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THE GEOPOLITICS OF ENERGY: OUT WITH THE OLD, IN WITH THE NEW?

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INTRODUCTION

Gathering momentum for the energy transition—supported by ambitious net-zero roadmaps by governments (EU, China, and US) and multinational corporations—has sparked debate on what the energy map will look like in 30 years. For more than half a century now, access to oil and natural gas has been at the heart of the geopolitics of energy; but with renewable technologies set to dominate energy supply systems, relations between states will change, while economies and societies will undergo structural transformations. This issue of the *Oxford Energy Forum* discusses the drivers and main features of the 'old' and 'new' geopolitics of energy. It assesses the power shifts that are unfolding, the winners and losers—both countries and technologies—that are likely to emerge from this process, and the potential implications for global governance regimes. Our authors ask whether the prospects of peak oil demand will dim the geopolitical forces shaping producer–consumer relations and upend geopolitical arrangements which have been defining elements of regional power systems. They discuss the future of natural gas in the energy transition, and whether producers are adapting their strategies. They ask: who will lead the race for new technologies and supply chains? And how will US–China competition and coordination impact global efforts to meet the Paris climate goals?

A thread running through this *Forum* is a warning against intellectual complacency. One key theme is that assumptions about the future geopolitical outlook of countries, regions, and trade relationships will hardly be guided by history, given the size and scope of the transformation. Demand-side policy and capital allocation shifts will create both challenges and opportunities for fossil fuel incumbents—a stark reminder that while some regions are moving more slowly, no region is standing still as the energy transition gathers pace. Similarly, identifying winners and losers is not as clear-cut as it seems, especially in light of concerns that the US is losing out in the race with the EU and China. The third theme serves as a stark reminder that the pathways to net zero will be neither linear nor uniform, especially in light of the falling costs of technologies. But the race for technological leadership and for control of the supply chains of new materials will become a key factor in the geopolitics of new energies.

Framing the energy transition and its geopolitical implications

In the opening article, Indra Overland highlights the analytical challenges when predicting the consequences of the energy transition based on our assumptions about the past. He presents six areas where interpretations of past and current issues are decisive for thinking about the winners and losers of the energy transition. First, do oil and gas lead to geopolitical competition? Second, does the US contribute to stability in the Middle East? Does Russia use energy as a weapon? Next, is natural resource endowment a curse? Do developed countries exploit developing countries and their natural resources? And finally, do trade and interdependence promote peace? Given the diverging views on how these factors shape the 'old' geopolitics, there are considerable uncertainties about their consequences for 'new' geopolitical arrangements, complicating scenario-building and prediction studies. Overland argues that more attention needs to be paid to how interpretations of the past and the present shape our predictions of the future, both regarding the geopolitics of the energy transition and beyond.

As such, our analytical frameworks are a potential barrier to thinking about the future of the energy transition. Similarly, *Kirsten Westphal* questions the suitability of the existing energy governance structure in dealing with the challenges of the energy transition. The challenges of governing or steering the energy transition from the top down led to the emergence of a new governance model, which provides states with the flexibility to manage their own transitions from the bottom up. Under the overarching climate regime, a sequence of recurring reporting, monitoring, and increasing ambitions has been designed. Yet this governance model depends on national and regional energy policy measures, such as emissions trading schemes, and on countries committing to an ambitious common goal, even though individual paths toward it differ markedly across the globe. As a result, one of the challenges will be developing policies and governance fit for an increasingly heterogenous, fragmented, and regional energy world. What is more, future pathways are highly unpredictable since the energy transition is also part of an industrial revolution. Westphal notes that the new energy system will be more electrified, digitized, demand-side driven, and distributed, leading to a relocation of production and demand which will be guided less by geology than by political choice. In this regard, two decisive trends need be watched closely. First, will regionalization result in competitive regional governance that fuels rivalry and fragmentation, or will regional governance provide stepping stones for global governance? Second, will the energy transition result in competitive and functioning new markets, or will states increasingly control key technologies and value chains?

China's role in the energy transition and the race for technological dominance

In this context, China has emerged as a dominant player in the energy transition. Given its heavy reliance on imported oil and gas, and growing concerns about energy security in light of escalating tensions with the US, a shift away from fossil fuels is a clear geopolitical win for China. That said, China's reliance on oil and gas is unlikely to fall dramatically over the next decade, despite President Xi Jinping's announcement in September 2020 that the country will peak its carbon emissions by 2030 and aim to reach carbon neutrality by 2060.

While there are debates about whether China's centrality in oil markets will weaken in five or ten years, as its electrification programme could limit its need for oil sooner than expected, its importance for gas markets will only grow over the next two decades. *Michal Meidan* argues that even though China will not be immune to geopolitical concerns about transit routes, cut-offs, and price spikes—especially since the leadership now estimates China is facing an extremely hostile international environment—its sheer size in oil and gas markets will lead to greater influence in fossil fuel pricing and governance. China will therefore remain an essential player in the 'old' geopolitics of energy.

Securing access to oil and gas through overland routes has been a key tenet of the Belt and Road Initiative (BRI) since its inception in 2013. *Dongmei Chen* assesses whether China's shift to non-fossil fuels will change the BRI investment focus. She argues that investments in BRI countries in the early 2010s highlighted a change in the country's energy security strategy: moving away from acquisitions of oil and gas fields around the world to a focus on transit routes, integrated trade and investment frameworks, and diversified energy cooperation. Chinese energy investments through the BRI have focused on five main energy channels which have helped diversify China's oil and gas import sources and reduce reliance on seaborne flows, even though some investments have been plagued by economic and geopolitical challenges. Yet due to concerns that China's vast investments in fossil fuels through the BRI could undermine global emissions-reduction targets, and become a bad financial risk for host countries as renewables become cheaper and more popular, there will likely be adjustments to how China views both energy security and the BRI. Indeed, the BRI will offer China new investment opportunities in renewable technologies and will be seen by the international community as a benchmark of China's commitment to its shift away from fossil fuels.

Despite China's continued support for fossil fuels at home and abroad, *Barbara Finamore* argues that China has done more than any other country to accelerate the diffusion of clean technologies. It is already dominant in the manufacture and deployment of first-generation clean energy technologies such as crystalline silicon solar, onshore wind, and lithium-ion batteries. Strong state support has helped China scale up the manufacturing and deployment of clean technologies, and reduce costs for their deployment around the world. In the past, the focus for technological innovation was on accessing foreign technologies and research and development (R&D) and shaving production costs. Now, Chinese companies are pursuing technological breakthroughs in potentially game-changing technologies that are essential in the battle against climate change. These include advanced solar technology R&D and developing floating offshore wind demonstration projects. The country is already focusing on the commercialization of hydrogen-powered fuel cell vehicles, largely based on hydrogen produced from fossil fuels, but is now widely expected to develop a national strategy for green hydrogen. China's upcoming five-year plan is also set to support the development of long-duration and high-efficiency energy storage technologies, decreasing prices and increasing lifespans to 15–30 years.

As China develops technologies and new digital ecosystems, can lessons learned in China be applied elsewhere? *Zhanghua Zheng* argues that China's success in improving domestic grid connectivity could benefit the energy transition by providing a model for other countries. While there are many arguments in favour of decentralizing electricity systems that rely on renewables—pointing to benefits such as energy independence and lower infrastructure costs—decentralization may not be the universal solution yet. The supply of green electricity to the Beijing-Tianjin-Hebei urban agglomeration (Jing-Jin-Ji) is a case in point: with decentralized grids and storage, powered by distributed wind and photovoltaic power, the Jing-Jin-Ji will require battery storage of 5 TWh at an investment cost of up to RMB 5 trillion (which is close to the total assets of power grids for the whole country, estimated at RMB 6 trillion). But having built an integrated grid in this vast urban agglomeration, China has delivered security of supply, while laying the foundations for improved connectivity going forward. Grid interconnections in Asia and Africa, for example, could help reduce emissions while increasing the levels of electrification in final energy consumption.

The debate between grid integration and decentralized power supplies will depend greatly on batteries and storage solutions. The global battery 'arms race' which is currently underway has been turbocharged by the coronavirus pandemic, according to *Simon Moores*, but the US is still a mere bystander in it. Lithium-ion batteries are not only the enabling technology for the 21st century automotive industry but also a disruptive technology for the energy and utility sectors, suggesting that control of the lithium-ion battery supply chain is a key element of modern industrial power. The modern-day arms race therefore revolves around super-sized lithium-ion battery cell manufacturing facilities and the mineral supply chains to support them. China is already leading in battery manufacturing capacity: of 181 battery megafactories in the pipeline for the next decade, 136 are based in China, 10 in the USA, and 16 in continental Europe. Put differently, China is building one battery gigafactory a week while the US adds one every four months. But with growing geopolitical tensions between China and the US, and considering that Western automakers are increasingly partnering with Asia-based battery megafactories, geopolitical conflicts could increasingly revolve around access to factories rather than oilfields. Moores further points out that the battery factories are only the end point in a supply chain that spans the mining of key raw materials (such as lithium, nickel, copper, cobalt, graphite, and manganese), chemical refining, and cathode and anode production, through to lithium-ion cell manufacturing. As such, those most active in investing and owning assets and in controlling the intellectual property along the supply chain will be in the most dominant position going forward.

While it remains hard to predict who will win geopolitical advantage and market share in these emerging clean energy businesses, competition is essential in driving down their costs. Indeed, China has dominated the geopolitical energy transition to date, but Europe and the US are now racing to take the lead in developing next-generation technologies that promise improved performance and flexibility, innovative applications, reduced environmental and social impacts, and lower costs.

A similar picture of competition for technology is emerging for hydrogen—another key technology for the energy transition**.** *Thijs Van de Graaf* analyses the geopolitical stakes in the hydrogen race. He notes that hydrogen is well positioned to become the next great prize, but for all the hype, hydrogen will not become the new oil and it is unlikely to ever eclipse oil's market share in the world's energy mix, let alone match its geostrategic significance. Since hydrogen is a conversion rather than an extraction business, rents will likely be smaller than those for oil. That said, the author argues that the global stakes surrounding hydrogen are huge, given that mastery of hydrogen technologies can reshuffle the geopolitical cards in the 21st century. For instance, Germany's massive green hydrogen push is a clear bid to outcompete China, while several oil- and gas-rich countries in the Middle East are banking on hydrogen to maintain their position as key energy suppliers to the world. The author notes that while some major powers may head towards hydrogen self-sufficiency, hydrogen is likely to become an internationally traded commodity which would form the basis for new bilateral energy-trading relationships. Transportation costs are currently emerging as a key bottleneck, although moving hydrogen through pipelines may make more sense, especially in cases where existing pipelines can be repurposed. Thus, the hydrogen market could mimic the natural gas market—with some key differences, including that climate-conscious importers will want to have certificates or guarantees of origin to make sure that the hydrogen they get is of the right 'color'. Van de Graaf concludes that technologies like wind, solar, and electrolysers are on learning curves, which will make the value proposition of carbon-free hydrogen attractive, especially as a growing number of governments set carbon- or climate-neutrality goals.

While there is considerable focus on new technologies, nuclear energy could play a larger role in the transition, although this raises questions regarding its geopolitics and governance. As *Jane Nakano* discusses, continued electricity demand growth from a combination of economic development, population growth, and industrialization is turning developing economies into potential customers for nuclear technology. But the key reactor technology holders and supplier countries, such as Russia, China, and France, tend to either have substantial government ownership of the nuclear industry or be state-led capitalist economies. They are able to offer generous financing to both developing and industrialized economies, in response to which private nuclear companies in industrialized countries have faced an uphill battle. The United States was a leading global supplier of nuclear technology and fuel for much of the last half century, but it has not landed a reactor sale since 2007. Japan has also pursued export opportunities since the early 2000s; however, these efforts have not yet come to fruition. The author argues that supplier countries that warrant particular attention are Russia and China, as their export endeavours come with geopolitical and security implications as well as market-distorting effects. Another security concern arising from the shifting supplier profile is the impact it may have on weakening nuclear governance. Nakano argues that these issues can complicate the prospect for this technology to meet its full potential in climate-change mitigation, and thus calls for a healthy and fair competition to allow a diverse pool of supplier countries to thrive.

The role of energy in US foreign policy

Meghan O'Sullivan looks at the energy transition and the enduring role of energy in US foreign policy. She argues that in the age of fossil fuels, energy has been both an end and a means to American foreign policy. For most of the past 50 years, America's dependency on imported oil has meant that securing energy has most often been an end—the objective—of many of

America's interactions with the world. In recent years, America found itself in a position to use energy as a means—an instrument—of foreign policy to achieve other, non-energy-related goals, largely due to the unconventional boom which catapulted the United States into the position of being the largest oil and natural gas producer in the world. Looking ahead, the author argues that energy will continue to play a critical role in U.S. foreign policy during the energy transition. But this role will be even more complex, and energy will infuse US foreign policy in other ways. America will seek to use foreign policy tools to acquire certain energy outcomes, such as access to markets, inputs, and resources needed to enable climate-friendly technologies. Also, the United States will use foreign policy to convince and cajole other countries to decarbonize their economies and, if through investment and innovation it should emerge as a major source of technology, it could further support a successful global energy transition. The author notes that in other cases, US provision of climate technology, financing, and other related energy assistance will support important foreign-policy goals, especially in its competition with China. Both countries are likely to use energy policy in their quests to extend their influence. O'Sullivan concludes that American foreign policymakers, infused with a new sense of urgency around climate, will continue to see energy as both an end and a means of their efforts to shape the world during the energy transition.

Sarah Ladislaw argues that many of the basic elements of the US 'energy dominance' doctrine—such as increased production, reduced regulation, and enhanced energy trade—seem quaint after the COVID-19 shock. During the crisis, the quest for energy dominance was flipped on its head as the Donald Trump administration sought ways to prop up the US oil and gas industry, and instead of being less reliant on other countries, the US had to engage directly in brokering discussions between Saudi Arabia and Russia. As for the deregulatory aspects of energy dominance, Trump's administration proved to be out of step with much of the energy industry, which had set emissions reduction targets and called for some sort of climate-related energy policy. As a result, the US oil and gas industry's reputation suffered because of the lax regulatory environment. As to the pursuit of energy trade relations, the Trump administration contributed to an atmosphere of heightened geo-economic competition. Looking forward, the author argues that the Biden administration will be motivated more by the pressing danger of unmitigated climate change, a fundamental change from the Trump administration's approach, which did not recognize this transformative goal. Ladislaw notes that while this seems like a daunting challenge, it is also an enormous strategic opportunity, though the goals of the Biden administration will have to be more ambitious in scope. In its international agenda, the Biden administration also faces different and perhaps more daunting objectives, as the world no longer simply needs to negotiate an agreement to govern the process through which countries will pledge climate targets. Rather, the goal is to meet those targets, make them more ambitious, and then meet the more ambitious ones. Ladislaw concludes that one lesson that the Biden administration can learn from its predecessor is that the global energy landscape is highly competitive, and the United States needs to work harder to compete against an increasing array of countries seeking to sell clean-energy technologies. This is a profound strategic shift that the new administration would ignore at its peril.

Are there clear-cut winners and losers from the energy transition?

In light of the importance of national policies—both climate and industrial—in the energy transition, it is likely to be a highly uneven process. *Paul Kolbe and Mark Finley* argue that Europe, for example, will march ahead to a clean-energy economy; countries in Asia and Africa, however, will continue to rely heavily on fossil fuels. An unmanaged energy transition, the authors caution, could exacerbate distributional inequities between advanced developed economies and emerging-market countries. Acknowledging the rise of clean-energy supply chains, the authors consider China a clear geopolitical winner in the energy transition; likewise, the EU, already shifting away from oil and gas, is likely to be a net beneficiary of greater renewable energy deployment and lower fossil fuel dependence. For major oil and gas exporters, the authors argue that those who have the ability to change are likely to thrive, even in a carbon-constrained world. The authors identify Saudi Arabia as a potential winner, albeit with the important caveat that the kingdom's success will depend heavily on its diversification efforts. A blunter projection is given on Russia, argued by the authors to be a clear geopolitical loser, 'unable to dance to a new tune'.

Indra Overland also questions whether Russia is failing to adapt to the changes in the global energy system brought on by climate policy and energy technology learning curves. The author argues that there are several reasons to think that Russian actors are ill prepared for the transition. First, the Russian petroleum industry is one of the oldest and most entrenched in the world. Second, Russian actors have a weak track record of anticipating and preparing for change in the energy sector. Third, the Russian government sends out mixed climate policy signals. Fourth, Russia seems to be betting on the role of natural gas as a transition fuel, underestimating EU countries' plans to reduce reliance on natural gas and focus on renewables, electric vehicles, and green hydrogen. The author argues that while Russia has proved resilient to oil and gas price drops, a permanent drop in fossil fuel revenue will require radical changes to the economy and to the political power structures. But should Russia start proactively addressing the looming threat of decarbonization, it could leverage its cheap oil, rich renewable resources, and rich minerals. Also, if blue hydrogen (from steam methane reforming with carbon capture and storage in old oil and gas fields) or turquoise hydrogen (from methane pyrolysis) emerges as a winner in the future energy mix, Russia will have a bigger role to play. Overland concludes that no other country in the world has as much vested interest in the success of blue/turquoise hydrogen as Russia.

Similarly, the clean-energy transition could challenge the socio-economic and geopolitical role of the Middle East and North Africa (MENA) region, which represents a cornerstone of the established global energy architecture. However, *Pier Paolo Raimondi and Simone Tagliapietra* warn against generalizations, as MENA oil and gas producers are not a homogenous group. Also, oil and gas producers have abundant renewable potential, which could provide them a future energy role as renewable or hydrogen powers. While MENA producers will have to contend with lower revenues, as global oil and gas demand declines, geopolitical outcomes will vary. This is because the trajectories of oil and gas demand are likely to differ in the future, and the speed of the energy transition will also vary across regions. Undoubtedly, producers will engage in a fierce competition for global market share, exacerbating geopolitical risks both regionally and globally. In this competition, some MENA producing countries such as Saudi Arabia and the United Arab Emirates could fare better than others, given the vast size of their reserves and their low production costs and carbon intensity. The authors conclude that while the global energy transition will inevitably affect MENA oil- and gas-producing countries, not all of them will see their geopolitical influence mutate in the same way.

In the same vein, *Ahmed Mehdi* challenges the notion that Middle Eastern producers are set to emerge as the ‘big losers’ of the energy transition. This is premised on the key prediction that oil demand growth will slow and eventually plateau and decline. The resulting lower oil price range for most Middle East economies will take place against the backdrop of fiscally rigid national budgets, high population growth and the resulting labour market pressures, and limited financial tools to navigate crises. While Mehdi acknowledges that tighter margins, a lower oil price outlook, and the prospect of volatile oil cycles will upend the region’s geopolitical status, the strategic fortunes of the region are likely to be more nuanced, especially given that the Middle East has not been standing still as the energy transition gathers pace. He makes the following predictions: (1) Middle East producers will not necessarily lose strategic influence as oil demand declines; (2) the geostrategic role of gas in the Middle East will grow; and (3) the energy transition will offer producers strategic opportunities to increase geopolitical leverage.

Vitaly Yermakov examines the dynamics between the world’s largest global oil producers and exporters—Saudi Arabia, Russia, and the US—arguing that each producer has its own set of strengths and weaknesses and that these will shape the future of global oil markets. For Saudi Arabia, the greatest concern is the sustainability of its budget and spending programs, and thus the kingdom has the incentive to keep oil supply in check for longer. Russia’s resilience to a prolonged period of low oil prices is quite high as a result of a flexible exchange rate that allows Russia to balance its state budget by way of macro policies, high levels of foreign currency reserves, and a self-adjusting tax take that protects oil producers in a low oil price environment. At the same time, Russia has not been a natural swing producer due to limited spare production capacity and the specifics of oil recovery. Russia’s main interest in the OPEC+ alliance has been to avoid extreme price volatility, especially on the downside. For the US, the key problem appears to be a balance between US shale output growth and profitability. Also, the new US administration has already indicated its focus on decarbonization. The impact of tougher economic terms—in the form of higher funding costs for oil and gas projects, greater investor scrutiny, and stricter regulation of flaring and venting—would increase the average breakeven prices for the US producers. Counterintuitively, this would make it easier for Russia and Saudi Arabia to cooperate. However, the author notes that decarbonization policies could also impact long-term oil demand, and the question is whether the increasing divergence in the long-term strategies of the world’s largest oil producers in response to the energy transition will create new rounds of increased competition, which will be driven not only by economics but by regulation, carbon border adjustments, and trade restrictions. The author concludes that it is difficult to make a prediction at this point, but this does not necessarily mean that competition will prevail over cooperation in global oil markets. Increased pressures from the energy transition could bring Russia and Saudi Arabia closer together, but the forms of cooperation will have to evolve if this cooperation is to persist.

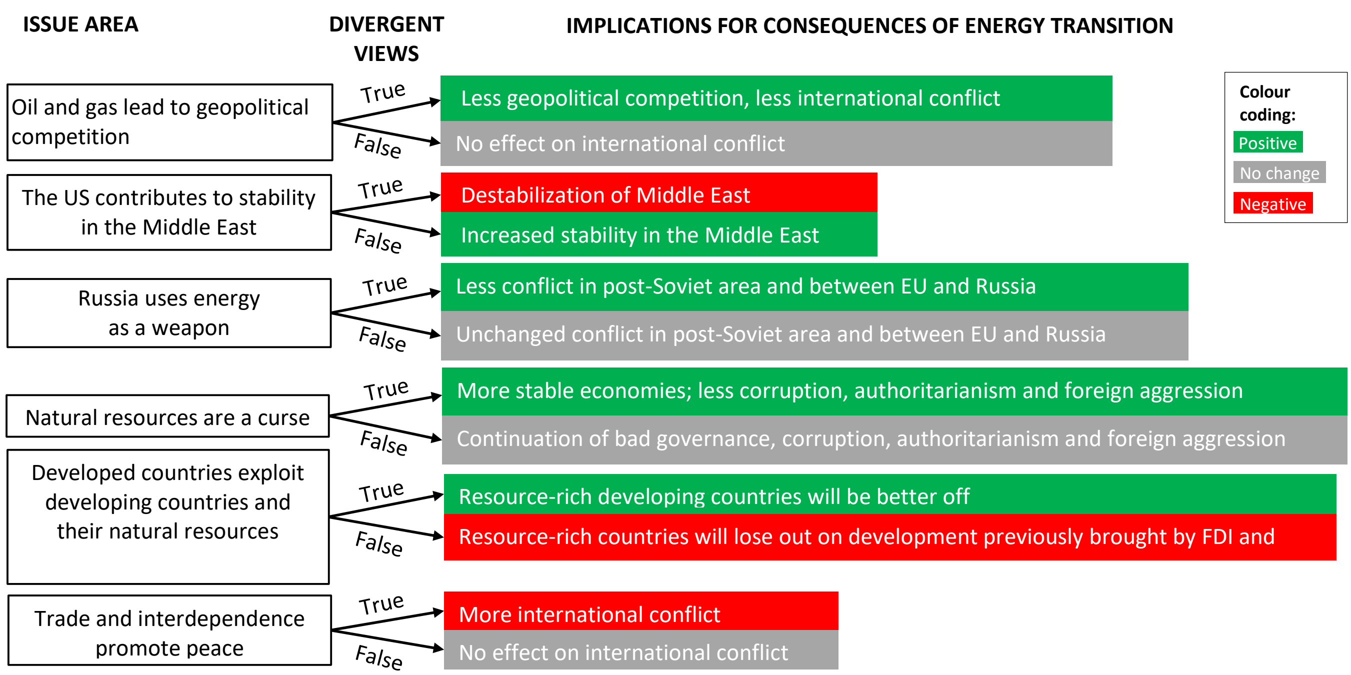
Zenonas Tziarras notes that a series of crises, particularly in 2020, have destabilized the eastern Mediterranean region and created a number of security and diplomatic problems. With energy resources becoming so central to discussions on eastern Mediterranean affairs, the author asks how much of the problem can really be attributed to the new hydrocarbon discoveries, given other underlying issues and the history of regional tensions. The author notes that many observers perceive the renewed tensions as a competition for control of natural resources. However, in reality the issues are more complex, and much of the analysis downplays more deeply rooted issues pertaining to security and diplomatic relations among the littoral states, and particularly sovereignty issues. These long-standing issues are playing out against a background in which the European Commission's vision for a climate-neutral EU by 2050 has started a race for decarbonization, a development that is bad news for fossil fuel projects, including many of the East Med pipeline projects under consideration.

UNCERTAIN PAST, UNCERTAIN FUTURE: HOW ASSUMPTIONS ABOUT THE PAST SHAPE ENERGY TRANSITION EXPECTATIONS

Indra Overland

The burgeoning literature on the geopolitics of the energy transition now numbers more than 200 publications (*Vakulchuk et al, 2020*). Many of these works conjecture boldly about how the replacement of fossil fuels by renewable energy will affect international affairs. However, many of these conjectures rest on unstated assumptions about the global energy system of the past, which is more contested than it is made out to be. Figure 1 presents six areas where one's interpretation of past and current issues are decisive for how one thinks about the changes that will be wrought by the energy transition. The rest of this article reviews each of them.

Figure 1. Implications of views on the past energy system for the consequences of energy transition



Geopolitical competition over oil and gas

A common assertion in recent decades is that oil and gas resources are geopolitically important and therefore subject to intense international competition. From this perspective, the American invasions of Iraq were all about oil, African and Latin American countries are subject to intense competition between China and Western countries driven by competition over oil and other natural resources, and the Arctic is a hotspot of territorial rivalry.

This geopolitical mindset harks back to the classical works of Halford Mackinder, Rudolf Kjellén, and Friedrich Ratzel, whose names geopolitical enthusiasts like to invoke to give themselves historical weight and credibility. However, if one actually reads these classics, it is clear that they represent a simplistic and deterministic social science that no longer has much credibility.

Admittedly, geopolitical competition was decisive during the colonial era and the First and Second World Wars. Then, great powers engaged in continuously expanding, cumulative, winner-takes-all competition over strategically valuable natural resources and locations. The great power with the most men (territories), tanks (steel), and diesel (oil) had a good chance of winning. The more geopolitical advantages a country could amass, the more likely it was to prevail over its competitors further down the line. Hence the fierceness of the Battle of Stalingrad (which was located on the supply route for Caspian oil) and the bombing of Pearl Harbour (which was partly triggered by competition over South-East Asian natural resources, especially oil).

However, since the advent of the nuclear bomb, it is not clear that maximum access to oil would be as decisive in a direct military confrontation between great powers. Furthermore, the end of colonialism means that there are no more ‘white spots on the map’ to compete over. Occasionally it is still possible to occupy a territory, and some states can be made military or economic clients, but that is a far cry from the classical geopolitical race.

If oil has not had the geopolitical value during the post-war period that some have thought, the transition to renewable energy might not usher in the era of peace and goodwill between great-power states that someone seeing the world through a geopolitical lens might expect. By contrast, if the geopolitical interpretation of the recent decades does makes sense after all, a transition from fossil fuels to renewable energy should greatly reduce tensions in the international arena. The United States should lose interest in the Middle East, competition between China and Western countries over client states in Africa and Latin America should soften, and oil-fuelled geopolitical hotspots such as the Arctic, the Persian Gulf, and the Caspian and South China Seas should lose some of their lustre.

It is not necessary to draw a final conclusion here on who is right about past geopolitics, just to recognize that the role of geopolitics in the oil-based international energy system is contestable—and that one’s choice of perspective has implications for how one envisages the geopolitical consequences of the energy transition.

US engagement in the Middle East

The most important piece in the putative puzzle of petroleum geopolitics is the Persian Gulf and the wider Middle East and North Africa region. Here, another set of assumptions comes into play. Apart from the question of how robust the argument is that geopolitical interest in oil is a *cause* of American engagement in the region, there is also the question of what the *consequences* are of that engagement. Has the US been a stabilizing or destabilizing factor in the Middle East, or both? Has it contributed to more or less democracy among the Muslim states? Clearly, those are contentious questions. The views one adopts lay the premises for how one thinks about the consequences of declining Western interest in Middle Eastern oil and gas and whether it will entail more chaos or stability and more authoritarianism or democracy.

Russia’s energy weapon

The Russian Federation is seen by some as having used its natural gas resources as a foreign policy tool or even a weapon. Proponents of this viewpoint to not only the disruption of gas supplies to Ukraine and other countries straying from Russia’s orbit, but also the use of discounted energy supplies to entice countries to stay close to Moscow.

However, while many see Russia using its fossil fuel resources to maintain a semblance of the Soviet Union, others see the opposite: the modernization, increasingly commercial orientation, and independence of post-Soviet Russia. From this viewpoint, if Russia’s neighbours want to continue using Russian energy resources, they must now pay the real cost, and their reluctance and/or inability to do so—not any heavy-handedness on Russia’s part—is the real problem.

Which of these two opposing views one adopts has implications for how one thinks about the consequences of the energy transition for international affairs in the post-Communist area. Those who perceive that Russian has been using energy as a weapon might expect the energy transition to disarm Russia. Those who do not subscribe to this view will not expect to see much change in terms of international security, just the loss of an important source of revenue for Russia.

The resource curse

A vast literature sees natural resource wealth as a curse, bringing corruption, bad governance, authoritarianism, and domestic and international conflict. In many contexts it is taken for granted that the resource curse is a real phenomenon and constitutes a major obstacle to development in resource-rich countries.

However, there is also an antithetical literature, which has been growing since around 2008. It argues that much of the resource curse analysis has been based on flawed statistical analyses and that the curse does not exist. In this view, the problems that many resource-rich countries grapple with must be due to climate, culture, religion, colonialism, or something else.

