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Geopolitics of the Energy Transition

Energy Industry Report

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The increasing penetration of renewables in the global energy mix, the rise of electrification from 20% currently to 60% by mid-century, and improvements in energy efficiency and storage are essential characteristics of the energy transition, which will have wide-ranging and profound geopolitical consequences.

How will the energy transition impact fossil fuel exporters and importers, green technology manufacturers, and countries rich in critical minerals and metals? Which countries could exploit their dominant positions within green energy supply chains? How will the energy transition impact great-power competition?

ENERGY 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 current energy topic that is of interest to the Foundation's members and partners. The 12 technical papers are distributed to members, partners, and universities, as well as made available on the Foundation's website.

- The primary characteristics of the energy transition are 1) the electrification of end-use, 2) growth in renewable generation, and 3) improvements in energy efficiency and storage.
- These characteristics are driven by technological improvements that contribute to declining costs of renewable energy generation and storage; in addition to large-scale renewable energy capacity deployment backed by regulatory policies.
- The geopolitical risks associated with the energy transition are due to differences between renewables and fossil fuels in terms of geographic concentration of resources, storage, scalability, and production-cost structures.
- The high energy prices and insecurity resulting from the war in Ukraine and a past period of under-investment are encouraging many countries to diversify their energy sources (geographically and by type), and to invest in boosting domestic renewables and energy efficiency.

Hydrocarbon Exporters & Importers, and Renewable Energy Leaders:

- Fossil fuel exporters across the Middle East, North and West Africa and CIS (including Russia) are the most exposed to a reduction in fossil fuel revenues from the energy transition, which will impact their geopolitical reach and influence, unless they restructure their economies and their energy sector.
- In contrast to the exporters, the energy transition will allow fossil fuel importers to develop their indigenous renewable resources, and mitigate risks associated with fossil fuel supply disruptions and price volatility caused by political instability or conflict across some fossil fuel exporters.
- The energy transition will allow countries with a high technical potential for renewable energy generation, critical minerals and metals production and processing, and technological innovation to enhance their global influence and reach.

Power Shifts, Alliances, & Trade Patterns:

- Renewable energy will not only reconfigure energy alliances and trade patterns but also create new interdependencies around electricity grids, and the exchange of renewable energy technologies and fuels.
- The reliance on regional electricity interconnections and international supplies of critical minerals and metals will create new vulnerabilities for countries.

Implications

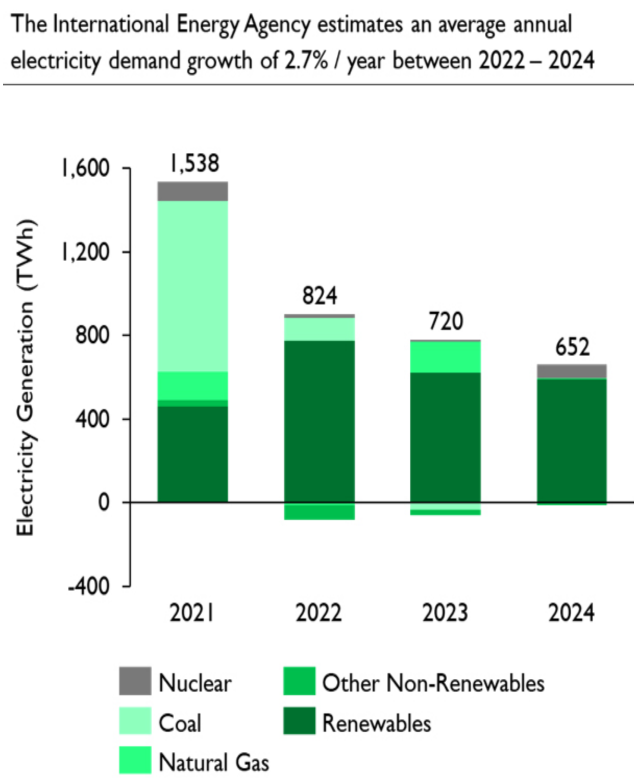
- Efforts to mitigate climate change effectively and tackle energy transition-related challenges could become fertile ground for global great-power competition.
- China, the United States, and the European Union will need to manage their climate ambitions by not only acknowledging the opportunities from the energy transition but also mitigating its potentially disruptive effects.

This ongoing transition is not just a shift from fossil fuels to renewables, but a deeper transformation of the world's energy sector, which will have major socioeconomic and political implications.

The primary characteristics of the energy transition are 1) the electrification of energy end-use, 2) growth in renewable energy generation, and 3) improvements in energy efficiency and storage.

Electricity currently accounts for 20% of global final energy consumption – its increasing share in the future will be driven by technologies that power heating, cooling, and transport using electricity. Electrification will reach at least 60% in net-zero carbon scenarios after mid-century. The growth in electricity demand will be met through renewables (mostly solar PV, wind, bioenergy, and hydropower, supplemented by solar thermal, geothermal, and ocean energy). This will improve the ratio of final to primary energy by eliminating thermal losses in conversion. For instance, internal combustion engines in gasoline (petrol) cars convert about 12-30% of the energy in the fuel to power at the wheels; an electric vehicle (EV) converts over 77% of the grid electricity to wheel power. End-use energy efficiency will also improve, enabling countries to unlock economic growth with lower primary energy inputs.
These characteristics are driven by technological improvements that contribute to declining costs of renewable energy generation and storage, in addition to large-scale renewable energy capacity deployment backed by regulatory policies.

