# PROGRESS FOR PEOPLE AND THE PLANET

A Report from
2021 Aspen-Columbia Global Energy Forum

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# EXECUTIVE SUMMARY

Tackling climate change and facilitating global development are urgent imperatives that will be incredibly challenging for the world to reconcile. The vast majority of the world's energy is currently based on hydrocarbons, and nowhere in the world has achieved victory over energy poverty without a mix of fuels, including fossil fuels. The energy transition in developing countries is looking likely to be a gradual one, balancing fossil fuels with investments in clean and renewable energy systems. While the continued use of fossil fuels for energy development may be the most realistic path forward, it means climate goals may not be met. The carbon budget is what it is, and climate change impacts are often harshest in developing countries. Climate change and energy for development may or may not be a zero-sum game, but there is no choice but to try to advance climate and development goals together.

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If a low-carbon development model is to take hold, finance has to be available to support it. There is an enormous gulf between the energy infrastructure needs in developing countries and the finance going to serve those needs and address climate change. The bulk of the needed investment will have to come from private capital, but development finance institutions play a critical role in de-risking markets and transactions, fostering project development, helping countries develop the right macro fundamentals, and mobilizing capital to enable growth of clean energy and climate-linked projects. While large parts of the transition will require incentives for private investors to put their capital to work, attention should also be paid to the solid returns that private investors can achieve from energy sector investments in developing countries.

Energy affects all aspects of daily life, but life was disrupted in the fall of 2021 when oil and natural gas prices surged in many parts of the world, especially in Europe and Asia. The crisis was caused by a confluence of factors, including a strong economic rebound, weather, lower availability of and tight markets for other energy sources, and exporting countries' decisions. Russia, for instance, is using the crisis to keep pressure on Europe to certify new gas infrastructure and to sign new long-term contracts. The energy crisis may be a preview of the market volatility that could occur during the energy transition. There are a few elements that make a bumpy transition more likely, including the increasing importance of electricity at the same time both electricity supply and demand will be more variable, the scale of the envisioned energy transformation, the extremely tight timeframe available to potentially meet climate targets, the fact that some parts of the energy sector and some countries will move faster in the transition than others, and increasing pressures to phase out polluting energy sources that currently provide flexibility or supply buffers. Energy price volatility could drain political and social support for the energy transition, and responses to energy crises could lead to fuel substitutions with higher emissions, such as the current shifts from gas to coal in Europe and gas to oil in Asia.

The issue of the role of natural gas in meeting both energy demand and the need for decarbonization elicits strong reactions from all sides. There are many who assert that natural gas is a necessary fuel for the energy transition. Net-zero does not mean a world free of fossil fuels, but net-zero scenarios contain a limited runway for gas. Given the incredibly tight carbon budget, everything needs to be thrown at the climate problem over the next decade, including technologies that decarbonize but are still emitting, but new gas infrastructure will last for decades. The eventual need to reduce emissions basically down to zero (or net-zero) may require different choices and systemic innovations. Developed

regions should be the first to move off fossil fuels, while many developing countries want to use gas to improve local air pollution, build and stabilize electricity grids, promote clean cooking, and reduce reliance on highly polluting energy options. Whether natural gas is even a near-term climate solution depends heavily on addressing its methane emissions. Venting, flaring, and methane leaks are a black eye for the fuel, and stopping them is both tremendously valuable to the climate and affordable to accomplish. The industry should be acting faster than its current goals suggest. Reducing methane emissions will be furthered by open-source data and growing usage of drones and satellites that can show both low-level leakage and super-emitters.

A significant challenge in building a cleaner energy future is how to move beyond coal or capture its emissions far more extensively and rapidly. The undertaking is daunting, especially since coal use is growing — not shrinking — around the world as global energy demand grows. Financial support for developing countries to transition off coal is only just starting to appear, and more is needed. China's cessation of financing for new coal overseas is significant, but more important in terms of climate is China's domestic coal fleet. Given the cultural, political, and economic entrenchment of coal in some places around the globe, relying solely on a strategy of coal retirement is risky; much greater efforts are also needed on co-firing with low-carbon fuels, retrofitting with carbon capture, or other strategies to retool plants. Even more difficult than retrofitting, repurposing, or decommissioning the world's coal assets will be the complicated social and community elements involved in a just transition. Many workers, communities, regions, and countries are dependent on coal for energy, jobs, and revenues. There needs to be a public, heavy emphasis on explaining what the paths to economic success for communities and workers will be in the transition, ideally involving the skills workers have, in the same communities where the workers already are, with equivalent pay. The transition will require substantial, tailored assistance for countries to figure out how to diversify their economies, skill and re-skill workers, and get off coal. The global problem will not be solved if the local worker and community aspects are not put at the core of the energy transition agenda.

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Transitioning off emitting energy sources requires there to be affordable, scalable, zero-carbon energy options available, and zero-carbon energy deployment is growing around the world. India, for example, has committed to a massive increase in renewables by 2030 solely to meet expected power demand growth (which means coal is not being replaced), and India could play a role in helping other countries in Southeast Asia build capacity to expand renewables. Climate neutrality commitments in Germany and the European Union, meanwhile, are driving interest in green hydrogen there, especially for harder-to-abate sectors, and developing countries could play significant roles in developing and exporting green hydrogen and ammonia. There is also increasing focus on the need for zero-carbon, firm power. Some countries are actively exploring expansions of nuclear power (including new advanced reactor designs), hydro, and advanced geothermal, while important innovations on demand flexibility and energy efficiency could limit the amount of generation growth needed. The expected growth in batteries, storage, and other clean energy components highlights the growing importance of critical minerals such as lithium and copper, which are available in many parts of the world and will almost certainly require more mining (done as sustainably as possible). Across these and other technologies, significant additional investment is needed to achieve net-zero by 2050, as are reforms to environmental review and permitting processes to enable infrastructure to get built.

