Received: 22 July 2019 | Revised: 2 October 2019 | Accepted: 4 October 2019

DOI: 10.1002/wcc.625

Check for updates

WIREs CLIMATE CHANGE WILEY

OPINION

Four scenarios of the energy transition: Drivers, consequences, and implications for geopolitics

Morgan Bazilian[1] | **Michael Bradshaw**[2] | **Johannes Gabriel**[3] | **Andreas Goldthau**[4] | **Kirsten Westphal**[5]

[1]Colorado School of Mines, Payne Institute, Golden, Colorado

[2]Warwick Business School, University of Warwick, Coventry, UK

[3]Foresight Intelligence, Berlin, Germany

[4]Willy Brandt School of Public Policy at the University of Erfurt, Institute for Advanced Sustainability Studies, Potsdam, Germany

[5]Global Issues Division and Head of Geopolitics of Energy Transformation (GET 2030) Project, Institute for International and Security Affairs, Stiftung Wissenschaft und Politik (SWP), Berlin, Germany

Correspondence
Andreas Goldthau, Willy Brandt School of Public Policy at the University of Erfurt, Institute for Advanced Sustainability Studies, Berliner Str. 130, 14467 Potsdam, Germany.
Email: andreas.goldthau@uni-erfurt.de

Funding information
German Federal Foreign Office, Geopolitics of EnergyTransformation (GET 2030) Project conducted at the Institute for International and Security Affairs, Stiftung Wissenschaft und Politik (SWP), Berlin

Edited by Mike Hulme, Editor-in-Chief

Abstract

This opinion article offers insights into the geopolitics of the ongoing global energy transition. In doing so, it draws heavily on a workshop in Berlin in late 2018, and a subsequent paper in the journal *Nature*. Four scenarios are presented. First, the "Big Green Deal" offers a positive story of the future, under the assumption that there will be a multilateral approach to tackling climate change. Second, "Dirty Nationalism" explores the fallout of nations choosing to turn inward and pursue a short-term, protectionist, and self-interested agenda. Third, "Technology Breakthrough" illustrates how a technological leap forward could lead to a great power rivalry and distinct regional energy blocs. Finally, "Muddling On" investigates the outcome of an energy transition that reflect business as usual. By comparing and contrasting the different scenarios, the article highlights the potential winners and losers of the different scenarios, and the geopolitical consequences. It also sketches the implications for policy, theory, and scenario thinking more broadly.

This article is categorized under:

Integrated Assessment of Climate Change > Integrated Scenario Development

The Carbon Economy and Climate Mitigation > Future of Global Energy

KEYWORDS

energy transition, geopolitics, scenarios

1 | INTRODUCTION

Climate policies are gaining traction among voters, investors, and businesses (Jackson & Boyon, 2019). Grassroots movements, such as Fridays for Future and Extinction Rebellion, have gone global within a few months. Witness the global climate strike on September 20, 2019. Sovereign wealth funds, institutional endowments, pension and investment funds, and insurance companies have started to move out of coal assets (Ralph, 2019), and some are leaving oil and gas too. In the 2019 EU parliamentary elections climate change became a make or break topic for winning majorities at the ballot box. The 2019 UN Climate Summit drew global attention from civil society. Indeed, the recent IPCC report on "Global Warming of 1.5°C" drives home the point that the world needs to move urgently to a low-carbon economy (IPCC, 2018).

 © 2019 Wiley Periodicals, Inc.

Going low carbon, however, comes with challenges. A recent report by the International Renewable Energy Agency [IRENA] (2019) suggests that an energy transformation driven by renewables could have severe geopolitical implications. The authors fear new tensions, for instance between China and the United States, as both seek global dominance in the strategically important clean tech sector and control of the raw materials required for their production (see also (O'Sullivan, Overland, & Sandalow, 2017). Beijing's recent threats to curb the export of rare earths are a testimony to that (Hornby & Sanderson, 2019). New global alliances have been formed around specific renewable technologies that challenge the incumbent institutional architecture governing global energy, including the Organization of Petroleum Exporting Countries, which may to radically change its composition and purpose or become irrelevant.