Figure 1: Global Change in Electricity Generation[i]



Some of the technological improvements include better solar PV module efficiency, larger and more cost-effective panels, bifacial panels that boost generation via reflected light from the ground, increased size of wind turbines, further offshore deployment of turbines where wind speeds are higher and more consistent, and efficiency improvements in battery storage and electric vehicles.

The large-scale deployment of renewables continues to unlock cost savings and has contributed to the steep decline in renewable electricity generation and storage over the last decade. In 2021, two-thirds (or 163 GW) of newly installed renewable capacity had lower costs than the world's cheapest coal-based option across the G20, whilst saving US$ 55 billion in energy generation costs, at current fossil fuel prices[ii] .

These developments have convinced governments around the world to introduce various policies that capitalise on the market opportunity for low-cost renewable generation, while decarbonising their energy sector.

For net energy importers, these regulatory policies intend to encourage the shift to renewables to reduce dependence on expensive or unreliable energy imports. In contrast, policies introduced by net energy exporters aim to free up and replace domestic consumption of fossil fuels for more profitable exports globally.

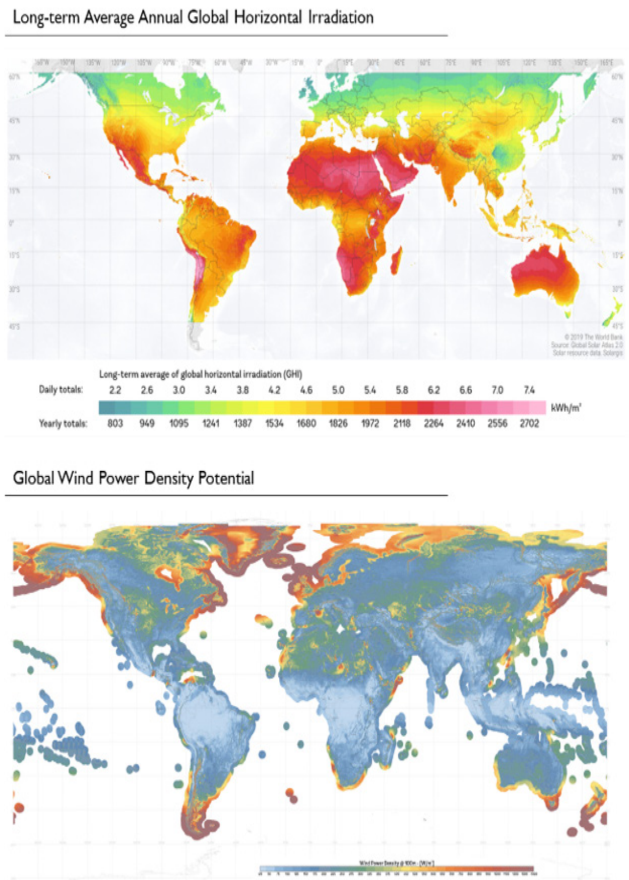
The geopolitical risks associated with the energy transition are due to differences between renewables and fossil fuels in terms of geographic concentration of resources, storage, scalability, and production-cost structures.

Unlike the fossil fuels trade that is dependent on the maritime security of key trade routes and chokepoints, renewable resources are not heavily concentrated in specific geographic locations and are available in some quantity across most countries.

Most renewable resources such as solar PV and wind are a form of energy flows, in contrast to fossil fuels that are energy stocks. The latter can be stored but only used only once, whereas the former does not exhaust itself and are harder to disrupt. Renewable energy flows can be deployed at any scale and can contribute to the decentralisation of electricity production and consumption. They have near zero marginal costs of production and enjoy cost reductions of typically ~20% for every doubling of cumulative capacity[iii] .

However, with most renewables being used to produce electricity, they intensify the challenge of balancing electricity supply and consumption in real time, as storing electricity for long periods (weeks or months) in bulk is very expensive. Weather and daily and seasonal cycles greatly affect renewable output. It will be easier to manage renewable variability with

Figure 2: Global Solar PV and Wind Resource[iv]



interconnections and large-scale grids, but this intensifies technical, commercial, and political interdependencies between countries.

The increase in renewable energy generation will continue to drive the energy transition, which in effect will contribute to the Paris Climate Goal of limiting global warming to 1.5°C. The transition to renewables will be difficult because fossil fuels currently provide 80% of the global energy supply and have been the foundation of modern society for much of the 20th century[v].