The energy transition will create new geopolitical risks and concerns that must be anticipated and considered. Some oil and gas states will increase their geopolitical influence during the transition, as more countries look to them for rescue amid greater market volatility. The notion that countries will exit from a strategic sector that generates so much revenue and is a source of core competitive advantage may be unrealistic, but some oil exporters in the Middle East are also investing in new technologies, including solar, wind, hydrogen, ammonia, and carbon capture. The strategies of OPEC+ and the global market structure will be affected by the decisions of developed countries, such as the United States,

**The energy transition will create new geopolitical risks and concerns that must be anticipated and considered.**

that are both producers and leaders on the climate agenda and that are facing political and market pressures that could limit production. With respect to clean energy technologies, China's ability to manufacture them cheaply and its dominance in the critical minerals supply chain will give it the ability to create global headaches, but not disruptive control over the ability of economies to function. The small number of developing countries that have advantages in production and export of hydrogen could increase their geopolitical influence. The United States and other countries will face geopolitical risks and damage to international relationships if they are not part of the solution on climate change, but tensions between the developed and the developing worlds are likely to increase during the transition due to developed countries providing inadequate climate finance, urging the developing world to "leapfrog" to cleaner sources, and moving in the direction of using more tools to compel others to decarbonize (e.g., border carbon adjustments). At the same time, if nationalism continues to rise globally and if anti-green positions become a winning populist position, that may disrupt global supply chains and erode support for the international cooperation needed to address both energy poverty and climate change.

# PEOPLE & PLANET

Tackling climate change is an urgent imperative. Addressing energy poverty and providing the energy that is central to countries' development are also urgent imperatives. It will be incredibly challenging for the world to reconcile development needs and climate needs, and how one thinks about meeting those needs can be very different depending on where one is in the world.

## TENSIONS & BRUTAL MATH

The math of the remaining carbon budget is really unforgiving, as humanity has not made much progress for decades in addressing climate change. The impacts of climate change are becoming clearer and more salient every day, with extreme weather event after extreme weather event. Yet the gap between current national climate goals and achieving net-zero by 2050 is large, and the divergence between goals and reality on climate action is growing. The world needs to achieve significant, rapid emission reductions.

The math of meeting the world's energy needs is also really unforgiving. There are at least a billion people in the world who lack energy access or who have just a fraction of what is needed. Energy is central to development and to giving people around the world a better standard of living. In many developing economies, meeting energy demands is how the countries get jobs and move forward.

**It is hard to make the math of meeting both climate targets and global energy demand for development pencil out.**

It is hard to make the math of meeting both climate targets and global energy demand for development pencil out. The world must drastically reduce its carbon footprint while also ensuring everyone has access to affordable, reliable, secure energy. The vast majority of the world's energy is currently based on hydrocarbons. The idea that the world will transition that huge amount of energy to something different at the same time that billions of people in emerging economies are trying to catch up with developed countries is highly improbable. Nowhere in the world has achieved victory over energy poverty without a mix of fuels, including fossil fuels, and developed countries have been finding it difficult to deploy clean energy technologies at scale. Some in developing countries therefore get frustrated by suggestions that they "leapfrog" to cleaner sources. Realistically, it seems unlikely that the U.S. Permian Basin will be shut down or that Africa will not have gas as a fuel as it develops. "Realistic" assessments of the need for continued use of fossil fuels for energy development may be accurate, but that means climate goals may not be met. The carbon budget is what it is; there are only so many tons that can be put into the atmosphere. Blowing through the carbon budget has serious ramifications; climate change impacts cause death and suffering around the world, with the harshest impacts often in developing countries. If new fossil fuel infrastructure is built somewhere, the reality of the carbon budget means that it either needs to be retired early, switch fuels, or be retrofitted with carbon capture — or that the world falls short of its carbon budget goals. Climate change may never be solved without first or simultaneously solving energy poverty, but it is unclear whether the tensions between them can be reconciled.

Climate change and energy for development may be a zero-sum game, but they also may not be. Trying to find common ground will be critical; there is no choice but to try to advance climate and development goals together. The energy

access community has been trying to highlight the urgent near-term needs of people in developing and emerging economies. The climate community has been trying to bring the global, longer-term crisis to the attention of private and public sector leaders and to increase recognition that climate change will have significant implications for societies, development paradigms, and energy. Humanity tends to focus too much on the short term and not enough on the medium and long terms, as is evident in several problems that humanity faces today, including climate change and pandemics. There is a need to focus on both the short and the medium/long terms, not just one or the other.

**Trying to find common ground will be critical; there is no choice but to try to advance climate and development goals together.**

More thought is needed on what a transition looks like that meets requirements for affordable and reliable energy, satisfies the moral requirement to enable energy access and development in developing countries, and keeps the world at least close to decarbonization scenarios. There may be a need for new guiding principles that are more holistic in thinking about energy, climate change, and people, factoring in metrics addressing livelihoods, workforce, energy poverty, energy affordability, public health, air and water quality, and decarbonization. More tools and guidance are needed for policymakers to navigate the difficult task of trying to optimize policies for all of these different goals.