Thanks to renewable energy supply generated at home, fossil fuel importers may gain the upper hand over their suppliers (Scholten & Bosman, 2016). It has therefore been suggested that traditional oil exporters, for instance in the Middle East, are likely among the potential losers of this transition (van de Graaf & Bradshaw, 2018). To be sure, not all oil producers will be equally affected (Goldthau, Westphal, Bazilian, & Bradshaw, 2019). But according to calculations by the IEA, oil prices could settle in a $60–70 a barrel range if the world embarks on a low carbon pathway, leading to trillions of dollars of lost revenue for oil and gas producer economies over the next two decades (IEA, 2018).

This opinion article adds to the emerging discussion on the geopolitics of the energy transition by challenging the linearity that (implicitly or explicitly) underpins existing contributions. Instead of focusing on an "end stage" in line with the UNFCCC 2050-time line, we consciously picked the energy systems and the geopolitics of today as our starting point and developed "theories of the future" to 2030. This reflects the fact that the energy system is a long-term sector—with investments having to pay-off over decades—and that decisions made in the 2020s need to set this system on the right path to peak global emissions by the end of the decade and then enable rapid reductions to achieve 2050 targets. Furthermore, we wanted to explore alternative energy transition pathways, their potential ramifications and path dependencies, as well as the opportunities that may emerge in the long run. This has important policy implications, but it also challenges theory and prevalent approaches to scenario thinking in the energy and climate space.

2 | WHY SCENARIOS

Scenarios are tools for thinking about plausible and internally consistent alternative pathways (Snoek, 2003). Scenario planning is now widely recognized as a method for dealing with high levels of uncertainly when determining future business strategies and government policies. In the energy sector the thinking of Pierre Wack (1985) and subsequent development of the "Shell Scenarios" (Bentham, 2014) are seen as the trailblazers in the field. In recent years more companies, DNVL, BP, and Equninor for example, have begun to engage in scenario planning to help them chart the potential impact of climate change policies on fossil fuel demand. In parallel, scenarios now play a critical role in the annual publication of the International Energy Agency, the *World Energy Outlook*. Finally, scenarios are central to research on climate change, for example, the IPCC's recent I.5 Degrees report (IPCC, 2018) generated a number of scenarios charting various emissions pathways.

Scenarios deal with questions of structural, instead of incremental, change, though they often include a business as usual (BAU) pathway. Furthermore, scenarios are tools for thinking about plausible and consistent alternative pathways. We understand scenarios as comprehensive pictures and narratives of the future (Gabriel, 2014). Moreover, scenarios are a description of possible futures that depict a point in time, as well as an exemplary chain of events leading to this situation (Bishop, Hines, & Collins, 2007). Hence, scenarios create a space for thinking about what is possible. Comparing the similarities and differences between the scenarios allows a better understanding of the key sensitivities and drivers underlying the subject at hand, as well as the key factors that might dictate the pace of change.

Below, we present four scenarios for the global energy transformation[1] in 2030 (GET2030), each of which results in a different end stage and entails its own logics.[2]

3 | FOUR PLAUSIBLE ENERGY PATHWAYS

Each of the four scenarios rests on a distinct key driver of change, with consequences for the pace of change, the international political architecture underpinning the trajectory, the shape of the resulting energy landscape and the consequences for the climate change mitigation (the implications for the UN's sustainable development goals (SDGs) were also considered as part of the wider policy landscape).

3.1 | Concerted policy drive: "Big Green Deal"

An energy transition driven by a global consensus on the urgent need for action sets in motion a cooperative dynamic. It also implies a rapid and deep decarbonization and a steady "ratcheting up" of ambition within the Paris Agreement. Thanks to clear, determined and concerted policy signals, financial markets heed the call, and divestment from fossil assets quickly gains momentum. As a corollary, companies specializing in low carbon technologies are strongly capitalized, and within a relatively short period of time, green technology corporations supplant big oil on stock markets, though some international oil companies succeed in reinventing themselves. A comprehensive green finance package gives petro-states in the Middle East a soft landing, enabling them to eventually manage the loss of fossil-fuel rents and leave the carbon-intensive economic model of old.

This "Big Green Deal" scenario represents the ideal case, comprehensively putting the world economy on the path from a high to a low carbon paradigm while bringing about significant growth and welfare effects in line with the SDGs. This is the only scenario that achieves the SDGs. Underpinned by a multilateral approach, the potential for energy related international and regional conflicts decreases significantly. While it is underpinned by a multilateral approach, the potential for conflict remains, but energy security concerns are no longer paramount reducing the potential for international and regional conflict.