Which of these perspectives one adopts influences how one thinks about the consequences for development of declining oil demand. From the resource-curse perspective, authoritarian and/or underdeveloped petroleum-exporting countries may be freed of a burden and finally flower. Countries such as Angola, Russia, and Saudi Arabia should then have a greater chance to become democratic, reduce corruption, and maintain peace with their neighbours. By contrast, from the resource-curse-sceptic perspective, energy transition should not bring much change in this area.

Dependency theory

Dependency theory used to be widely taught in Western universities in various guises, including neo-Marxism, world systems theory, and periphery capitalism. The central idea of dependency theory is that 'central' (wealthy, Western) states exploit 'peripheral' (poor, non-Western) states, draining their natural resources and ensuring by political, military, and economic means that they are unable to develop. Obviously, dependency theory never gained much popularity among people holding free-market, pro-Western views, who see underdevelopment as mainly caused by internal problems such as bad governance, corruption, weak institutions, and authoritarianism.

After the collapse of Communism, dependency theory lost much of its popularity. However, many people—including academics—continue to believe explicitly or implicitly that poor countries are poor because they are subjugated and exploited by wealthy countries. From this perspective, a transition to renewable energy and the concomitant reduced interest in the fossil fuel resources of developing countries should improve the lot of poor countries, as wealthy countries will have less interest in exploiting them. By contrast, those who do not see dependency theory as having much explanatory power might not expect the energy transition to unlock developing countries' supposedly thwarted powers of self-determination.

Potential of trade and interdependence to promote peace

It has frequently been argued that globalization and growing trade and interdependence between countries promotes peace, for example by Keohane and Nye in their international-relations classic '*Power and interdependence*'. They envisaged that growing trade would create multiple 'channels' between countries while also reducing the importance of war in international affairs, leading to greater emphasis on economic tools and relations and opening the field to a more diverse set of actors. This liberal argument was energy-centred from the start and was thought to be supported by the oil crisis of 1973. It was intended as a critique of realist approaches to international relations, in which military force and physical resources had primacy.

Both perspectives live on today and provide opposing starting points for interpreting the consequences of the energy transition. From a realist perspective, the transition should reduce international tension. As countries become 'prosumers' that produce and consume their own energy from domestic renewable resources, they should become less dependent on the world's hydrocarbon resources and should therefore have less reason to compete over them.

By contrast, from the liberal perspective of complex interdependency, growing reliance on domestic renewable energy resources should *increase* the risk of international conflict, as prosumer countries will be less dependent on one another and have fewer interlinkages to dampen their bellicosity. Peace-loving, pro-renewables liberals may find this counter-intuitive, but it is the result of a linear extension of the logic of complex interdependence to the clean-energy era.

Conclusion

These points indicate that existing projections of the consequences of the energy transition are more uncertain than they appear. But they also have implications for scenario-building, prediction, and foresight studies more broadly. Predicting future developments and events is challenging even when one agrees on the past. When the past is open to conflicting interpretations, prediction is yet more difficult. More attention needs to be paid to how interpretations of the past and present shape our predictions of the future, both regarding the geopolitics of the energy transition and beyond.

GLOBAL ENERGY GOVERNANCE: MEETING THE CHALLENGE OF THE ENERGY TRANSITION

Kirsten Westphal

Policymakers worldwide face the Herculean task of making the energy system more sustainable and climate friendly. While the world has seen other energy transitions, this one is different. In the past the world switched from one energy source (wood, coal, oil, electricity) to another, and the fuel switch was driven by major inventions (steam engine, combustion engine, light bulb).

These transitions happened organically, reflecting technological life and innovation cycles and without too much concern about lock-in effects. This time, a whole range of new, climate-friendly energy sources and applications must be deployed, and this must happen rapidly.

Past energy transitions brought about profound systemic changes beyond the energy system—affecting economic and financial structures, societies, and cultures, and even shaping states' political organization. Learning from these past experiences can help us to grasp the magnitude of the transformation that is ahead of us now.

The Paris Agreement and subsequent annual climate change conferences by the COP and UN FCCC reports have highlighted the urgency of climate change mitigation. This time the energy transition has to take place in a rapid and rigorous manner. Article 2.1 of the Paris Agreement stipulates that nationally determined contributions should be formulated in line with the goal of keeping global warming to less than 2°C over pre-industrial levels, preferably no more than 1.5°C. The Paris Agreement establishes a bottom-up governance process to achieve the climate target.

Besides climate change mitigation, there is the broader goal of sustainability and respecting planetary boundaries. Sustainable Development Goal 7 aims to provide 'affordable and clean energy' by 2030 for a population that is expected to reach 8.5 billion by then (*United Nations, The 17 Goals*). The goal of sustainable growth has grown more acute, given the socio-economic consequences of the COVID-19 pandemic and the world's search for blueprints for a better recovery. The EU's Next Generation recovery programme of €750 billion reflects a political understanding that the huge public expenditure should lay the foundation for better living conditions for future generations.

The energy transition encompasses incremental changes (e.g. in energy efficiency), structural ruptures (e.g. those created by the coal exit), and systemic shifts (e.g. towards electrification, digitization and hydrogen). At the same time, the security of fossil fuel supplies has to be ensured during the transition without perpetuating the existing energy system. Phasing-out and decommissioning challenge the system's robustness and functioning.

The energy transition also has to take place at all levels and stages of the energy production chain, from producers to end users. Yet its pathways look very different across the globe in terms of starting and end points, speed, and components. Transitions imply uncertainty and unpredictability, as they profoundly alter the supply-and-demand balance in incumbent markets, affect business and financial models, and change the political economy of energy.

Neither the energy transition nor energy governance start from scratch. The challenge is to make use as efficiently, inclusively and effectively as possible of the existing system while fostering the changes needed to navigate current and future changes.

The governance task: Meeting targets, balancing objectives, and reducing uncertainty

At least in the OECD, energy governance has been guided by three principles: security of supply, affordability, and sustainability. Globally, this constituted the trilemma of addressing security of supply, ecological sustainability, and energy justice simultaneously, as the World Energy Council has put it. The overarching target of fighting climate change and addressing sustainability rests on the belief, for good reason, that a sustainable energy system will create synergies between the three goals.

In the past, the balancing of energy policy objectives and priorities has usually taken place at the national or regional level. In international relations, governance approaches have been traditionally directed to energy security, which was defined as national energy security. The international governance organizations (e.g. IEA and OPEC) were built to address supply and demand security. During the 1990s and after the end of the Cold War, human security moved into focus, putting a spotlight on individuals and their living conditions. A new emphasis was placed on the global commons. This meant a paradigm change, and today the guiding principle of sustainable energy security is bridging the gap between the individual and the global commons. These paradigm changes are also reflected in new governance organizations such as IRENA (the International Renewable Energy Agency).

What we are witnessing since the turn of the first decade of this century is a new model of governing through goals and targets. With regard to the task of governance, the targets for the energy transition were declared by the UN's Sustainable Development Goal 7 for 2030 and set in a binding manner by the Paris Agreement for 2050. The latter has been translated into regional and national commitments to climate neutrality by 2050 (e.g. the EU) or carbon neutrality by 2060 (e.g. China).

This new governance model was a way out of the governance crises that emerged from the inability to steer an energy transition from the top down. It provides states with flexibility, and the hope is that the objectives will be achieved from the bottom up. The national pledges and nationally determined contributions are expected to help achieve the common goal.

What does this mean for the mechanisms developed to achieve the targets? The global climate regime calls for a recurring sequence of reporting, monitoring, and increasing ambitions. This requires translation into specific national and regional energy policy measures, such as emissions-trading schemes, and these may differ markedly from one country or region to the next, creating a high level of uncertainty about the future pathways of different players and their interactions regionally and globally. Even if the endpoint is agreed on, the type, timing, and sequence of measures linked to specific energy carriers and solutions are not. To reduce transaction costs, limit free-riding, and create as big and level playing fields as possible, converging and harmonized instruments have to be developed by 'coalitions of the willing'.

Finally, energy is obviously a cross-cutting issue that intersects with climate, environmental, economic, and industrial issues. The energy transition is part of an industrial revolution, as are digitalization and artificial intelligence. The challenge to govern the energy transition on these different levels is paramount. The existing energy governance architecture is outdated; it has not kept pace with changing energy pathways and security perceptions, and it is not fit to govern the energy transition in line with Sustainable Development Goal 7 and the Paris Agreement. Energy governance and its targets have gone through a fundamental paradigm shift. The search for effective and legitimate governance measures and instruments is on.

The search for a new governance model

The energy transition will profoundly change the energy world into one where value is no longer generated primarily from a fossil fuel resource such as coal, oil, or gas but rather at the stage of conversion into end-user energy or services (*IRENA, 2019*; *Goldthau et al, 2018*). The generation of rents from fossil fuel reserves will be increasingly difficult as the deposits are devalued. Instead, more and more value will be created downstream of the energy supply chain and in services, and profits will be generated by low-carbon technologies. New business and financial models will have to be developed and proven.

The new system will be more electrified, digitized, demand-side-driven, and distributed. Today's energy system is divided into individual sectors (e.g. electricity, buildings, transport, heating and cooling, and industry), each characterized by a dominant mix of fuels. In the system of the future, the sectors will be coupled by the use of climate-friendly electrons and molecules. As a consequence of the changes in the system, a relocation of production and demand will take place. The parallel trends of supergrids and decentralized energy generation, combined with new battery and blockchain technologies, are increasingly blurring the boundaries of the existing energy system. This is challenging states' traditional roles and responsibilities. The energy landscape is being remapped, and the process is guided less by geology than by political choice.

Energy regions with centres and peripheries may emerge. Energy efficiency and renewable energy are available and can be harvested anywhere. This is not only a plus for energy security, but also makes it possible to shape new energy communities and connections based on political choice rather than geologic necessity. Connectivity is defined politically, reassessing existing interdependencies, alleviating old sensitivities and vulnerabilities, but also creating new ones. This is particularly true for electricity grids and their different shapes (centralized or decentralized) and sizes (local, national, continental, or transcontinental). 'Grid communities' (*Scholten, 2018*) are a case in point.

Hydrogen is seen as the missing pillar for decarbonization of difficult-to-abate sectors. Hydrogen and its derivatives will be a centrepiece of the new industrial revolution, but will also create new cross-border value chains with knock-on effects on industrial locations, clusters, and production chains. Here too, the emerging trade and production patterns will be determined less by geology and more by common political interests and energy pathways.

Of course, these trends are far from comprehensive. The IEA's World Energy Outlook 2019 clearly states that there is no silver bullet to stop or mitigate climate change. Rather, a combination of technologies (including energy efficiency, renewables, fuel switching, nuclear energy, and carbon capture) and, not least, behavioural change are needed to put the world on track. In this complex arena, three major challenges stand out:

1. New energy governance institutions and instruments are needed to manage emerging energy spaces for which the current system is not well suited.
2. The increasing complexity of governance calls for a 'networked' approach. This is necessary both to manage transnational energy flows, in particular where and when critical infrastructures such as electricity and

telecommunications intersect, and to deal with corporations, non-governmental organizations, and civil society, whose role is increasing as the political importance of states and territories weakens in the international energy order.

3. The energy transition brings major uncertainty and risks. In the OECD, the challenge is to guarantee energy security in the current system, without perpetuating it, and at the same time to accelerate incremental structural and systemic changes. The challenges elsewhere, for example in the global South, are very different. Managing the phase-out of the hydrocarbon trade can help to reduce vulnerabilities and hedge risks and costs on both sides of the value chain.

Conclusions

The goals for the energy transition are set. The question remains whether all states will deliver, and whether the contributions will suffice to achieve the goals. Commitment to the goals does not create a level playing field. Instead, it raises questions of the fair distribution of responsibilities, costs, and benefits. Inequalities, fragmentation, and regional heterogeneity may increase.

The next challenge is to develop policies and governance to smooth the transition. The pacing problem and the different measures and ambitions create an environment of competition and rivalry. To reduce costs and share the burden, joint horizon-scanning and scenario-planning and early engagement are essential.

New governance institutions and measures have to be developed. A sustainable energy transition requires multiple components, from energy efficiency to renewables, hydrogen, carbon capture and storage, and behavioural change. Most of the components will require tailored governance approaches. The exchange on best practices and most efficient, effective, and legitimate policies should be part of governance. How to design best policies to break path dependencies, achieve catalytic effects, and best connect the different levels?

Multilateral governance has been in crisis. The energy world is likely to become more heterogenous and fragmented, which will result in scattered governance. Regional energy blocs might emerge. The fact that there is no common script for the energy transition and no single solution requires non-hierarchical, polycentric, and polythematic approaches in specific regions, coalitions of the willing focused on specific energy sources, carriers, and technologies.

Two decisive trends will have to be watched closely. First, will regionalization result in competitive regional governance, intensifying rivalry and fragmentation, or will regional governance provide stepping stones to global governance? Second, will the energy transition result in competitive and well-functioning new markets, or will states increasingly control key technologies and value chains?

Finally, energy is no exception to the overall trend of non-governmental and private governance. Even if ‘networked’ governance implies a multi-stakeholder approach, the nation state will remain important in certain functions. Efforts to create a level playing field and a rules-based energy system will help make the transition as smooth as possible. Free-riders and cherry-pickers as well as technological hegemony have to be addressed. The more norm- and paradigm-driven the international governance system is, and the more it strives for justice, inclusiveness, and solidarity, the more evenly costs and benefits will be shared.

This text is a revised and condensed version of M. Pastukhova and K. Westphal (2020), ‘Governing the global energy transformation’, in M. Hafner and S. Tagliapietra, eds., The Geopolitics of the Global Energy Transition*, Cham, Switzerland: Springer Nature, 2020.*

CHINA’S EMERGENCE AS A POWERFUL PLAYER IN THE OLD AND NEW GEOPOLITICS OF ENERGY

Michal Meidan

As the world transitions away from fossil fuels and towards renewable energies in increasingly electrified economies, China stands to benefit. The perception is that China’s shift to a low-carbon economy will help that country, a large consumer of imported oil and gas, to ensure energy self-sufficiency (since renewable sources are all locally generated), thereby offsetting the strategic vulnerabilities associated with imported fossil fuels.

While this is true—and likely one factor informing China’s ambition to reach carbon neutrality by 2060—it is an overly simplistic view of China’s role in the geopolitics of energy. Indeed, the road to energy self-sufficiency through electrification is long; and in the interim, China stands to benefit increasingly from its position as the largest source of incremental fossil fuel demand as well as its dominance of clean tech manufacturing and of critical mineral supply chains.

Energy security in the fossil fuel era

China is today the world's largest importer of crude oil and the biggest source of incremental oil and gas demand. It relies on imported oil for over two-thirds of its total demand, while overseas gas, both piped and liquefied, accounts for just under half of the gas used in the country. The reliance on imported fossil fuels takes a large financial toll on the country; but more importantly, it exposes China to a variety of risks that could undermine the continued supply of energy. These include instability in producer countries, military clashes along supply routes, threats of supply cut-offs, and, over the past few years, financial sanctions and export controls imposed by the United States.

China's decision makers have long been concerned about these vulnerabilities and have sought to mitigate insecurities throughout the supply chain, using the state's deep pockets and its ability to influence corporate investment decisions. China's oil and gas majors have invested in upstream assets around the world, but they have also secured supplies of natural resources as repayment for loans. The country has developed a merchant fleet to transport commodities but has also prioritized a diversity of supply sources globally, while investing in pipelines to offset its reliance on seaborne imports. Beijing has also stocked up on strategic reserves of crude oil, to minimize economic damage in the event of a supply disruption.

The trading arms of China's energy giants have become dominant actors on global benchmarks; Beijing is also looking to gradually reduce its exposure to trading in the US dollar and to the US market more broadly, given Washington's growing recourse to export controls and its ability to disrupt supplies of technologies and services to China. Meanwhile, at home, the Chinese government has launched an ambitious programme to electrify its vehicle fleet, as part of its energy security programme and efforts to reduce tailpipe emissions.

While not all efforts to mitigate supply insecurity have been effective, the wide range of responses suggests that a supply disruption or spike in prices will not cripple the Chinese economy. If anything, a new host of challenges will likely present themselves as the energy transition accelerates: the loss of oil and gas revenues could create political instability in producer countries, and some of China's overseas investments could become stranded assets. The loss of revenue or output in producer countries could also inhibit their ability to repay loans that China has issued.

For now, though, the Chinese leadership remains focused on supply security and curbing its import dependency. Indeed, China's oil demand is not expected to peak before 2025; and given the importance of crude oil in its chemicals industry—which Beijing continues to develop—its appetite for crude will remain strong for another decade. Even if India begins to displace China as the largest source of *incremental* oil demand in the mid-2020s, the China National Petroleum Corporation (CNPC), China's largest oil company, estimates that the country's refining system will exceed that of the US and reach close to 20 million barrels a day by 2025. Put simply, despite the acknowledgment that reliance on fossil fuels needs to come to an end, China's economic and energy outlook suggests this will only happen in a decade or so for oil and not before the 2040s for gas.

But this may also play to China's advantage as producers continue to look to China for demand security. Given China's ongoing need for imported oil, just as demand peaks and begins to decline elsewhere, China's importance for producers will only rise, and with it, its ability to impact flows, price discovery, and benchmarks. And while there are debates about whether China's centrality in oil markets will weaken in five or ten years, as its electrification programme could limit its need for oil sooner than expected, its importance for gas markets will only grow over the next two decades. China will not be immune to geopolitical concerns about transit routes, cut-offs, and price spikes—especially since the leadership now estimates China is facing an extremely hostile international environment—but its sheer size will lead to greater influence in fossil fuel pricing and governance.

Still active in the old energy markets, ahead of the curve in the new

For close to two decades, as part of its efforts to limit its dependence on fossil fuels and as part of its industrial policies, China has developed its electric transport industry and green manufacturing capabilities. As the energy transition also implies an accelerated electrification of end uses, the production and deployment of renewable energy resources are becoming increasingly central to global energy consumption and therefore to geopolitical competition. While renewables do not require access to fossil fuels, and their generation is conducive to energy self-sufficiency, manufacturing wind turbines, solar panels, and batteries requires raw materials such as copper, graphite, lithium, and cobalt. One area of geopolitical focus, and potentially tension, is the extraction and processing of these materials.

But China has a first-mover advantage here. Chinese companies have invested in mines in the Democratic Republic of Congo (DRC), Chile, and Australia, among other countries, securing access to critical minerals. So, while Chinese investments in unstable oil- and gas-producing countries have yielded mixed results in terms of energy security, Chinese companies' tolerance for political and operational risk, and their ability to deal with cost overruns, have afforded it a major role in the extraction of these critical materials. For example, in the DRC, China is estimated to have secured equity stakes and supply agreements with over half of the local cobalt producers. Chinese companies have stakes in projects accounting for one-third of Argentina's lithium reserves and two-thirds of Chile's lithium production. China's ability to offer producer countries financial loans and infrastructure development will continue to facilitate its access to resources, while increasingly creating tensions with other consumers of these minerals.

Beyond resource extraction, China is also dominant in processing critical minerals as well as in renewable energy and battery manufacturing. China now produces more than 70 per cent of the world's solar modules and is home to nearly half of global wind turbine manufacturing capacity. It is also the largest producer and buyer of electric vehicles in the world, and it dominates the supply chain for lithium-ion batteries, controlling 77 per cent of cell capacity and 60 per cent of component manufacturing, according to Bloomberg New Energy Finance.

China refines more than twice as much lithium and eight times as much cobalt as any other country. And its centrality in the downstream is set to continue due to a combination of factors. First, material costs in China are currently lower than elsewhere; second, it is one of the few countries to have both the infrastructure to set up a large refining base and the willingness to tolerate its environmental impact. Finally, China's strong refining capacity and large consumer base have prompted many companies to focus their investments in the country, as it is expected to be a large driver of growth. China's size affords it influence in fossil fuel markets but is equally significant for the energy transition, as its ambitious plans to electrify the economy and decarbonize transport and power will require massive production and deployment of new infrastructure and systems.

But in light of rising tensions with the US, and concerns about a potential technological decoupling with the US (and the West more broadly), China is looking to enhance its technological self-sufficiency and global leadership. Indeed, China's focus on energy security and technological self-reliance are key factors informing Beijing's aim to reach carbon neutrality by 2060. Chinese ministries have estimated that achieving this goal could yield over RMB 100 trillion ($14.7 trillion) in investments over the next 30 years.

Taking a leading role in the global economy through low-carbon, high-tech, and information technologies is a direct continuation of China's industrial policies and the ambition to rise up the industrial value chain. The much-criticized Made in China 2025 policy, and the more recent High Quality Development model and New Infrastructure Plan, highlight these priorities. Going forward, China's 2035 vision and its China Standards 2035 policy blueprints will further stress that China is seeking a role in higher-margin industrial manufacturing—including in some of the key technologies that underpin the energy transition—and increasingly in standard-setting, too.

While the rise of China as a leading manufacturer of renewables led to a dramatic fall in global costs, it was also fraught with commercial disputes. Future developments in clean technologies are likely to lead to similar dynamics; but with the increasing securitization of commercial ties, the quest for technological dominance will intensify and take on a strategic dimension. Technological competition could encompass the design and manufacture of electric vehicles and batteries, grid solutions, energy storage, and hydrogen, with the EU and the US potentially looking to create 'China free' supply chains. Moreover, heightened concerns in many developed economies about China's commercial practices, and growing reluctance to allow Chinese equipment manufacturers to play a key role in strategic industries (such as power generation), could limit China's outbound investments of cleantech. It is precisely these dynamics, however, that are adding impetus to Beijing's determination to develop its domestic capabilities and cement its position as a leader in the global energy transition.

China's pledge in September 2020 to reach carbon neutrality by 2060 also suggests Beijing is looking to take on a leading role in climate governance. The 2060 pledge will have wide-reaching implications for China's energy system and economic structure, but it is also a significant milestone in China's diplomatic stance. China's environmental diplomacy has long emphasized that developed and developing economies should not share an equal burden in tackling climate, and China, as a developing nation, was the torchbearer for a group of 77 developing nations in this assertion. But in September, President Xi Jinping signalled that China is ready to take on a leading role in global efforts to tackle climate change, irrespective of the steps taken by other countries, including the US.

Indeed, China was widely expected to wait until after the outcome of the November 2020 US presidential election, and potentially even until after the incoming administration took a clear stance on climate, before issuing its own enhanced climate targets under the Paris Agreement. The fact that Xi himself announced a clear pathway to decarbonize China's economy, well before the US elections, was therefore hugely significant. Xi dismissed attempts by the EU to issue a joint announcement earlier in September. But it remains to be seen whether China, the US, and the EU can now work jointly to strengthen the UN Framework Convention on Climate Change, or whether climate leadership will become another area of competition.

Conclusion

The energy transition should, for the reasons discussed above, allay some of Beijing's strategic concerns. The shift to renewables—many of which rely on home-grown technologies and manufacturers—will limit reliance on imported fossil fuels and the complex geopolitical relations that govern their supply and transit. In the interim, the Chinese market will remain central for suppliers and exporters of fossil fuels, offering Beijing growing impact on flows and prices. Moreover, China has already established a dominant position throughout the supply chain of critical materials and the production of renewables equipment. Beijing's concerns about technological decoupling with the West will only accelerate its efforts to set technical standards across a range of industries, hoping to shape the playing field for future innovation. Increasingly, China may be looking to take a leading role in global climate diplomacy as well.

CHINA'S BELT AND ROAD INITIATIVE: CHANGING INVESTMENT PRIORITIES IN PURSUIT OF ENERGY SECURITY AND CARBON NEUTRALITY

Dongmei Chen

Since its initiation in 2013, China's Belt and Road Initiative (BRI) has continued to expand in strategic and geographic scope, with $1.38 trillion of Chinese investment and financing provided to more than 2,500 projects in more than 138 countries. In October 2017, the Chinese Communist Party mentioned the BRI in its new constitution, highlighting Beijing's long-term commitment to the initiative. BRI is also part of China's efforts to ensure security of energy supplies, although changing views on how to maximize energy security have also led to changes in investments in the BRI.

Investments in BRI countries initially highlighted China's shift away from acquisition of oil and gas fields around the world to a more holistic approach with attention to transit routes, integrated trade and investment frameworks, and diversified energy cooperation. It focused on five main energy channels which have helped diversify China's oil and gas import sources and reduce reliance on seaborne flows, even though a number of these channels have been plagued by economic and geopolitical challenges.

In 2019, concerns began mounting over the viability of some of the BRI investments as China's economic growth slowed and overseas investments dipped; and in the wake of COVID-19, countries along the BRI have been asking for debt relief. At the same time, activist groups and environmental organizations in a number of BRI countries have argued that China's vast investments in fossil fuels as part of the BRI could undermine global targets for reducing carbon dioxide emissions and could increasingly become a bad financial risk as renewables become cheaper and more popular. Indeed, China's own efforts to reach carbon neutrality by 2060 will likely lead to additional adjustments of its views of energy security.

Oil demand is expected to peak in 2025 and fall thereafter, raising questions about the viability of some of the oil-focused channels along the BRI. Gas demand is expected to continue growing, requiring a balance between overland supplies—which the BRI has focused on facilitating—and seaborne supplies. Increasingly, however, the BRI will offer China new investment opportunities in renewable technologies and will be seen by the international community as a benchmark of China's commitment to its shift away from fossil fuels.

A shift of the energy security paradigm

China's overseas investments have undergone structural shifts since the launch of the BRI. Investment in 2014–2020 totalled $787 billion, almost double the level in 2007–2013. Meanwhile, investment in energy projects shrank from $200 billion in 2007–2013 to $177 billion in 2014–2020, with its share in total overseas investment lowered from 48 per cent to 22 per cent in the corresponding period (*China Global Investment Tracker, 2020*). A similar trend was seen in the metals industry: its share of the total shrank from nearly 20 per cent in 2007–2013 to less than 8 per cent in 2014–2020. In contrast, Chinese overseas investment in transport grew quickly, from 5 per cent in 2007–2013 to 14 per cent in 2014–2020. Increasing investment in agriculture, technology, tourism, real estate, and logistics further diversified China's overseas presence.

This shift does not mean China has downgraded the importance of energy in its strategic considerations in the BRI. Energy investment in BRI regions accounted for 64 per cent of China's overseas energy investment in 2014–2020, which is much higher than the proportion of BRI investment (37 per cent) in China's total overseas investment. Oil and gas remain important in China's energy strategy, but instead of acquiring foreign oil and gas assets directly, China is taking a more holistic approach to energy security, as described above, with variations in strategy tailored to each energy channel.

The rising power of the northeast energy channel

China's northeast energy channel transports oil and gas from Russia. Strategic energy cooperation between China and Russia dates back to 1996, but a breakthrough was achieved in 2008 with the establishment of an energy negotiation mechanism at the vice premier's level.

Financing from Chinese policy banks led the way during 2007–2013. A total of $25 billion in loans from China were agreed in 2009 in exchange for 15 million tonnes of Russian crude oil exports per year for 20 years. This facilitated the construction and operation of the Russian Eastern Siberia–Pacific Ocean (ESPO) oil pipeline and two spur lines directly linking Skovorodino in Russia to Daqing in China. The total delivering capacity through the two spur lines reached 30 million tonnes per year in 2018. The total crude delivery capacity from Russia to China through the ESPO line, including shipment through the Kozmino terminal, could reach at least 40 million tonnes a year.

Chinese investment played a more active role after 2013. From 2014 to 2020, around 70 per cent of Chinese energy investment in this channel flowed into natural gas projects, including the eastern route through the Power of Siberia pipeline, and the Yamal liquified natural gas (LNG) production and transport project. Gas delivery through the Sino–Russian east-route pipelines could ramp up to 38 billion cubic meters (bcm) per year once three sections in China are operational. Investment in the Yamal project has innovatively opened up the Northern Sea LNG transport to East Asia, with 4 bcm of LNG export to China added every year beginning in 2019.

The Sino–Russian west-route natural gas pipeline across Mongolia is still at the pre-investment stage. This project is expected to become operational in 2031, delivering 50 bcm of natural gas per year directly to the Beijing-Tianjin-Hebei region.

Abundant oil and gas resources and diversified transport routes are of critical importance for China's energy security. The Sino–Russian oil pipelines marked a historic change for oil transport in this channel, which had previously relied mainly on rail transport. The opening of three natural gas pipelines directly linked Russian gas fields with Chinese petrochemical bases and energy consumption centres; and the Yamal LNG project created a new route that is 20 days quicker than the westbound route through Europe and Suez. If all these routes are running at full capacity by 2030, 40 million tonnes of crude and 92 bcm of natural gas could be delivered to China. The Sino–Russian oil trade agreement signed in 2013 has secured 30 million tonnes of crude export through the land line till 2038. A re-evaluation of this line is expected by then, given the rapid pace of the global energy transition and China's carbon neutrality pledge.

The steady growth of the northwest energy channel

China's northwest energy channel consists mainly of transport routes through Kazakhstan, Turkmenistan, Uzbekistan, Tajikistan, and Kyrgyzstan.

The Sino–Kazakhstan Oil Pipeline was China's first oil import pipeline, running from Kazakhstan's Aktobe to China's Xinjiang Province. It first delivered oil to China in 2006 and has maintained delivery of around 10 million tonnes of oil per year over the last 10 years, though the delivery capacity could reach 20 million tonnes per year.

The Central Asia–China Gas Pipelines comprise four lines. Lines A, B, and C are all in operation, running in parallel from Gedaim on the border of Turkmenistan and Uzbekistan to Horgos in China's Xinjiang Province, across Kazakhstan and Uzbekistan. Line D is planned to connect Galkynysh on the border of Turkmenistan and Uzbekistan to Wuqia in China's Xinjiang Province, across Tajikistan and Kyrgyzstan. Though the first tunnel in Tajikistan was completed in January 2020, difficulties in tunnelling through the mountain areas and financial risks emerging from the impact of COVID-19 make the future of line D uncertain. The annual deliverable capacity of the Central Asia–China Gas Pipelines could reach 85 bcm once line D becomes operational.