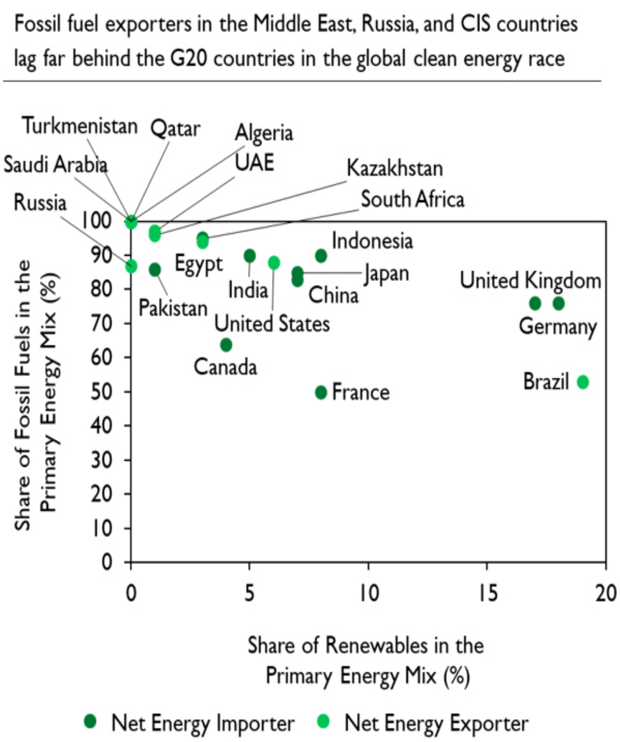
Yet, the forces behind the energy transition will prevail because 80% of the world's population lives in net energy importing countries[vi]. And the transition will continue to be supported by a decline in the cost of renewable generation. Five years after the Paris Climate Accords, 127 countries that collectively account for 63% of the global emissions have committed to net-zero targets by 2050[vii].

However, what is hard to predict is:

- how the political economy will play out in each country
- what the non-linear consequences of the transition are
- when fossil fuel demand will peak
- how long the natural gas bridge to a full renewable dominated future will be
- how will innovations disrupt / support the transition
- What the role will be of supporting technologies, notably nuclear, carbon capture and storage, and hydrogen
- which countries will be future energy leaders.

How countries position themselves in the energy transition is dependent on their exposure to changes in fossil fuel trade flows, their position in the clean energy race and their ambition / potential to become leaders in renewable energy deployment and technology.

Figure 3: Impact of the Energy Transition across Selected Regions and Countries[viii]



The United States is one of the most well-positioned countries in the global clean energy race, with American companies being the front runners in technological innovation, robotics, artificial intelligence, and electric vehicle manufacturing. The country is also the closest to energy self-sufficiency due to the shale oil & gas revolution, which has turned it into a net exporter of oil & gas in 2020 and 2017, respectively[ix].

In contrast to its economic rival, China is highly dependent on fossil fuel imports and is the largest importer of both oil & gas, importing 13 Bbbl / d and 163 BCM in 2021, respectively[x]. Yet, the energy transition will improve its energy security, mainly because of its leading position in global technology manufacturing and large-scale deployment of renewable energy technologies. China is the largest destination for foreign renewable energy investments that topped US$ 7 billion in 202[xi]. China is the leading country for mining and/or processing many critical minerals for renewable and zero-carbon technologies, such as rare earth elements (REEs), lithium, copper, and cobalt.

The energy transition will also support China's emerging economic rival, India which aims to meet 50% of its electricity demand from renewables by 2030[xii]. Renewables will help India meets its rising energy demand as the country is estimated to have the largest population in the world by 2024[xiii].

The European Union, very dependent on fossil fuels imports, is expected to hold a strong position in renewable technology innovation, further solidified by the European Green Deal, which aims to help the region achieve climate neutrality by 2050. While the deal serves as a "master clock" to reach the Paris Climate Goal, the union will face challenges in acquiring reliable and cost-effective supplies of natural gas in the medium-term that are necessary for complementing variable renewable electricity generation. The region is also exposed to clean energy supply chains, producing little of the required critical materials, and having lost most of its solar manufacturing to China.

Russia, which is the world's largest exporter of natural gas and a leading exporter of oil and coal, may face challenges in adapting to a world that is powered by renewables. Despite the Russian economy being more diversified than its

Middle Eastern peers, oil & gas rents are a vital component of the national budget, accounting for around 40% of fiscal revenues[xiv]. Even though Russia is stepping up renewable energy deployment and Russian national oil companies (NOCs) continue to invest in research and development, the country still lags far behind the United States and China, which will further widen due to economic and financial sanctions imposed on it in response to the Russian invasion of Ukraine.

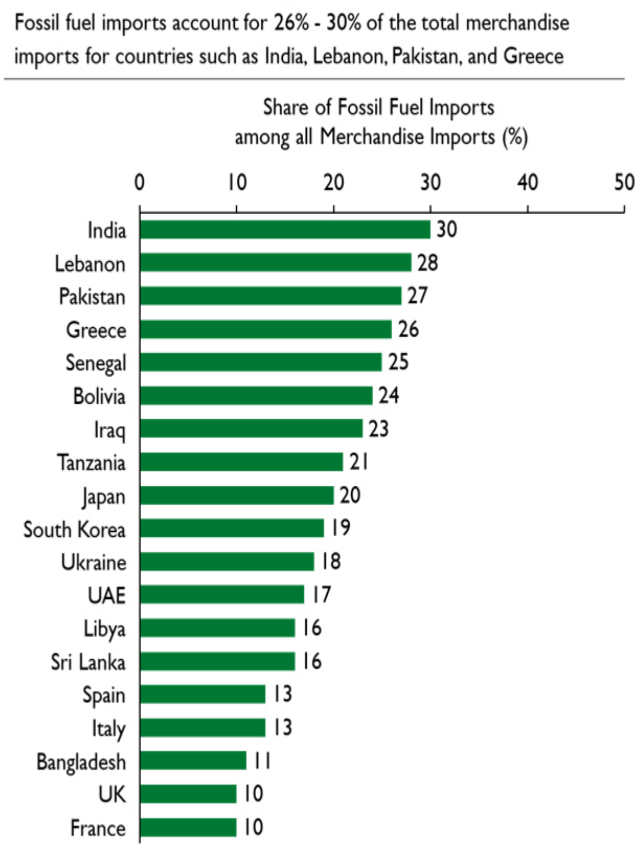
Fossil fuel exporters across the Middle East, North and West Africa, and CIS (including Russia) are the most exposed to a reduction in fossil fuel revenues from the energy transition, which will impact their geopolitical reach and influence, unless they restructure their economies and their energy sector.