3.2 | Zero-sum anarchy: "Dirty Nationalism"

The opposite dynamic emerges in this case where the primary driver is nationalism. Inward-looking policies favor self-interest and autarchy over interdependence and cooperation. This in part helps the development of renewables as they are seen as domestic energy sources replacing imported ones, thus reducing vulnerability (defined as import dependence). But it primarily helps fossil fuels if available, notably coal, as well as unconventional fossil fuels such as tight oil and gas. Importantly, as national governments seek their own solutions to what is a global problem, global markets fragment, thus prohibiting the scale economies that are needed to drive down costs and help deploy novel low-carbon technologies at scale. The divestment campaign loses momentum in the face of renewed state subsidy of domestic fossil fuels, which also undermines the prospects for investments in green technologies. National energy security trumps concerns about climate change. Moreover, as states favor conflict over cooperation, multilateral institutions such as the World Trade Organization and the UNFCCC become side-lined or abandoned. This results in a failure of the Paris Agreement, and the NDC mechanism committing countries to reduce CO_2 emissions. It also undermines support for the SDG.

In this scenario, change is slow, if not stalling, a focus on national self-interest is the dominant model (in keeping with realist theories of international relations), with an emphasis on power politics centered on the nation-state making the political architecture fragmented, while climate change remains unabated and an increasing "threat escalator" that brings about climate-induced conflict. Fossil fuel producers, albeit under pressure, continue with their existing business model.

3.3 | Hegemony and disruption: "Technology Breakthrough"

Let us assume, by way of contrast, a technology breakthrough in, say, electricity storage and high-voltage direct current lines, plus continued cost reductions for solar and wind generation technologies. Their sizeable markets, coupled with a technology-friendly regulatory environment puts China and the United States in the lead in scaling up the production, deployment and trade of critical technologies. The resulting competition is not only about technology leadership, with tech giants such as State Grid of China and Google vying for market share. It also extends to geopolitical rivalry, which is reinforced and cements regional blocs—now defined in large part by their respective integrated energy systems (transnational electricity grids). These blocs end up in conflict over critical materials needed for low carbon tech. While such a "Tech Breakthrough" scenario helps to mitigate climate change; some regions lose out. As market scale and might matter most in technology leadership, Europe, for instance, ends up being marginalized. Russia, having failed to diversify its economy, faces falling government revenues from oil and gas, the decline of its national champions, Gazprom and Rosneft and growing social unrest.

There is, of course, a potential alternative pathway whereby technological advances in carbon capture and storage (CCS) and negative emissions enable a significant amount of fossil fuel production to remain in the mix, however, the falling cost of low carbon technologies and their relative abundance and absence of other environmental externalities means that they still win out. Equally, biomass energy and CCS are preferred to using that technology to retain fossil fuels, though the scale of deployment is limited by concerns over biodiversity and food security.

In this scenario, change is fast (though not as fast the "Big Green Deal") but uneven, the political architecture is regional hegemony. This scenario demonstrates a pathway that is politically and socially problematic, but one that does resolve the climate change challenge.

3.4 | BAU: "Muddling On"

Finally, the "Muddling On" path reflects a BAU scenario, which is a traditional requirement of scenario planning, whereby prolonged linear cost reduction for renewables is the major driver of climate change mitigation. Consequently, renewables claim an increasing share of the energy mix. However, the speed of the energy transition is too slow to mitigate global climate change, but still too fast for most of the incumbent fossil fuel industry to adapt successfully. This results not only in a series of bankruptcies of National Oil Companies, but also in many of their private international counterparts facing significant financial stress. In addition, fossil-fuel exports to the EU soon become a risky business model, putting severe financial pressure on oil producer economies in the Middle East, Russia and Africa, some of which may experience domestic political turmoil as a result. Moreover, China's motivation for transforming their energy system lies in improving air and water quality and in building sizeable state champions fit for the global market. Europe, by contrast, is more concerned with climate change, pushing bilateral low carbon energy partnerships. The United States remains on standby, focused on domestic matters. This implies diverse growth models for energy technologies, an increasingly heterogeneous world of "clubs" led by the EU and China, and limited global cooperation. As some regions remain characterized by inadequate regulation or fail to benefit from select partnerships, this scenario also reinforces existing economic and geopolitical imbalances, and increasing energy inequality. This serves to undermine progress on the SDG.