Chinese investment in this channel focused solely on Kazakhstan in 2007–2013, with major attention to oil and gas projects. This diversified in 2014–2020, with growing investment in Turkmenistan, Uzbekistan, and Kyrgyzstan, though Kazakhstan still receives the largest share at 60 per cent. This channel provided China a way to balance its relations and cooperation with other energy-producing countries, and helped to diversify its energy import routes. However, competition with other pipelines for limited oil and gas provision from this region, difficulties coordinating the interests of pipeline transit countries, and growing challenges on price competitiveness have limited its growth. Chinese energy investment and financing in total amounted to $6 billion from 2014–2020, which was only 30 per cent of the pre-BRI level.

The special role of the south energy channel

Myanmar is a focal point in the south energy channel. The Sino–Myanmar oil and natural gas pipelines run in parallel, from Made Island in Myanmar to China's Yunnan Province. The natural gas pipeline began operation in 2013, with a capacity of 12 bcm per year. The crude oil pipeline began operation in 2017, with a capacity of 22 million tonnes per year. By August 2020, China had imported 33 million tonnes of crude oil and 330 bcm of natural gas through these lines, far short of their designed capacity.

This channel has strategic meaning for China, adding a new transit route through the Andaman Sea and Bay of Bengal to China. To ensure the safety and security of this channel, China's strategy is to create long-term benefits for both countries, increasing its investment in deep-water ports, railways, industrial parks, and power projects.

However, high transport costs for pipeline oil, limited gas provision from this region, armed conflict, political instability, and other concerns have posed challenges for further development of this channel. Chinese investment in Myanmar did not jump after the inception of the BRI, remaining at $3 billion, the same as in 2007–2013.

A broad maritime energy channel

LNG is increasingly needed to bridge the energy supply–demand gap in China. LNG's price competitiveness and transport flexibility compared to pipeline gas made it more favoured by the market. LNG imports jumped to 83 bcm in 2019, accounting for 62 per cent of China's natural gas imports. Along the coastline, 23 LNG regasification terminals with a combined capacity of 113 bcm/year were in operation by 2019. Another 84 bcm/year capacity is due to come online in the next two to three years. At the end of 2013, China only had 9 LNG terminals in operation with a total receiving capacity of 38 bcm/year. Increasing LNG volumes were shipped to northern ports without transiting through the Malacca Strait and South China Sea. Chinese investment in the Russian Yamal project created a new route for LNG transport. As over two-thirds of China's LNG imports and more than 80 per cent of crude imports pass through the South China Sea, the security of transport through this channel is still of highest concern.

Close attention to the China–Pakistan Economic Corridor

The China–Pakistan Economic Corridor (CPEC) is China's fifth energy channel. CPEC road and rail networks will link seaports in Gwadar and Karachi with northern Pakistan, and will extend further north to Kashgar in China. Energy and industrial cooperation projects are planned along these routes to stimulate local economic development. Chinese investment in the CPEC in 2014–2020 was nearly $14 billion, seven times pre-BRI levels. Energy project financing from two Chinese policy banks reached $20 billion in 2014–2020, 10 times pre-BRI levels. A wide range of infrastructure investment and construction is not only economically vital for Pakistan's growth, but also strategically important for China in reducing its dependence on the South China Sea routes. The CPEC could potentially provide China with an alternative and shorter route for energy imports from the Middle East and Africa, thereby reducing shipping costs and transit times. However, challenging geographical and geopolitical conditions in the China–Pakistan border area are also slowing progress and increasing construction, operation, and management costs for these projects. This creates uncertainty about when this strategic channel could begin to play a meaningful role and at what cost.

China's carbon-neutrality commitment

In September 2020, President Xi announced that China would strive to be carbon neutral by 2060. This will have profound implications for China's energy investment and security strategy.

Modelling studies project that the share of non-fossil fuels in China's overall energy mix will reach at least 85 per cent by 2050, so as to achieve the carbon-neutral target by 2060 (*Launch of the outcome of the research on China's long-term low-carbon development strategy and pathway, Tsinghua University Institute for Climate Change and Sustainable Development, 2020*). Oil demand in China is expected to peak at 730 million tonnes by 2025, before declining to 270 million tonnes by 2060; and demand for natural gas will likely continue to rise until 2040, before plateauing at 550 bcm (*Launch of China Energy and*

Petrochemicals Industry Development Report 2021, Sinopec Economic & Development Research Institute, 2020).

Such a rapid transition will only be possible if there are significant shifts in the pattern of investment, economic structural reforms, and additional technological innovations. Substantial investment will be required for carbon capture and storage to be deployed at scale in coal power plants and hard-to-abate industries, and for electric vehicles and hydrogen technologies to be rolled out in the transport sector. Continued investment in energy efficiency and renewable energy industries, to make them the central pillars of this transition, could help drive down the costs of green power and energy storage. All these will help strengthen China's position as a low-carbon technology provider for decarbonization globally.

Financial institutes will play a critical role in this transition. Following President Xi's announcement, five central government entities—the Ministry of Ecology and Environment, National Development and Reform Commission, People's Bank of China, China Banking and Insurance Regulatory Commission, and China Securities Regulatory Commission—jointly issued 'guidance on promoting investment and financing to address climate change' in October 2020. Improving green finance standards and policy frameworks was included in the top 10 priorities of the Chinese central bank's working plan in 2021. In the 14th five-year plan, more concrete programmes, pilots, and promises are expected in support of carbon neutrality.

Conclusion

Based on the total delivery capacity of its major energy channels, by 2030 China could receive 82 million tonnes of oil imports and 185 bcm of gas imports through these pipelines. Given China's carbon-neutrality pledge, gas transport could be well balanced between land and sea routes, and its import needs could be relatively stable at 190–230 bcm.

For crude oil imports, it will be a different story. China will still need to import 497 million tonnes of crude oil by 2030 in the net-zero scenario (*BP Energy Outlook* 2020), and the majority of these imports have to pass through the Malacca Straight. However, driven by efforts towards carbon neutrality through 2040–2050, the need for crude oil imports could drop rapidly to 149–248 million tonnes. Reduced reliance on oil will give China more flexibility in land and sea transport routes, and significantly reduce the importance of energy transit as a BRI consideration.

China's perception of energy security has changed in the past decade, from obtaining overseas oil assets towards actively engaging in the global market, though the tension of US–China relations has pushed China to increase exploration of its domestic resources. China's announcement on carbon neutrality is motivated by both geopolitical considerations and domestic industrial innovation. Being active as a green energy technology provider and investor throughout the BRI regions would strengthen China's competitiveness in future markets, as climate action becomes more material to economic growth globally. A more integrated and diversified portfolio of trade and investment cooperation in BRI, with green energy as a prominent feature, will also change the definition of energy security.

Growing attention to the environmental impact of BRI investment is gradually shaping China's policy and practices. In 2017, the Chinese government issued a series of guidance documents to promote and encourage green development projects in the BRI regions. In 2019, major Chinese banks signed on to the Green Investment Principles, which call for acute awareness of potential impacts of investments and operations on climate, environment, and society in the BRI region. In 2020, the BRI International Green Development Coalition proposed a project categorization system to help China apply more stringent environmental controls to its outbound investments. China's public commitment to carbon neutrality means that its global footprint will be closely watched, which will drive its investment in green energy rather than fossil fuels in the BRI.

CLEAN TECH INNOVATION IN CHINA AND ITS IMPACT ON THE GEOPOLITICS OF THE ENERGY TRANSITION

Barbara A. Finamore

The year 2020 not only brought a devastating global pandemic, but also tied with 2016 as the hottest year in recorded history (*Kann and Miller, 2020*) and saw record-breaking wildfires, flooding, droughts, and severe storms. COVID-19 and climate change together cost millions of lives and billions of dollars. The need for rapid and coordinated global action against these common dangers has never been more apparent. Climate change has also become a matter of national security, a threat multiplier that is increasing the risk of political instability, terrorism, mass migrations, and conflict over resources.

The window for effective global action is narrowing, requiring massive scale-up of existing clean technologies and breakthroughs in new ones at a pace never achieved before. Finding effective ways to cooperate in accelerating the battle against climate change is therefore of paramount importance to all nations, even as they compete for geopolitical advantage in the global energy transition.

Many governments, companies, and individuals have contributed to the unprecedented growth of renewable energy and other low-carbon technologies. China, despite its continued support for fossil fuels at home and abroad, has arguably done more to date than any other country to accelerate the diffusion of clean technologies. But much more needs to be done, and quickly, to reach the goals of the Paris Agreement and avoid the worst consequences of climate change. There is plenty of room for healthy competition, especially in developing the frontier technologies that are needed in hard-to-decarbonize sectors such as heavy industry and long-haul transportation.

China's impact on the global energy transition

Driven by economic, energy security, and air pollution concerns, as well as market opportunity, China has invested nearly $900 billion in renewable power and fuels since 2009, more than twice as much as the next largest investor, the United States (*Renewables 2020 Global Status Report, REN21*). It now has more than a third of global solar and wind installed capacity, and leads the world in bio-power, hydropower, solar water heating, and geothermal heat output (*Renewables 2020 Global Status Report, REN21*). The country controls over 60 per cent of global manufacturing in every step of the solar supply chain (*Bloomberg News, 14 September 2020*) and is home to five of the world's top 10 wind turbine manufacturers (*BloombergNEF, 18 February 2020*).

On the transportation side, China is home to half of all electric passenger vehicles (*Automotive World, 15 January 2021*), 98 per cent of electric buses (*Sustainable Bus, 19 May 2020*), and 99 per cent of electric two-wheelers (Rathi, 2019). It leads in electric vehicle charging infrastructure and high-speed rail. Chinese firms also dominate the lithium-ion battery supply chain, controlling 80 per cent of the world's raw material refining, 77 per cent of cell capacity, and 60 per cent of component manufacturing (*BloombergNEF, 3 December 2020*).

Several factors have contributed to China's clean-energy leadership, including long-term planning, targets, and mandates; policies, regulations, codes, and standards; financial incentives and market mechanisms; easy access to financing; public procurement and infrastructure development; and support for research and development (R&D), including applied research in manufacturing. Taken together, these measures constitute what scholars have termed China's 'energy technology innovation system', which is also part of the growing global system of energy technology innovation (*Gallagher, 2014*).

This system is largely responsible for China's ability to massively scale up its capacity to manufacture and deploy clean-energy technologies—although other factors, such as vast domestic markets and low labour costs (now of diminishing importance as automation takes hold), have also played important roles. The country's often-lax environmental regulations have made it easier to site renewable-energy facilities, build ultra-high-voltage transmission lines and high-speed rail infrastructure, and mine and process the critical minerals and metals that power current technologies. China has also protected its domestic industries against foreign competition through such means as local-content regulations, government procurement directives, and mandatory joint-venture requirements. Those measures are in many cases being eliminated as China's own industries grow.

In the beginning, China's clean-energy entrepreneurs often trained overseas and relied on partnerships with foreign firms to access new technologies, rather than their own R&D. Instead, they turned a razor-sharp focus on shaving production costs in order to stay competitive against domestic rivals. This led to a continuing series of cost-cutting innovations in the manufacturing process (*Helveston and Nahm, 2019*). These innovations have often been incremental. But given the scale of manufacturing, they have contributed more than any other factor to making clean technologies affordable, and increasingly competitive with fossil fuels, in every country.

Largely as a result of China's innovative manufacturing techniques, economies of scale, and integrated supply chains, solar photovoltaic (PV) module prices have dropped around 90 per cent in the last decade (*Roser, 2020*). The International Energy Agency has declared solar power to be the 'new king' of global electricity markets, the cheapest source of electricity in history (*Boyle, 2020*). Onshore wind turbine prices have declined by 55–60 per cent since 2010 (*IRENA, not dated*). It is now cheaper to build new wind or solar capacity than to continue to operate 60 per cent of existing coal plants (*Carbon Tracker, 12 March 2020*). In 2019, for the first time ever, the majority of the world's new power-generation capacity came from solar and wind (*Eckhouse, 2020*).

The price of lithium-ion battery packs has dropped 89 per cent in the last decade, now averaging $137 per kilowatt-hour (kWh) (*BloombergNEF, 16 December 2020*). For some Chinese electric buses, battery prices have been reported below $100/kWh, the tipping point at which electric vehicles become cost competitive with traditional internal combustion energy vehicles. This is the geopolitical energy transition in action.

China still lags behind many other countries in overall innovation, but it is catching up fast. It has climbed quickly up the Global Innovation Index and now ranks 14th, the only middle-income country in the top 30 (*Global Innovation Index 2020: Who Will Finance Innovation?*). Total Chinese spending on R&D rose 12.5 per cent in 2019 to $332 billion, second only to the United States, though it is still only 2.23 per cent of China's gross domestic product (*Gawora, 2020*). The China region is also home to five of the world's 10 largest climate tech hubs, attracting $20 billion in venture capital in 2019, second only to North America ($29 billion) (*The State of Climate Tech 2020*).

New climate commitments

In September 2020, China's President Xi Jingping made a startling commitment: that the country would peak its CO_2 emissions before 2030 and aim to reach carbon neutrality by 2060. At the international Climate Ambition Summit in December 2020, President Xi further committed to enhancing China's Paris commitments by:

- reducing carbon intensity by over 65 per cent by 2030 (compared to its initial Paris commitment of 60–65 per cent);
- increasing the share of non-fossil energy in China's energy mix to around 25 per cent by 2030 (compared to 20 per cent in its initial target); and
- expanding total installed capacity of wind and solar to 1,200 gigawatts (GW) by 2030 (no previous target) (*Schmidt et al, 2020*).

These new 2030 commitments are an important step forward, though research shows that the plunging cost of renewables makes much higher targets both achievable and cost-effective (*He et al., 2020*). The upcoming 14th five-year plan (2021–2025), which will be unveiled in March, with more detailed five-year plans for energy, power, renewables, and climate to follow, will show whether China is on track to achieving carbon neutrality by 2060 or leaving much of the heavy lifting to later years.

In the meantime, China is no longer content to rely primarily on scaling up clean technologies that have been developed abroad. It is also pursuing technological breakthroughs in potentially game-changing technologies that are essential in the battle against climate change. Other countries, however, have also thrown themselves into the clean-energy innovation race, determined not to cede leadership to China again.

The race is on

Four key areas of competitive innovation are solar power, offshore wind, batteries, and hydrogen.

Solar power

China is phasing out generous subsidies for solar PV and other renewables, favouring subsidy-free projects that can compete with coal power on price (*Gao, 2020*). In determining the eligibility of solar projects for remaining subsidies, the Ministry of Finance gives priority to ones that utilize advanced technologies under its Top Runner program (*Xiao, 2020*). To compete effectively, Chinese solar firms are therefore investing heavily, not only in massive capacity expansions, but also in advanced technology R&D.

One Chinese company, JinkoSolar, just announced two world-record breakthroughs in advanced TOPCon n-type solar technologies, one of the leading new technologies in crystalline silicon solar, which dominates the market today (*Taiyang News, 7 January 2021*). Chinese researchers have also made strides in developing perovskite solar cells, a highly promising alternative to crystalline silicon solar that, if commercialized, could transform the entire solar industry (*Moser, 2021*).

But they face stiff competition from other countries. Europe has united all the major institutions involved in solar research into the European Perovskite Initiative (*Bellini, 2019*). This collaborative platform will create and support joint research programs and develop a common roadmap for perovskite commercialization. In the United States, an omnibus spending bill recently approved billions of dollars for clean-energy innovation, including $1.5 billion to support new PV technologies and initiatives to expand solar manufacturing and recycling technologies (*Shieber, 2020*). The Biden administration is poised to do much more.

Offshore wind

The International Energy Agency forecasts that the market for offshore wind, what it calls the only variable-baseload power-generation technology, could increase 15-fold and become a $1 trillion industry by 2040 (*International Energy Agency, Offshore Wind Outlook 2019*). The agency calculates that the best offshore wind sites could supply more than the total amount of electricity consumed worldwide today (*Ambrose, 2019*). The cost of offshore wind power has fallen by 62 per cent since the 2015 Paris Agreement, making it competitive with fossil fuel electricity (*Gerdes, 2021*).

Europe is currently home to nearly 80 per cent of global offshore wind capacity, with ambitious plans to expand capacity (*Toulotte, 2020*). It also dominates offshore wind turbine manufacturing and technical innovation, including the development of floating offshore wind projects. But competition is growing. General Electric is testing a prototype offshore wind turbine, the Haliade-X, that is the largest and most powerful in the world to date (*Reed, 2021*). It has the potential to transform the offshore wind industry.

Offshore wind capacity is surging in China. The country now ranks third in installed capacity behind the UK and Germany, despite the fact that its technology is less advanced than in the West (*Global Offshore Wind Report, World Forum Offshore Wind, August 2020*). Companies are moving up the technology learning curve**,** however, and have begun to develop floating offshore wind demonstration projects.

Batteries

Batteries are widely considered an essential 'silver bullet' technology for decarbonizing the transport and electricity sectors. The market is expected to explode in the coming years, driven by ambitious government electric vehicle adoption targets, fossil fuel vehicle bans, and the demand for battery storage to integrate growing amounts of renewable energy into the grid.

China dominates the global market in the production of lithium-ion batteries, the leading battery technology today. It continues to invest heavily in R&D, including in alternative chemistries, in order to achieve further cost reductions and higher energy densities. For example, Contemporary Amperex Technology, the world's largest lithium-ion battery producer and a supplier to Tesla, is building a $450 million battery R&D centre at its headquarters in China (*Scott, 2020*). The company plans to hire thousands of workers to develop next-generation energy storage technologies, including lithium metal, solid-state, and sodium-ion batteries.

Europe is determined to catch up. European governments, manufacturers, development banks, and commercial lenders are investing an estimated €100 billion in battery supply chains (*Krukowska and Starn, 2019*). Seven EU member states have also joined forces to provide €3.2 billion for battery R&D across the continent (*Publicover, 2019*). In addition to supporting the development of advanced chemical materials, cell and module design, and system integration, the program will focus on reducing the environmental and social impacts of the battery supply chain through innovative battery designs, more sustainable raw material sourcing and processing practices, and stepped-up battery recycling efforts.

Over the longer term, analysts agree that the cost and characteristics of lithium-ion batteries, as well as resource constraints, make them less attractive for long-duration energy storage. There is growing interest in developing alternatives to lithium-ion batteries using materials such as zinc, vanadium, or sodium. In 2020, more than $500 million in venture capital was allocated to energy storage-related start-ups (*Wesoff, 2020*). The Biden climate plan calls for R&D to develop grid-scale storage technologies at one-tenth the cost of lithium-ion batteries (*The Biden Plan for a Clean Energy Revolution and Environmental Justice, 2021*).

China's upcoming 14th five-year plan will reportedly support energy storage R&D designed to overcome current technology-development bottlenecks and improve China's international competitiveness (*National Development and Reform Commission, People's Republic of China, Guiding Opinions on Expanding Investment in Strategic Emerging Industries, 25 September 2020*).

The focus will be on developing long-duration and high-efficiency energy storage technologies, decreasing prices, and increasing lifespans to 15–30 years. The plan will also promote modular, standardized, and intelligent technologies, second-life applications, whole life cycles, and sustainable critical technologies.

Hydrogen

'Green' hydrogen produced using renewable energy is a flexible and versatile breakthrough technology with the potential to play an enormously important role in reaching net-zero emissions. Although hydrogen could in theory replace virtually all fossil fuel use, its most promising applications to date are in decarbonizing heavy industry and long-distance transport.

China is the world's largest producer of hydrogen, but most of it is 'brown' or 'grey' hydrogen produced from fossil fuels and used as feedstock for ammonia plants (*Brasington, 2019*). Only three per cent is 'green' hydrogen (*Yue and Wang, 2020*). But this is starting to change, with a growing number of provinces and state-owned energy firms developing renewables-based hydrogen projects (*Yuki, 2020*).

China's current focus is on the commercialization of hydrogen-powered fuel cell vehicles, presumably in order to reduce its growing reliance on oil imports and capture the market for this emerging technology (*Elective, 3 November 2020*). The central government has not yet developed a national strategy for green hydrogen development. But a national incentive program unveiled in September 2020, in which cities compete for RMB 1.7 billion in funding for fuel cell vehicle demonstration projects, gives extra credit to cities with the capability to provide low-carbon hydrogen (*Yuki,2020*). This signal has already triggered an increased interest in green hydrogen throughout the country.

In a bid to outcompete China, the EU has launched a €470 billion Hydrogen Strategy, designed to develop a world-class green hydrogen production and manufacturing industry (*Schubert and Haas, 2020*). The initial aim of the plan will be to develop cost-effective green hydrogen solutions for use in heavy industry. It aims to build 40 GW of capacity to produce hydrogen from renewable sources in this decade. President Biden's climate plan calls for using renewables to produce carbon-free hydrogen at the same cost as that from shale gas (*The Biden Plan for a Clean Energy Revolution and Environmental Justice*, 2021).

Conclusion

China has dominated the geopolitical energy transition to date with first-generation clean-energy technologies such as crystalline silicon solar, onshore wind, and lithium-ion batteries. Europe and the US are now racing to take the lead in developing next-generation technologies that promise improved performance and flexibility, innovative applications, reduced environmental and social impacts, and lower costs.

It is hard to predict who will win geopolitical advantage and market share in these emerging multibillion-dollar clean-energy businesses. But one thing is clear. Competition is essential in driving down the cost of green hydrogen and other breakthrough technologies to the point where they can compete with fossil fuels. Strategic collaboration in addressing major decarbonization challenges—such as how to reinvent cities, redesign industries, and minimize impacts on declining communities—is also vitally important (*Seven Challenges for Energy Transformation,* Rocky Mountain Institute, 2019). No country can succeed on its own in a fight for our future that we can't afford to lose.

IMPROVING GRID INTERCONNECTION TO SUPPORT CLIMATE CHANGE MITIGATION

Zhanghua Zheng

The year 2020 concluded the earth's warmest 10-year period, and was the second warmest year on record (*Met Office, 14 January 2021*). Greenhouse gases in the atmosphere have reached their highest concentrations in nearly 800,000 years, threatening human and natural systems.

Energy systems and resources are increasingly affected by climate change, and the impacts involve the entire energy supply chain, including demand, supply, and transmission (*WMO, 2017, table 1*). For example, in terms of energy demand, warming climate leads in some areas to decreasing energy demand for heating but increasing energy demand for refrigeration (*GEIDCO, WMO and IIASA, 2019*).

Climate change and extreme weather events also affect the security of the energy supply. Weather and climate hazards such as hail, strong winds, and heavy rains can affect wind and solar power generation hardware. High temperatures may cause increased energy transmission losses. Heavy winds, ice, and snow may cause damage to overhead lines. Changes in soil can affect pipeline transportation. There are also indirect effects through other economic sectors—for example, water and agriculture (*Ebinger and Vergara [eds.], 2011*).

Specific vulnerabilities of the power sector to projected climatic changes are as follows (*Johnson and Lambe, 2009*):

- Increases in air temperature will reduce generation efficiency and output and increase customer cooling demands, stressing the capacity of generation and grid networks.
- Changes in precipitation patterns and surface water discharge, as well as increasing frequency and/or intensity of droughts, may adversely impact hydropower generation and reduce water availability for cooling of thermal and nuclear power plants.
- Extreme weather events, such as stronger and/or more frequent storms, ice accretion loads, extreme winds, and offshore hazards can reduce the input of energy (for example, water, wind, solar, or biomass), damage generation and grid infrastructure, reduce output, and affect security of supply.
- Sea-level rise can affect energy infrastructure in general and limit areas appropriate for the location of power plants and grids.
- Solar energy is affected by the distribution and variability of cloud cover.

While renewable energies currently account for 11.41% of global primary energy (*BP Statistical Review of World Energy 2020*), the growing recognition of the need to phase out fossil fuels and the falling cost of renewable energy technologies suggest that their share of energy demand is likely to increase substantially.

The Paris Agreement sets out a framework for global climate governance after 2020, with the goal of limiting the global mean temperature increase to 2°C, or even 1.5°C, over the pre-industrial level. Achieving these goals is of great significance to global sustainable development and social well-being, but the gaps and challenges are enormous (*Emissions Gap Report 2018*). For example, nearly half of G20 members are unlikely to fulfil their national climate plans (NDCs) without further action. Countries urgently need to enhance their NDC ambitions.

Key trends in the energy transition

Anthropogenic emissions, especially emissions from fossil energy, are the main cause of rising greenhouse gas concentrations and global warming. Accelerating the electrification of economic end-uses, developing renewable energy, and realizing decarbonization of power systems are fundamental ways to achieve the energy transition and reduce emissions (*GEIDCO, WMO and IIASA, 2019*). This transition is already under way. In 2018, fossil energy accounted for 85 per cent of global carbon dioxide emissions, but with the large-scale development of global onshore wind and photovoltaic power, renewable sources are likely to be more cost-competitive than fossil-fuel sources before 2025.

In this context, improving grid connectivity and dispatching electricity over wide areas is emerging as a key trend. With the development of green and electrified energy systems, the role of power grids as the main platform for energy allocation has become increasingly essential. Global clean energy resources and electricity demand are unevenly distributed, and many renewable sources (wind and solar) are mostly located in remote areas, for example the Arctic and the equatorial region. The intermittency and randomness of wind and solar create the need to improve energy interconnection regionally and globally to realize optimal transnational, trans-regional, cross-continental, and global allocation of clean energy.

For example, in China, transmission lines thousands of kilometres long are built to improve the domestic grid interconnection, as 74 per cent of wind and 58 per cent of solar generation capacity is located in the ‘three-north’ area (northwest, north, and northeast) of China, which is far away from densely populated big cities in the east with limited space for distributed generation (*State Grid Corporation of China, 2018*).

Great changes in energy interconnection are taking place in Europe, Africa, the Arab countries, Southeast Asia, and other regions, and power grids will play an important role in realizing large-scale optimal allocation of renewable resources and improving mutual energy support between regions for security of supply.

At the same time, energy is becoming increasingly integrated with information and transportation technologies. Innovative breakthroughs have been made in energy and power technologies such as efficient and clean power generation, advanced transmission and transformation (e.g. long-distance transmission, flexible direct current, and superconducting transmission), operational control of large power grids, energy storage, and hydrogen energy.

Energy and power will be deeply integrated with modern information, communication, and control technologies such as artificial intelligence, big data, the Internet of Things, and 5G cell phone technology, to create a highly controllable and flexible intelligent energy system, realizing multi-energy complements and intelligent interaction, with due consideration of risks such as cybersecurity and privacy violations.

Potential benefits of improving grid connectivity

The transition from fossil to renewable energy is assuredly the most promising option for the climate future and Paris goals, especially for the power sector. There are different ways to achieve the transition, and opinions on the direction differ. If future energy demand is met mostly by renewable power generation, decentralization (distributed generation and energy storage) and improving grid connectivity are two potentially feasible and plausible solutions. There are many more arguments in favour of a decentralized electricity system and an independent energy supply than there are for improving grid connectivity for renewables. However, there are many cases showing considerable benefits from grid connectivity, suggesting that decentralization is not a universal solution.

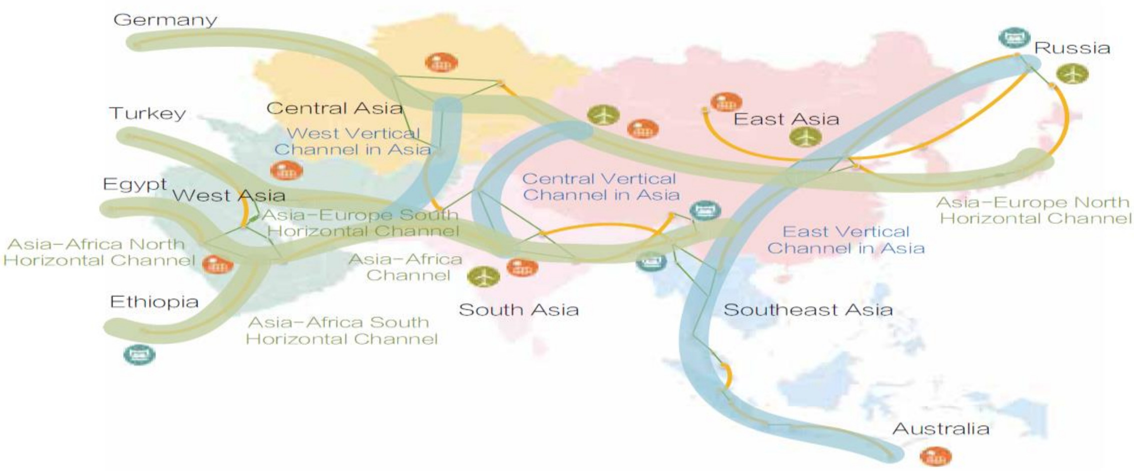
One example is the supply of green electricity to the Beijing-Tianjin-Hebei urban agglomeration (Jing-Jin-Ji). This area had gross production of RMB 8.46 trillion in 2019, accounting for around 8.5 per cent of China's GDP. Its electricity consumption was around 590 TWh in 2019. If distributed generation with energy storage is considered the only solution to electricity supply, without consideration of grid interconnection with neighbouring provinces—that is to say, if the area's entire 590 TWh electricity demand is powered by local wind and photovoltaic generation—battery storage of 5 TWh is expected to be needed to maintain the security of supply and avoid blackouts due to the intermittent presence of wind and sunlight, especially during the summer. Considering the cost of batteries is around RMB 1,000 per kWh, the total investment for installing the 5 TWh battery could be up to RMB 5 trillion, which is close to the assets of power grids for the whole country (RMB 6 trillion).