## THE ENERGY TRANSITION IN DEVELOPING COUNTRIES

For many developing countries, the climate conversation is the energy conversation, and the energy challenge is first and foremost a prosperity challenge. The billions of people in emerging economies want to catch up to developed economies, and they want to do so as soon as possible, not in decades. Fulfilling that desire will require significantly greater energy supply. A key consideration in Africa is its youth bulge; huge percentages of its population are under 25. Those youth will need employment, housing, and opportunity; they are migrating to cities and want the good life. Providing those things will require heavy industry and manufacturing (which are energy intensive) and will create new energy demand. If the demands of young people are not met, there will be unrest. (On the other hand, a big unknown is what happens once young people — who have concerns about climate change — start coming into power in Africa.) As long as energy prices are affordable, demand is insatiable. Developed countries cannot tell the other countries of the world that they are not entitled to growing energy consumption for development.

In thinking about growing energy demand and global energy access, the focus has tended to be on households, but they need far more than just a single solar lantern to meaningfully raise their standard of living. The focus on households also misses a lot that is happening beyond the household. Agriculture, small refrigeration, and other livelihood needs are significant sources of electricity demand and are the nuclei of growth.

Record-high levels of renewables capacity have been deployed globally, and renewables have become the cheapest option in most geographies, but most of the capacity additions are occurring in the European Union (EU), the United States, and China. Despite Africa's real need for energy access and its abundant renewable resources, only a tiny fraction of deployment is occurring there; the same is true of the associated manufacturing and job creation. There is a need to support both centralized and distributed renewables in developing markets; the scale of the energy access challenge is so vast that capital is needed for both on-grid and off-grid solutions.

Expanding renewables may not be able to meet all the demand growth expected in developing countries, and as variable renewables grow, there is a greater need for baseload power for a stable grid — whether hydrocarbon, geothermal, hydropower, nuclear, or something else. Many developing countries are still building coal plants, partially because they are familiar and known, the countries are good at and comfortable with building them, and everything else feels risky. There is a lot of path dependence; business-as-usual is much easier than radical change, and the past is much more familiar to regulators and industry. Africa also has huge gas resources, and in the Global South, there will be gas

infrastructure built, even if only to integrate renewables. The transition in developing countries is looking likely to be a gradual one, balancing fossil fuels (especially natural gas) with investments in clean and renewable energy systems.

Developing and emerging economies' almost insatiable demand for electricity requires investment not just in clean generation, but also in the entire supportive ecosystem, including distribution and transmission infrastructure. Investments and regulatory overhauls for grid infrastructure are needed (regardless of the generation source) if increasing levels of electrification are to be achieved.

The energy transition is about more than just cleaner electricity. It is also about things like clean cooking, which billions of people around the world have no access to. Cooking with firewood and charcoal can cause serious indoor air pollution and health effects, as well as deforestation. Developing countries want gas and propane for clean cooking, just as developed economies have. More broadly, there is a need for more infrastructure that moves gases and liquid molecules, not just electrons. These molecules fuel economic growth, jobs, and industrial bases, even as decarbonization of those molecules and of the economy progresses.

**There is a need to support both centralized and distributed renewables in developing markets.**

With respect to transportation, electric vehicle deployment in Africa will have to look different than in developed countries, as there is sometimes not a grid that works properly. Something more like off-grid charging could make sense, with parallel systems for transport and for the grid.

In addition, energy sector initiatives in developing countries tend to focus on the supply side and neglect the potential on the demand side. There are big inefficiencies to address and significant opportunities to invest in public transit (not just electric vehicles) and highly insulated public housing. Such investments could have big social benefits, address critical needs, and reduce the extent of energy growth.

Solutions are different in different parts of the world, and even different regions within countries. The transition narrative should be more aggressive in developed countries than in developing countries, and different development trajectories have to be supported. Development in African, Latin American, and other countries may depend on the revenues from the hydrocarbons that many countries are endowed with. The technologies exist now to help solve energy poverty, and developing countries argue they can migrate away from those technologies later. With the climate crisis being the dominant narrative, however, it can be very difficult to discuss the nuances and complexities of the energy transition, such as which fuels can be used where and for how long, where fossil fuel production will come from and will cease, and other elements that would need to be figured out to have an orderly transition. A new low-carbon development model must be found and pioneered — from a climate perspective, developing countries cannot emulate China's high-carbon development model — but finance has to be available to serve such a model. Much can be done to serve both energy development needs and climate, but those synergistic investments are not being made at the requisite scale.

## GROWING CLEAN ENERGY INVESTMENT IN DEVELOPING COUNTRIES

Financing the energy transition will involve huge sums of capital — several trillion dollars per year through mid-century — but capital is not yet moving at scale to where it is needed on the ground in developing and emerging economies. There is an enormous gulf between the energy infrastructure needs in developing countries and the finance going to serve those needs and to address climate change. Developed countries demonstrated during the pandemic how much they can put into their economies quickly. In comparison, what is being done to support and enable investment in developing countries for energy and climate needs is paltry. Climate change is not seen as an emergency in some developing countries because the funding does not match the rhetoric. If climate change is truly a crisis and solutions have to be local, developed countries that have made financial promises they are not meeting need to step up. (A challenge is that, while the climate science and advocacy communities often refer to climate change as an existential threat, recognition of that threat does not exist in the broader political culture.)

If countries want to develop cleanly, there is woefully inadequate technical and financial support to make that happen. The scale of the transition means the bulk of the needed investment will have to come from private capital, but public finance plays a critical role in reducing risks and attracting capital into countries. Investors will not spend money they do not want to spend. The vast majority of private Western clean energy investment stays in the West. Clean energy in the developing world is still grossly underfunded, and ways must be found to attract capital to the places where investment is needed. Development finance institutions (DFIs) are an essential part of the picture in mobilizing capital for clean energy projects and infrastructure in developing countries.