In this scenario, change is slow, the political architecture is clubs, and climate mitigation is too slow to meet climate targets. This highlights that even "Muddling On" is not really BAU as the growing environmental consequences of climate change challenge the status quo.

Table 1 summarizes the main findings of the four scenarios on the basis of the key dimensions.

4 | IMPLICATIONS FOR POLICY, ANALYSIS AND METHODOLOGY

A key takeaway from the scenarios is that the low carbon shift will change energy geopolitics. Yet, at the same time, (geo)politics may well drive the pace of energy transition and its specific trajectory. The share of renewables at 2030 varies significantly, depending on the pathway and driver underpinning a given scenario. So, do the carbon consequences, which range from a new green growth model to unmitigated climate change acting as a stress amplifier. This has important implications for policy, analysis and scenario thinking more broadly.

4.1 | Policy: focus on pathways not the endgame

In terms of policy, the scenarios offer several important insights. First, the geopolitics of the low carbon transition essentially changes what states are fighting about. In a high-carbon world, the race for what is left continues to center on fossil fuels. In a

TABLE 1 Drivers, and consequences of four plausible energy transition pathways

Scenario	Key drivers	Pace of change	International political architecture	Carbon consequences and sustainable development goals
Big Green Deal	Concerted, multilateral policy drive	Fast and even	Multilateralism	Green globalization meets SDGs and climate targets
Dirty Nationalism	Nation-first policies	Slow if not stalling	Zero-sum, anarchy	Unmitigated climate change acts as a stress amplifier (SDGs fail)
Tech Breakthrough	Disruptive advancement in energy technology	Fast but uneven	Regional hegemony	Successful climate change mitigation (but not all SDGs)
Muddling On	Falling costs, but slow progress	Slow	Clubs	Mitigation too slow to meet climate targets (SDGs compromised)

low carbon world, with binding emission constraints, it is about the remaining global carbon budget. As a corollary, the game shifts from control over resources to control over clean tech. A low carbon world may therefore be not necessarily less conflictual than one dominated by fossil fuels: a multilaterally driven decarbonization scenario gives hope for a better future; a technology-driven one may well end up in fierce geoeconomic battles between rivaling tech blocs, where electrons increasingly replace molecules in concerns about energy security.

Second, the pathways towards a low carbon future may be messy. Even if they result in a decarbonized world, they are not always overly positive in terms of their side effects. For instance, the continuous but slow and uneven progress characterizing the "Muddling On" scenario still means that petrostates struggle to adapt to falling global oil demand, and become a source of geopolitical instability (van de Graaf & Bradshaw, 2018). Another problem is that the transformation dividends are unequally distributed (Goldthau, Keim, & Westphal, 2018). The breakthrough scenario, for instance, results in only slow technology diffusion beyond the hegemonic power blocs of the United States and China, a function of their geo-technological rivalry.

Third, not all possible paths to a low-carbon endpoint are politically feasible in Western settings. As the Tech Breakthrough scenario suggests, a heavy state-hand, authoritarian rule and regional hegemony is just as likely to generate a breakthrough in low carbon technology as a democratic, liberal, market-oriented approach. This throws up a normative trade-off between the policy goals of an even deployment of renewable energy technology and fast and rigid climate change mitigation. The former may well be achieved in incumbent multilateral settings, the latter potentially in a world where few powerful countries control renewable energy technologies. The IRENA report is a political document that focuses on the potential benefits of a future dominated by renewable energy, and it remains silent on the potential geopolical tensions of different pathways to a low(er) carbon future.

Finally, renewables dominating the global energy system is only one possible endpoint of the transition. In fact, the scenario process came out with only one scenario resulting in a win-win for geopolitics and the climate—which, coincidently, comes closest to the transformation IRENA depicts in their report. Yet there exist alternative trajectories leading to possibly less desirable states of transformation. For instance, a nation-first scenario keeps fossils firmly in the mix, as does a BAU scenario. Both are no less likely than a "Big Green Deal." This suggests that policy should likewise focus on the decarbonization path and on the desired end result.