In other words, power grids in China are an important platform for facilitating the integration of renewable generation more broadly, creating more opportunities to smooth renewable outputs as a whole, and reducing the cost of supplying renewable electricity on demand. A recent study showed that energy storage alone is not feasible to keep electricity supply stable, if the share of renewable generation exceeds 50 per cent (*GEIDCO, 2020*). It is necessary to keep a balance between local self-reliance and improved grid connectivity with neighbouring areas, integrating technologies that are available and feasible to take up renewable energy while reducing costs—such as grids, microgrids, and power-to-gas.

In that sense, improving power grid interconnection regionally and globally can be a beneficial energy solution. Take Asia and Africa as examples.

For Asia, if an interconnected power grid serving East Asia, Southeast Asia, Central Asia, South Asia, and West Asia and connecting with Europe, Africa, and Oceania, thereby forming a large-scale optimal allocation platform for clean energy, is developed following a smooth roadmap, energy-related CO_2 emissions in Asia (the geographic region of the UN M49 standard, excluding Turkey) will peak around 2025 and fall to around 6.2 gigatonnes in 2050, a reduction of two thirds from the 2016 level. By 2050, the proportion of clean energy in primary energy will rise to about 69 per cent, while that of coal will drop to about 7 per cent, representing a 68 per cent reduction from 2016. Electrification levels will also see rapid growth, promoting industrial transition and upgrading. The proportion of electricity in total final energy consumption will increase from about 22 per cent today to over 55 per cent by 2050 (*GEIDCO, 2019*).

Asian power grid interconnections

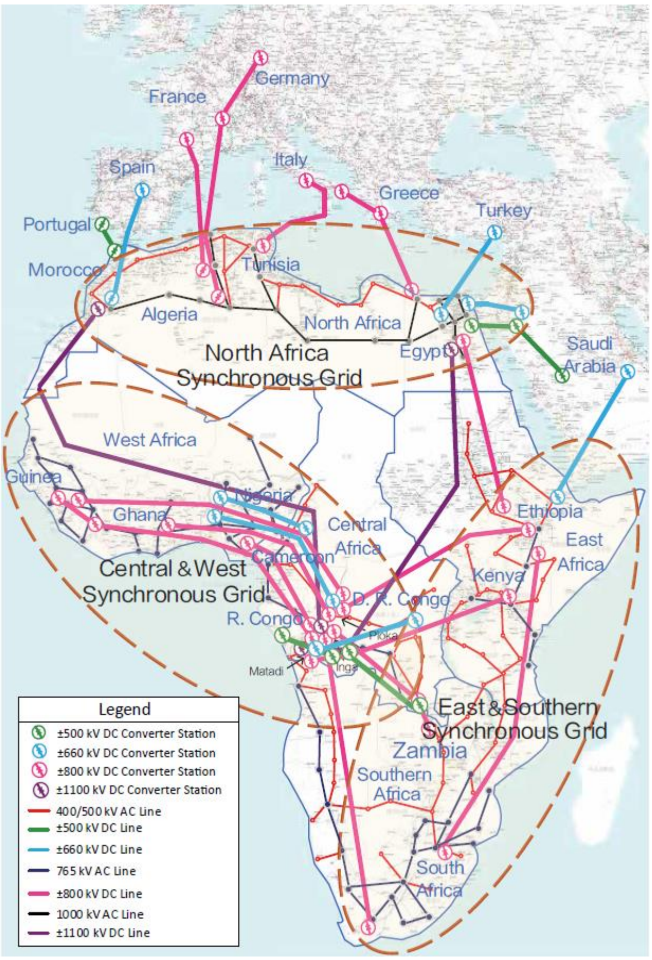


Source: GEIDCO, Research and Outlook on Asian Energy Interconnection, China Electric Power Press, 2019.

Africa is the continent with the world's lowest per capita energy consumption. The challenges in Africa include lack of universal power access and weak climate adaptability. Infrastructure in Africa is weak, and 590 million African people still lack access to electricity. From 1995 to 2015, 136 severe droughts occurred in Africa, 77 in East Africa alone. The cumulative economic loss caused by extreme weather from 1994 to 2015 reached US$10 billion. However, Africa is likely to experience rapid population growth and economic development for the next few decades, and energy consumption and carbon emissions are expected to increase enormously.

If a wide-area and large-scale power grid is developed to optimize the electricity supply between renewable sources and demand centres throughout Africa, energy-related CO_2 emissions are expected to reach a peak before 2035 and fall to around 1.7 gigatonnes by 2050, helping African countries to achieve the Paris goals. By 2050, clean energy will account for about 56 per cent of primary energy. The proportion of electricity in total final energy consumption will increase from 9.2 per cent now to more than 31 per cent by 2050 (*GEIDCO, 2019*).

African power grid interconnections



Source: GEIDCO, Research and Outlook on African Energy Interconnection, China Electric Power Press, 2019.

China has developed 19 long-distance transmission projects since 2009; these have greater transmission capacity over longer distances with reduced power losses compared with ordinary power lines, so that renewable generation in the 'three-north' area can be delivered to China's industrialized eastern regions. Eight of these are alternating-current projects, and the rest are direct-current projects, so they are known as '8 AC 11 DC', with an inter-regional and inter-provincial power transmission capacity of 210 GW and a total grid-connected installed capacity of 1,470 GW. It is widely recognized inside the country that these megaprojects are one of the key reasons China has managed to transform its electricity mix from coal-dominated to more than 36 percent renewable generation (hydro, wind, and solar) and stabilize its carbon emissions without squeezing the economy too far (*Xinhua, 11 September 2019*).

It is becoming increasingly clear that improving grid connectivity is considered part of the effort to deploy new infrastructure to boost high-quality economic development. The State Grid Corporation of China announced in March 2020 that it planned to invest RMB 181.1 billion in ultra-high-voltage projects in 2020, spurring an investment of RMB 360 billion for Chinese economy. For the next five years, a surge in the approval, commissioning, and construction of ultra-high-voltage projects to improve domestic grid connectivity is very likely in China.

Implications for energy governance

To improve energy connectivity in order to achieve the goals of the Paris Agreement, a national, continental, and global coordination framework for clean development is necessary. The Paris Agreement addresses climate change through the submission of NDCs by all countries, ensuring the active and flexible participation of all parties. However, some countries might lack adequate resources and capacity to implement various clean and low-carbon projects. Considering the gap between the NDCs and the goals of the Paris Agreement, it is necessary to provide a systematic framework of strategy, policy, mechanisms, and tools for all countries to raise ambitions for NDCs together. Stakeholders at the national and international levels need to innovatively coordinate their clean-energy development plans, creating synergies that reduce the barriers at national borders, so as to achieve the Paris goals as soon as possible.

Electricity–carbon market coupling should be promoted regionally and globally, and financial resources should be mobilized for climate change. Currently, global clean development and climate change are facing a huge financial gap. The Paris Agreement has established a financing mechanism, which calls for developed countries to provide up to US$100 billion each year to developing countries by 2020, and extends this target to 2025. However, only US$38 billion was provided in 2016, causing a huge challenge for all countries', especially developing countries', efforts to cope with climate change. Innovative financial mechanisms are needed to narrow the gap. Improved grid connectivity infrastructure can facilitate the optimal allocation of low-carbon and clean resources, reducing mitigation costs, providing better chances of achieving a coupling market integrating electricity and carbon trading. Becoming connected physically is fundamental for trading internationally and mobilizing financial resources globally.

Geopolitics and energy security

Countries tend to rely on their own electricity grids for the sake of energy independence. From a security point of view, it makes sense that dependence on neighbouring countries might threaten energy security. However, if sufficient political will, solidarity, and mutual trust between the countries are developed carefully, a more interconnected grid can provide considerable benefits for everyone involved.

The year 2020 was a reminder of how fragile our humanity can be. International cooperation and solidarity carry hope even in the face of challenging emergencies such as climate change and the pandemic. This is a planet we all share together.

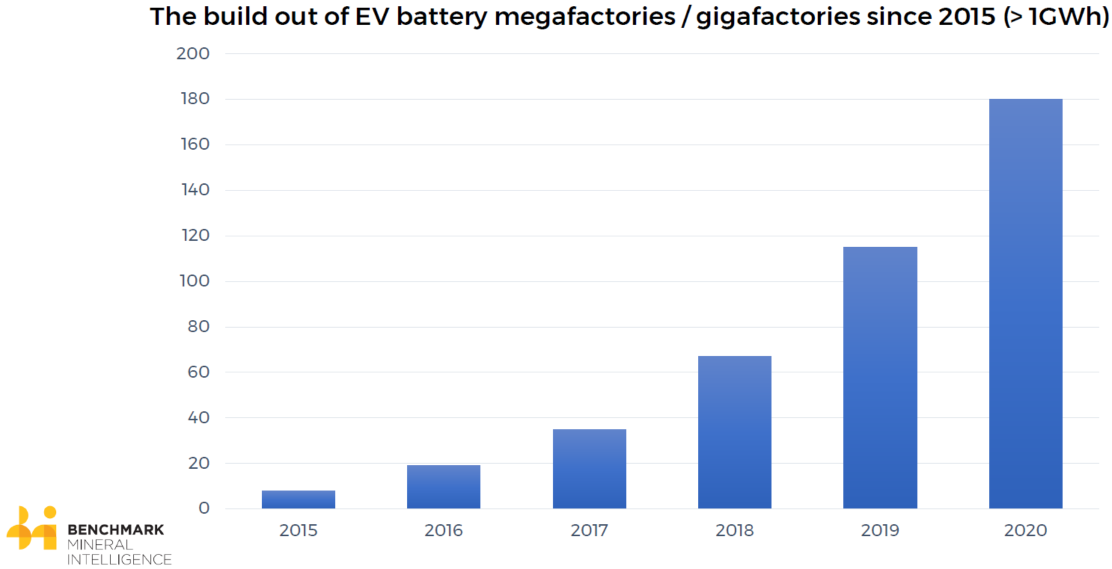
THE GLOBAL BATTERY ARMS RACE: LITHIUM-ION BATTERY GIGAFACTORIES AND THEIR SUPPLY CHAIN

Simon Moores

The coronavirus pandemic has turbocharged the lithium-ion-battery-to-electric-vehicle (EV) supply chain and accentuated a global battery 'arms race' between China, the United States, and Europe. The build-out of this supply chain is the blueprint for the 21st century automotive and energy storage industries, and since the onset of the pandemic in March 2020, lithium-ion battery and EV plans have accelerated. Data from Benchmark Mineral Intelligence shows that the number of individual battery megafactories, also referred to as gigafactories, in the pipeline over the next 10 years increased from 118 in 2019 to 181 in 2020. (For context, only four were being planned in 2015). Of the 181, 136 are based in China, 10 in the US, and 16 in continental Europe. As I testified to the US Senate Committee for Energy and Natural Resources in 2019: 'We are in the midst of a global battery arms race in which the US is presently a bystander' (*Moores, written testimony, 5 February 2019*).

Battery megafactories are super-sized producers of lithium-ion battery cells, which will be the platform technology for all EVs, and China has taken the initiative to build battery capacity at speed and scale. Of the 181 battery megafactories in various stages of planning and construction, 88 are currently active, making cells for EVs. While there may be a 'global battery arms race', the furore has a real and tangible bedrock of battery production.

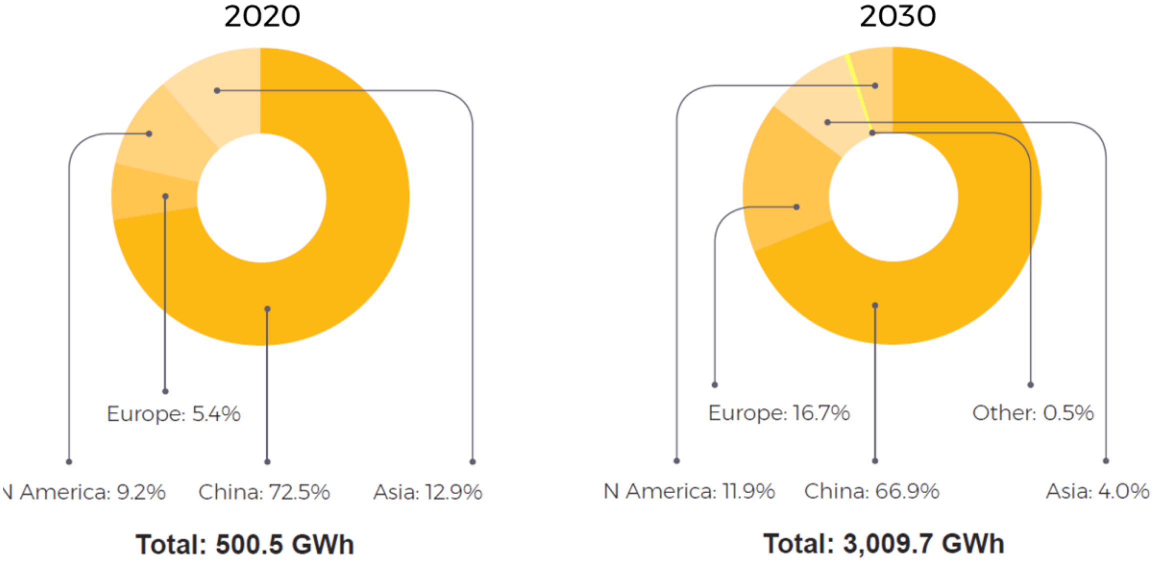
Build-out of battery megafactories (>1 GWh), 2015–2020



Source: Benchmark Mineral Intelligence.

In terms of battery capacity, in 2020, cell capacity plans to 2030 increased by 845 GWh to a fraction over 3 TWh. This is the biggest single annual increase in pipeline battery capacity since Benchmark started collecting this data in 2014. China once again surged ahead in 2020 by building even more lithium-ion battery megafactories and increasing future capacity. Of the total capacity of all of the lithium-ion battery plants either active or under construction, China accounts for 66.9 per cent, while the US is only forecasted to account for 11.9 per cent. As I explained to the US Senate Committee for Energy and Natural Resources in 2020: 'China is building one battery gigafactory a week; the US one every four months'.

Lithium-ion battery cell capacity in 2020 and planned for 2030



Source: Benchmark Mineral Intelligence.

Battery megafactories could become geopolitical hot potatoes

Another trend to watch is the emergence of joint-venture battery megafactories by a major automotive producer and a major battery producer. With the vast majority of auto majors being Western and most lithium-ion battery majors being Asia-based, these plants are at risk of becoming geopolitical hot potatoes—especially as most are government-backed in some way.

The first wave of battery megafactories saw South Korean producers, especially LG Chem and Samsung SDI, establish operations in mainland China and Europe between 2015 and 2017. Once the EV momentum hit the mainstream, Europe's response was to encourage European auto and battery conglomerates to team up: VW Group with Sweden-based but EU-backed Northvolt to establish a plant in Germany, and France's SAFT (owned by French oil producer Total) with PSA Group. A similar response was seen in the US with General Motors and LG Chem planning a megafactory in Ohio, a blueprint inspired by Tesla and Panasonic's original Gigafactory in Nevada. The US response was driven by Tesla's momentum rather than government involvement, unlike in the European Union, which is one reason the US lags behind in this race.

The bigger question remains: What happens when China wants to establish battery megafactories outside of its borders? The battery producer CATL (Contemporary Amperex Technology Co. Limited), founded in 2011, was barely on the EV radar in 2015. Today, it has become the Chinese government's champion for the industry and is the world's biggest producer of lithium-ion batteries. In 2020 it had a capacity of 110 GWh, 22 per cent of the world's total of 500 GWh. CATL has five operational battery plants and six under construction, of which one is based in Erfurt, Germany. There is little doubt that its next move is to establish operations in the US and expand its presence in Europe and other global automotive hubs.

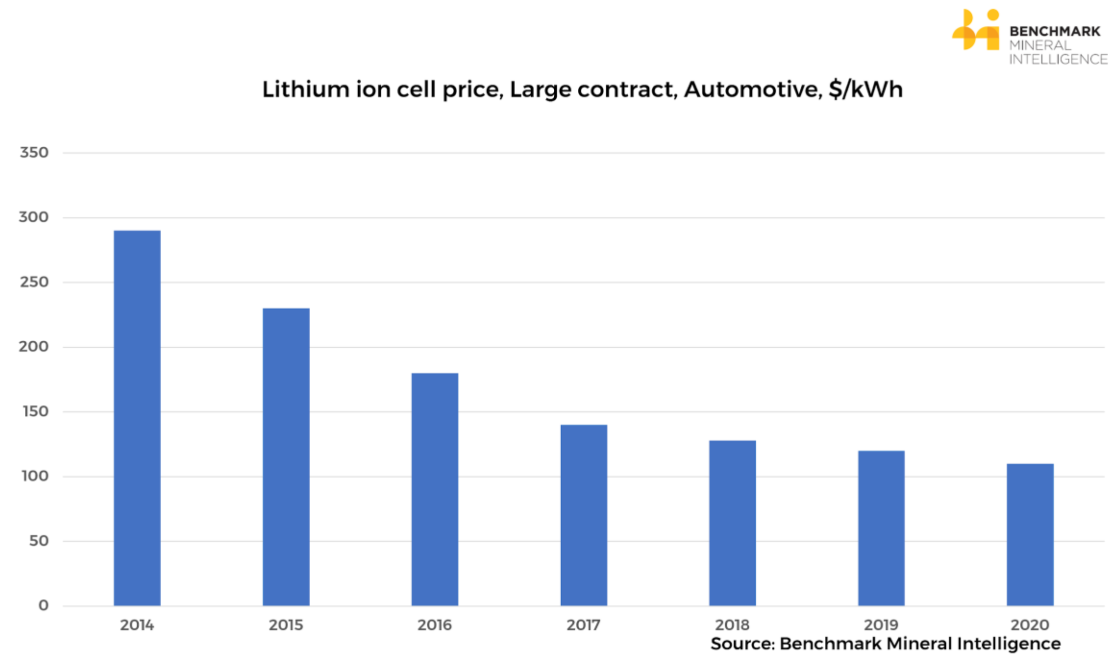
A global lithium-ion economy is being created

What does this build-out of lithium-ion battery capacity actually mean, besides the world needing a lot more batteries? It demonstrates a fundamental shift for a number of the world's most important industries—the implications of which are fully understood by European and Chinese leaders but less so in Washington, DC.

This shift is the ability to store energy in widespread locations, both large and small, at a reasonable cost. Lithium-ion batteries make this possible, and they are becoming more abundant (as shown above) as well as better and less expensive. The lithium-ion battery megafactory is an engine for growth.

The selling price for lithium-ion battery NCM cells used in electric vehicles fell from $290/kWh in 2014 to $110/kWh in 2020, a decline of 14.9 per cent a year, primarily due to increased scale of manufacturing. However, these declines have significantly slowed in recent years, from a compound decline of 21.6 per cent a year between 2014 and 2017 to a decline of 7.7 per cent a year between 2017 and 2020. The slowing is due to raw materials making up a larger proportion of the cost—now 75–80 per cent, compared to 50–60 per cent in 2014, when the batteries were made in much smaller plants. Nonetheless, the cost is expected to fall below $100/kWh; Benchmark estimates this will occur by 2022/2023.

Declining cost of lithium-ion batteries used in electric vehicles ($/kWh), 2014–2020



Source: Benchmark Mineral Intelligence.

Technological improvements, falling costs, and increasing prevalence are driving what Benchmark has called the creation of a global lithium-ion economy. Lithium-ion batteries are the enabling technology for the 21st century automotive industry and will be a disruptive technology for the 21st century energy and utility sectors—the first widespread energy storage to couple with increasing production of wind and solar power. Those that control these supply chains will control the balance of industrial power for the remainder of this technological cycle, which could last well into the 22nd century. And the lithium-ion battery supply chain is at the heart of any global lithium-ion economy. It is crucial for governments to understand this.

Understanding this supply chain will be key to auto manufacturing success

The lithium-ion-battery-to-EV supply chain has five fundamental sections. Each is intrinsically linked to the next, and the quality of the raw materials will directly affect the cost and quality of the EV being produced.

Mining

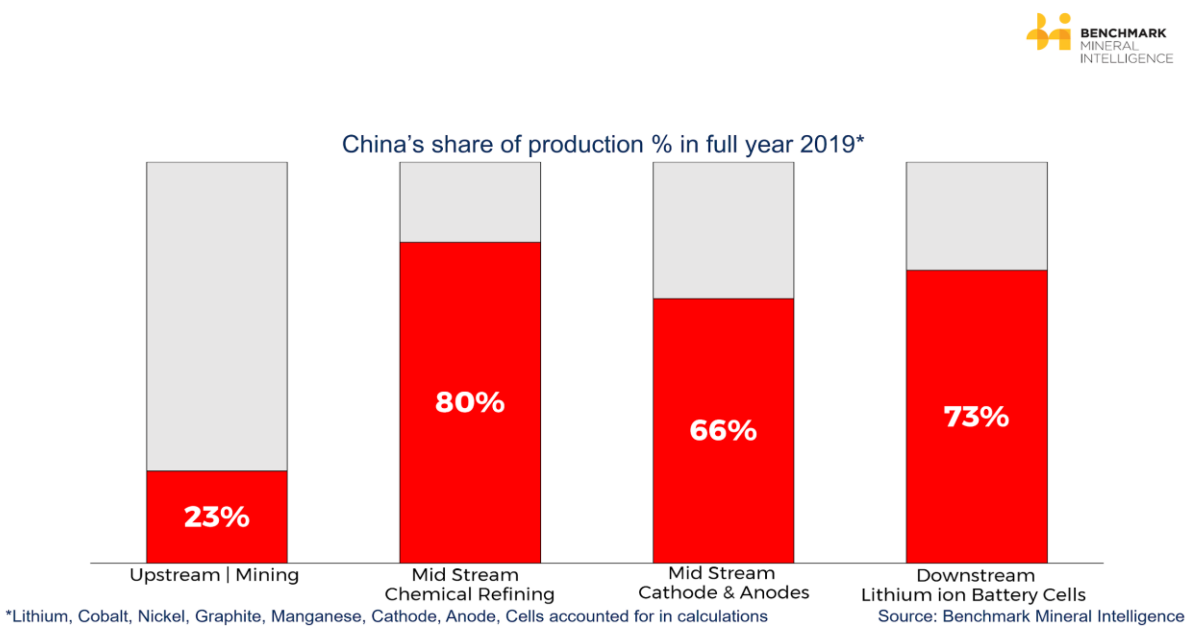
The key battery raw materials of lithium, nickel, copper, cobalt, graphite, and manganese need to be mined from the ground. Lithium and cobalt are particularly challenging due to their scale—measured in the hundreds of thousands of tonnes instead of the millions of tonnes—and will need to evolve from a niche to the mainstream within the decade. Any foreseeable future battery technology shift, such as solid-state technology, will still be lithium based and wholly reliant on the same supply chains and starting points.

Chemical refining

Chemically refining key raw materials into cathode- or anode-ready products is a critical step that is often overlooked when analysing the battery supply chain. It is also often the biggest hurdle when bringing new supply onstream. Many of these raw materials are actually chemically refined and engineered products, with specific purities and particle size requirements that differ per end user. Lithium and graphite especially have challenges related to this step.

While China only domestically mines 22 per cent of its battery raw materials, it domestically produces 66 per cent of this chemical stage, ensuring the global supply chain arrows point towards China. China's lack of domestic battery raw material production is compensated by mid-stream supply chain dominance. This is also a strategy to ensure strong battery cell and EV production share.

Share of China's lithium-ion battery manufacturing produced domestically in 2019



Source: Benchmark Mineral Intelligence. Data account for production of lithium, cobalt, nickel, graphite, manganese, cathode, anode.

Cathode and anode production

The quality of the raw materials, together with the quality of the cathode and anode manufacturing, will determine the quality of the lithium-ion battery cell and with it the performance of the EV that contains the battery. Automakers' futures will ultimately rely on how well high-quality cathode and anode making scales, an expansion that needs to go hand in hand with the previous two steps.

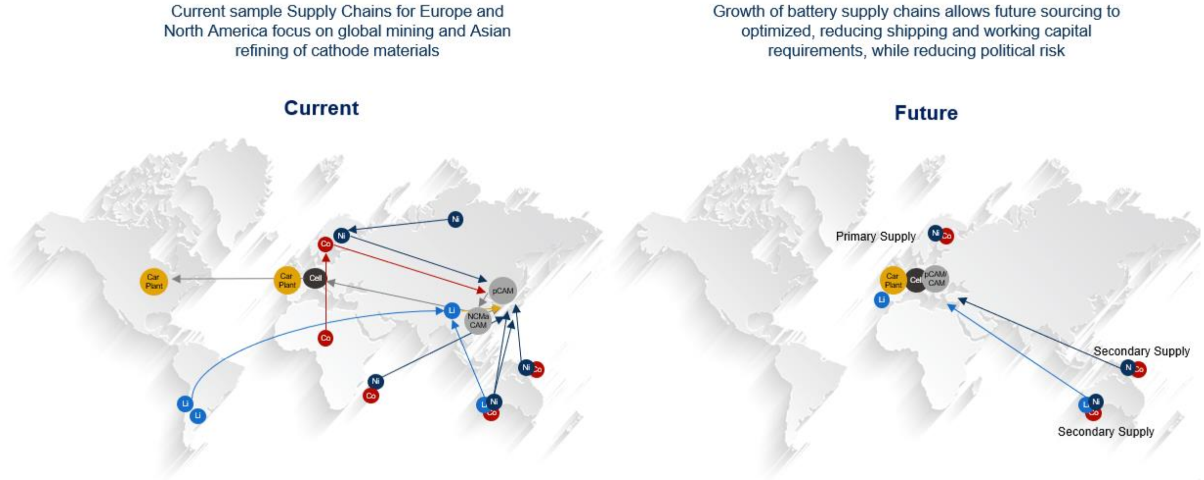
Lithium-ion cell manufacturing

While lithium-ion battery making is expanding, there is a wide variety of qualities, not all of which can be used in all EVs. High-specification EVs made by western auto manufacturers outside of China will require Tier 1 quality cells—presently made by CATL, Tesla-Panasonic, Samsung SDI, LG Chem SK Innovation, and Envision AESC—which are expected to account for 35 per cent of total output in 2030.

Auto manufacturing

Traditional automakers are fast evolving into battery pack manufacturers and software engineers. An increasingly close relationship between the battery cell makers and automakers is also evolving—for example, with VW Group teaming up with Northvolt, and General Motors and LG Chem jointly creating a battery plant in Ohio. Future success in the automotive industry will not involve dominating an existing and scaled supply chain, but understanding the criticality of asset ownership along the new supply chain as this industry scales over the next 20 years.

Current and potential future supply chains



Source: Benchmark Mineral Intelligence.

Automotive decision makers need to understand that the lithium-ion battery and EV supply chain needs to be built from scratch and scaled to a blueprint over the next decade. Those most active in investing in and owning assets and controlling the intellectual property along the supply chain will be in the most dominant position a decade from now. True scale, akin to what traditional auto manufacturing is used to, will arrive in the 2030s.

Automakers who quickly understand the importance of these linked steps in the battery supply chain to the quality and cost of their EVs will be the most successful at navigating the next decade. For governments, the shifts in the economics of the supply chain outlined in this article provide opportunities to create jobs, garner influence over a strategic industry, and establish new trading relationships, particularly relevant as Europe and the United States, under a Biden presidency, will seek to reduce reliance on China as a single point in the supply chain. Those who do not see the importance of the lithium-ion battery will have no meaningful future.

THE NEXT PRIZE: GEOPOLITICAL STAKES IN THE CLEAN HYDROGEN RACE

Thijs Van de Graaf

In his seminal work *The Prize*, energy historian Daniel Yergin chronicles the history of how and why oil became the largest industry in the world and a force that shapes the geopolitical relations between nations. Yergin could not have picked a better title for the book—not just because he was awarded a Pulitzer for it, but because he masterfully exposed how oil was a game of huge risks and monumental rewards. Today, judging by all the excitement, hydrogen seems well positioned to become the next great prize, a zero-carbon version of oil.

Hardly a week goes by without a government or a company announcing a new hydrogen plan or project. The enthusiasm for hydrogen is understandable: whether it is used in a fuel cell to produce electricity or burned in an engine to produce heat, the only ‘exhaust’ it creates is water vapor. As more and more governments commit to net-zero-emission targets by mid-century, hydrogen becomes an appealing energy carrier to decarbonize hard-to-electrify sectors, such as heavy industry and long-haul transport.

For all the hype, though, hydrogen will not become the new oil. It is unlikely to ever eclipse oil’s market share in the world’s energy mix (currently more than 30 per cent of primary energy), let alone match the ubiquity, liquidity, and geostrategic significance of oil, which has long been and still is an indispensable fuel for the movement of goods and people and to power the machines of war. Since hydrogen is a conversion business rather than an extraction business, rents will likely be smaller than those for oil. If anything, hydrogen bears more resemblance to natural gas, and is more likely to lead to regional or even distributed markets.

That said, the global stakes surrounding hydrogen are huge. Even as a locally or regionally traded commodity, hydrogen is one of those technologies that can reshuffle the geopolitical cards in the 21st century, alongside other technologies such as artificial intelligence, machine learning, electric vehicles, and smart grids. Countries and companies are jockeying to gain mastery over what is set to become a multi-billion-dollar international commodity market in a decade or two. The size and scope of that market is still uncertain, but the clean hydrogen race is clearly on, and is deeply affected by geopolitical motives and consequences.

Hydrogen’s promise

For decades, the geopolitics of energy has revolved around fossil fuels, and oil in particular. As new energy sources, particularly solar and wind, have achieved spectacular cost reductions, the contours of a new energy order begin to emerge. For large chunks of our energy demand, renewable-powered electrification will be the most efficient way to abate emissions. The decarbonization of other sectors, however, will require different solutions, based on molecules rather than electrons. This is where hydrogen comes into the spotlight, either in pure form or as a compound (for example, ammonia).

