largest producer of REEs – until the late 1980s when China emerged as their largest low-cost producer and exporter, forcing US miners and producers to withdraw from the market. In 2018, China produced 12,557 MT of REEs, accounting for 63% of the global supply, followed by Estonia with 1,072 MT[xv].

As the adoption of renewable energy technologies and components increases in the future energy system, so does the demand for an uninterrupted supply of REEs. Countries aspiring to lead global renewable energy technology, including the US, will be exposed to a new and severe dependency on REEs with high geopolitical stakes. The competition for REEs, and the risk and vulnerabilities associated with their supply is important in the context of the US – China Trade War.

In addition to the end-use of REEs across the US technology and industrial sector, REEs have numerous military applications for the US. Every advanced weapons system in the US military arsenal from Tomahawk missiles

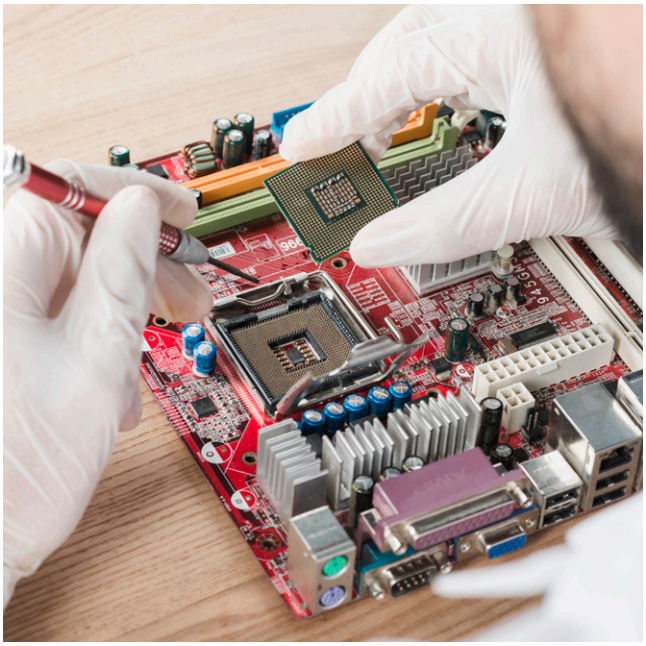


to the F-35 Fighter Jets, to Aegis-equipped destroyers and cruisers, is absolutely reliant on components made using rare earth elements, including critical items such as permanent magnets and alloys that are almost exclusively made in China[xvi].

Furthermore, US concerns over China's control over the global supply of REEs results from its history of waging economic warfare in response to perceived provocations.

In September, 2010 China sharply reduced REE exports to Japan over a maritime incident, when a Chinese trawler ship operating in disputed waters in the Sea of Japan region collided with the Japanese Coast Guard boats, resulting in the detention of 15 Chinese seamen. In order to acquire leverage over its demands for their release, China halted its exports of REEs to Japan. In the aftermath of the incident, the Government of Japan allocated ¥ 53 bn ($480 million) to diversify its REE supplies.

Over the last two decades, China has introduced a number of initiatives to consolidate the control of the domestic REE industry by introducing export quotas and temporary export taxes as part of a broader strategy that 1) provides preferential low-cost supply of REE to domestic Chinese industrial and technology manufacturers, 2) forces foreign manufacturers that rely on the supply of REEs to move their production facilities to China, and 3) subsequently share their technology with a local Chinese partner in order to secure a reliable supply.



In September, 2018, the US Department of Defense in cooperation with other federal agencies published a report authorised by an Executive Order issued by then President Donald Trump, which concluded "China's domination of the REE market illustrates the potentially dangerous interaction between Chinese economic aggression guided by its

strategic industrial policies and vulnerabilities and gaps in the US's manufacturing and defense industrial base. China has strategically flooded the global market with REEs at subsidised prices, driven out competitors, and deterred new market entrants"[xvii].

Also in that year, the US imposed Section 301 Provisions – Tariffs and Foreign Trade Barriers on China, which resulted in 25% tariff hikes on US$ 250 bn worth of imports from China. On 10th May 2019, former US President Donald Trump instructed the US Trade Representative (USTR) to impose additional tariffs of US$ 300 bn on all remaining imports from China, excluding REEs. On 20th May, 2019 Chinese President Xi Jinping, on a visit to a Chinese REE magnet production facility, warned the US "risks losing its supply of materials that are vital to sustaining its technological strength"[xviii].

On 29th May, 2019 in an official commentary published by a state-owned, Chinese media outlet warned the US "if anyone wants to use imported REEs against China, the Chinese people will not agree"[xix].

The impact on the US economy from potential Chinese restrictions on the supply of REE are hard to measure. And how the competition for natural resources and REEs fares in the future is difficult to predict. In the event of trade restrictions by China, the US might seek alternative supplies of REEs and / or replacement metals. Some analysts argue that the US should seek public-private partnerships to develop its own REE resource, including the development of local downstream REE industries, in order to weaken China's near monopoly of REEs. It is unclear how such a goal could be achieved.