DFIs can invest without seeking big returns. A key part of the DFI role is the ability to take higher risks than other forms of capital. DFI capital can take early risks and be very patient and long-term. DFIs can be first movers into sectors or countries in the developing world that foreign investors consider more challenging or risky. They can partner with local banks to absorb risks those banks otherwise could not. Development banks can also leverage other funding sources, such as the Green Climate Fund.

**Market fundamentals, political and regulatory risks, tax rates, the currency involved, exchange rates, and many other factors need to be assessed from a risk perspective to attract capital.**

Increasingly, DFIs see their role as catalytic. To be catalytic, some DFIs are moving capital away from renewables generation and focusing on grid infrastructure and coal transition. There is also a shift from relying heavily on governments and state-owned enterprises to build energy projects and infrastructure in developing countries to relying more on the private sector. Multilateral development banks (MDBs) are well placed to look at the entire ecosystem and assess what package of interventions will catalyze the market and open it up for the private sector at scale.

Market fundamentals, political and regulatory risks, tax rates, the currency involved, exchange rates, and many other factors need to be assessed from a risk perspective to attract capital. Investors interested in emerging markets often see deficits with respect to country governance. The experience in Latin America, for instance, has been that it is difficult to finance infrastructure when there are real risks regarding inflation, devaluation, regulation, and other areas. Utilities in developing countries can also represent real risks to private-sector investments; anything can become a failed project if the state-owned utility goes bankrupt or if there is not enough electricity available for a manufacturing project to succeed. Efforts are needed to help countries develop the right macro fundamentals, regulations, policies, markets, infrastructure, and incentives to enable private-sector capital to come in at scale and be deployed effectively.

Even developing countries that have policies in place sometimes cannot attract private investment in renewables. One reason for this is that, when it comes to DFIs and the energy sector, repetitions matter for risk. Even if there is little technical risk to something like a wind project or a solar-plus-storage project, there is perceived risk to it because there have been fewer repetitions of the transactions as compared to frequently transacted technologies. Problems come up with transactions involving newer energy technologies that do not come up with more transacted technologies, where people are more comfortable and have developed understandings of the real risks and issues. An additional challenge in attracting private investment in clean energy is that the broader ecosystem of companies needed for successful energy projects is sometimes lacking. Export projects could be an accelerant for that ecosystem; for instance, exporting clean energy (whether electrons or ammonia or something else) from Africa to Europe could provide a huge energy security benefit to Europe while at the same time growing jobs and experience in Africa. (Conversely, adding a component of local supply within projects could increase local energy access and security, but the projects might not get financed by foreign investment, which tends to pay less attention to the developmental aspects; governments also make more revenue if the product is exported than if it is used for domestic supply.)

The risk profile of an investment affects the time horizon, the levels of required return, and the types of guarantees demanded. For a long-term contracted asset (e.g., solar) in the United States, private investors would be looking for a

single-digit rate of return; where there is merchant risk and construction risk, the returns would have to be in the low double digits. Investors in emerging markets generally want a premium on what they could earn on a similar asset in the United States, to compensate for the additional risk. Where there is a predictable, defined, scalable program, though, other investors are coming into emerging markets (e.g., Egypt, South Africa) and have been happy with returns in the single digits (or low double digits). It may turn out to be the case that local funding in developing countries (e.g., from the capital markets, pension funds, and other sources) begins to supersede the Western financial institutions, to the point that those institutions either have to jump in at lower margins or get locked out.

There are financial tools, including political risk insurance tools, that get short shrift in discussions but can be very important in de-risking markets and transactions to enable growth of clean energy and climate-linked projects. In the new model where the private sector takes the lead, DFIs should also be thinking carefully about lending in domestic currency or undertaking the exchange rate risk, otherwise the private sector may not go along on projects. Technical assistance to help ripen projects will be vital as well. DFIs in the past have financed projects that are good and bankable to begin with, but financing the energy transition at scale will require MDBs and DFIs to think differently to foster projects. MDBs can use their capability and experience with project development (as well as their balance sheets) to mobilize pipelines of projects and unlock private capital at a different scale. Nearly every major clean energy project has to go through some pre-financing development stage, and technical assistance can help ripen those projects. That said, capital to help prepare projects and bring them to bankability is a challenge for some development banks. Small DFIs in the developing world often have limited resources and multiple competing priorities, so putting forth risk capital is a challenge.

**Spurring a several-fold increase in investment in developing countries will likely require not just help with project preparation but also fundamental changes in culture, including staffing up DFIs with people expert in particular developing countries or regions.**

Spurring a several-fold increase in investment in developing countries will likely require not just help with project preparation but also fundamental changes in culture, including staffing up DFIs with people expert in particular developing countries or regions. In addition to scaling approaches that have worked well in the past (e.g., project finance, working with local financial institutions, supporting aggregators of small projects), new structures will be needed as well. There are conversations in some countries about new structures that can blend different stacks of capital together to achieve particular objectives, vehicles at much larger scales, and other ideas. More thought is also needed about how to utilize institutions that are not as subject to political forces to provide financial impacts that may not happen otherwise. Central banks, for instance, have saved the world more than once in recent years, and climate change is a greater threat than COVID or the 2008 financial crisis. Getting to scale will require all possible solutions on finance.