4.2 | Analysis: it depends which world you live in

The conceptual implications of the scenarios are striking when viewed against the incumbent climate change regime. Though the "Big Green Deal" and the "Dirty Nationalism" scenarios are both driven by politics, their implications are fundamentally different. The former scenario lives in a Kantian world underpinned by a liberal paradigm in International Political Economy (IPE), where the mode of politics is cooperative and rational actors aim for win-win situations. The result is a joint push for a Pareto-optimal outcome—green globalization. The latter scenario, by contrast, is deeply rooted in the realist school of thought, that is the Hobbesian idea of an anarchic international system in which states play zero-sum games. International cooperation is not ruled out per se, but the ontology underpinning the "Dirty Nationalism" scenarios injects a great potential of hard conflict. Though the "Tech Breakthrough" scenario delivers on climate change, it also falls into the realist school in IPE. Because low carbon technology becomes a source of economic power, strategic trade policies and protectionist measures prevail, to the detriment of global solutions. More geoeconomic than geopolitical in nature, technology becomes a proxy for "war by other means" (Blackwill & Harris, 2016). "Muddling On," finally, subscribes to the notions of interdependence and market drivers, which in conjunction with domestic political imperatives shape the international political architecture. While rooted in liberal IPE in principle, the outcome is clubs forming around socio-technical and socio-regulatory systems. This scenario highlights the limits of market forces and technology progress in bringing about effective global regimes to generate global public goods. Even access and diffusion of renewable technologies require a supportive financial and governance architecture as evinced in the "Big Green Deal" scenario.

The findings therefore highlight the importance of the principle paradigm underpinning the global energy transition. The present UN-centered approach to climate change mitigation, essentially subscribing to a liberal IPE model, will need to be seen in light of the above scenarios.

4.3 | Scenario thinking: look at 2030 not beyond

The scenarios also offer some methodological lessons. In the energy and climate sphere there is a tendency to build scenarios over a long time period, with 2050 as a critical mid-point and 2,100 the end point. This is because the energy system involves

long-term, large-scale, capital intensive projects. For example, a decision to invest $30–40 billion today in a plant to produce liquefied natural gas will operate for 40 years. The policy time frame for climate change mitigation also tends to focus on long-term targets. This provides plenty of time for a wide range of possible outcomes and scenarios to be considered. Many models also assume a carbon-neutral endpoint and develop target-driven scenarios. It also enables political commitments to be made without fear of being held to account if they are not delivered.

Contrasting this, the time frame in the present scenarios was to 2030, which proved to be particularly challenging when it came to considering the rate of technological change that was plausible over a period of little more than a decade. Moreover, it is clear that by 2030 global carbon emissions must peak and the global energy system must be on a path to deep decarbonization and global GHG emissions must be peaking if it is be on the trajectory to constrain global warming to less than two agrees by the end of the Century. Finally, the scenarios presented above questioned the assumption of carbon-neutrality. A key methodological lesson, therefore, is to put more emphasis on developing robust mid- to short-range scenarios, notably in the context of the global energy transition. This is not only because everything that happens in the long run—in the case of the energy transition after 2030—is a source of "radical uncertainty" (Bentham, 2014). It is also because it is imperative to consider a range of possible "future histories" for effective policy planning to anticipate potential unintended consequences, opportunities, and threats.

5 | CONCLUSIONS

The gap between our policy ambitions in relation to emissions reduction and the pathway that we need to be on to achieve this ambition is widening and deepening. It is a relatively easy task to model a world in which the global energy system is transformed and the worst impacts of climate change are avoided. The real challenge lies in the process of the transition. In short, (geo)politics matter. This scenario exercise has highlighted that the road to net-zero is fraught with geopolitical dangers that threaten to de-rail progress and create new sources of conflict and inequity. It is only by asking the difficult questions, identifying the possible threats to a successful energy transition and presenting a set of possible solutions that we can close the gap in our climate ambitions and set us on the road to a just transition. A failure to consider and prepare for the geopolitical challenges and tensions that arise from the process of transformation may make it more difficult to maintain a path towards deep decarbonization.

CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

AUTHOR CONTRIBUTIONS

Morgan Bazilian: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; supervision; validation; visualization; writing-original draft; writing-review and editing. **Michael Bradshaw**: Conceptualization, data curation; formal analysis; investigation; methodology; project administration; resources; supervision; validation; visualization; writing-original draft; writing-review and editing. **Johannes Gabriel**: Conceptualization, data curation; formal analysis; investigation; methodology; project administration; resources; supervision; validation; visualization; writing-original draft; writing-review and editing. **Andreas Goldthau**: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; supervision; validation; visualization; writing-original draft; writing-review and editing. **Kirsten Westphal**: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; supervision; validation; visualization; writing-original draft; writing-review and editing.