Over the last three decades, some exporters (particularly those in the GCC) have acquired significant geopolitical influence as they have been large, growing, and reliable suppliers of fossil fuels. Their export revenues allowed them to finance various social welfare and economic diversification programmes, strengthened their defence capabilities, and enhanced their global economic contribution by allowing their sovereign wealth funds and national companies to invest in foreign assets across developed markets in North America, Europe, and Australasia.

A decline in fossil fuel rents from the energy transition could destabilise some fossil fuel exporters, particularly those that are unprepared such as Nigeria, Iraq, Venezuela, Libya, Angola, and the Republic of Congo. The loss in fiscal revenues could fracture fiscal programmes and social contracts, and weaken governance, which could lead to political instability.

However, these countries could cooperate with GCC countries that are highly resilient to the energy transition (while also being highly exposed) and are successfully using their surplus fossil fuel export earnings to reinvent and adapt their economies to the energy transition.

Figure 4: Share of Fossil Fuel Imports in all Merchandise Imports across Selected Countries[xv]



In contrast to the exporters, the energy transition will allow fossil fuel importers to develop their indigenous renewable resources, and mitigate risks associated with fossil fuel supply disruptions and price volatility caused by political instability or conflict across some fossil fuel exporters, which could enhance their energy security.

Some form of economically viable renewable resource is available across most fossil fuel importers, which offers them various strategic and economic benefits.

An increase in renewable energy deployment could enhance their freedom to set their energy priorities and national goals, without being exposed to pressure or coercion relating to fossil fuel supplies from large exporters. It will also allow them to mitigate the risk of supply disruptions and price volatility caused by political instability, armed conflict, and / or terrorist attacks that may occur across some fossil fuel exporting countries.

Economically, an increase in renewable energy capacity will improve their balance of payments, which otherwise could lead to substantial amounts of wealth transferring abroad, increasing imported inflation, which in effect curbs consumer spending, stifles economic growth, and raises the cost of doing business.

The energy transition will allow countries with a high technical potential for renewable energy generation, critical minerals and metals production, and technology innovation to enhance their global influence and reach.

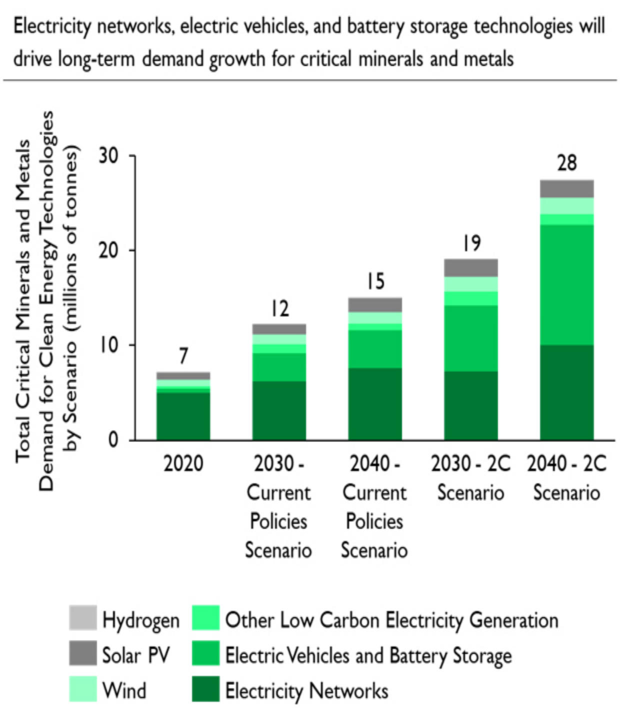
A high technical potential for renewable energy generation could turn countries and regions such as Australia, Chile, and the Middle East into important exporters of renewable electricity and fuels. The Australasian continent has one of the highest solar irradiations per square metre of any continent and consequently some of the best solar energy resource in the world, ranging between 1,387 – 2,264 kWh / m^2.[xvi] Chile, the GCC, and North Africa are also among the best places for a large solar PV resource, in addition to a high potential for onshore wind and ocean energy generation in certain sites.

Tapping into domestic renewable resources could also allow net electricity exporters such as Brazil, Norway, Laos, and Bhutan to expand their exports. Presently, Brazil exports hydropower to Argentina; Norway exports to neighbouring Scandinavian countries, Germany, and the United Kingdom; Laos exports its hydropower to Thailand; and Bhutan exports to India.

The widespread adoption of renewable energy and related technologies, such as solar PV panels, wind turbines, electric vehicles, and energy storage, will increase the demand for a range of critical minerals and metals.

Lithium, nickel, cobalt, manganese, and graphite are crucial to battery performance, longevity, and energy density. Rare earth elements and copper are essential for magnets used in wind turbines and electric vehicles.