While there will be large parts of the transition that will require incentives for private investors to put their capital to work, it seems that investors in developing countries often want everything to be perfect, even though things are not perfect in the developed world either. In Africa, for instance, the development space has been accustomed to assertions that people do not want to invest and therefore need sweeteners to induce them to do so. As a result, those who do want to invest are now waiting for additional guarantees and sweeteners. Perceived risk regarding Africa is often greater than actual risk, and more attention should be paid to returns. There are good deals in Africa in the energy space. Energy markets are not perfect there, but they are growing. Investments in the African energy sector will yield returns that are much higher than in many other parts of the world. More needs to be done to demonstrate that private investors can get solid (but not exploitative) returns.

# THE ENERGY SUPPLY CRISIS

Energy is pervasive, affecting how people move, eat, heat, and otherwise go about daily life. When prices are low, it is easy to forget the impact of energy on a global basis, but when energy prices are high, reality catches up. Starting in the fall of 2021, oil and natural gas prices surged, especially in Europe and Asia.

## GAS CRUNCH IN EUROPE

What has occurred recently in energy markets is both a perfect storm prompted by idiosyncratic factors and a new normal in global energy markets. It is a perfect storm in the same way that the Texas winter freeze was — a rare confluence of factors, but an event that seems to be happening with increasing frequency. The confluence leads to losses of redundancy and resiliency and increases in volatility in energy markets.

The situation in Europe was spurred by a strong economic rebound, lower availability of wind and hydro, weather leading to high demand for heating and cooling, tight markets for fuels, liquefied natural gas (LNG) supply issues, and Russia's decisions about gas supplies. The problem is about both price and actual availability of gas (though the issue is broader than gas). There had been some complacency about the ease of getting energy cargos; people grew to expect energy to be available, but that is not the case in Europe now.

**What has occurred recently in energy markets is both a perfect storm prompted by idiosyncratic factors and a new normal in global energy markets.**

It is not surprising that Europe has been more impacted than other regions. Liberalization of gas markets and a switch to spot indexation brought many benefits for European consumers in the form of lower bills, but those benefits may be balanced out this year. Europe is also a balancing market in the global market. It is in competition with Asia, and the energy crisis in China, including widespread blackouts, led the Chinese government to direct energy supplies to be obtained at whatever cost. Europe should have paid more attention to that.

Russia has not organized the energy crisis, but it is clearly benefitting from it and is playing some role. Speculation about what Russia is or is not doing can lead to substantial price movements during the course of a day. Gazprom is unwilling to provide Europe with additional volumes, which does not violate contracts or rules but could have longer-term geopolitical consequences, with gas markets becoming more politicized. Part of Russia's motivation is to keep pressure on Europe to get faster certification of the Nord Stream 2 pipeline. In addition, like all holders of fossil fuel reserves, Russia is trying to ensure financing of the next investment cycle and, to the extent possible, monetize existing assets that face threats from the energy transition. Many contracts in Gazprom's European portfolio are expiring within the next year or two, and the current period of high prices and scarce supplies presents a window of opportunity to sign new long-term contracts. Long-term contracts come back into fashion every time prices go up or something unusual happens, and the current crisis is highlighting the value of long-term guarantees and the risks of relying on spot prices. Long-term contracts provide supply security in a world with supply disruptions and with more competition for limited gas resources expected in the near term.

There is a view that part of what is happening in global energy markets today is due to the clean energy transition, but leading analyses have suggested that is not the case — and that the energy transition is the solution. Still, at least in the short term, the energy transition unavoidably takes flexibility away from the energy system.

## REACTIONS TO THE OIL CRUNCH

The oil price spike has spurred responses. In the United States, for instance, where there is no meaningful long-term energy or climate policy, there is little that is more political than the price of gasoline at the pump, so everyone is scrambling to figure out what to do about that. The Republicans' reaction has been predictable, pushing to move away from electrifying the transportation fleet and talking about opening more public areas to long-term hydrocarbon development. The Democrats' reaction has also been predictable, with bills to stop oil exports, policies seen as hostile to LNG export terminals or other infrastructure that could address short-term needs, and efforts to punish an industry they see as taking windfall profits.

**There is little that is more political than the price of gasoline at the pump**

The Biden Administration's positions are based at least somewhat on climate concerns, and, from an emissions standpoint, the energy world today is different from the future one. Additional leasing ensures future production, which may not be desirable climate-wise and would not address current needs. Instead, the Administration spearheaded an effort that resulted in six nations agreeing to add to the market from their strategic stocks, explicitly in order to bring down the price of gasoline. In the past, such releases were limited to instances of supply disruption (or at least framed as such), but as oil's role diminishes over the energy transition, there will be more temptation by those with strategic stocks to use them to address price concerns. It is intriguing that the countries involved in the strategic releases included large importers of oil, signaling to OPEC countries that they can affect the market too (though it is not clear that the releases had much effect). The fact that China joined in the joint stock release (at least somewhat), coupled with the U.S.-China climate declaration at COP26 in Glasgow, highlights the role of climate and energy as potentially the only area of cooperation between the two countries.

## VOLATILITY AHEAD

The current energy crisis represents a messy and volatile environment, and the current roller coaster volatility could be a preview of the market dynamics during the energy transition. Volatility is not inevitable in theory, but the way energy policy is conducted, it is almost guaranteed. Policy is rarely optimized. The transition will be bumpier than models suggest, and it is worth thinking about how markets can adapt to a new, extremely volatile, unpredictable reality.

There are a few elements that make a bumpy ride more likely. For one thing, electricity will be of growing importance at the same time there will be greater variability in both supply (e.g., increasing deployments of variable sources such as wind and solar) and demand (e.g., electric vehicle charging, increased deployment of heat pumps and air conditioners). This means poor infrastructure (e.g., poorly managed charging of vehicles) and weather events (e.g., cold snaps, heat waves) could lead to big fluctuations in demand and supply. The needed flexibility to handle this will involve complicated interactions between electricity, fuels, and storage, and any failures of coordination there could produce greater volatility.