ENDNOTES

[1] We use the term of *transition* to describe the narrower focus on the energy system, as opposed to a wider socio-economic and political *transformation* process.

[2] These scenarios rest on a series of structured scenario workshops that brought together an interdisciplinary group of international experts, held at the Institute for International and Security Affairs, Stiftung Wissenschaft and Politik (SWP) in Berlin in the fall of 2018. It was facilitated by Foresight Intelligence, Berlin, Germany. This opinion also draws from an article jointly published by the present authors in *Nature* (Goldthau et al., 2019).

ORCID

Michael Bradshaw https://orcid.org/0000-0001-8842-3953
Andreas Goldthau https://orcid.org/0000-0001-9814-6152

RELATED WIREs ARTICLES

Developing qualitative scenario storylines for environmental change assessment
A critical review of global decarbonization scenarios: What do they tell us about feasibility?
The overlooked role of discourse in breaking carbon lock-in: The case of the German energy transition

FURTHER READING

Goldthau, A., & Westphal, K. (2019). Why the global energy transition does not mean the end of the petrostate. *Global Policy*, *10*, 279–283. https://doi.org/10.1111/1758-5899.12649

REFERENCES

Bentham, J. (2014). The scenario approach to possible futures for oil and natural gas. *Energy Policy*, *64*, 87–92.
Bishop, P., Hines, A., & Collins, T. (2007). The current state of scenario development: An overview of techniques. *Foresight*, *9*(1), 5–25.
Blackwill, R. D., & Harris, J. M. (2016). *War by other means: Geoeconomics and statecraft*. Cambridge, MA: Harvard University Press.
Gabriel, J. (2014). A scientific enquiry into the future. *European Journal of Futures Research*, *15*(31), 1–9.
Goldthau, A., Keim, M., & Westphal, K. (2018). *The geopolitics of energy transformation. Governing the shift: Transformation dividends, systemic risks and new uncertainties*. Berlin: German Institute for International and Security Affairs. SWP Comment Nr. 42.
Goldthau, A., Westphal, K., Bazilian, M., & Bradshaw, M. (2019). How the energy transition will reshape geopolitics. *Nature*, *569*(May), 19–21.
Hornby, L., & Sanderson, H. (2019, June 4). Rare earths: Beijing threatens a new front in the trade war. *Financial Times*.
IEA. 2018. *Outlook for producer economies. What do changing energy dynamics mean for major oil and gas exporters?* Paris.
IPCC (2018). Summary for policymakers. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. C. Roberts, J. Skea, P. R. Shukla, et al. (Eds.), *Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (pp. 3–24). Geneva: International Panel on Climate Change.
International Renewable Energy Agency. (2019). *A new world. The geopolitics of the energy transformation*. Masdar City: IRENA.
Jackson, C., & Boyon, N. (2019). *Climate change increases in importance to citizens around the world*. Washington, DC: IPSOS.
O'Sullivan, M., Overland, I., & Sandalow, D. (2017). *The geopolitics of renewable energy*. Cambridge MA: Belfer Center for Science and International Affairs.
Ralph, O. (2019, July 1). US insurer Chubb pulls Back from coal. *Financial Times*.
Scholten, D., & Bosman, R. (2016). The geopolitics of renewables: Exploring the political implications of renewable energy systems. *Technological Forecasting and Social Change*, *103*, 273–283.
Snoek, M. (2003). The use and methodology of scenario making. *European Journal of Teacher Education*, *26*(1), 9–19.
van de Graaf, T., & Bradshaw, M. (2018). Stranded wealth : Rethinking the politics of oil in an age of abundance. *International Affairs*, *94*(6), 1309–1328.
Wack, P. (1985). Scenarios: Unchartered waters ahead. *Harvard Business Review*, *63*(5), 73–89.

How to cite this article: Bazilian M, Bradshaw M, Gabriel J, Goldthau A, Westphal K. Four scenarios of the energy transition: Drivers, consequences, and implications for geopolitics. *WIREs Clim Change*. 2020;11:e625. https://doi.org/10.1002/wcc.625