Figure 5: Total Critical Minerals and Metals Demand for Renewable Energy Technologies by Scenario[xvii]

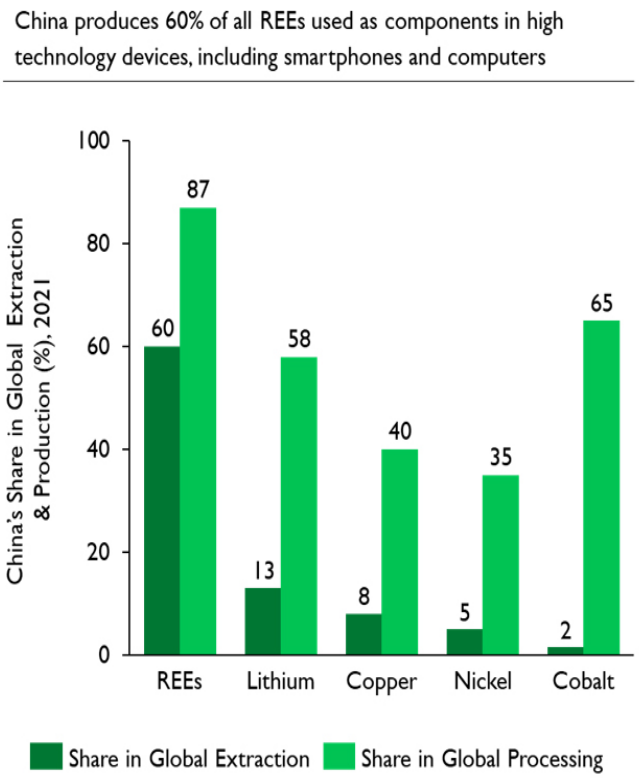


Electricity networks need a huge amount of copper and aluminium, with the former being a cornerstone for all electricity-related technologies.

The increase in demand for critical minerals and metals will not only boost the strategic importance of newly mined supplies from countries such as Bolivia, Mongolia, and the Democratic Republic of Congo (in addition to reliable supplies from Australia, Indonesia, and Chile) but also expand their fiscal revenues, provided they have the right regulatory policies and governance frameworks.

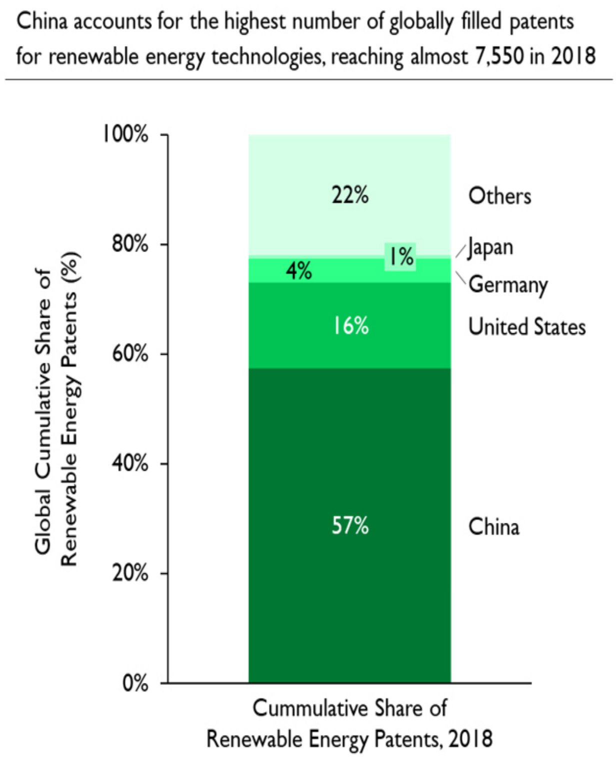
Leaders in technological innovation such as China are well positioned to gain the most from the global energy transition. Chinese companies are the largest producers of solar panels, wind turbines, batteries, and electric vehicles.

Figure 6: China's Share of Extraction & Processing of Selected Critical Metals & Minerals, 2021[xviii]



China's concerted investments in research and development in its renewable technology and electric vehicles industries could result in Chinese technologies increasingly competing with supplies from the United States and Europe.

Figure 7: Global Cumulative Share of Renewable Energy Patents[xix]



The nature of the competition could be similar to the global telecoms and cell phone industry, where Apple, Samsung, and Huawei continue to compete for global leadership.

If renewable energy technologies are dominated by a few countries, it could stifle competition and suppress innovation across the global value chain and distort markets, with technology importers being heavily dependent on a few countries and companies. To avoid this, supply chains and technology standards could become balkanised, limiting interoperability, and raising costs, so slowing global decarbonisation.