In addition, the scale of the energy transformation being envisioned has never been accomplished before, which means trial and error (especially by the early movers) is inevitable. Given the extremely tight timeframe available to potentially limit global warming to 1.5°C, many things will have to happen in parallel, with little margin for error. That increases the risk of imbalances and international fragmentation. The idea of a smooth transition is fanciful. There has been a great deal of work on optimal, least-cost transition pathways, but more thinking is needed about what messy, poorly sequenced transitions look like. Parts of the energy sector will move faster than others. Generation might move faster

than infrastructure, technology might move faster than regulation, supply changes might move faster than demand changes, and so forth. Some countries will press ahead on the transition more than others, some will compete for position in clean energy value chains, and some will remain dependent on hydrocarbon revenues. Global multi-speed transitions will be complicated and messy.

**Given the extremely tight timeframe available to potentially limit global warming to 1.5°C, many things will have to happen in parallel, with little margin for error.**

Increasing pressure to phase out polluting activities could also eliminate energy sources that provide flexibility or supply buffers. While today's energy mix is the most diverse in history, there is still substantial volatility partially because parts of the world are also shifting away from resources that create stability in markets. For example, Fukushima was a very consequential event in spurring shutdowns of many reactors and scrapping plans for nuclear expansion. Likewise, while demand for fossil fuels was robust this year (and is likely to be next year) due to recovery from the recession, it may be misleading to think demand will continue to grow at a high level. The pre-pandemic trendline of eroding growth in oil demand is likely to reassert itself after a couple of years. Europe is also doubling down on renewables, retiring coal generation, impeding the growth of gas generation, and reducing supply durability and resilience (though gas will still matter in Europe for a while). Even before this crisis, the next couple of years were expected to be tight in gas markets, and it is possible the next few years could be even tighter, with higher prices. The energy transition will keep testing the grid and fuel redundancies for a long time to come, and there could be underinvestment in or premature phaseouts of things that are needed for more time.

Energy price volatility drains political and social support for the energy transition. People may believe price spikes in natural gas or other sources of energy are being driven by climate policy, regardless of whether analyses say otherwise. Populations will not buy into climate action if they do not have heat for their homes. When confronted with both an energy crisis and the climate crisis, governments will always choose keeping the lights on and energy available to citizens over decarbonization. Energy security and affordability are seen as the more pressing concerns. Higher gas prices could affect future demand for gas, such as its potential place in decarbonization strategies in Asia, but responses to energy crises can also lead to substitutions with higher emissions, such as shifts from gas to coal in Europe and gas to oil in Asia. The implications of energy crises for the limited carbon budget and for ambitious climate action are not promising.

# THE ROLE OF NATURAL GAS

The issue of the role of natural gas in meeting both energy demand and the need for decarbonization elicits strong reactions from all sides. There may not be any black-and-white answers.

## IS GAS A TRANSITION FUEL?

There are many who assert that global leaders have to accept natural gas as a necessary fuel for the energy transition. Not that many years ago, and even during the Obama Administration, there seemed to be consensus and a clear message that natural gas was a key transition fuel, but that consensus and message are gone now. There are reasons for that, including that methane has become a clearer and bigger problem, the remaining carbon budget has gotten smaller over time, and the consensus climate target has shifted from 2°C to 1.5°C. Net-zero does not mean a world free of fossil fuels, but net-zero scenarios contain a limited runway for gas. In analyses of how to achieve net-zero by 2050, natural gas demand goes up globally for the next few years before tailing off, and gas demand in many developing countries is higher in 2030 than now. There are no new gas fields developed, but that does not mean no new investment in midstream and downstream gas infrastructure. There is still a long tail on using gas, though much less than today. It is probably technically possible to achieve the necessary carbon reductions and global development progress without natural gas, but it does not seem like a likely path going forward.

**Everything that can be scaled up needs to be, from wind to keeping existing nuclear alive to replacing coal with natural gas.**

The main argument for natural gas as a transition fuel is as a substitute for higher-emitting coal. The United States may have achieved significant emission reductions from fuel switching from coal to natural gas, and fuel switching in the rest of the world might also provide near-term emission reductions. For example, the scale of coal use in Asia is so large that even if gas plays only a niche role in replacing coal, that niche is still quite substantial. It is not clear, though, what the scale of the emissions win was from coal-to-gas switching in the United States, as the U.S. Environmental Protection Agency's inventories, particularly with respect to methane emissions, may not be accurate reflections of reality.

A global switch from coal to natural gas would require vastly expanded natural gas production and trillions of dollars to accomplish. Gas infrastructure, though, lasts several decades, and there is some skepticism of assertions that gas infrastructure built now can just be used later for low-carbon fuels (e.g., hydrogen) or with carbon capture. Assuming the near-term fuel-switching benefits are real, there may need to be a split between near-term and long-term strategies. There is an incredibly tight carbon budget, and everything needs to be thrown at the problem over the next decade. Everything that can be scaled up needs to be, from wind to keeping existing nuclear alive to replacing coal with natural gas. Cumulative emissions matter, which means near-term emission reductions matter. If everything available is not deployed now, including technologies that decarbonize but are still emitting, humanity will blow the carbon budget. Eventually, though, to stabilize the climate, humanity needs to reduce emissions not just a little bit but basically down to zero (or net-zero), which may require different choices and systemic innovation.