Hydrogen is not an energy source, however, but an energy carrier. It can be produced in different ways, from a range of sources, each with a different impact on climate change. Various colours are used to describe these different production pathways.

The different shades of hydrogen

Colour	Process	Source
Grey hydrogen	Steam methane reforming or gasification	Natural gas or coal
Blue hydrogen	Steam methane reforming or gasification with carbon capture and storage	Natural gas or coal
Green hydrogen	Electrolysis	Renewable electricity
Purple hydrogen	Electrolysis	Nuclear electricity
Turquoise hydrogen	Pyrolysis	Natural gas

While the bulk of hydrogen is still made from unabated fossil fuels (‘grey’ hydrogen), the falling costs of renewables and electrolysers improve the prospects of ‘green’ hydrogen becoming competitive sooner rather than later—within less than a decade according to IRENA. ‘Blue’ hydrogen will be its biggest contender as a decarbonization fuel, though it still has 5–15 per cent of the carbon footprint of the natural gas or coal that it was made from.

The outlook for hydrogen has further improved in the wake of the COVID-19 pandemic, as some governments have allocated large funds to hydrogen as a way to foster both economic recovery and climate action. In Europe alone in the last six months, governments have announced more than $30 billion of hydrogen investments by 2030. In sum, the prospects for hydrogen to finally live up to its promise of becoming a key part of the clean-energy puzzle have, it seems, never been better.

For policymakers, the lure of hydrogen is that it can provide a secure and reliable supply of energy and heat at all times, night or day, winter or summer, at a cost that is bound to come down and without emitting carbon dioxide (in the cases of green, purple or turquoise hydrogen). It is a key enabler of sector coupling. As a storable and dispatchable energy carrier, hydrogen beats intermittent sources of electricity from solar and wind, as well as grid-connected batteries, which can only provide storage for a few hours at most. Unlike oil and gas, it can be produced anywhere in the world, reducing the risks of asymmetric trade relationships that can be politically exploited by either side.

The race for technological leadership

The anticipated boom in hydrogen could create large new markets. McKinsey and the Hydrogen Council estimate that a global hydrogen market could meet 18 per cent of final energy demand by 2050. By that time, sales of hydrogen as a commodity and related equipment (such as electrolysers, hydrogen refuelling stations, and fuel cells) could be worth $2.5 trillion per year and generate 30 million jobs. Bloomberg New Energy Finance (BNEF) believes hydrogen could even meet up to 24 per cent of final energy demand by 2050, which would open up $11 trillion of investment opportunity over the next 30 years (*BNEF, 2020*).

As such, hydrogen is just another battleground for technological and economic supremacy between the established and rising powers of this world. Just as the US ascent to global supremacy in the 20th century was inseparable from oil, countries are now vying to control the key energy technologies of the future: not just hydrogen, but also solar, batteries, digital networks, electric vehicles, and so on. Countries have a strategic interest in being technology makers, not technology takers in these critical areas.

This geo-economic calculus is already influencing hydrogen policies. Germany's massive green-hydrogen push, for example, is a clear bid to outcompete China, mindful of the painful experience of losing its solar photovoltaic (PV) manufacturing industry to China a few years ago (*Amelang, 2020*). While China has done a lot to drive down the unit costs of PV and wind, it has also acquired dominant positions in the value chains of these and other energy technologies, like electric vehicles and rare earths.

Electrolysers have the same kind of modularity as PV solar panels or batteries, and could thus experience the same kind of price deflation that we have seen for those technologies. BNEF estimates that, as of 2019, electrolysers were already 83 per cent cheaper to produce in China than in Western countries, (*BNEF, 2020*). Admittedly, Chinese manufacturers focus on the more standard alkaline electrolysers, which are less flexible than the solid oxide and proton exchange membrane technologies that European firms have focused on. But in many respects, it looks like the race has already been run. It will be hard for European manufacturers to beat China on costs.

Trade opportunities and risks

While some major powers may head towards hydrogen self-sufficiency (the United States, China, India, and Brazil, for instance), hydrogen looks set to become an internationally traded commodity. The largest single component of green hydrogen production is the cost of renewable electricity, so producers need cheap electricity to be competitive, not just cheap electrolysers (*IRENA, 2020*). This creates an opportunity to produce hydrogen at locations with optimal renewable sources and export it from there.

Some countries, like Japan, Korea, and Germany, are gearing up to become large-scale importers of hydrogen, while others, like Australia, Chile, and Morocco, aim to become significant exporters of hydrogen. That creates the basis for new bilateral energy-trading relationships—for example Chile with Japan, Morocco with Germany, and Oman with Belgium—which could add up to a completely new geography of energy trade (*Van de Graaf et al., 2020*).

Several oil- and gas-rich countries in the Middle East are banking on hydrogen to maintain their position as key energy suppliers to the world. While the desert kingdoms of the Gulf have ample solar potential, underground storage space, and experience in molecule trade, their ambitions might be constrained by lack of sufficient water and, more importantly, competition from their own (cheaper) oil and gas exports.

Japan, which is currently importing all of its oil and gas, strongly supports hydrogen. In 2017, it announced its ambition to become a full-fledged 'hydrogen society', envisaging widespread use of hydrogen across virtually all sectors. It has marshalled its diplomatic apparatus both to catapult hydrogen to the top of the international agenda (e.g. by convening a ministerial meeting on hydrogen in 2019 as G20 host), and to scavenge for potential suppliers of imported hydrogen. In June 2020, Japan received its first cargo of liquid organic hydrogen carrier from Brunei and is set to begin with trial shipments from Australia soon.

Europe is serious, too, about hydrogen imports. A European industry alliance has developed a plan to develop 2x40 GW of electrolysers by 2030, 40 GW in Europe and 40 GW in neighbouring regions, for export of hydrogen to the EU (Van Wijk and Chatzimarkakis, 2020). Germany's national hydrogen strategy foresaw not only €7 billion earmarked for domestic production of green hydrogen but also €2 billion for overseas production. Germany is currently exploring imports from countries as diverse as Morocco, the Democratic Republic of the Congo, and even remote Australia. Some of these schemes smack of 'green colonialism', as they see developing countries solely as the providers of raw materials to power the industrial centres of the rich world (Van de Graaf et al., 2020).

Hydrogen valleys and corridors

A key bottleneck in all this will be transportation costs. Hydrogen could be moved across borders in ships or pipelines. One way to ship hydrogen is to liquefy it, but for that it needs to be cooled to −252°C, which uses a lot of energy (for comparison, LNG requires cooling to −160°C). It's more practical to use a vector like ammonia or toluene (a liquid organic hydrogen carrier) for hydrogen transport, but those conversions are expensive. In September 2020, Saudi Arabia sent its first shipment of 'blue ammonia' (made from natural gas with carbon capture and storage) to Japan, where it will be used to produce electric power.

Pipelines may make more sense, especially if existing pipelines can be repurposed for hydrogen transport, such as in Europe, which already has good connections to Norway, Ukraine, and North Africa. The gas transmission industry is confident that such retrofitting is technically feasible and affordable (Enagás et al.,2020). The expected decline of gas demand in Europe opens opportunities for the conversion of gas transmission infrastructure. The upshot is that, akin to natural gas, hydrogen could be traded more on regional markets than on global markets. All in all, transporting hydrogen is an order of magnitude more expensive than transporting natural gas, which is itself more expensive than shipping oil.

Of course, the initial steps will be more modest. At present, around 85 per cent of all hydrogen is still produced and consumed on site (e.g. at refineries). Scaling up both supply and demand infrastructure for hydrogen could be achieved through industrial clusters, especially in different coastal areas. Europe's hydrogen strategy is geared towards establishing such 'hydrogen valleys' or hubs (e.g. ports or cities). From there, 'hydrogen corridors' could be developed that connect regions with high renewable potential to demand centres.

Over time, then, the hydrogen market could come to mimic the natural gas market: North America largely self-sufficient, Europe importing some piped hydrogen from neighbouring countries, and Japan relying on seaborne shipments of hydrogen. A key difference with natural gas, however, is that all major countries (including importers like Europe, Korea, and Japan) will be prosumers. Another difference is that climate-conscious importers will want to have certificates or guarantees of origin to make sure that the hydrogen they get is of the right 'colour', as well as technical standards for safety and quality of handling equipment.

A reality check

Based on the growing drumbeat of the media, one could easily think that cost-effective green hydrogen is just around the corner and will be traded on global markets that eclipse those for oil and gas before 2050. In truth, though, there remain significant hurdles and pitfalls in scaling up hydrogen markets. Green hydrogen is still nowhere near competitive with blue or grey hydrogen, let alone with fossil fuels. There is a risk that blue hydrogen will continue to dominate the supply picture, which would be incompatible with mid-century net-zero targets.

In order to create demand, there is a risk that countries will support policies that lead to carbon lock-in (for instance, when hydrogen-blending mandates prolong the lifetime of natural gas and limit the spread of residential heat pumps) or that are simply inefficient, such as promoting hydrogen cars instead of electric vehicles. As the CEO of Volkswagen recently put it: 'to drive the same 100 km [with a hydrogen car] you need three times the wind farms than you do with electric cars', (Quoted in: Todts, 2020).

For some advocates, indeed, hydrogen is the answer to every energy question. Its real value, however, will be as one focused part of a suite of energy solutions.

Conclusion

Interest in hydrogen has waxed and waned, yet this time might be different. Technologies like wind, solar, and electrolysers are on learning curves, which will make the value proposition of carbon-free hydrogen ever more attractive, especially as a growing number of governments set carbon- or climate-neutrality goals. Some countries, like Germany, want to leapfrog to green hydrogen straight away, skipping the blue hydrogen phase, but this will be very difficult to achieve given the current cost advantage that blue hydrogen enjoys. Yet sustaining or expanding the value chain of blue hydrogen creates a clear risk of carbon lock-in.

Green hydrogen has to travel an even longer and more winding road to become competitive with fossil fuels. The current fervour with which new hydrogen value chains are created offers cause for optimism. Numerous players are placing different bets. From Airbus announcing concept designs for hydrogen airplanes, to a Swedish joint venture launching a pilot plant to make carbon-free steel, to Saudi Arabia planning to build a 4 GW green hydrogen plant on the shores of the Red Sea, it is clear that hydrogen is gradually moving from niche to mainstream.

Just as in Yergin's grand story of oil, hydrogen is a game of huge risks and geopolitical significance. Whether it will yield the same monumental rewards remains to be seen.

THE GEOPOLITICS OF NUCLEAR ENERGY IN THE ERA OF ENERGY TRANSITION

Jane Nakano

Marked by the changing profile of the leading suppliers of nuclear reactor technologies, the geopolitics of nuclear energy is undergoing a major shift. Key reactor technology holder and supplier countries tend either to have substantial government ownership of the nuclear industry or to be state-led capitalist economies. These countries offer generous financing to attract developing economies that are interested in introducing nuclear energy for the first time, as well as more industrialized economies that strive to preserve their nuclear power generation fleets. In particular, the export endeavours of Russia and China come with geopolitical and security implications as well as market-distorting effects. These are serious concerns that can complicate the prospect for this zero-carbon-emitting power generation technology to meet its full potential in climate change mitigation.

Electricity accounts for only about one-fifth of total final energy consumption today. However, the global effort to combat climate change and to decarbonize the energy system will continue to facilitate electrification. Nuclear energy is a technologically proven source of electricity with a significant potential to contribute to existing carbon reduction efforts. Nuclear has multiple unique attributes that make it a viable option for many governments around the world. For example, nuclear not only is a zero-carbon-emitting source of electricity but also is dispatchable and does not depend on weather conditions, making it highly compatible with variable renewable sources like wind and solar. Also, nuclear generates more energy than other zero-carbon sources of energy per unit, thereby requiring less space for siting.

Nuclear energy technology is capital-intensive, however, and the capital cost can account for more than 80 per cent of the cost of energy from a new nuclear plant, according to a 2018 study by the Massachusetts Institute of Technology. Reducing capital costs, like the cost of building the plant (including equipment, construction materials, and labour), is therefore critical for the viability of nuclear power generation.

Besides the high capital cost, other issues—the prospect of significant overruns in construction time and budgets, and the uncertainty about power prices over the lifetime of a nuclear power plant in the era of ever-cheaper renewables and advances in energy storage technology—have led nuclear power users in liberalized power markets, ranging from ratepayers to national governments, to scrutinize their exposure to nuclear power generation. Moreover, the 2011 nuclear accident in Fukushima, Japan, has rendered nuclear energy politically and societally contentious in some markets.

For example, faced with sustained low prices for natural gas, ever-cheaper renewables, and low power demand, the US nuclear power generation fleet is shrinking, although it still is the largest in the world. The situation was only exacerbated by the suspension of the V.C. Summer project in 2017, as well as the delays and cost overruns for the Vogtle project—the first two projects to obtain construction and operation licences in the United States in nearly 40 years.

It merits close attention how much the Biden administration's commitment to achieve carbon neutrality by 2050, and to decarbonize the electric power sector by 2035, may help to revitalize the US nuclear power sector. Even in the United States, which has enjoyed the economic and emissions-reduction benefits of natural gas for the past decade or so, national discourse around nuclear power generation is becoming more favourable across the political spectrum. Nuclear power generation, which has traditionally enjoyed conservatives' support on national security grounds, used to face a headwind among pro-renewables liberals. However, the sense of urgency to address climate change and growing pragmatism seem to have muted earlier opposition to nuclear energy. For example, the Democratic Party platform, released in summer 2020, made a favourable mention of nuclear energy for the first time in almost 50 years.

Meanwhile, continued electricity demand growth from a combination of economic development, population growth, and industrialization is turning developing economies into potential customers. Even while the COVID-19 pandemic has dampened electricity demand in both advanced and developing economies, the International Energy Agency has noted that the power demand in developing/emerging economies could recover and exceed pre-crisis levels by 2021—several years ahead of the advanced economies—thanks to rising levels of ownership of household appliances and air conditioners, as well as growing consumption of goods and services (*World Energy Outlook 2020*). Nuclear power generation is among the options in many of these economies. According to a 2019 report by the International Atomic Energy Agency, nearly 30 countries without a nuclear power plant are considering, planning, or starting nuclear power generation programmes (*IAEA Annual Report 2019*). As of January 2021, Bangladesh, Belarus, and Turkey are constructing their first nuclear power plants.

The stagnation of domestic nuclear power demand and reactor orders in advanced, industrialized economies that are also nuclear technology suppliers pushes their nuclear industry to seek market opportunities abroad. The export efforts by private nuclear companies have been an uphill battle, however. The United States was a leading global supplier of nuclear technology and fuel for much of the last half century, but it has not landed a reactor sale since the 2007 sale of four Westinghouse AP1000 reactors to China. Striving to regain competitiveness, the US nuclear industry seeks to turn recently signed intergovernmental agreements into actual contracts in several eastern European countries while also continuing to develop small modular reactors for eventual export.

Japan has also pursued export opportunities since the early 2000s, notably in close partnerships with American and French firms. Japan's nuclear industry doubled down on the export effort following the 2011 accident as commercial prospects at home dimmed. Largely due to changing public sentiment towards nuclear (for example, in Lithuania and Vietnam), or economic difficulties in the host market (for example, the United Kingdom and the United States), however, the Japanese efforts have not yet come to fruition.

Nuclear power projects and export programmes have fared better in countries with more direct government involvement. Home to the second largest commercial nuclear reactor fleet and the world's largest net exporter of electricity, France has long viewed nuclear energy as a strategic industry, and the government maintains a dominant stake in the nation's nuclear power business. A series of setbacks with its European Pressurized Reactor project in Finland, whose original completion target of 2009 is now postponed until after spring 2021, has dealt reputational damage to the French nuclear industry. Yet, having completed projects in China recently, France—where the state-owned utility Électricité de France operates all of its commercial nuclear power plants—appears focused on delivering several European Pressurized Reactors to the United Kingdom.

Another key global supplier with strong state support is South Korea. Successful export of its APR1400 reactors to the United Arab Emirates (UAE) propelled South Korea to the global nuclear market scene in 2009. The Korean consortium, which was led by its state-owned electric power utility, outbid American and French competitors. Having completed the first nuclear power generation plant in the Arab world, South Korea seeks to replicate its UAE success in the region and around the world despite the current government's aversion to nuclear energy.

Supplier countries that warrant particular attention are Russia and China, two state-led capitalist economies that have made significant investments in their export endeavours. Having managed to resurrect its nuclear export business, which was shattered by the Chernobyl accident in 1986, Russia is the most dominant global supplier country today. Between 2009 and 2018, Russia accounted for 23 of the 31 export orders placed around the world and for about half currently under construction around the world, including reactors in Bangladesh, Belarus, Finland, Slovakia, Turkey, and Ukraine. Since the inception of the Rosatom State Atomic Energy Corporation, Russia has been locking up emerging markets with intergovernmental agreements. The nuclear industry is entirely under the control of the Russian state, with its strategic objectives set by the president of Russia.

China seeks to leverage its robust domestic nuclear power generation capacity expansion to become a leading global supplier. In the last decade, China brought 35 reactors online, 10 units more than all of the non-Chinese new units combined. In December, China began operating its first Hualong One reactor, which the country positions as its flagship design for export. China's expanding nuclear power generation capacity is positioned to surpass that of France in the next few years and that of the United States by 2030. China's rising competitiveness has a climate benefit as its robust capacity expansion underpins the growth of its nuclear manufacturing base as well as the maturing of its project management skills, which are important factors in keeping the project cost low.

So far, Pakistan is the only foreign host of Chinese reactors. China's state-owned nuclear companies are actively marketing the

Hualong One reactor. The reactor is currently in the fourth and final phase of design assessment by nuclear regulators in the United Kingdom, where China is investing in several French nuclear power plant projects with the expectation that Hualong One would be welcomed on UK soil in return. Approval from highly regarded British nuclear regulators could jump-start China's global nuclear export effort.

The Chinese and Russian export of nuclear power plants and related services has raised security and geopolitical concerns, however. Chinese investment was initially welcomed as the UK government sought to finance the plan to update its aging nuclear power generation fleet. Half a decade and two cabinets after the decision was made, however, the scope of the UK nuclear modernization plan looks uncertain, as renewables have become ever more competitive, and UK–China relations have soured. Following the UK government decision in July to phase out Huawei's 5G technology from the UK telecommunications network, the security implications of hosting a Chinese nuclear reactor have come under intense scrutiny.

Another security concern arising from the shifting supplier profile is whether it may weaken nuclear governance. A nuclear accident or proliferation incident can generate significant opposition to the use of nuclear power and can deal reputational damage to the supplier country. As such, every nuclear technology supplier country has a vested interest in preventing nuclear accidents and proliferation by adopting and enforcing high safety and non-proliferation standards that in the past were put in place under US leadership. However, it remains uncertain whether Russia and China will act to strengthen the existing norms and standards. For example, Russia is generally tolerant of countries acquiring proliferation-sensitive nuclear technologies, for example for enrichment and reprocessing. Also, while China has come to accept various non-proliferation principles, the country is known for generally prioritizing commercial benefits over non-monetary values in many of its global economic endeavours.

Nuclear export also has a high geopolitical currency for Russia, which otherwise has limited means to preserve relevance in global affairs. For example, Russia's Akkuyu project in Turkey significantly complicates diplomatic relations between the United States and Turkey, which is a member of the North Atlantic Treaty Organization (NATO). Built, owned, and operated by the Russians, the Akkuyu plant would raise a range of security and legal issues for transatlantic relations and the Western security architecture. Key concerns include the rights and obligations of the United States and NATO if a foreign power attacked a Russian-owned reactor on the land of a NATO member, or if Russia deployed its military there in response.

Furthermore, the nuclear export endeavours by Russia and China stand out because their export strategy has distorting effects on global nuclear commerce. For example, the Russian and Chinese approach to nuclear commerce features generous funding which other key supplier countries would find it hard to match. Unlike the United States, Japan, France, or South Korea, Russia and China are not members of the Organisation for Economic Cooperation and Development (OECD). As such, neither Russia nor China is bound by the OECD export credit rules, and both are free to offer export credit terms superior to what the OECD deems acceptable for repayment terms, repayment frequencies, rates, and other terms. As the profile of key technology supplier countries changes, the time is ripe to update the existing financing rules and commonly accepted terms of commercial competition.

The future of nuclear power generation is closely tied to its contribution to climate change mitigation. One cannot overstate how significant it is that bipartisan support in the United States is emerging for nuclear energy as a technology to combat climate change and buttress national security. The growing competition in the global nuclear market could help to lower the barrier to entry for developing countries that face the dual challenge of economic development and climate mitigation. Global nuclear commerce requires healthy and fair competition to allow a diverse pool of supplier countries to thrive, and to ensure that choosing nuclear power would not come at a risk to the integrity of a country's critical infrastructure.

THE ENERGY TRANSITION AND THE ENDURING ROLE OF ENERGY IN US FOREIGN POLICY

Meghan L. O'Sullivan

American foreign policymakers have rarely been energy experts. But in practice, for decades, they have confronted and manoeuvred around energy issues. Energy has been both an end and a means in American foreign policy. The heavy reliance of the American and global economies on oil and gas has shaped US foreign policy in distinct ways for nearly the last 100 years. As the world moves away from fossil fuels and towards a different energy mix and an alternative energy system, energy will continue to sculpt US foreign policy, but in a very different manner.

Energy as an Ends and Means of Foreign Policy in the age of fossil fuels

For most of the past 50 years, America's dependency on imported oil has meant that securing energy has often been an end or objective of America's interactions with the world. Most obviously, the need to maintain access to oil at reasonable prices was the original foundation of the strategic relationship between the United States and many countries in the Middle East. America used its myriad of foreign policy and national security tools to help ensure that the country was not deprived of the oil supplies it and the world needed to continue to grow.

Military assets have been—and continue to be—deployed to the Gulf to ensure the passage of oil, and the extreme case of the 1991 Gulf War demonstrated the willingness to go to war to prevent one dictator from dominating the global oil market. At the other end of the spectrum, diplomacy produced trade agreements with America's neighbours that included special provisions, such as the 'proportionality' clause of the North American Free Trade Agreement (NAFTA) that was in force until 2020, to prevent other governments from limiting US access to their energy resources.

America also found itself in a position, especially in recent years, to use energy as a means or instrument to achieve non-energy-related foreign policy goals. This was largely on account of the unconventional oil and natural gas boom, which catapulted the United States into the position of being the largest producer of these resources in the world, and a very significant exporter of each commodity as well.

'Energy dominance' – the term used by then-US President Donald Trump to describe his administration's energy policy and the country's energy position – was commonly thought to simply reflect these high levels of oil and gas production. Yet on closer examination, what made Trump's 'energy dominance' distinctive was that, for the first time in a long time (with the notable exception of the use of sanctions), the United States was both able and eager to use its energy advantage as a way of trying to achieve other, non-energy-related foreign policy goals.

Most notably, the Trump administration sought to use its energy exports to address the country's large trade deficits, a high priority for the president. The Phase One agreement with China explicitly committed China to purchase $52.4 billion of American oil, LNG, refined products, and coal—an amount which constituted roughly a quarter of the total dollar value of the two-year arrangement.

American's energy position also enabled it to advance one of its top aims in the Middle East: pressuring Tehran. Energy markets flush with US oil helped Washington to enact crushing sanctions on Iran aimed at reducing its oil exports to zero and creating pressure on both the country's leadership and society. The Trump administration also sought to use its status as the third-largest exporter of LNG in the world to keep Europe from building stronger commercial ties with Russia; when European countries still preferred the cheaper gas from Russia, senior Trump officials did not hide their frustration. The president himself revealed that he saw energy and national security as inseparable when he publicly mused that it vexed him how Europeans could ask the United States to support their defence through NATO at the same time that they were creating new dependencies on Russia.

When Secretary of State Mike Pompeo announced $1 billion in energy financing to countries in Central and Eastern Europe, his words were illuminating: 'Our aim is quite simple: It is to galvanize private sector investment in the energy sector to protect freedom and democracy around the world' (https://useu.usmission.gov/secretary-pompeo-remarks-at-the-munich-security-conference/). Similarly, in May 2020, only a few months before Belarussian President Alexander Lukashenko came under intense domestic pressure to leave office, Secretary Pompeo announced that US oil was being sold to Belarus, declaring that the move purposefully 'strengthens Belarusian sovereignty and independence' (https://by.usembassy.gov/on-first-shipment-of-u-s-oil-to-belarus/).

Energy as Ends and Means in US Foreign Policy during the energy transition

Energy will continue to play a critical role in US foreign policy during the energy transition. The intersection of these two arenas, however, will be even more complex, given the ongoing geopolitics of oil and gas and the ever-growing foreign-policy complexities and opportunities associated with alternative sources of energy.

Oil and gas will remain important energy sources well into the transition, as is seen from the multitude of climate-friendly scenarios that still anticipate significant (if reduced) global consumption of these commodities. Nevertheless, oil and gas will diminish as both ends and means of American foreign policy over the course of the transition.

The extent to which US foreign policy continues to focus on securing oil will depend in part on the pace at which global oil demand declines and on how long American production remains competitive in a lower-priced oil environment. The United

States is unlikely to be among the ‘last producers standing’ absent major (and inefficient) policy interventions, although its oil output may be sustained longer than that of some other high-cost producers, as investment could continue to flow to short-cycle oil even after investors are unwilling to make bets that would only pay off over a longer time period.

It is reasonable to assume that the United States will use much less oil and be able to meet most of its oil needs domestically. However, it is also possible that the United States may once again rely on foreign countries to meet its remaining oil needs, requiring it to again orient its foreign policy more towards this aim.

American’s ability to use its oil and gas production as a foreign policy instrument will also diminish sharply as the energy transition progresses. In markets that are likely to become increasingly oversupplied, producers in general will be able to wield less political influence through the sale of their exports; US oil and gas will no longer shape the oil and gas markets as they have, and access to US exports will be less meaningful in a world with too much oil and gas.

What role natural gas will play in the transition is, however, an open question. For countries whose decarbonization plans include increases in natural gas use, America’s natural gas may prove critical for a time. But, on the whole, the geopolitical influence the Trump administration sought to harness through its ‘energy dominance’—as related to oil and gas—will drop sharply as the transition unfolds.

Nevertheless, energy will infuse US foreign policy in other ways. It will remain one of the largest drivers of US engagement with the world, but not in the sense that America will seek to obtain physical commodities. Instead, America will seek to use non-energy foreign-policy tools to achieve other types of energy outcomes, such as access to markets and to the inputs and resources needed to enable climate-friendly technologies. Even more importantly, the United States will use its foreign policy instruments to convince and cajole other countries to decarbonize their economies—an energy outcome Washington will increasingly see as in its national interests.

President Biden has promised to make the decarbonization of other economies one of the highest priorities in American foreign policy (just as decarbonization of the US economy will be a high domestic priority). This will represent a major shift in US foreign policy. Even when climate-related matters were considered important, as they were in the Obama administration, climate was largely treated as a subject matter for specialists, and discussion of climate was largely handled in relation to climate forums.

What will the effort to infuse decarbonization into American foreign policy look like? It will involve diplomacy, as the United States seeks to regain a leadership role in international climate talks such as the UN Climate Change Conference taking place in Glasgow in November 2021. But it also means that climate and decarbonization will take a central place in America’s bilateral discussions, with countries from Asia to Europe. Some such discussions will be easy, as the parties share common goals and the political will to pursue them. But in other cases, promotion of decarbonization will run up against other, sometimes higher or more immediate, US policy priorities such as nuclear non-proliferation, counter-terrorism, and conflict resolution. America’s climate diplomacy will also extend into other international forums, such as the World Trade Organization, where the US will seek reform of the organization with an eye to climate, among other things. Climate will also become an organizing principle for the distribution of US aid, and in assessing threats that will need to be handled in some cases by the US military.

A climate-centric foreign policy could also involve tariffs, such as those which might be required under a carbon border adjustment mechanism that seeks to level the playing field between American manufacturers and those operating in economies that have no price on carbon. Both economic incentives and sanctions could also find a place in the US quest to prevent countries from taking actions that compromise the world’s ability to address global warming. For instance, the United States could spearhead an effort to make it economically sensible for developing countries heavily reliant on coal to switch to lower-carbon sources even before their investments in existing coal infrastructure become outdated.

Energy will also serve as a means for America to achieve other, non-energy-related goals in a decarbonizing world. If the United States makes the sorts of investments in energy research, development, and innovation that many of America’s business and public leaders are calling for, the country should emerge as a major source of technologies essential to realizing a successful global energy transition.

In many cases, America is likely to share these technologies with other economies simply to support global decarbonization. But in other cases, its provision of technology, financing, and other energy assistance to other countries will support important non-climate foreign-policy goals—especially in its competition with China. Both countries are likely to use energy policy in their quests to extend their influence. Similarly, Washington will seek a leadership role in climate talks—in part to influence the outcome and advance climate goals it views as critical for the world, but also as a means of demonstrating to the world that the United States has the appetite and capability to lead again on the global stage.

Likewise, climate cooperation with Europe will have multiple objectives. Washington and Brussels will be in greater alignment on climate, which will both advance environment-friendly outcomes and serve as a basis for bolstering the frayed transatlantic relationship. Finally, Washington will use energy instruments as new ways to advance more traditional goals, such as addressing poverty and promoting peace and stability.

Conclusion

Although it is rarely articulated, some see geopolitics as at least part of the imperative to move to a cleaner energy system. These people assert that once oil and gas are no longer a source of economic or geopolitical power, geopolitics will be more peaceful and cooperative. The opposite, however, could be true. During the multi-decade energy transition, the world will continue to grapple with geopolitical realities associated with oil and natural gas use. But it will also see the rise of alternative energies, which will have their own distinct geopolitical features. And the steps that countries like the United States take to advance or thwart decarbonization will bring their own geopolitical implications. Ultimately, energy's role in shaping international cooperation and competition during the transition may be more benign that its role during the age of fossil fuels, but it is too early to conclude that definitively.