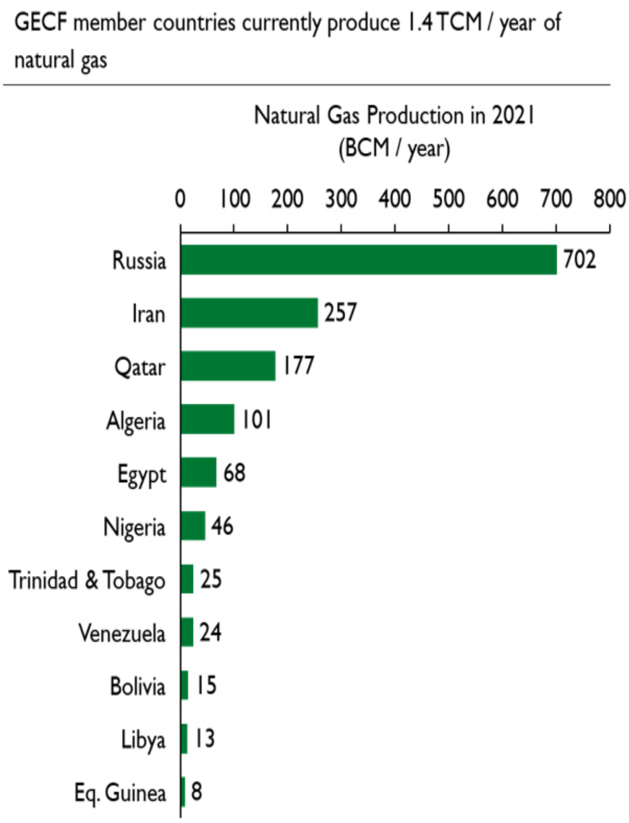
Despite the risk of technology dominance, renewable energy leaders are unlikely to gain the degree of market dominance that fossil fuel producers have enjoyed, due to the ubiquitous nature of renewable energy sources.

Renewable energy will not only reconfigure energy alliances and trade patterns but also create new interdependencies around electricity grids, and the exchange of renewable energy technologies and fuels.

As the energy transition accelerates, multilateral alliances built on fossil fuels are likely to weaken. The Organisation of Petroleum Exporting Countries (OPEC) may have to re-invent itself as it balances the increase in shale oil & gas supply from the United States, the prospects of a global peak in oil demand from climate policies, and the falling costs of renewable energy generation[xx]. Qatar's decision to leave OPEC while remaining within the Doha-based Gas Exporting Countries Forum (GECF) demonstrates the challenges that OPEC might face in the future amid rapid and structural changes in global oil markets. GECF was founded in 2001 to maximise the value of natural gas production; develop short, medium, and long-term analysis and forecasts; facilitate cooperation on issues of common interest among member states; promote natural gas as a fuel and position the GECF as an internationally recognised organisation[xxi]. The United States, the world's largest producer of natural gas, and the third-largest exporter of LNG, is not a member of the GECF[xxiii]. Similarly, Australia, the sixth-largest natural gas producer, and the second-largest LNG exporter, has not joined the GECF; alongside other prominent natural gas producers such as Norway, Turkmenistan, and Azerbaijan[xxiv].

Despite concerns that GECF may become a natural gas cartel (like OPEC), there are two main structural aspects of the global natural gas markets that make this difficult. Firstly, the global natural gas market is not entirely integrated, as natural gas is a regional commodity and prices vary between regions.

Figure 8: Natural Gas Production by GECF Member[xxii]



Secondly, most natural gas is sold based on long-term contracts between producers and consumers. LNG projects have high capital costs and new projects have historically been built after securing 20-year take-or-pay contracts, which make up the majority of global LNG trade.

Moreover, bilateral relations between countries may evolve significantly as countries become less dependent on international oil supplies. The United States – Saudi Arabia alliance is an example of a strategic relationship in which oil plays a key role. It began in 1945 when King Abdul Aziz ibn Saud and President Franklin D. Roosevelt came to a tacit understanding that the United States would provide military assistance in exchange for access to Saudi Arabian oil supplies[xxv].

As countries begin to reconsider energy diplomacy, several new alliances are emerging to promote multilateral cooperation and boost specific renewable technologies. The International Renewable Energy Agency (IRENA), based in Abu Dhabi, was founded in 2009. The 2015 Paris Climate Conference produced the International Solar Alliance, the Global Geothermal Alliance, and Mission Innovation. While these alliances are at an early stage of development and focus on technological cooperation, they are likely to gain importance as the energy transition progresses.

The transition to renewables will create new energy trade patterns supported by regional (or intercontinental) connected electricity grids and the exchange of renewable energy-related technologies and fuels. Most countries will specialise in what they have a comparative advantage based on their renewable resource endowment, technological capabilities, the relative price of electricity generation or technology production, and the cost of transport.

Electricity trade will involve new interconnections that will make grids more stable and resilient allowing supply and demand to be balanced in real-time. Interconnections will be made between neighbouring countries at a regional or intercontinental scale.

Presently, notable regional electricity grids include the Central American Electrical Interconnection System (SIEPAC), the North American Power Transmission Grid, and the Synchronous Grid of Continental Europe, whereas others such as the GCC Interconnection and the ASEAN Power Grid are in the process of development.

Trade in renewable energy-related technologies will include solar PV panels, wind turbines, smart meters, electrolysers, and batteries, as well as their components and parts. As these technologies proliferate, trade in fuels such as synthetic ammonia, methanol, kerosene, and methane produced from renewable electricity-powered electrolysers will also grow significantly. International trade in carbon dioxide could also grow to move from emitters to good storage locations; some cross-border pipeline projects are already under development in the North Sea.