Gas will not solve the world's climate problems. There are only so many LNG facilities and a finite amount of gas being exported from the United States. Gas likely has to be part of the solution in some places and under some circumstanc-

es, though, given the scale of emission reductions needed, the time frames involved, and the complexity of the energy system. At the moment and for the foreseeable future, there are not great alternatives to natural gas, and those molecules are needed to enable standards of living. The key is to use it in ways that eliminate the emissions. There is a need to focus more boldly on innovations that are underway, including in carbon capture and storage (CCS) and in turning gas into needed chemicals and materials.

Indeed, some argue that natural gas could be not just a transition fuel but a longer-term clean fuel in terms of greenhouse gases. If natural gas can be deployed with zero carbon impact, whether through CCS or other technologies (which exist but are nowhere close to being available at scale), it is conceivable that natural gas could continue being widely used in a net-zero scenario.

## ROLE OF GAS IN DEVELOPED AND DEVELOPING COUNTRIES

The positioning of gas in the energy transition is different region by region, and its role in developed economies may be different from its role in developing economies. Gas investments are quite jurisdiction-specific. A similar investment in two different countries could reduce emissions in one but increase them in another. It is difficult to develop hard and fast rules or absolutist positions. When looking at the possibility of new gas infrastructure, there is a need to get to a granular level to understand the details.

In Europe and the United States, gas is widely used both for power generation and to provide heat for the building sector (among other uses). Building decarbonization strategies have focused on improving energy efficiency and replacing natural gas with renewable heat or heat pumps, but that is proving to be a very slow process. Gas consumption is still quite high, and building renovations are going very slowly. A more robust conversation is needed about how fast the sector can transform, and more thinking is needed about how to handle a gas system that cannot be shut down until everyone is off it. In power generation, gas is increasingly the high-carbon electricity source, but it is still currently essential for energy security. Even some extremely green jurisdictions recognize that gas is still needed today, but investments in gas infrastructure are still treated as being undesirable. In short, developed countries have the most resources to transition away from gas and yet remain heavily reliant on it.

**Gas investments are quite jurisdiction-specific.**

Given that developed countries still rely on natural gas, there is strong distaste in developing countries about dictates that they should not use it, which are seen as hypocritical. The transition to net-zero should involve market segmentation. Developed regions that can afford more expensive alternatives should be the first to move off fossil fuels. It is hard to imagine not using natural gas in many developing countries, in part because of its potential to improve local air pollution challenges. In Africa, natural gas could provide the baseload that makes electrification with lower carbon intensity (including off-grid or microgrid solar developments and utility-scale renewables) easier to manage. The natural gas that is currently being flared in African gas fields could be used well locally, and new gas infrastructure in Africa could be repurposed later for hydrogen or other low-carbon gas options. Failure to invest in the energy transition in Africa will leave people reliant on very polluting energy options, such as coal, diesel generators, petrol generators, and heavy fuels.

Assertions by countries and DFIs that they will not fund gas look like a punitive act to developing and emerging economies, especially when the world is not mobilizing finance at scale for cleaner alternatives. These policies are largely based on what it will take to achieve net-zero by 2050; the world probably will not achieve that by 2050, but it is hard for governments and institutions to say that out of fear of providing an excuse for people to take a step back. There have been difficult conversations with people in DFIs, especially around clean cooking; sometimes exemptions have been won to allow for funding for propane for clean cooking, based on both climate and health impact arguments, but women in Africa cooking with small propane canisters are not the ones killing the climate. Even if Africa uses natural gas for a few decades, it would use up a small amount of the carbon budget.

## METHANE EMISSIONS

Whether natural gas is even a near-term climate solution depends heavily on addressing its methane emissions. The oil and gas sector is not the only source of methane, but it is low-hanging fruit, with opportunities to reduce leakage, improve flare efficiency, and so forth. Venting, flaring, and methane leaks are a black eye for the fuel. There is no role for leaky gas. It is critical to fulfill the global methane pledge made at COP26, where half the world's nations signed on to reduce methane emissions 30% by 2030, with annual stocktakes. Stopping methane leaks as soon as possible is tremendously valuable to the climate, given the much greater warming impact of methane over relatively short timescales. To achieve stabilization at 1.5°C of warming, even more rapid reductions in energy-related methane emissions (e.g., 75% by 2030) are needed.

**Whether natural gas is even a near-term climate solution depends heavily on addressing its methane emissions.**

Because of the Obama-era methane regulations, the oil and gas industry has studied methane emissions and what it would cost to clean them up. Stopping methane leaks can be done now, affordably. It should no longer be acceptable for oil and gas companies to dump methane into the atmosphere, and it is not going to be enough for companies to have individual promises; industry-wide solutions are needed. The industry has to take responsibility for its methane, and it should be acting faster than its current goals suggest. Some industry leaders want to get methane right and address the issues, but methane emissions are still a rampant problem, and the industry has not done a great job overall. Industry probably cannot self-regulate adequately. Putting a price on methane leaks would be one way to spur action, in addition to regulations to stop venting and flaring.

Reducing methane emissions will be furthered by open-source data, advanced models, and growing usage of drones and satellites that can show both low-level leakage and super-emitters. For instance, flyovers of oil and gas infrastructure have found methane super-emitters in many places, and the operators often do not know they have a leak. Such improved data and intelligence have to be built into global gas trading, including from emerging markets, such as through certification programs that highlight the best actors. It is possible that new development (e.g., in Africa) could eclipse the leaky Russian and U.S. gas supplies, though developing countries will go with the cheapest and most established approach, especially absent funding and financing to pursue cleaner options.