However, the United States Congress has authorised the US Department of Energy to develop advanced separation technologies for the extraction and recovery of REE and minerals from coal and coal by-products [xx].

CONCLUSIONS

The rise of new energy systems and the intended progressive transition to low-carbon energy sources have put the spotlight on emerging strategic resources and critical minerals such as lithium, copper and rare earths required by renewable and energy systems. These strategic resources also include renewable energy flows, which require high-quality sites for wind, solar, geothermal, hydropower generation and biofuel cultivation, as well as subsurface space for carbon dioxide storage.

These emerging strategic resources have unique characteristics and are unevenly distributed, in contrast to fossil fuels that shaped much of the 20th century, which was built on the legacy of coal and steam, dominated by oil and gas, and in the second half of the century by a liberalising and Western-centric trade model.

The transformation of the global energy system to one driven by renewables constructed from critical minerals will have important geopolitical implications. Over this century, international power structures will change and the dynamics of strategic alliances, bilateral relationships, and the geographics of trade will be transformed. The role of renewables tends to push towards a more decentralised, multi-polar, and diffused global power structure. But situations such as technological mastery, market dominance and control of critical mineral mining or processing may nevertheless give certain countries an advantageous position.

The large-scale supply of energy will no longer be limited to a small number of states, as the majority of countries will increasingly acquire the potential to achieve renewable energy generation, which will enhance their self-sufficiency.

The influence of countries such as China will increase as they continue to invest heavily in the new energy sector and reap the benefits of the opportunities it creates. And conversely, countries that are heavily reliant on fossil fuel exports and do not evolve with the energy transition risk losing power and influence.

APPENDIX

i.BP Statistical Review of World Energy, 2020
ii. The decoupling of GDP and energy growth: A CEO guide, McKinsey Quarterly, 2019
iii. World Energy Outlook, IEA, 2019
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v. Energy Transition Outlook, DNV-GL, 2020
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viii. Solargis: Solar Irradiance Data and Global Solar Atlas, The World Bank
ix. BP Statistical Review of World Energy, 2020
x. G7 set to agree 'green belt and road' plan to counter China's influence, Financial Times, 2021
xi. Violence in the Democratic Republic of Congo, Global Conflict Tracker, Council of Foreign Relations
xii. China focuses on deep-sea mining to fuel rare metals "gold rush", Financial Times, 2017
xiii. One Chinese company now controls most of the metal needed to make the world's advanced batteries, Quartz, 2018
xiv. China hones control over manganese, a rising star in battery metals, Wall Street Journal, 2021
xv. USITC Data Web: US Merchandize Trade and Tariff Database
xvi. How China could shut down America's defenses, Foreign Policy Magazine, 2019
xvii. Assessing and strengthening the manufacturing and defense industrial base and supply chain resiliency of the United States, US Department of Defense, 2018
xviii. "Plenty of cards to play": Chinese media suggest cutting rare earth exports to US, NPR, 2019
xix. Commentary: US risks losing rare earth supply in trade war, People's Daily, 2019
xx. Rare Earth Element Advanced Coal Technologies Act, Committee on Energy and Natural Resources, 116th Congress, Senate Report, 2019

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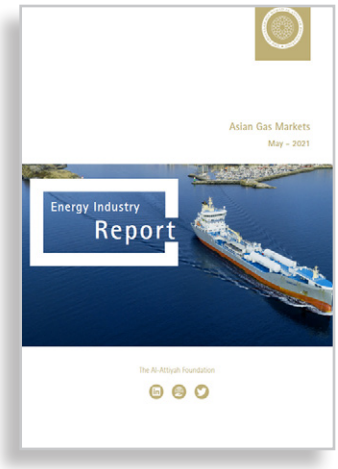

May – 2021
Asian Gas Markets

Asia-Pacific is emerging as the key area for global gas demand growth, consuming 60% more gas than Europe. Yet the level of interconnectivity is low, and there are wide disparities in gas use, infrastructure and regulation.

(QRCO.DE)

April – 2021
OPEC's Long-Term Outlook

The Organization of the Petroleum Exporting Countries (OPEC) was created in 1960 by five founding members, Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela, with the aim to coordinate and unify the petroleum policies and ensure the stabilization of oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital.

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March – 2021
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CCUS refers to a range of technologies for capturing carbon dioxide (CO_2) from human-made sources including oil, gas and coal-fired power generation and industry, and using it to create useful products or storing it safely underground indefinitely.

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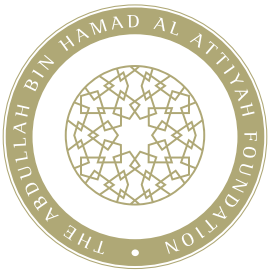

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