As global energy trade evolves, the geopolitical map will take a new form. The importance of maritime fossil fuel trade routes will be reduced in favour of control over electricity grid infrastructures, which will become vital for national security and for projecting global influence and power. Grid infrastructure includes physical assets such as power lines and storage facilities and virtual interconnections that will multiply as the energy sector digitalises, complementing land, sea, and air defence infrastructure. However, maritime and select pipeline routes will remain important for the transport of hydrogen and derivatives, with the Suez Canal appearing particularly important.

The reliance on regional electricity interconnections and international supplies of critical minerals and metals will create new vulnerabilities for countries.

Countries that dominate electricity grids may exercise undue control over their neighbours, and cross-border electricity cut-offs could become an important intimidation tool, which could be applied strategically in the same way as oil & gas supply sanctions[xxvi].

Therefore, electricity importers will look to diversify flows either through local generation or with alternative supplies from neighbouring countries. Cut-offs would be counter-productive for the embargoing country, which would lose customers and investors, but still could be undertaken in times of stress.

States that run short of electricity due for example to technical problems, demand surges, weather, or natural disasters, could limit exports. Norway, a crucial electricity exporter to European neighbours, has already proposed this because of low water levels at hydroelectric dams.

Countries that have a rich endowment in critical minerals and metals may use them to exert pressure on importers. This view was given credence in 2010 when China restricted the supply of rare earth elements (REEs) to Japan in the aftermath of the Senkaku Islands / Diaoyutai Qundao Crisis, which resulted in a sharp increase in the price of REEs. Currently, China controls 80% of the global supply of REEs[xxvii].

However, there are alternatives to the use of REEs and other critical metals used in renewable technologies. Efforts are being made to create cobalt-free batteries, while only 2% of US wind turbines are currently built with REEs[xxviii]. Most minerals and metals can also be recycled, re-used and stockpiled, thereby further reducing their perceived scarcity.

IMPLICATIONS

Efforts to effectively mitigate climate change and tackle energy transition-related challenges could become fertile ground for global great-power competition.

Unless the world's major powers find a way to ensure that this competition is conducted as fairly and productively as possible, the future will not only look less green but also less secure.

Over the last five years, the worsening relationship between the United States and China has severely impeded progress on global climate mitigation. The two countries are the world's largest emitters of CO2, accounting for more than 40% of global emissions.

Their fierce competition has compromised scientific collaboration on research and development of low-carbon and renewable energy technologies, as well as joint action to shape international climate governance including efforts to establish green international trade rules[xxix].

And the expansion of trade barriers and efforts at economic decoupling by both countries have hampered further cost reductions of renewable energy technologies and increased the risk of disrupting low-carbon and renewable energy supply chains.

The United States, China, and the European Union will need to manage their climate ambitions by not only acknowledging the opportunities from the energy transition but also mitigating its potentially disruptive effects.

The key to mitigating the latter is to ensure fair energy transition policies at the national, regional, and international levels such as those pursued by the European Union's Just Transition Fund. The fund is a financial instrument within the European Commission's Cohesion Policy that aims to provide support to countries facing serious socio-economic challenges arising from the energy transition towards climate neutrality[xxx].

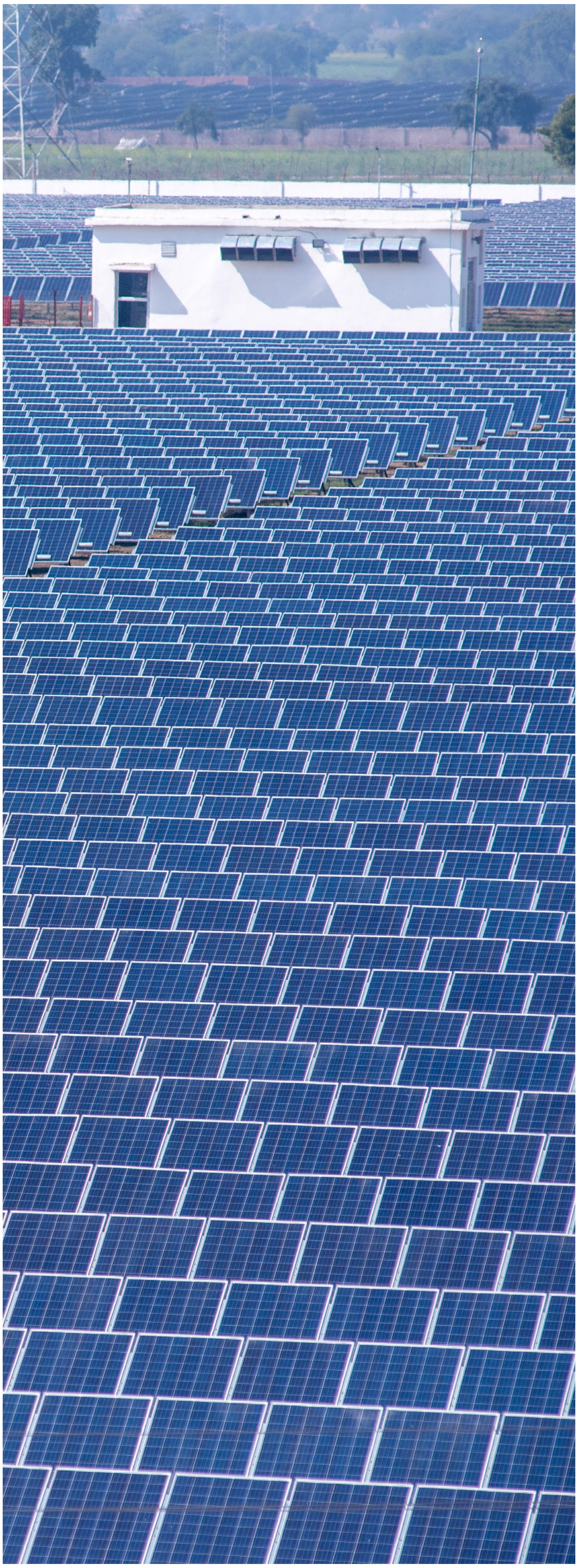
In addition to this, equitable technology transfers and financial support for developing countries will be crucial, as well as the development of global standards relating to the sourcing of critical minerals and metals, and the transfer / trade of low-carbon and renewable energy technologies.