What we do know with some certainty is that energy will continue to be both an ends and a means in U.S. foreign policy. American foreign policymakers, having a new sense of urgency around climate and perpetually frustrated by the limited non-military tools in their toolkit, will continue to see energy as both an objective and an instrument of their efforts to shape the world during the energy transition.

LESSONS FROM A STRATEGY OF ENERGY DOMINANCE

Sarah Ladislaw

In 2017, I wrote a submission for this publication titled, "Dissecting Energy Dominance." The purpose of the article was to explain the energy slogan and strategy put forth by the Trump administration. Now, as President Joseph Biden enters office, it is worth revisiting the performance of this strategy and exploring what can and should come next.

The clearest explanation of the term 'energy dominance' came in a speech at the US Department of Energy during which Trump said that it meant the United States would 'no longer be vulnerable to foreign regimes that use energy as an economic weapon; American families will have access to cheaper energy, allowing them to keep more of their hard-earned dollars; and workers will have access to more jobs and opportunities' (*President Trump speech at U.S. Department of Energy, June 29, 2017*).

In fact, this description could have been given by any US politician over the last 40 years in support of US energy policy and is reflective of the same principles underlying a more enduring US energy slogan, 'energy independence', offered up by Richard Nixon after the oil crises of the 1970s.

The basic elements of energy dominance were as follows (ibid):

1. Produce more energy to lower the cost as a basic input to the economy.
2. Remove regulations on the energy sector to increase production opportunities.
3. Pursue energy trading opportunities with other countries.

Many countries, including US allies, understandably bristled at the idea of US energy dominance because of its undiplomatic tone. The somewhat nativist term 'freedom molecules', used by one official to describe US exports of natural gas, was similarly ridiculed by many outside the administration. To its credit, toward the latter half of its tenure, the Trump administration toned down the promotion of energy dominance and mentioned it far less frequently. Nonetheless, the basic elements of the strategy persisted.

Assessing energy dominance

The objectives listed above—increased production, less regulation, and enhanced energy trade—seem quaint since the COVID-19 crisis has rocked the US energy system, particularly the oil and gas industry. COVID-19 resulted in the largest single downturn in energy consumption in history, which precipitated record bankruptcies, job losses, and reduced investment in the US oil and gas industry. The electric power sector was less impacted, with a much smaller decline in consumption even at the height of the spring 2020 restrictions, though the industry is owed a great deal in back payments as a result of policies designed to keep electricity and gas services from being denied to households who could not pay during the crisis.

During the crisis, the quest for energy dominance was flipped on its head as prices plummeted, the world risked running out of storage due to steep declines in consumption, and the Trump administration had to search for other ways to prop up the US oil and gas industry. Instead of reducing its reliance on other countries and detaching itself from global oil politics, the US had to directly engage in brokering discussions between Saudi Arabia and Russia, along with OPEC and the G20, to find a way to balance global oil prices. The administration heralded its ability to broker such a deal as a concrete sign of its energy and geopolitical dominance. Others saw it as an indication that rather than the US being freed from oil-related geopolitics, it was now much more intimately tied to them.

Regarding deregulation, the administration proved to be out of step with much of the energy industry itself. On key aspects of Trump's deregulatory agenda, the oil and gas industry, along with major utilities, investors, and auto manufacturers, have asked for more consistent regulation and clearer policy guidance, rather than less. This trend is most pronounced when it comes to climate change. Over the course of the Trump administration, nearly all the major integrated oil and gas companies and a good share of the large independents and large service companies set emissions-reduction targets and called for some sort of climate-related energy policy. They did this in recognition that failure to pursue a low-carbon transition may render them less competitive in the US and in other countries.

This point was brought into stark relief when the French government intervened in an LNG deal being pursued by Engie to import natural gas from a major US shale play over concern that suboptimal US regulation on methane flaring made the gas 'dirtier' than should be allowed in France. While only one incident, it symbolized the deep concern that, rather than representing the world's best environmental performers, the US oil and gas industry's reputation would suffer because of a lax regulatory environment.

Thus, the first two elements of the energy dominance strategy—increasing production of fossil-based energy resources, and removing environmental restrictions during a time of global oil and gas oversupply and increasing concern among most major governments and investors about the environmental attributes of energy resources—were simply the wrong recipe for success.

The last element of the energy dominance strategy was the pursuit of energy trade relations with other countries and by extension the effort to use energy as a tool of foreign policy. Here the Trump administration contributed to an atmosphere of heightened geo-economic competition and energy mercantilism by tying energy trade and investment to trade disputes and sanctions regimes. As described in a recent report (*Ladislaw and Tsafos, 2020*), this type of energy mercantilism did not fundamentally alter energy trade relations with any countries beyond what was likely to happen because of the United States' emergence as a net exporter of oil and natural gas. Nor did the fact that US oil abundance freed the country to more heavily sanction global oil producers like Iran and Venezuela definitively help the US achieve its broader foreign policy objectives in those two countries (though in fairness, this has more to do with shortcomings in the overall strategies and less with sanctions themselves).

Although not a direct result of the Trump administration's policies, the world has grown more competitive and the energy landscape is no exception. Many of that administration's actions to promote the sale of US energy and energy technologies—commercial diplomacy, expanding the capabilities of the Development Finance Corporation, and reconstituting the Export-Import Bank—will be important to sustain if the United States wants to compete globally in selling the energy technologies of the future.

Lessons for the Biden administration

The Biden administration, like the Obama administration before it, will be motivated more by the pressing danger of unmitigated climate change and the opportunity to reinvent the US and global energy system to end greenhouse gas emissions by 2050 or sooner. This is a fundamentally different strategic platform than the Trump administration's approach of energy dominance, which did not recognize this transformative goal. To pursue deep decarbonization of the world's energy system on a timeline commensurate with the challenge of climate change requires a massive deployment of new energy technologies, some of which are ready to deploy at scale today while others require more innovation to be ready for mass adoption. All of this is required over a 30-year time frame, and much of it will require the existing energy system to operate differently—in a more distributed, efficient, electrified, and integrated way.

This can seem like a daunting challenge, but it is also an enormous strategic opportunity. Much like the Obama administration (and many other national governments) seized on the recovery from the 2007–2008 financial crisis to champion a 'green growth' agenda, the Biden administration has embraced a 'build back better' strategy (*Build Back Better: Joe Biden's Jobs and Economic Recovery Plan for Working Families*, 2021) with the goal of creating a new era of economic growth and job creation—not by producing more oil, gas, and coal, but by investing in clean-energy infrastructure and research and development, with a focus on creating new industries and new jobs.

To be fair, the goals of the Biden administration will have to be more ambitious in scope and timing than those of the Obama administration, because of the widespread recognition that the current scope and timing are insufficient to avoid the worst impacts of climate change. The administration has sought to reflect the necessary level of ambition by adopting goals of carbon-free electricity by 2035 and a net-zero-emissions energy sector by 2050.

In its international agenda, too, the Biden administration faces different and perhaps more daunting objectives than the Obama administration. No longer does the world simply need to negotiate an agreement to govern the process by which countries will pledge climate targets. Today, the goal is to meet those targets, make them more ambitious, and then meet the more ambitious ones. By all accounts, this is not happening in enough countries around the world. So rather than simply rejoining the Paris Agreement and submitting a new pledge, the real leadership task for the United States is to find additional ways to deliver near-term emissions reductions by more countries and to set the stage for delivery of additional reductions in the future, mostly through a revitalized research and development effort.

This is so different from the Trump administration's goal of energy dominance that it is hard to think of areas where the incoming administration might learn from the outgoing administration's strategy. The most obvious possibility is the extent to which the Trump administration embraced the idea that the global energy landscape was full of competition and that the United States needed to work harder to compete against an increasing array of countries seeking to sell clean-energy technologies (like solar photovoltaic, wind turbines, battery technology, and nuclear energy) to the global market as well as to manufacture them at home.

This is a profound strategic shift that the incoming administration would ignore at its peril. If, in fact, there is a race to decarbonize the global energy system, it will happen in the context of a global economy where the world's major energy producers and consumers are less trusting of one other, from a basic trade and national security vantage point, and in which countries seek to capture more economic and job-creating value from energy production to help support their low-carbon ambitions. Chances are that this is not a world where clean-energy supply chains will benefit from a move toward uninhibited free trade and an atmosphere of trust between the world's two largest greenhouse gas emitters, the United States and China.

In this context, one option for the next administration would be to seek a continuation of the 'energy dominance' strategy but simply applied to low-carbon energy resources. The United States would benefit from energy dominance element 1, increasing domestic production, by investing heavily in its own clean-energy industries and positioning all its energy industries and sources for competitive advantage in a low-carbon energy arena.

The United States has natural advantages already given its diversified and abundant energy supply base, deep and expert financial markets, and world-class pool of innovators. It has not, however, realized the leverage to be gained through deployment-led innovation, nor has it adequately considered that it does not simply need inexpensive energy resources but also to extract more value throughout the clean-energy supply chain, create jobs, alleviate environmental injustice concerns, and build new infrastructure. The United States must also take stock of the potential threats to energy security or supply chain resilience that may come from increased reliance on clean-energy supply chains.

It would not, however, be in the US interest, nor is it likely feasible given China's position today, to merely seek clean-energy dominance, where the US is the global supplier of choice and can shape clean-energy markets by virtue of its position. Instead, because mitigating climate change is a shared goal that can only be achieved through joint action, the US would be better off attempting to spark an era of positive competition in which the world's most important energy producers and consumers try to develop the best technologies, drive down their costs, and deploy them as far and wide and quickly as possible. While the era of energy dominance may be over, the intensity of clean-energy competition is just getting started.

WINNERS AND LOSERS IN AN UNEVEN ENERGY TRANSITION

Paul Kolbe and Mark Finley

When thinking about the energy transition, it is useful to recall the quote by *Neuromancer* author William Gibson, "The future is already here, it's just not evenly distributed." The same can be said of the energy transition, and the uneven distribution is likely to last decades. Hydrocarbon distribution currently drives strategic advantage or disadvantage – geology is destiny. In the future, however, geopolitical winners and losers of the transition will be determined by the development of and access to new energy supply chains. In addition to geology, the ability to harness intellectual and financial capital means poorer countries in particular are unlikely to join the transition rapidly, with continued reliance on fossil fuels driving economic and political choices. Countries interested in promoting a successful global transition would be well advised to consider the uneven energy and geopolitical challenges and opportunities, and to adopt policies to help poorer countries manage these disparate impacts.

Between now and 2050, patterns of energy use will be highly divergent, with some locations well down the path to a clean-energy economy and others still relying heavily on fossil fuels to provide heat, light, cooling, and transportation for growing populations with high aspirations. While acknowledging the massive uncertainty surrounding the future of the world's energy system, for ease of argument this discussion is based on the International Energy Agency's (IEA's) *World Energy Outlook* scenarios.

Early manifestations of the accelerating transition from fossil fuels to renewable and lower-carbon sources suggest which countries—both producers and consumers—stand to win and lose the most. At one end of the spectrum, Norway is already reducing its dependence on oil revenue and decarbonizing its economy. It has the wherewithal to thrive in and benefit from a low-carbon future. At the other end of the spectrum, Nigeria is reducing neither its dependence on oil revenue nor its oil consumption; it will remain heavily dependent on and impacted by the hydrocarbon economy. Even as the world, particularly developed countries including China, becomes less dependent on coal, oil, and natural gas, India and Africa may become even more dependent as they (understandably) prioritize economic growth.

Energy demand will likely grow and fossil fuels consumption will likely persist

Over the next four decades, demand for energy, regardless of fuel source, will likely increase, driven by rising standards of living and industrial activity—certainly in the world's poorest countries, including India and much of Africa, and likely in the richer countries as well, except under the most aggressive transition scenarios. Energy producers will meet that demand with both renewable and fossil-fuel-based supplies. In the major industrialized areas including Western Europe, Japan, the United States, and even China, increasing efficiency and fleet electrification means that demand for oil (gasoline and diesel) and coal will likely decline. At the same time, demand for natural gas may well increase as an alternative to coal, with ample supply keeping the cost low.

In other locations—for example, India, along with much of developing Asia, Africa, and Central and South America—economic growth means that consumption of all forms of energy will likely increase. Even as renewables make up an increasing share of the energy pie, growing vehicle fleets, industrialization, and rising standards of living will drive increased use of gasoline, diesel, and potentially even coal.

On the supply side, there will be a continuing need for fossil fuel production, even in a successful transition scenario. For example, even as global coal and oil consumption decline significantly in the IEA's sustainable-development scenario, fossil fuels (largely oil and natural gas) continue to meet the bulk of global energy demand at least through 2050.

Renewables will create new global supply dependencies

The relationships and dependencies created by fossil energy supply chains have been a powerful force in geopolitics for the last century, and a key underlying factor in wars, alliances, embargoes, and sanctions. The geopolitical impact of the energy transition will in large part rest on whether (or what) new energy supply chains evolve, and to what extent old fossil fuel dependencies persist or new ones arise.

Multiple factors will affect the impact of the energy transition

Given the massive technological, economic, and political uncertainties of the energy transition, it is worth considering the variables that will drive differentiated outcomes for producers and consumers before considering the impact on specific countries.

For producers of fossil fuels, the most obvious factor is the cost-competitiveness of their fossil fuel resources, including the carbon intensity of production. For example, Saudi Aramco is already highlighting the low cost and low carbon intensity of its oil production operations. Also relevant is the importance of fossil fuel production to both national economic activity and government revenues: Countries that depend heavily on fossil fuel revenues will face difficult challenges as falling prices combine with lower demand.

This highlights a final key variable: ability to change. Can fossil fuel producers succeed in diversifying their economies and government revenue streams? (See for example Saudi Arabia's Vision 2030 and National Transformation Plan.) Will factors as diverse as corruption, sunk costs, cultural attachment, and psychology hasten or slow efforts to diversify? In Russia, for example, how will the deeply held perception that fossil fuels are key to the country's geopolitical power affect the energy transition?

For large energy consumers as well, a number of variables will affect the timing and impact of the energy transition. Most importantly, does the national political and economic system assist or obstruct the transition? What combination of market forces and command-and-control measures will prove most effective in reducing fossil fuel use? What role does dependence on imports (of both fossil fuels and new energy sources) play? Finally, how important are energy-intensive industries to the national economy, and how successful will countries be in reducing their dependence on difficult-to-abate sectors (or in finding ways to successfully abate them)?

The emergence of new supply chains for the new energy system will pose potential challenges for producers and consumers alike. This is true not only for energy forms themselves, but also for the inputs on which the new energy system depends—metals such as lithium and rare earths, as well as production of batteries, wind turbines, and solar panels.

Surprising winners and losers will emerge in a tiered energy world

Winning and losing are relative, and may balance a number of advantages and disadvantages. This assessment focuses on relative strategic advantages which may be won or lost in the course of the transition. It focuses only on energy—for example, it does not consider what a warming planet may mean for Russian agriculture or access to newly opened Arctic shipping lanes.

Clear winners

China stands to gain more strategic advantage from the energy transition than any other country. Reducing dependence on vulnerable foreign oil and natural gas supplies, increasing price leverage with Russia and Middle Eastern suppliers, cleaning up the nation's polluted air and water, and providing for tech-driven economic growth and jobs are all huge advantages which China stands to accrue. Its dominance over the battery metals supply chain (important for global electrification) will eventually erode, but will be a useful advantage for decades to come. China's dominance of global nuclear construction will provide not only domestic energy but also export potential. Dependence on hard-to-abate heavy industry to drive economic growth is significant but already declining. Finally, China will continue to use massive amounts of domestically produced coal, but coal's relative weight in the Chinese energy mix will decrease.

Europe, already seeing a dramatic shift away from fossil fuels, is well positioned to prosper in an energy transition. In addition to dramatic reductions in both energy intensity and import dependence, some countries stand to benefit as exporters of new energy technologies such as electric vehicles. Potential dependence on imports of new energy inputs (e.g. metals) dampens an otherwise optimistic picture.

Potential winner

Saudi Arabia could be a winner, even in a world moving away from oil. Oil is not disappearing, even if its share of the energy mix is declining. A shrinking market with lower demand and prices favours low-cost and low-carbon-intensity producers. Saudi Arabia, as one of the world's lowest-cost producers, is well positioned to dominate, and even thrive in, in such a market—if it can diversify its economy and government revenues. Today, heavy national dependence on oil revenues leaves the country working with other OPEC members and other producers, including Russia, to cut production and support global prices. While this is not a sustainable strategy in an energy transition, it highlights the work needed to diversify economic activities and government revenues. If successful, Saudi dominance of a declining global oil market will also allow it to benefit disproportionately during those periods when prices spike—as they will, given disinvestment in oil as investors also pursue the energy transition.

Win some, lose some

The United States, despite being the world's largest oil and gas producer as well as a major coal producer, stands to be a big winner if it manages the energy transition well. US companies have proven that, while they are not the lowest-cost suppliers, they can compete successfully in global oil and natural gas markets. Moreover, US domestic infrastructure and proximity to a large domestic market (both homes and industry) ensure that natural gas will be a prime energy source well into mid-century. Home to major research institutions including universities, the US will also benefit from being at the forefront of the innovation driving the energy transition, including transportation electrification and the development of multi-energy-source electric grids. However, the lack (so far) of a clear national policy mandate threatens to hinder the US position. US firms have moved more slowly into the new energy space than their European and Asian competitors. Moreover, concern over the climate risks of loose regulation of methane flaring recently led France to deny a requested permit to import American LNG.

India, if it can follow the Chinese model, stands to nudge itself into the win column, but rising use of fossil fuels and the resulting economic, environmental, and dependence costs will mitigate gains. If India—and other emerging economies—can leapfrog the fossil fuel era and jump directly to new energy forms, they could bypass traditional security concerns related to fossil-fuel dependence. But many analysts agree with the IEA that, even in successful global transition scenarios, the least-cost development options for India and other emerging markets would be to pursue a slower transition and remain dependent on fossil fuels.

Clear loser—unable to dance to a new tune

Many have argued whether **Russia's** President Vladimir Putin is a grand strategist or an opportunistic tactician. How he positions Russia to deal with the energy transition will be a litmus test. At first blush, Russia stands to be perhaps the world's biggest loser. The Russian state currently depends on oil and gas revenue for about 50 percent of its budget, and hydrocarbons make up about 30 percent of Russian GDP. While a relatively low-cost producer, Russia also has an aging and dirty infrastructure which will require enormous capital investment in the coming decades to sustain production. Foreign investment from partners in the West and elsewhere will be hard to come by, particularly for arctic or offshore projects. Russia risks declining production, declining revenues, and decreased leverage vis-à-vis China. It may offer a rich source of the materials (such as rare earths or blue hydrogen) needed in the new energy economy, but that would still leave it as a commodity supplier rather than a value-added innovator.

Existing relationships will face new challenges

Assessments of winners and losers is, of course, an exercise in relative standing. Accordingly, it is also important to consider the implications of the energy transition for key relationships.

OPEC and the IEA: Can organizations dedicated to serving the interests of dominant oil producers and consumers remain relevant as country dominance and energy types evolve? OPEC has already reached out to non-OPEC producers to coordinate oil production, and the IEA is conducting outreach to non-members with large energy needs. What new groupings may emerge as new energy supplies grow rapidly?

The US, China, the EU, and Japan: Will the new energy system drive new coalitions of large energy consumers and/or advocates of a rapid transition—or will competition to exploit new energy technologies be another wedge issue? Will big consumers see the transition as an area of common interests, or as a battleground for competitive advantage in new industries?

The US and Saudi Arabia: A lot of ink has already been spilled analysing the future of US–Saudi relations as the shale revolution has made the US a net oil exporter. But the relationship has been a cornerstone of the post-war geopolitical order, with ramifications far beyond oil markets. What dimensions of that relationship might survive, and how will the energy transition impact them?

Russia, the EU, and China: How will Russia's main bilateral relationships be affected by the energy transition? Europe is currently Russia's main customer, but Russia is pivoting to China and to Asia generally. If European demand shrivels, what does this mean for Russia's commitment to supply gas and oil to China? Will Russia merely exchange dependence on one buyer for dependence on another? Russian commercial leverage looks to decrease dramatically in a world of plentiful and diverse energy supplies.

It is in the winners' interest to help those left behind

The uneven pace of the energy transition could threaten to derail its success if not properly managed. Given the global nature of the challenge, winners have a stake in the overall success of the transition, not just in their part of it. It is not helpful (or appropriate) for richer countries to force the cost of this transition onto poorer countries—they are, after all, appropriately trying to strike a balance between improving quality of life for their citizens and supporting energy/climate sustainability. Indeed, access to affordable and clean energy is merely one of the UN's 17 Sustainable Development Goals. How might transition winners help more vulnerable countries also win in an energy transition?

As one example, an international trade regime should balance climate priorities (e.g. as pursued through carbon pricing border adjustments) with development, equity, and fairness considerations. Another approach might be to consider how existing energy (largely oil) security policies in richer countries (such as IEA's emergency protocols, including strategic stockpiles) can be repurposed to serve countries with ongoing hydrocarbon dependencies such as India.

An approach to the energy transition that acknowledges its inequities, disadvantages, and negative economic impacts will ultimately have a better chance of succeeding.

IS THIS RUSSIA'S KODAK MOMENT?

Indra Overland

In 2003, Kodak was over 100 years old, had one of the world's most recognized brand names, employed 145,000 people, and had a turnover of US$13 billion. The important moments in life—such as weddings and birthday parties—were recorded on Kodak film, hence the advertising slogan 'a Kodak moment'. The company believed that digital photography would remain a niche product and decided to stick to traditional photographic film. Nine years later, Kodak filed for bankruptcy.

Is Russia similarly failing to see the accelerating changes in the global energy system brought on by climate policy and energy technology learning curves? Is it prepared for the impact of these changes on demand for Russian fossil fuel exports?

As the world's largest fossil fuel exporter, Russia will be affected by the energy transition more than any other country. Unlike Saudi Arabia—with which it vies for pre-eminence as the world's largest oil exporter—Russia is also the world's largest gas exporter and third-largest coal exporter. Fossil fuels play a pivotal role in Russia's income, employment, power on the international stage, and identity. Russia also has the world's second-largest nuclear arsenal and the world's largest territory, giving it a major presence in Asia, Europe, and the Middle East alike. There is, therefore, also no other country whose fate in the global energy transition will matter as much to the rest of the world.

Do Russian decision-makers know?

There are several reasons why one might think that Russian actors are not particularly well prepared for the ongoing changes in the global energy sector. Firstly, the Russian petroleum industry is one of the oldest and most entrenched in the world. It dates back to 1745, with the first oil well and refinery in the town of Ukhta producing kerosene for lamps in churches and monasteries (*Poussenkova and Overland, 2018*). Since then, hydrocarbons have played a central role in the country's development. Baku (then part of the Russian empire) produced half of the world's oil in 1900; the west Siberian oil and gas fields buoyed the Soviet economy in the 1970s, and Russian President Vladimir Putin drew on rising oil prices to firm up his power in the 2000s. As a result, hydrocarbons play an important role in Russia's higher education system, government apparatus, physical infrastructure, and corporations. According to theories of path dependency, social and technical co-evolution, and carbon lock-in, a country such as Russia is unlikely to handle changes in the energy sector well.

Secondly, Russian actors have a weak track record of anticipating and preparing for change in the energy sector. The Communist Party was unprepared for the oil price instability in the 1980s, which contributed to the unravelling of the Soviet Union. In the 2000s, Russian actors continued to deny the significance of the shale revolution, as it shook first international natural gas and then oil markets. The deputy head of Gazprom, Alexander Medvedev, referred to shale gas as a bubble, and CEO Alexey Miller argued that shale gas would remain a luxurious side-dish: 'If you like *foie gras*, that doesn't mean you no longer need a regular steak' (*cited in Elder, 2012*).

Thirdly, the Russian government sends out mixed climate policy signals. Compared to China or the USA, the Russian state has been relatively supportive of international climate policy in the past. Unlike those two countries, Russia ratified the Kyoto Protocol, ensuring the necessary number of ratifications for the protocol to come into force. Russia subsequently over-fulfilled its emissions-reduction targets, thus helping compensate for countries that did not fulfil their own targets.

However, Russia has remained a laggard on climate change in many other respects. Moscow was the last major greenhouse gas emitter to ratify the Paris Agreement. Like their American counterparts, many prominent Russians have expressed deeply climate-sceptical views in public. After visiting Franz Josef Land in the Arctic, President Putin declared that climate change was not due to human activity (*Farand, 2017*). Also the country's second-most powerful person, politician and oil executive Igor Sechin, has publicly expressed strong climate-sceptic views, denying that the effect of anthropogenic greenhouse gas emissions could compare to those of volcano eruptions or rotting algae, and stating that climate change is largely due to 30-million-year climatic cycles (*cited in Armitage, 2015*).

Similar to former US President Donald Trump's statement that climate change is a Chinese hoax, some major Russian media have cast climate change as a foreign plot to undermine Russian energy exports or as 'US weapon aimed at Russia' (*Davydova, 2017*). The implications of climate policy for energy markets do not seem to have fully registered either. Russian Minister of Energy Alexander Novak has predicted that electric vehicles will make up only 1 per cent of all cars in the world by 2035, and therefore will not have much impact on oil demand (Novak, 'Intervyu Aleksandra Novaka Radiostantsii Ekho Mosvky' [Interview of Alexander Novak by the radio program Echo of Moscow], *Ekho Moskvy, 2016*).

The official energy strategy of the Russian Federation foresees a significant rise in the country's fossil fuel exports. It expects that only crude oil exports will decline, and that is because the government plans to refine more oil domestically and export higher-value refined products instead. In its most bullish scenario, it expects up to 86 per cent growth in coal exports, 373 per cent growth for petrol, and 603 per cent for liquified natural gas. Even in the government's most modest scenario, substantial growth is expected.

As a result of such signals, some of the literature on the Russian energy sector takes a dim view of the country's ability to adapt to the ongoing changes. Andreas Kraemer writes, 'In the new geopolitics of renewable energy, post-fossil Russia does not have a value proposition . . . . Oil addiction is hard to cure, and Russia is not even trying' (*Kraemer, 2017*).

Consequences of the global energy transition for Russia

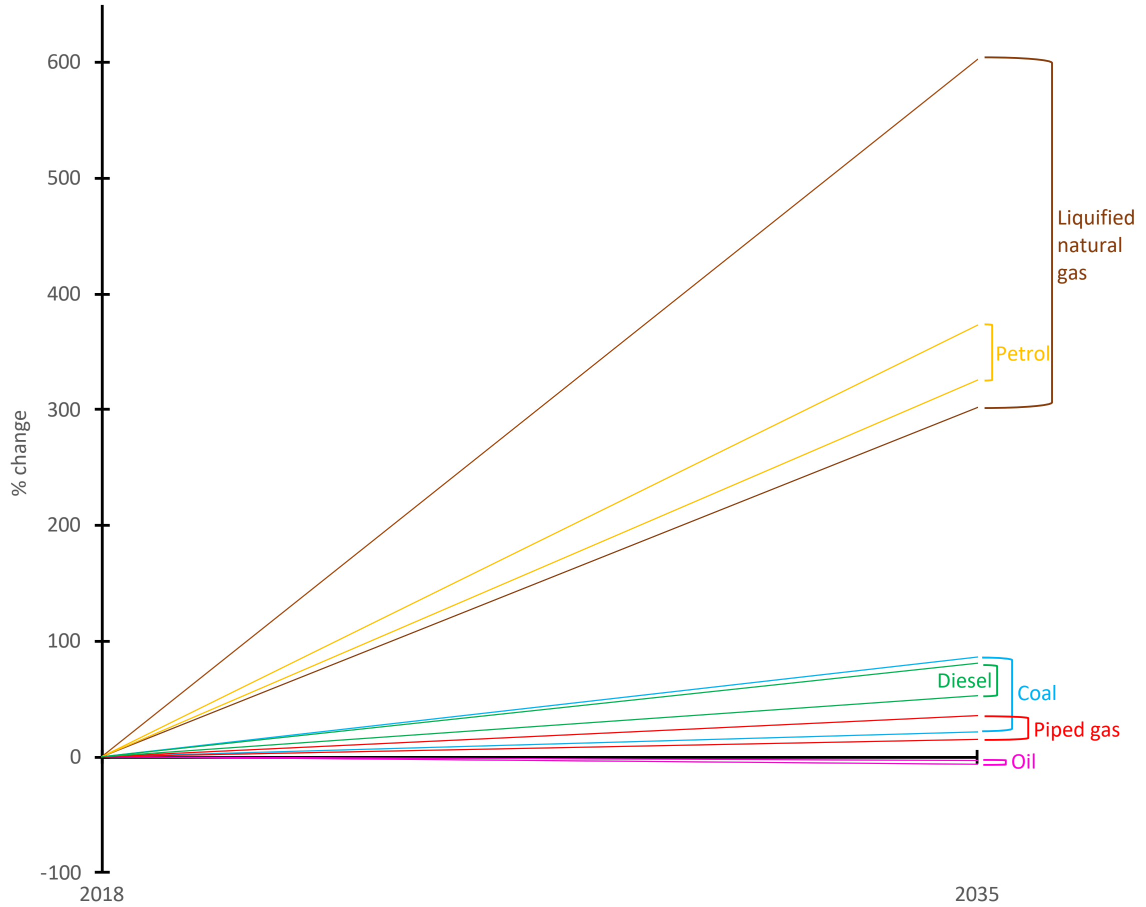
It has been estimated that global climate-related action will lower Russia's economic growth rate by about a third (*Makarov et al, 2020*). Such calculations are inevitably based on assumptions that are moving targets, subject to changes in politics, policy, and technology. Currently, in all three areas, there are signs of acceleration that might cause even greater losses to the Russian economy: the pro-climate political momentum is stronger than ever; serious new climate measures are being planned; solar power, wind power, and batteries are all evolving rapidly and their cost declining precipitously.