United States President Joe Biden has made climate action one of his top political priorities and expressed his willingness to cooperate with China when it is in the interest of the United States, which could spur their allies to improve the prospects of international climate cooperation.

There are also opportunities for the United States and China in climate leadership, which is increasingly seen as a strategic asset that may provide them with valuable geopolitical leverage. If effectively managed, the clean energy competition between both countries could inspire "a race to the top" that could boost green investments, climate goals, and the energy transition[xxxi].

The United States and the European Union are in a powerful position to align their respective climate and energy transition plans and lead the way toward a more sustainable future.

According to the European Commission, a comprehensive transatlantic green deal could include collaboration on a global regulatory framework for sustainable finance; a transatlantic green trade deal, which incorporates joint efforts to price carbon across borders; and a technology alliance for investment in and development of low-carbon and renewable energy technologies, such as hydrogen electrolysers and carbon capture and storage (CCS)[xxxii].



CONCLUSION

The energy transition, if not managed well, has the potential to be highly disruptive. It may lead to the destabilisation of some fossil fuel exporters, force fossil fuel importers to reconsider their relationship with exporters, create a new green resource curse for some countries, and increase strategic risks relating to the supply of renewable energy technologies, critical minerals and metals, and electricity from interconnected grids.

Despite the difficulties, the energy transition will move the world in the right direction by addressing climate change and promoting prosperity and sustainable development. For most countries, it will strengthen their energy security and energy independence, promote prosperity and job creation, improve food and water security, and enhance sustainability and equity.

While the energy transition has become a central domain for great-power competition, the United States and the European Union must ensure their competition with China is conducted fairly and productively, in a way that encourages further green investments and emboldens global climate action.

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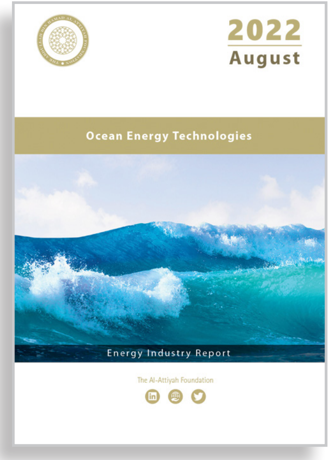

August – 2022

Ocean Energy Technologies

The world's oceans contain vast renewable energy potential, equivalent to more than double the global current electricity demand. Ocean energy is highly predictable, well-suited to provide baseload power, and could abate CO2 emissions from power generation.

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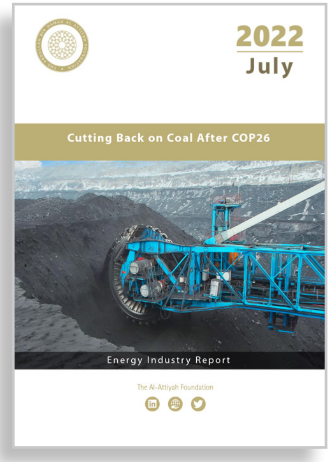

July – 2022

Cutting Back on Coal After COP26

Global LNG prices surged to never-beforewitnessed heights in 2022, as market tightness and concern over supply gripped the market. The interconnectedness of gas markets in Europe and Asia-Pacific through LNG trade has resulted in the European benchmark, Dutch TTF, topping US$ 60 / MMBtu in 4Q 2021 while the spot Asian LNG benchmark, JKM, hit nearly US$ 60 / MMBtu in March 2022.

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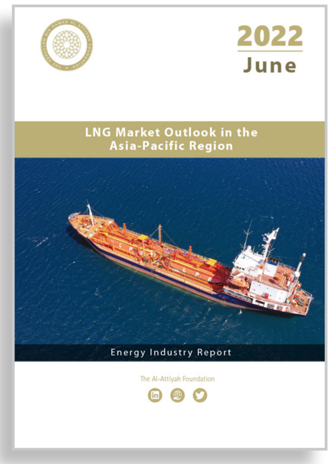

June – 2022

LNG Market Outlook in the Asia-Pacific Region

Global LNG prices surged to never-beforewitnessed heights in 2022, as market tightness and concern over supply gripped the market. The interconnectedness of gas markets in Europe and Asia-Pacific through LNG trade has resulted in the European benchmark, Dutch TTF, topping US$ 60 / MMBtu in 4Q 2021 while the spot Asian LNG benchmark, JKM, hit nearly US$ 60 / MMBtu in March 2022.

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Our partners collaborate with The Al-Attiyah Foundation on various projects and research within the themes of energy and sustainable development.

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