One of Russia's main decarbonization bets is on natural gas as a transition fuel and on the EU needing to import more of it to replace its own declining production. A decade and a half ago, this line of thinking was dominant in the EU, too. However, more and more EU countries are placing their bets on renewables, electric vehicles, and green hydrogen rather than natural gas.

The price of emissions allowances in the European Emissions Trading System rose 665 per cent between 2017 and 2021 (Daily EU ETS carbon market price (Euros), *Ember, accessed 10 January 2021*). The EU's proposed Green Deal involves further raising the price of greenhouse gas emissions substantially. To maintain a reasonably level playing field for European industry and avoid carbon leakage from the EU, this will need to be accompanied by some form of carbon border adjustment measure (CBAM). This means that companies exporting to the EU will face similar emissions costs as those based within the EU. Without CBAM, the EU will not be able to raise the price of its own emissions sufficiently to achieve the cuts it needs to contribute to the mitigation of climate change. In other words, either EU climate policy will fail, or Russia will face an effective CBAM.

Russia has proved highly resilient to oil and gas price volatility because of the popularity of its government, strong macroeconomic governance, and the automatic relief provided by the drop in the value of the Russian rouble when the oil price drops. However, dealing with a permanent drop in fossil fuel revenue would be different from dealing with oil price fluctuations. The economy would have to be diversified in earnest, which in turn might require changes in the ways the elites operate and in the upholding of property rights. Military spending and foreign affairs initiatives might have to be curtailed substantially. An alternative would be to cut back on healthcare, education, and other social services, but the patience of even the Russian population has limits. A dwindling Russian economic pie might also lead to more infighting among the country's elites. Cities and regions where the oil and gas industry is concentrated would be hard hit, including Nefteyugansk, Surgut, and Tyumen. Especially in coal mining regions such as Kuzbass and Kansk-Achinsk, much of the labour is low-skilled and immobile, leaving workers particularly vulnerable to a downturn.

Projected fossil fuel exports through 2035 according to the Russian Energy Strategy, low- and high-growth scenarios



Source: Government of the Russian Federation, *Energeticheskaya strategiya Rossiyskoy Federatsii do 2035 goda* [Energy Strategy of the Russian Federation until 2035], adopted 9 June 2020, https://minenergo.gov.ru/node/1026

Is Russia worse positioned than others?

Many countries and actors have also been slow to recognize the prospects for an energy transition, among them international oil companies. ExxonMobil's denial of climate change has received particular attention. However, many international oil companies—including BP, Equinor, Shell, and Total—are now beginning to shift capital expenditure from the petroleum sector to solar and wind power. Their Russian counterparts also have some clean energy projects, but on a much smaller scale.

While the United States has some entrenched oil companies, it is also home to some of the world's leading clean-energy companies, such as First Solar, NextEra Energy, QuantumScape, and Tesla. Similarly, although China continues to build new coal power plants, its portfolio of clean-energy companies—such as Goldwind, JinkoSolar, NIO, and Xpeng—is also impressive. Russia's corporate ecosystem is less diverse, leaving it more weakly positioned to seize the opportunities brought by the energy transition.

What are Russia's options?

If it starts dealing more proactively with the looming threat of decarbonization, what strengths can Russia leverage in a decarbonizing world?

Cheap oil

Russia's large West Siberian oil and gas fields have some of the world's lowest lifting costs. As the prices oil producers are able to obtain decline due to reduced demand and/or rising carbon prices and companies go out of business, Russia should be one of the last producers standing. This means that Russia may have more time to adapt than oil and gas producers with higher costs. However, it postpones the problem rather than solving it and Russia's deep dependency on multiple fossil fuels—coal, natural gas, and oil—means that it is more vulnerable than most countries that only export one type of fossil fuel.

Renewable energy

Russia is richly endowed with renewable energy resources. It has the world's largest solar power resources, second-largest wind power resources, and fourth-largest hydropower resources (*Overland et al., 2019*). Only two G20 countries have greater renewable energy resources per capita than Russia: Australia and Canada. Accordingly, Russia could produce renewable energy for export, in the form of electricity or hydrogen or embedded in energy-intensive goods.

However, Russia is not leading on the relevant technologies and is held back by its passive climate policy and abundance of fossil fuels and nuclear power. Furthermore, Russia's renewable energy resources are a function of its large size and low population density. This is an advantage in terms of not-in-my-backyard responses, which are becoming increasingly salient for renewable energy installations as they occupy land and (in the case of wind power) generate noise. However, this also means that Russia's renewable energy resources are highly dispersed and located far from infrastructure and markets.

Critical energy transition materials

As the country with the world's largest surface area, Russia is inevitably also rich in minerals. While fuel for renewable energy is free, the equipment for generating it requires vast amounts of metals and industrial minerals, and this is one of the main decarbonization bottlenecks. Russia has the world's third-largest reserves of nickel (a key component in electric vehicle batteries), fourth-largest of copper (used for electric turbines, motors, and cables), fourth-largest of rare earths (used for several technologies), and seventh-largest of uranium (used for nuclear power). In terms of minerals and mining, Russia clearly has a contribution to make to the energy transition.

Blue and turquoise hydrogen

One of the most salient energy transition questions concerns the role of hydrogen and how it will be produced. The prospects for large-scale adoption of hydrogen-fuelled passenger cars have waned, but hydrogen remains a likely solution for industrial processes and grid-scale storage to handle the intermittency of solar and wind power. If green hydrogen (from electrolysis powered by renewables) turns out to be the most cost-efficient, it may represent a new export opportunity for Russia and its vast renewable energy resources, but there will also be many strong competitors, for example in North Africa.

However, if blue hydrogen (from steam methane reforming with carbon capture and storage in old oil and gas fields) or turquoise hydrogen (from methane pyrolysis) is the winner, Russia will have a bigger role to play. In fact, no other country in the world has as much vested interest in the success of blue/turquoise hydrogen as Russia. Russia has the world's largest natural gas reserves; the world's second-largest gas pipeline network, connecting it to both China and Western Europe; high-tech LNG export facilities; and conveniently located depleted oil and gas fields that could be used for CO_2 storage. If blue or turquoise hydrogen can become sufficiently cost-efficient to compete with solar and wind power plus storage, and if natural gas pipelines can be repurposed for hydrogen, Russia could go from being a major victim of decarbonization to becoming its saviour. The energy transition is indeed a high-stakes game for Russia.

THE GEOPOLITICAL IMPLICATIONS OF GLOBAL DECARBONIZATION FOR MENA PRODUCING COUNTRIES

Pier Paolo Raimondi and Simone Tagliapietra

Endowed with half of the world's proven oil and gas reserves, the Middle East and North Africa (MENA) region represents a cornerstone of the established global energy architecture. As the clean-energy transition gains momentum worldwide, this architecture might shrink—challenging the socio-economic and geopolitical foundations of the region in general, and of its oil- and gas-producing countries in particular.

This challenge has two dimensions: domestic and international. Domestically, a decline in global oil and gas demand would reduce revenues for producing countries. Considering the profound dependency of these countries on oil and gas rents (the 'rentier state' model), this could have serious economic and social consequences. Internationally, the global clean-energy transition might push producers towards a fierce competition for global market share, exacerbating geopolitical risks both regionally and globally.

In 2020, MENA oil and gas producers experienced a situation that some observers have described as a preview of what the future might look like for them beyond 2030, as global decarbonization unfolds. The COVID-19 pandemic resulted in an unprecedented crash in global oil demand. At the same time, oil prices collapsed (for the first time in history, the benchmark West Texas Intermediate entered negative territory) due to a lethal combination of falling demand and OPEC+ coordination failure. All this generated a perfect storm for MENA oil- and gas-producing countries, which led to unprecedented macroeconomic imbalances.

The evolution of oil markets, national stability, and prosperity as well as international influence are closely linked in the MENA region, but MENA oil- and gas-producing countries are far from homogenous. Different countries are likely to experience different impacts from the global clean-energy transition, depending on a number of domestic and international factors.

International factors

MENA producers are likely to be affected by the differences in the trajectories for oil and gas markets, the speed of the energy transition in different world markets, increased competition between energy producers, and increasing penalties for carbon intensity in production.

While gas is set to play a role in the global energy mix for decades, oil is expected to lose relevance as a result of decarbonization policies and technological developments in electric vehicles. BP's 2020 *Energy Outlook* warned about the imminence of peak oil demand. In its business-as-usual scenario, oil demand is set to recover from the pandemic by 2025 but drop slowly thereafter. In its rapid-energy-transition scenario, oil demand drops from around 100 million barrels per day (mb/d) in 2019 to 89 mb/d in 2030 and just 47 mb/d in 2050. Such a scenario would represent a challenge for MENA oil producers. By contrast, in the business-as-usual scenario, gas demand is expected to increase from 3.8 trillion cubic meters (tcm) in 2018 to 5 tcm in 2040, underpinned by a massive coal-to-gas switch in Asia and elsewhere. Such a scenario would be beneficial for MENA gas-producing countries such as Qatar and Algeria, which could remain geopolitically relevant by providing an important transition fuel to a decarbonizing world.

In the MENA region, Qatar seems to be the best positioned to preserve its geopolitical role, thanks to its significant liquified natural gas (LNG) capacity and its geographical location between Europe and Asia. Nevertheless, gas-producing countries will not be immune to the challenges posed by decarbonization policies in the long run. Gas demand is especially difficult to predict starting in the second half of the 2030s, as a result of increasing cost competition in power generation from renewables, as well as stricter environmental regulations (e.g. the EU Methane Strategy). It will thus be of paramount importance for MENA gas-producing countries to cut emissions in their gas value chain, in order to preserve their position and geopolitical influence.

The speeds of the energy transition in different world regions will also affect MENA geopolitical shifts. For instance, Europe's oil and liquids demand is expected to decrease from the current 13.3 million tons of oil equivalent (Mtoe) to 8.6 Mtoe in 2040, according to the International Energy Agency's stated-policies scenario. By contrast, Asia-Pacific countries' oil and liquids demand is set to increase from the current 32.5 Mtoe to 37.9 Mtoe in 2040. Thus, MENA producers more exposed to the European market are likely to suffer more—and earlier—from the global decarbonization process than others more exposed to Asian markets. That is, energy demand will increasingly dominate energy geopolitics, especially in an oversupplied energy market.

In such a scenario, export portfolio composition and diversification will determine the evolution of geopolitical influence for MENA oil and gas producers. Exporters that depend heavily on European markets will see their geopolitical position erode and their revenues fall. For example, Algeria, which mostly exports gas via pipeline to Europe, has been an essential element of the European gas supply architecture. Unless it manages to decarbonize its gas exports, this important role will shrink as the European Green Deal is implemented. In 2019, 85 per cent of Algeria's total gas exports flowed to Europe, 62 per cent via pipeline (mainly to Italy and Spain). By contrast, LNG provides more flexibility to gas exporters, which will enable them to respond effectively to the geographical shifts of the energy demand. Qatar is the world's top LNG exporter. In 2019, Qatar exported 83 per cent of its total gas exports via LNG. Of this volume, 67 per cent was directed to Asia Pacific countries. Asian markets are expected to drive energy demand growth in general and LNG in particular until 2030. Oil and gas producers will increasingly try to gain market share in such growing energy markets.

While energy demand will be crucial in the future, energy supply issues will not disappear. Competition among producers will persist, and even increase in the foreseeable future. The peak of oil demand will create a harsher world of more intense competition and tighter revenues for MENA oil producers. Regional oil and gas producers are likely to pursue different supply strategies, which will need to deal with the consequence of the global energy transition.

The transition indeed raises an existential dilemma—requiring a choice between maximizing production, which would weaken higher-cost exporters, and coordinating production cuts to increase prices, which could deprive governments of vital revenues. These are not trivial issues, as maximization of production would put into question established assumptions about saving reserves for future production and avoiding stranded assets. An intensification of competition among producers could thus undermine coordinated actions (e.g. OPEC agreements), which are important to oil price stability. This was illustrated by the collapse of OPEC+ talks in March 2020—spurred by disagreements between Saudi Arabia and Russia on the introduction of production quotas, as the two were also competing for market share with US shale oil producers—and the consequent fall in oil prices.

Another example of the growing competition among producers is the growing opposite visions between the United Arab Emirates (UAE) and Saudi Arabia that emerged openly during OPEC talks in late 2020. Although they managed to reach an agreement within OPEC, the UAE's ambitious plans to increase its oil capacity from about 4 mb/d to 5 mb/d by 2030 puts further pressure on the traditional alignment among Gulf OPEC producers. Moreover, in late 2020 the Abu Dhabi National Oil Company announced a $122 billion investment plan for 2021–2025, suggesting that the UAE had abandoned its more cautious approach to the oil sector. The plan suggested that MENA national oil companies might gain a growing share of world oil and gas production in the future. That is also due to (Western) oil companies' decisions to cut their capital expenditure and other investments. Such decisions are motivated mostly by low oil prices and their commitment to decarbonization.

In a more competitive world, some MENA producing countries such as Saudi Arabia and the UAE have the economic advantage of vast oil reserves (298 and 97 billion barrels, respectively), the lowest production costs (under $4 per barrel), and the least carbon-intense production. In the next years, due to expected higher carbon prices, carbon intensity will play a key role in determining which oil and gas producers will be able to preserve their geopolitical influence. MENA oil producers with higher production carbon intensity, such as Algeria and Iraq, might thus lag behind.

Domestic factors

The global energy transition can also impact MENA oil- and gas-producing countries' governance, due to their heavy dependence on revenues from these resources. To address this issue, regional oil and gas producers have launched several strategies (referred to as Visions) aimed at economic diversification (e.g. by increasing productivity, strengthening the private sector, and developing non-oil sectors), as well as increasing the share of renewables in the energy mix. These Visions were largely developed as a response to the 2014 oil price drop; COVID-19 and the acceleration of the global energy transition make it necessary to accelerate them. A country's chances of success at this are likely to be affected by domestic factors including population size, government capacity, and financial ability to implement diversification measures.

Countries with a large, young, and growing population (Algeria, Saudi Arabia, and Iraq) will encounter significant obstacles to the transformation of their rentier-state model. By contrast, countries with a smaller population, like the UAE and Qatar (9.7 and 2.8 million inhabitants, respectively) are likely to find it easier to adjust.

The ability to govern and finance major domestic socio-economic transformation will also be crucial. For example, North African countries could exploit their geographical vicinity to Europe and become major clean-electricity suppliers. In this sense, the recent EU Hydrogen Strategy considers imports of 40 GW of green hydrogen from the EU's eastern and southern neighbours. However, countries like Algeria and Libya are experiencing major social and political instability, which undermines such scenarios and discourages the needed foreign investments. Thus, countries with major governance issues like Algeria, Libya, and Iraq are expected to lag behind on energy and economic diversification. The risk is that these countries will focus political energies on an intensifying fight for a share of the diminishing global oil and gas market, rather than on a strategy to reorient their economy. By contrast, countries with stronger governance are better equipped to transform their economies, bear the negative consequences of the transition in the short term, and navigate the geopolitical evolution.

The availability of large foreign exchange reserves will be crucial for the transformation of MENA producing countries. With such reserves, countries could offset the negative economic effects of lower oil demand and revenues in the short term, while investing in renewable energy projects for the medium and long term. Thus, countries like Saudi Arabia, the UAE, and Qatar (with $500, $108 and $38 billion of foreign reserves, respectively) are potentially well equipped to manage the negative effects of lower revenues and foster economic transformation. Additionally, countries with large sovereign wealth funds could use them as an integral part of the diversification effort, for example to finance research and development and renewable-energy projects in MENA countries.

Producers with large foreign exchange reserves, sizable sovereign wealth funds, and small populations to appease are potentially the best placed to navigate the uncharted waters of the global energy transition.

MENA oil and gas producers have also considered developing their high renewable-energy potential, especially solar. This could help them pursue several goals, including economic diversification and reduction of greenhouse gas emissions. It could also free additional oil and gas volumes, currently used to meet fast-growing domestic energy demand, for sale abroad to produce additional revenue—thus avoiding the negative economic effects of growing energy consumption and positioning themselves as major renewable powers in a low-carbon future.

More recently, MENA oil and gas producers have begun to consider the growing interest in hydrogen as a way to preserve their geopolitical influence and remain pivotal actors in the future energy system. Given the region’s abundant renewable energy and carbon capture and storage potential, MENA countries could be at the forefront in both the green and blue hydrogen markets. In the short and medium term, blue hydrogen could benefit from its cost advantages. In the longer term, the MENA countries could exploit their excellent solar conditions and low-cost renewables in order to produce and export green hydrogen. Three MENA oil producers (Saudi Arabia, the UAE, and Oman) have announced major hydrogen plans. For example, in July 2020 an international consortium announced plans for a $5 billion green renewables and hydrogen plant in Saudi Arabia, which aims to begin shipping ammonia to global markets by 2025. In September 2020 Saudi Arabia shipped 40 tons of blue ammonia to Japan in a pilot project undertaken by Saudi Aramco and the petrochemical giant Sabic.

Conclusions

The global energy transition will inevitably affect MENA oil- and gas-producing countries, both macroeconomically and geopolitically. However, not all MENA countries will see their geopolitical influence change in the same way. Some countries are better equipped than others to offset the negative effects domestically and internationally. Internationally, MENA oil and gas producers will start to focus more on energy demand differences among world regions. MENA countries with lowest-cost and least-carbon-intensive production are better positioned to preserve their geopolitical influence. Moreover, export portfolio composition and diversification will crucially define whether a country will lead or lag behind in the energy transition. Oil and gas producers are also endowed with an abundant renewable potential, another possible route to future energy leadership.

Nevertheless, competition among producers will remain or even increase, potentially undermining coordinated efforts to stabilize oil prices. Due to the strong link between hydrocarbons and the nature of the state in the MENA region, the domestic sphere will be a key element in the geopolitical shifts. Population size, strong governance, and the financial ability to adapt to change will help some MENA oil and gas producers to preserve their geopolitical role, while managing domestic socio-economic transformation.

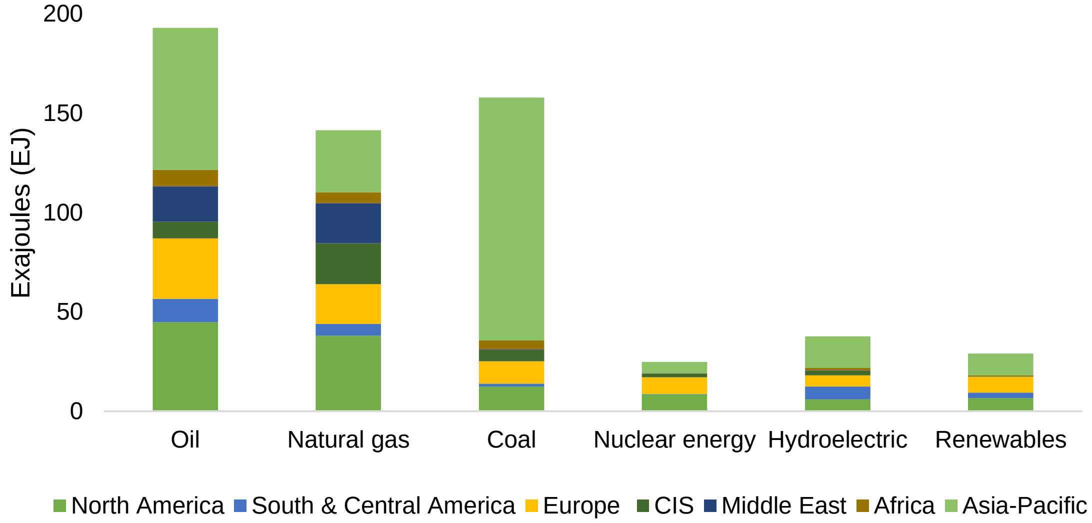
THE MIDDLE EAST AND THE GEOPOLITICS OF THE ENERGY TRANSITION: MYTHS AND REALITIES

Ahmed Mehdi

A look at today’s energy mix provides a sobering reminder that oil, gas, and coal continue to dominate the global energy system. This is important to remember when considering the energy transition – the attempt to achieve a net-zero emissions energy system by 2050 in the effort to keep the increase in the global average temperature well below 2°C. With the energy sector accounting for over two-thirds of total greenhouse gas emissions - ~32 gigatonnes of carbon dioxide equivalent (Gt CO2e) – oil and gas have become primary targets for emissions reduction and policy action.

At the same time, renewables and energy storage (batteries), non-carbon energy carriers (hydrogen), and carbon abatement technologies have become core features of net-zero roadmaps. This makes sense. The cost of renewables has declined over 80 per cent in the past decade, making the levelized cost of producing renewable energy cost-competitive against fossil fuels; likewise, battery cell costs have halved over the past five years from $230/kWh in 2015 to $110/kWh in 2020. The growing electrification of the energy system—where electricity consumption is expected to grow from now until 2040—will undoubtedly drive greater inter-fuel competition, particularly as renewables and gas assume a greater share in the global energy mix.

Primary energy consumption by fuel and region, 2019 (exajoules)



Source: BP Statistical Review 2020

However, the pathways to net-zero will be far from smooth.

While renewables are scaling up and investment flows are growing, there are pockets of demand which renewables won't meet (e.g., aviation and maritime transport). Likewise, full deployment of wind and solar and rapid take-up of electric vehicles will not be enough to keep global warming under 2°C. Carbon-abatement technologies for hard-to-tackle and emission-intense sectors such as steel remain in their infancy.

Indeed, the cost competitiveness of CO_2-abatement technologies is not a done deal. For batteries, while cell chemistries and design have improved significantly over the past decade (helping improve energy density), the 'energy transition' is also a 'commodity transition', increasing demand for metals such as nickel, lithium, cobalt, and manganese. With the majority of a cell cost made up by the cathode, raw material input cost sensitivities remain key issues, particularly given the challenging outlook for raw material balances over the next several years.

Likewise, for other critical technologies such as carbon capture and storage, full-cycle costs remain well above current carbon prices, inducing the need for further policy intervention.

For gas, while its share in the energy mix is set to grow through 2040, decarbonizing the value chain remains key, particularly given the role of methane leakages (more harmful than CO_2) and the need to remain relevant as a transition fuel. With major LNG-importing countries such as Japan setting net-zero targets, major utilities such as Tokyo Gas and JERA will pay a premium for low-carbon LNG—creating new winners and losers in the market.

Finally, while absolute oil demand is expected to decline from 2035–2040, the pattern of oil demand will shift by product and across geographies, creating new trade flows, price dislocations, and geostrategic outcomes. As an example, while gasoline and fuel oil enter structural decline, demand for liquefied petroleum gas, naphtha, and ethane is expected to grow as petrochemical demand grows over the next decade.

In this light, attempts to attach neat path-dependent outcomes for countries based on their economic profiles, energy mix, and the shifts likely to take place over the next 30 years appear simplistic. The energy transition will be neither geopolitically neutral nor predictable in its outcomes.

The Middle East—a net loser?

Oil underpins the economies and political structures of the Middle East. Besides being the world's largest net crude exporter, the region hosts almost half of the world's proven oil reserves and more than a third of its gas reserves. The region also remains one of the most energy-intensive regions globally: strong population growth, subsidies, and power demand for cooling and desalination all remain key drivers.

The region's role as a major oil and gas exporter has also shaped its geopolitical status in the following ways:

- **The US-Gulf security umbrella—**this has been shaped historically not only by the US role as both producer and consumer, but also by Saudi Arabia's strategic role in oil markets as the most powerful member of OPEC and its spare production capacity—both a signalling tool and a mechanism for absorbing geopolitical supply-side shocks.
- **Qatar's dominance in LNG markets—**The expansion of Qatar Petroleum's liquefaction and regasification capacity and portfolio of international oil company partners has allowed Qatar to pursue an expansionist foreign policy and to buffer itself against major geopolitical shocks (e.g., the Gulf blockade).
- **Russia's strategic ties with the Middle East—**both US strategic disengagement from the wider Middle East and the weaponization of US trade tools (e.g., sanctions against Iran, Venezuela, and Russia) have given countries such as Russia strategic licence to expand their energy diplomacy in the region. Notwithstanding Moscow's deepening involvement (after a decade of mistrust) with OPEC since 2016 (forming OPEC+ under the Declaration of Cooperation), Russia has also built strategic ties with Qatar (where the Qatar Investment Authority became a shareholder in Rosneft in 2016), Iraq (where GazpromNeft, Lukoil, and Rosneft all remain actively involved, as either operators, offtakers or critical infrastructure equity-holders), and the United Arab Emirates (UAE).
- **Increased focus on Asian markets—**with oil demand having peaked in Europe in the mid-2000s and the growth of US tight oil having transformed the country's oil balances, Middle East crude flows have accelerated their shift eastward over the past decade, intensifying competition between exporters, highlighted by physical pricing formula shifts and the overseas refining (and storage) investments made by major Gulf producers such as Saudi Arabia, UAE, and Kuwait.

Against this backdrop, assumptions that Middle East countries will be the 'big losers' of the energy transition (*Yergin, 2020*) appear premised on the following assumptions:

- Oil demand growth will slow and eventually plateau and decline. A lower oil price range for most Middle East economies will take place against the backdrop of fiscally rigid national budgets (increasing current account deficits), high population growth (creating labour market pressures), and limited financial tools to navigate crises.
- The decline of oil's strategic influence will erode not only corporate and national power but also geopolitical prestige, and will upend the organizing logic of previous geopolitical arrangements (e.g., US hard-power support for the Gulf).

While it cannot be denied that tighter margins, a lower oil price outlook, and the prospect of volatile oil cycles risk eroding the region's geopolitical status, the strategic fortunes of the region are likely to be more nuanced. No region is standing still as the forces shaping the energy transition take root.

The Middle East is no exception.

Reality #1: Middle East producers will not necessarily lose strategic influence as oil demand declines

One of the transformational impacts of the COVID-19 crisis has been the decimation of upstream oil and gas capital expenditure (capex). The year 2021 is expected to see approximately $315 billion in upstream spend, almost 30 per cent lower than pre-2019 levels and 60 per cent below 2014's peak of $752 billion.

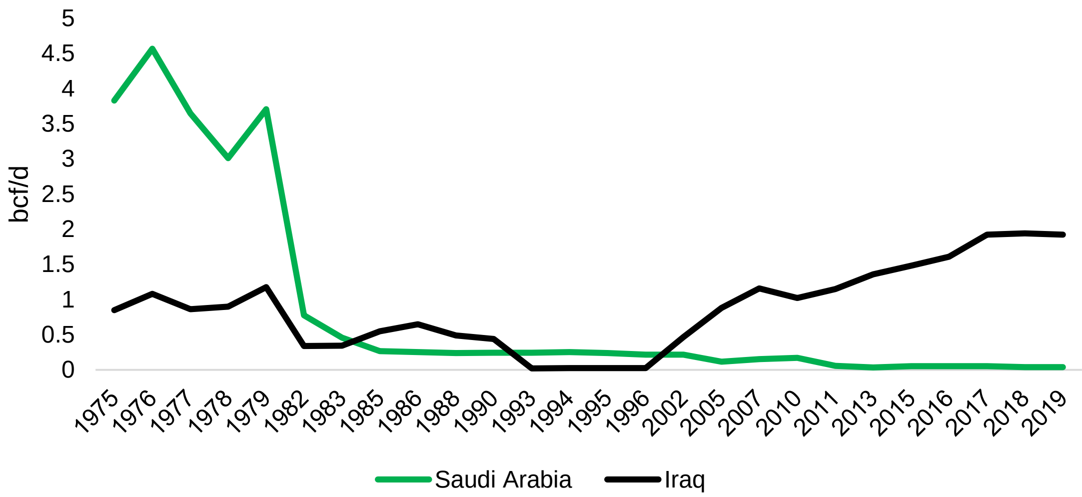
Likewise, 2020 saw European oil majors announce net-zero roadmaps, devising carbon-neutral asset portfolios aligned with the goals of the Paris Climate Agreement. These efforts are not necessarily being driven by peak oil demand anxieties, but rather by investor demands. BP, for example, has announced an ambitious target to cut its oil and gas production by 40 per cent (1.1 million barrels per day) over the next decade and ramp up its renewable portfolio, with the aim of reaching 50 GW of capacity by 2030 (from 2.5 GW today). Likewise, Total outlined a ramp-up in installed renewable capacity from 7 GW today to 35 GW by 2025. Long-term stable returns brought by renewables (and zero short-run marginal costs) are also playing their role in this capital allocation shift.

This pullback in global capex is unlikely to satisfy medium-term oil demand, offering strategic opportunities for low-cost Middle East producers to expand market share. Saudi Aramco has the world's lowest lifting costs and has plans to increase capital spending to offset mature declines and increase offshore field capacity (e.g., at Marjan, Zuluf, and Safaniyah fields).

Likewise, the Abu Dhabi National Oil Company (ADNOC) has plans to allocate $122 billion over the next five years to reach its target of 5 million barrels per day by 2030. In the gas sector, Qatar's North Field Expansion will also raise capacity from 78 million tonnes/year to 126 million tonnes/year over the next decade. These capacity expansions are also taking place at a time when innovative project financing mechanisms are being developed to raise capital both to extract value from productive oil and gas assets and to develop new energy financing tools (helping ease reliance on export earnings). ADNOC's sale last year of its midstream asset gas pipelines was one example (and is expected to be followed by a similar move by Aramco).

However, while the call on both Saudi and OPEC crude is expected to increase over the next decade, not all Middle East producers will necessarily benefit. In a world of carbon border taxes and rising (fixed) carbon prices, the carbon efficiency of Middle East upstream oil and gas will be a key metric of competition. It is widely known, for example, that Saudi Aramco has the second-lowest carbon intensity – greenhouse gas emissions per unit of energy produced - in upstream operations globally (~4.6 g CO_2e/MJ)—a result not only of effective flare management techniques but also of integrating solar in oil and gas processing and the low water cut per barrel produced (reducing energy-intensive practices such as recycling produced water). This is likely to benefit the future competitiveness of Saudi Arabia's largest export stream, Arab Light. In comparison, Iraq's oil and gas production is one of the most emission-intense globally, with an average carbon intensity of ~15 g CO_2e/MJ, largely driven by high gas flaring rates (over 18 billion cubic metres per year) and water cut per barrel produced.

Saudi Arabia and Iraq gas flaring, billion cubic feet per day (bcf/d)



Source: KAPSARC, OIES

Beyond competitive production costs and carbon efficiency, the energy transition will also accelerate competition over Asian market share—the future axis of demand growth. With COVID-19 having already accelerated the rationalization (and closure) of west-of-Suez refining capacity, competition between Middle East exporters will intensify in Asia, a dynamic likely to test the marketing arms of Middle East national oil companies. This year's launch by the UAE of a new futures contract (Murban ICE) and the expansion of Middle East trading desks are examples of innovation in the attempt to capture strategic opportunities in a highly dynamic physical oil market. Examples of the energy transition's creation of opportunities for these trading arms include physical swaps, third-party trades and optimization opportunities (particularly for those with extensive storage and distribution networks across the region).

Reality #2: the geostrategic role of gas in the Middle East will grow

Gas will play a greater role in the Middle East energy sector. Saudi Arabia is pushing forward with unconventional gas development at South Ghawar and Jafurah, helping displace liquids in the power sector; likewise, ADNOC has put forward plans to increase its own gas security (increasing negotiating leverage as pipeline contracts come up for expiry, e.g., Dolphin in 2032).

Iraq, both a major gas flaring country and an importer of gas, has entertained the prospect of importing surplus gas from Kurdistan (Khor Mor) as well as developing non-associated fields in western Iraq and Diyala province. A more competitive oil market under the energy transition and rapidly rising power needs (for cooling as temperatures rise, to serve a growing population, and to meet massive pent-up demand on a per-capita basis) could incentivize Iraq to bury political differences in favour of improved energy resilience.

While these trends point to the growing role of gas as a tool for building resilience in the Middle East as oil margins come under pressure, a more direct example of growing geostrategic power can be found in Qatar.

As previously mentioned, Doha's geostrategic leverage will not only grow as gas increases its share of the energy mix; more importantly, the decarbonization of the gas value chain—supporting gas's role as a transition fuel and building new demand centres in a world aspiring to net-zero emissions—will be crucial.

In this light, Qatar Petroleum's development of carbon capture and storage projects (with plans to sequester more than 5 million tonnes by 2025) and solar power at the new trains at the North Field Expansion will give Qatar further leverage and market power. One example of this was the deal signed late last year between Singapore's Pavilion Energy and Qatar Petroleum's trading unit for 1.8 million tonnes per annum of LNG for 10 years starting in 2023. Singapore's request that cargo deliveries also include wellhead-port greenhouse gas emissions signals a future trend—placing Qatar in a highly competitive position, not only as the lowest-cost producer but also due to its ability to negotiate premium contracts as it seeks to place volume in the market.

Reality #3: the energy transition offers producers opportunities to increase their geopolitical leverage

The Middle East has not been standing still as the energy transition gathers pace.

Notwithstanding ADNOC's transformation since 2017 (concession restructuring, privatization, asset capitalization), the UAE has made strategic bets on hydrogen (blue and green), expanded its footprint in green energy financing deals, and expanded its carbon capture project pipeline (where it currently captures around 800,000 tonnes per year for enhanced oil recovery purposes).

Within Saudi Aramco, the establishment of a division focused on 'technology tipping points' signals the company's alertness to emergent technology trends, key not only to the Kingdom's hydrogen strategy but also to its circular carbon economy approach. Renewables are central to this approach. With plans to have 50 per cent of its energy mix covered by renewables by 2030, this will support Saudi energy flexibility and lay the cornerstone for new industries.

Geopolitically, as clean energy geopolitics gather pace, countries like Saudi Arabia, UAE, and Oman have multiple opportunities to be key players.

US and European anxieties about China's dominance over the battery supply chain could benefit some Middle Eastern countries. For example, cathode precursor chemical production is currently dominated by Chinese refiners (particularly lithium hydroxide). With the EU currently planning to build out significant battery cell capacity out to 2030, geopolitical pressure to reduce reliance on China will grow. As a result, Saudi Arabia and the UAE could become either major battery chemicals hubs (serving European cathode plants) or cathode manufacturers themselves. Not only do countries such as Saudi Arabia and UAE have low reagent (e.g., sulphuric acid) costs but also benefit from well-capitalized financial systems and strategic industrial support – especially given the importance placed by these countries on new sources of taxable revenue and job creation.

THE 'BIG THREE' OIL PRODUCERS AND THEIR STRATEGIES: WILL THE OLD CONUNDRUM RETURN WHEN THE CURRENT CRISIS RECEDES?

Vitaly Yermakov

A live experiment for global oil markets has been occurring for the past seven years, testing the pain thresholds of the oil-producing nations with respect to the economically viable cost of production, fiscal break-evens, and elasticity of supply and demand in a rapidly changing market. In addition to the extreme cyclical movements, caused by supply and demand shocks the energy transition narratives are predicting a fundamental structural change for the oil industry and oil markets as the world turns to non-carbon sources of energy.

A supply-side shock during 2014–2019 was centred on the rapidly rising US tight oil production and OPEC's reaction to this challenge. It was followed by an unprecedented demand-side shock caused by the COVID-19 pandemic in 2020, which forced record production cuts among all oil suppliers and brought to the spotlight the ability of key players to rebalance the global oil market.

The extraordinary challenge of shrinking demand required extraordinary solutions. The consultations between the leaders of the United States, Saudi Arabia, and Russia in the beginning of April 2020 ended the price war. The OPEC+ alliance (which almost fell apart in March owing to tactical disagreements between Saudi Arabia and Russia on how to tackle the emergency) was rekindled, with the participants committing to the largest-ever production cuts in May 2020. The US, not part of the agreement formally due to its antitrust legislation, initially toyed with the idea of using the regulatory powers of the Texas Railroad Commission to restrict oil output but eventually ruled this out. Oil production in the US fell dramatically for economic reasons in 2020 regardless, and this reduction broadly matched the cuts made by Russia and Saudi Arabia.

As restrictions ease and the global economy opens up, oil demand is projected to increase and crude inventories to fall, providing support for the oil price. But this raises an important question: when the global economy goes back to some sort of normality, will this bring back the same conundrum among the Big Three that existed before the crisis, when every time OPEC+ was reducing its output to support oil price it was also giving up its market share to higher cost producers (US shale operators, in particular)? At the crux of the matter is the canonical problem of collective action—market managers versus free riders—exaggerated by the spread of narratives suggesting an imminent and radical transition to a low-carbon economy, fast-forwarding the existential threat of stranded oil and gas assets for the producing nations.

The ‘big three’ global oil producers and exporters—Saudi Arabia, Russia, and the US—have key roles to play in the dynamics of the global oil market. At the same time, each has its own challenges and its own set of strengths and weaknesses.

For Saudi Arabia, the greatest concern is the sustainability of the budget and spending programs. Saudi Aramco has the world’s lowest cost of oil production. Yet the Saudi economy is dependent on oil revenues, and the Saudi budget has had fiscal break-even oil prices exceeding market prices since 2014, which has forced the kingdom to draw down its foreign exchange reserves and resort to debt to finance the budget deficit. The International Monetary Fund estimates that the fiscal break-even oil price for the kingdom was about $80/barrel in 2020, while the Brent oil price averaged about $41/barrel.

In spite of Saudi efforts to adjust the economy and public finances to a prolonged low-oil price scenario, it managed to reduce its fiscal obligations only partially. Very tight budgetary policies threaten the key goals of Saudi Vision 2030, a program of broad social and economic reforms that the kingdom promotes. As a result, the kingdom might want to keep oil supply by OPEC+ in check for longer, trying to push oil prices higher. Saudi Arabia’s decision to cut oil production sharply following the January 2021 OPEC+ meeting is a case in point.

Russia’s main interest in the OPEC+ alliance has been to avoid extreme price volatility, especially on the downside. Rich in oil reserves and heavily dependent on oil revenues, the country experienced a dramatic production decline after the breakup of the Soviet Union. But since the early 2000s, it has managed to grow its oil output steadily, from 7 million barrels per day in 2000 to over 11 million barrels per day by the mid-2010s, on the back of robust oil prices. Russia’s position outside of OPEC was allowing Russian companies to plan their activities without regard to output restrictions applied by OPEC.

The oil price crash in 2015 was a game changer for Russia. The emergence of US shale as a giant new source of supply, which is highly responsive to price signals due to its short production cycle, has become a challenge for the traditional management of the global oil market. The magnitude of the crisis meant that Saudi Arabia could not confront the task of balancing the market alone. The alliance between Saudi Arabia and Russia at the end of 2016 surprised market watchers, but the Kremlin was apparently convinced that a managed and more predictable oil market gives Russia, as a relatively low-cost producer, more benefits than a destructive war for market share.

Russia’s resilience to prolonged low oil prices is quite high as a result of a flexible exchange rate that allows it to balance its state budget by way of macro policies, high levels of foreign currency reserves, and a self-adjusting tax take that protects oil producers in a low-oil-price environment. Russia’s solution to its budgetary dependence on oil revenue has been a large-scale depreciation of the rouble and active import substitution, especially in the food market. Russia’s budget needed $42 oil to break even in 2020, and the country’s Central Bank has managed to increase its foreign currency reserves even under the current extreme situation. Currently, a large share of the Russian oil companies’ output comes from brownfields with low before-tax production costs. Russian oil taxes are revenue-based and are linked to the international oil price, so when prices declined, producers’ fiscal obligations were reduced. The developers of many large oilfields also enjoy special tax exemptions. While trade-offs between reduced tax take and the fiscal needs of the state are inevitable in the longer term, for the next few years both the Russian budget and the Russian oil companies are well positioned in a low-price environment. This suggests that the oil price that Russian policymakers are targeting is lower than the price desired by Saudi Arabia.

At the same time, Russia has not been a natural swing producer due to limited spare production capacity and the specifics of oil recovery (a typical method of production in Western Siberia is by water flooding, which makes interruptions during winter potentially damaging for well equipment). Russian decision-makers have been convinced of the importance of having their say in formulating the OPEC+ pricing policies but have envisaged a limited role for Russia in the alliance: reining in increases in oil output planned by Russian companies by postponing some new projects rather than forcing them to introduce significant cuts to the current production. During the market rebalancing in 2016–2018, this arrangement worked relatively well and helped the price recovery. But the real test of Russia's commitment came in 2020 when, for the first time, it had to introduce major production cuts and face difficult technical and economic trade-offs.

Russian oil companies have been concerned about deactivating their producing wells for too long, for fear of permanently losing significant production volumes. Russia clearly indicated that it wanted to relax its obligation to cut output in 2021. Longer term, for Russia, with an outlook for relatively stable oil production levels, the main challenge is to maintain oil output by managing declines at its legacy fields while transitioning to higher-cost new assets (deeper layers of the existing oilfields and remote new greenfields). To achieve this, Russia needs predictable and stable oil prices in the range of $50–60 per barrel.

For the US, the key challenge appears to be a balance between output growth and profitability. In terms of production volumes and technological advances, US shale has produced a miracle, almost doubling output in the past decade. However, in financial terms, it has been a bust. As a group, shale producers generated negative cash flows in every year of the past 10 years. The US shale business model of delivering volumes while disregarding profitability has frustrated investors. But US oil producers proved much more resilient to low oil prices than initially expected, and their ability to drastically cut costs to outlive the crisis has moved them to the middle of the global cost curve. This was partly due to the spectacular technological advance that allowed detailed knowledge of layers and so-called 'sweet spots'. US producers have been able to employ high grading tactics with fewer drilling rigs to deliver a greater level of output, thanks to a focus on the most prolific sections. Multilaterals have further extended this effect, enabling producers to extract oil with fewer vertical wells but many horizontal extensions from a single well.

Another explanation lies in the symbiosis of tight oil production and the US financial system. US oil producers successfully hedged prices for their output during price spikes and achieved average prices at levels much higher than prompt market prices. The availability of financing at low interest rates for US producers has also played a key role. But what have been tailwinds for the US shale sector might become headwinds as producers run out of lowest-cost opportunities and the 'green agenda' introduces penalties for financing oil and gas projects.

This calls for the difficult task of finding a balanced solution in the immediate term, particularly between Saudi Arabia and Russia within the OPEC+ format. The two producers need to find a way to manage the oil market, especially on the upside. If the market becomes too tight, it might give US shale producers an opportunity to renew price hedges that would prolong the oversupply crisis rather than solve it. The US shale space is made up of dozens of independent oil companies that do not act in concert, but rather as independent actors guided by Adam Smith's 'invisible hand'. The adjustment, therefore, might not happen in time, or might come along as a classical overproduction crisis with excess price volatility and significant collateral damage, such as postponed and cancelled investments in the next generation of long-cycle projects, which would then cause problems and possible price spikes.

One of the lessons from 2020 was that US interests with regards to oil price have become more nuanced. In the past, the US, as a large net importer of oil, would unequivocally support lower oil prices, as these would benefit consumers. But the shale revolution has transformed the US into a net exporter of hydrocarbons and has made its oil and gas industry an important engine of economic growth and a domestic job creator. When the crash of the oil price in 2020 started to threaten the shale industry and the prospects for US 'energy dominance', US policymakers issued a series of contradicting policy responses that suggested a lack of understanding of this new reality. Eventually, the US played the part of a broker in ending a short and destructive price war in April 2020. But where will it go from here?

The new US administration has already indicated its focus on decarbonization, setting the course for less friendly policies towards fracking. The impact of tougher economic terms (higher interest rates for oil and gas projects and greater investor scrutiny) and stricter regulation (with regards to flaring and venting in particular) would set average break-even prices for US producers at higher levels and may help avoid the next unsustainable surge of US oil output. It could also help find a compromise between Russia and Saudi Arabia on a sustainable oil price level. Calibrating the target oil price for the balanced oil market in the near term, therefore, becomes a juggling act. The response from US producers to $50 oil in the beginning of 2021 will be a key signpost to watch. A possible relatively wide range of $50–70 per barrel can satisfy the main oil-producing countries, as it allows them to achieve their goals.

So counterintuitively, if US shale becomes more constrained and less responsive in the future due to its higher break-even cost, this would make it easier for Russia and Saudi Arabia to cooperate. However, decarbonization policies could also impact long-term demand for oil; and therefore, in addition to reaching the immediate goal of market rebalancing, the world's largest oil producers need to ensure long-term marketability of oil against the competitive market pressures of non-carbon sources of energy.

With this in mind, Saudi Arabia has been promoting the 'circular carbon economy' approach and expanding its value chain by investing downstream, particularly in petrochemicals. Russia is off to a slow start in the energy transition, looking instead at incentivizing demand for oil and gas at home. Its immediate efforts have been focused on diversifying its export markets in favour of Asia, where peaks in oil and gas demand are likely to occur later. The US is hoping to use its competitive advantage in green technologies as it manages its energy transition and foreign policy.

The question, then, is whether the increasing divergence in the long-term strategies of the world's largest oil producers in response to the energy transition will create new rounds of increased competition, within the traditional energy markets such as oil and between old and new sources of energy, which will be driven not only by economics but also by regulation, carbon border adjustments, and trade restrictions. It is difficult to make a prediction, as this depends on many factors, including the speed of the energy transition, how disruptive it is, and how successfully each producer adjusts to it. However, this does not necessarily mean that competition will prevail over cooperation in global oil markets. Increased pressures from the energy transition could bring Russia and Saudi Arabia closer together, but the forms of cooperation will have to evolve if this cooperation is to persist.

ENERGY AND SOVEREIGNTY IN THE NEW GEOPOLITICS OF THE EASTERN MEDITERRANEAN

Zenonas Tziarras

A series of crises over the past two years and particularly in 2020 have destabilized the eastern Mediterranean and created a number of security and diplomatic problems. With energy resources becoming so central to discussions on eastern Mediterranean affairs, it is widely perceived that newly discovered hydrocarbons are the main drivers of these incidents. But how much of the problem can really be attributed to hydrocarbons, given other underlying issues and the history of regional tensions?

The eastern Mediterranean conundrum

Starting in the middle of 2019, Turkey initiated a series of drillings within the continental shelf (CS) and exclusive economic zone (EEZ) of Cyprus. This occurred as the culmination of Ankara's efforts to gain a role in the region's energy development and started with hydrocarbon surveys after Cyprus discovered its first natural gas reserve (Aphrodite in Block 12) in 2011. The continuation of the Republic of Cyprus's (RoC's) energy programme and Turkey's parallel operations have given rise to many tensions between Turkey and the RoC as well as between the Greek-Cypriot and Turkish-Cypriot communities on the island; the latter supports and is dependent on Turkey.

Later in the 2010s, Turkey expanded its area of operations further to the west. It issued a series of Navigational Telex warnings both within Cyprus's EEZ and in the maritime space which Greece claims as its own CS/EEZ according to the principles of the International Law of the Sea. Turkey thereby designated maritime areas for offshore surveys or drilling that often fell outside its own maritime zones and in areas where Greece has potential—but not yet delimited—EEZ-related sovereign rights, particularly south of the Kastellorizo Island complex.

The RoC attempted to garner support from regional and international partners, including Greece, Egypt, the United States, and the European Union (EU), even pursuing the imposition of sanctions on Turkey by the EU. Greece followed a similar path somewhat later. The latest Greek–Turkish crisis, which started in the summer of 2020, was more severe, as naval and other forces were mobilized, leading to a standoff, though no military confrontation ensued.

The role of energy

Many analysts have associated these crises, as well as new or strengthened international partnerships in the area, with recent hydrocarbon discoveries in the eastern Mediterranean—with fields off Israel, Cyprus, and Egypt and the potential of more discoveries. The tensions are seen as competition for control of natural resources and a race to establish survey and drilling locations. However, the reality is more complicated.

Offshore natural gas reserves in the eastern Mediterranean

	Field name	Year discovered	Estimated amount (trillion cubic feet)	Production status
Cyprus	Aphrodite	2011	4.5	Pending development
	Calypso	2018	6.0-8.0	Further appraisal needed
	Glaucus	2019	5.0–8.0	Further appraisal needed
Israel	Noa	1999	1.2	Nearly depleted
	Mari-B	2000	1.6	Nearly depleted
	Tamar	2009	8.4	In production
	Leviathan	2010	22.0	In production
	Tanin	2012	0.92	Under development
	Karish	2013	1.4	Under development
Egypt	Zohr	2015	30.0	In production

Sources: "Israel", *Energean,* energean.com/operations/israel/; "Exploration History", *Ministry of Energy, Israel*, https://www.energy-sea.gov.il/English-Site/Pages/Oil%20And%20Gas%20in%20Israel/History-of-Oil--Gas-Exploration-and-Production-in-Israel.aspx; "Zohr", *ENI*, https://www.eni.com/en-IT/operations/egypt-zohr.html; "Operations", *Delek Drilling*, https://www.delekdrilling.com/natural-gas/gas-fields; "ExxonMobil makes natural gas discovery offshore Cyprus", *ExxonMobil*, https://corporate.exxonmobil.com/News/Newsroom/News-releases/2019/0228_ExxonMobil-makes-natural-gas-discovery-offshore-Cyprus; Sonia Korodeisky, "Major Cypriot offshore gas field discovered – report", *Globes*, 4 February 2018, https://en.globes.co.il/en/article-report-major-cypriot-offshore-gas-discovery-1001222229.

Over the past decade, academic and policy discussions about the region have been dominated by the view that the recently discovered hydrocarbons has been a catalyst for change in the geopolitics and international relations of the Eastern Mediterranean. Hopes rose that energy, and natural gas in particular, could help alleviate regional enmities, enhance cooperation, and even function as an incentive for the resolution of the Cyprus problem. One should certainly not disregard the various benefits of hydrocarbon discoveries. However, retrospectively, it appears that much of this analysis downplayed more deeply rooted issues pertaining to the security and diplomatic relations among the littoral states.

Sovereignty and geopolitics at the core of competition

Many of the changes in eastern Mediterranean geopolitical relations since the early 2010s preceded the hydrocarbon discoveries. The Cyprus problem and the Aegean Sea dispute are two of the main factors that have created tensions and complicated relations in the region.

During the 2000s, the RoC developed a keen interest in hydrocarbon exploration. To this end it proceeded to delimit its EEZ boundaries with Egypt (2003), Lebanon (2007) and Israel (2009), and launched its first licensing round in 2007. By declaring and delimiting its EEZ south of the island, the RoC obtained, in accordance with the International Law of the Sea, exclusive sovereign rights over the exploration and exploitation of natural resources.

However, Turkey does not recognize the RoC and has a different view on maritime boundaries; it has not signed the International Law of the Sea Convention (*United Nations Convention on the Law of the Sea*, 1982) and does not consider it binding. It was no surprise then, that the RoC's EEZ agreements were rejected both by Turkey and by the breakaway 'Turkish Republic of Northern Cyprus' (recognized only by Turkey).

Although Article 121 of the 1982 International Law of the Sea makes clear that islands can have a CS and EEZ, Turkey disagrees. This is also the main issue in the Greek–Turkish Aegean dispute, where Turkey does not accept that Greece's islands can have a CS/EEZ. Turkey's argument is that, if the Greek islands obtain these maritime zones, its own sovereign rights in the Aegean will be greatly and unfairly restricted. Therefore, Turkey suggests that in terms of CS/EEZ, the Aegean should be split in half – a proposal that Athens rejects categorically. Based on the same logic, Ankara claims that, in the case of Cyprus, its own maritime zones extend as far as the island's south waters and abut on Egypt's EEZ (*Gürel et al, 2013*).

Maritime zone delimitation agreements in the eastern Mediterranean

Year	Parties	Type of agreement	Status
2003	Cyprus and Egypt	International delimitation agreement: Exclusive Economic Zone and Continental Shelf	Signed and ratified by both parties.
2007	Cyprus and Lebanon	International delimitation agreement: Exclusive Economic Zone and Continental Shelf	Ratified by the RoC; pending ratification by Lebanon.
2009	Cyprus and Israel	International delimitation agreement: Exclusive Economic Zone and Continental Shelf	Signed and ratified by both parties.
2019	Turkey and Libya (Government of National Accord)	Memorandum of Understanding: Exclusive economic zone and Continental Shelf	Signed by both parties. Ratified by the Turkish parliament. In the (UN-recognized) Government of National Accord, ratified by the prime ministry but the parliament remains divided due to the civil war. Rejected by the Tobruk government in eastern Libya.
2020	Greece and Italy	International delimitation agreement: Exclusive Economic Zone and Continental Shelf	Ratified by Greece; pending ratification by Italy.
2020	Greece and Egypt	International delimitation agreement: Exclusive Economic Zone and Continental Shelf	Signed and ratified by both parties.

Sources: "Cyprus-Legislation and Treaties", *United Nations*, https://www.un.org/Depts/los/LEGISLATIONANDTREATIES/STATEFILES/CYP.htm; "Greece-Legislation and Treaties", *United Nations*, https://www.un.org/Depts/los/LEGISLATIONANDTREATIES/STATEFILES/GRC.htm; "Ratification of the Agreement between the Hellenic Republic and the Italian Republic on the delimitation of their respective maritime zones" [In Greek], *Hellenic Parliament*, 28 August 2020, https://www.hellenicparliament.gr/Nomothetiko-Ergo/Anazitisi-Nomothetikou-Ergou?law_id=6bddb604-48c0-4571-ab1a-ac1d00e29b01

The dispute between Greece and Turkey has existed since the early 1970s, well before natural gas became a major issue in the area. The dispute included a disagreement over the continental shelf, the Cyprus conflict and a competition over access to and control of the sea. The 1974 Turkish invasion of Cyprus, which came after the Greek junta and Greek-Cypriot nationalists overthrew the RoC government, was followed by Turkish occupation of the island's north. With the island de facto divided, the new contentious status quo had not only politics but also sovereignty at its core. The RoC had effectively lost control over 37 per cent of its territory, which was now controlled by Turkey and Turkish Cypriots.

The underlying causes of these long-standing conflicts were clearly geopolitical and sovereignty issues. From this perspective, the natural gas discovered in the area, particularly since 2010, cannot be dissociated from matters of sovereignty and more specifically maritime sovereign rights. In fact, the crises in question can only be seen as extensions of sovereignty disputes. The discovery of hydrocarbons has exacerbated the existing disputes, but in no way is it their primary cause. In this context, Turkey's recent activity aims to legitimize and support Ankara's CS/EEZ claims in the eastern Mediterranean rather than create the conditions for hydrocarbon exploration. This is true both for Turkey's explorations in areas claimed by Greece and for the arbitrary Memorandum of Understanding on maritime zones between Turkey and Libya's Government of National Accord.

Similarly, the growing networks of cooperation in the eastern Mediterranean between Cyprus, Greece, Egypt, and Israel have been strengthened by the prospect of regional energy cooperation and security but were not only, or even primarily, prompted by it (*see Tziarras [ed.], 2019*).

The changes in Turkish foreign policy over the 2000s gradually led to the deterioration of Ankara's relations first with Israel (between 2008 and 2011) and later (in 2013) with Egypt after General Abdel Fattah el-Sisi overthrew the pro-Turkey Muslim Brotherhood government in that country. These tensions enabled Cyprus and Greece, which already had their own problems with Turkey, to develop closer relations with Israel and Egypt.

Energy cooperation became a frequent agenda item in meetings since the mid-2010s of the Cyprus-Greece-Israel and Cyprus-Greece-Egypt partnerships (*see Sotiriou, 2020*). With the participation of other states (Italy, Jordan, and the Palestinian

Authority), the Eastern Mediterranean Gas Forum was established, based in Cairo (*Reuters, 22 September 2020*). However, even though the discussions have strengthened cooperation between these countries, little has so far been done collectively in the domain of energy.

For example, after almost 10 years of discussions and planning, the EastMed pipeline project—which involves Israel, Cyprus, Greece, and Italy—is still at the stage of a political agreement and feasibility studies; investors are still being sought, and Italy has not yet signed the deal. Likewise, plans for an agreed Cyprus–Egypt pipeline have not yet materialized. To be sure, Israel exports natural gas through an Egyptian liquified natural gas (LNG) plant, while Egypt imports natural gas from Israel's Leviathan field and exports LNG to Cyprus. But in general, no major step has been made to advance a cohesive regional energy architecture.

With great expectations surrounding it, the EastMed pipeline is an indicative example of the energy–politics nexus in the eastern Mediterranean. Israel, Cyprus, and Greece signed a political deal by which they agreed to move forward with the pipeline. But on a technical and commercial level, many questions still challenge its feasibility and viability. The oversupply of and decline in demand for natural gas—particularly amidst the pandemic—has reduced prices and made investment in the project even more difficult. The gas price at the destination of the EastMed in Europe is projected not to be competitive against, for example, Russian gas (*Ellinas, 2020*). Another challenge is that the great length (more than 2,000 km) of the pipeline and great depths (more than 2,000 metres) at some locations in the eastern Mediterranean render the EastMed an even more high-risk project, though not impossible in principle.

What is more, the European Commission's vision for a climate-neutral EU by 2050 started the Union on a race for decarbonization, a development that is bad news for fossil fuel projects. It is expected that the European Investment Bank will stop funding fossil fuel projects by the end of 2021 or at least within the next few years (*BBC, 14 November 2019*). As the EastMed final feasibility studies are still ongoing, it is likely that these shifts in EU policy on natural gas will negatively affect the pipeline's prospects as well.

However, this has not discouraged the governments of the involved countries from feeding expectations. The EastMed is useful as a political and diplomatic instrument. It advances their relations, provides a sense of common purpose, attracts international interest, sounds good to domestic audiences, and challenges—at least rhetorically and politically—Turkey's plans in the area. In this case, too, it is obvious that energy is not a primary driver but a means through which multilevel cooperation is enhanced and other concerns are dealt with—even when real prospects for multilateral energy cooperation are thin. From this perspective, good relations among these countries seem to depend more on common regional challenges, and most importantly common perceptions of and problems with Turkish foreign policy. As such, although Turkey's reconciliation with one or more of these countries would not necessarily overturn their relations, it would likely change the character and degree of their cooperation.

Conclusions

As events progress in the eastern Mediterranean, natural resources are becoming another item on the long list of unresolved issues among littoral states, particularly between the two poles of the current regional competition: Turkey on the one hand, and Cyprus, Greece, Egypt, and Israel on the other. Connected with geopolitical rivalries and sovereignty and security issues, energy is complicating developments but not by itself driving them.

It is no secret that natural resources can exacerbate political and geopolitical conflicts that must be addressed before effective energy cooperation can take place. Considering the deep-rooted and long-standing issues in the eastern Mediterranean, economic prosperity, international cooperation, energy security, and stability will have a chance if these states manage to resolve their fundamental and sometimes decades-old differences. Only in this way can the discovery of hydrocarbons have a positive impact on eastern Mediterranean dynamics. Otherwise, energy will remain a point of contention and competition, exacerbating existing disputes. Finally, energy-related developments such as the European Commission's vision for a climate-neutral EU by 2050, though important for the future of natural gas projects in the region, will not be catalytic in de-escalating the region's geopolitical tensions as they are fundamentally fuelled by other factors. However, the EU will remain engaged in the area, for example through the Turkey-Greece exploratory talks and the efforts for the settlement of the Cyprus Problem to the end of supporting de-escalation and stability.

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