Methane emissions are not the only climate challenge that gas presents. There are also greenhouse gas emissions from upstream and midstream gas combustion. For midstream companies, for example, a large source of emissions is combustion for compressors in the field, though companies face a conundrum in trying to reduce those emissions. Compressors could be electrified, but in many places, the new Scope 2 emissions would outweigh the reduced Scope 1 emissions, which leaves companies caught between acting now and taking heat from investors and stakeholders for increasing emissions on the one hand, or on the other, waiting for the grid to decarbonize first and taking heat for inaction. Beyond all of that, even if all methane leaks and upstream and midstream emissions globally ceased immediately, emissions from end-use combustion mean there are still limits to the amount of gas that can be combusted in a 1.5°C world.

# GETTING PAST COAL

One of the particular challenges in thinking about how to build a cleaner, more prosperous, more secure energy future and meet climate goals is how to move beyond coal or capture its emissions far more extensively and rapidly. Coal presents unique challenges given its role in many countries' power and industrial sectors, the role coal (both thermal and potentially metallurgical) plays economically and politically in many countries, and the complexities of figuring out what a just and politically feasible transition looks like.

## THE OPTIONS FOR COAL

The world will not reach its climate goals without significant action to phase out unabated coal emissions. Getting off coal is hard, but in terms of the climate, there is not a choice. The global Powering Past Coal Alliance calls for phasing out unabated coal and putting a moratorium on new coal, with developed countries off coal by 2030, China by 2040, and the rest of the world by 2050. The scale of action needed is staggering — on the order of closing one coal-fired power plant per day for about 25 years. (That only takes into consideration existing coal; new coal plants are still coming online globally.) Even if there are only half as many coal plants, the undertaking is daunting, especially since coal use is growing — not shrinking — around the world as global energy demand grows. The global coal fleet is mostly very young and represents huge amounts of unrecovered capital. These plants will last decades and cost trillions to replace.

**The world will not reach its climate goals without significant action to phase out unabated coal emissions.**

Studies have suggested that phasing out coal in the EU already makes economic sense, phasing out coal in the United States could represent either net savings or costs depending on policies, and phasing out coal in developing countries represents a net cost for several years. Support is needed for developing countries to pursue this agenda — especially in the context of the pandemic, as countries are even more distressed in terms of debt. Achieving a transition off coal is a global public good; more global ambition is needed to support developing countries to do so, and MDBs are starting to shift. The Asian Development Bank, for instance, announced at COP26 significant new efforts to work with countries to retire coal generation assets. The Bank is at the very preliminary stages of piloting the mechanism, with international financial institutions, governments, philanthropies, and others putting money (e.g., guarantees, equity, debt) into a country-level fund to finance accelerated coal decommissioning (as well as into a fund for accompanying clean and renewable energy investment). There was also an announcement at COP26 that South Africa will be receiving aid from richer countries for its plan to decommission coal assets.

China's announcement about ceasing financing for new coal outside China is significant. China had already ceased funding new overseas coal a couple of years ago, but the announcement formalized it. China's commitment only covered overseas finance, though, and the majority of new coal plants commissioned last year were in China. China had shut down a lot of coal in the previous few years, but when confronted with an electricity shortage, it responded rapidly, with orders to buy coal and announcements of new coal plant construction. There are deep concerns about air pollution and health impacts in China (as well as in India and elsewhere), which has led to lots of pollution control technologies on coal (e.g., scrubbers), but those do not address carbon emissions. China has made a clear medium- to long-term

bet to shift away from oil and gas and toward everything else, but from a climate perspective, the key question is how China addresses its emissions from coal.

Given the cultural, political, and economic entrenchment of coal in some places around the globe, relying on a strategy of phasing out coal to fight climate change is very risky. There is also lots of vertical integration in coal companies, from mining to generation, which means the actual operating cost for a coal plant is often very low, requiring super-cheap renewables or painful economic policies to force a shutdown. The transition economics are even more challenging in the current price environment, where coal is becoming more attractive and competitive price-wise compared to gas. Other options may be needed in addition to coal asset retirement. Much greater efforts are needed to retool plants, which could involve co-firing with low-carbon fuels (e.g., ammonia), retrofitting with CCS, or other strategies to improve coal's emissions profile.

**Given the cultural, political, and economic entrenchment of coal in some places around the globe, relying on a strategy of phasing out coal to fight climate change is very risky.**

## SOCIAL & COMMUNITY ASPECTS OF A JUST TRANSITION

Retrofitting, repurposing, or decommissioning the world's coal assets will be incredibly difficult — but may well be simpler than the complicated social and community elements involved in a just transition. Getting off coal is tough at the human level. Cost to ratepayers from getting off coal is a significant issue, and plans to get off coal are seen as plans to phase out people's jobs and communities' livelihoods. No one is doing a great or even a good job with the transition from coal to cleaner energy, and too few are taking seriously what to do in the transition with the workers, communities, regions, and countries dependent on coal for energy, jobs, and tax base.

Local and national governments often rely heavily on coal-related revenues. In some places, for instance, fossil fuel revenues provide a large portion of the funding for public education. In countries such as China with state-owned coal companies, the profits go straight to the government, making it an important source of revenue. In countries such as South Africa, coal exports are a large source of foreign exchange. There are also impacts on railways in countries such as India, where coal is the largest source of railway revenue and subsidizes fares for the rest of the population. These and other profound challenges mean the transition will not be easy in any country.

For many communities, all they know is a coal-dependent economy — both the good (jobs) and the bad (pollution). In some places, history with coal goes back hundreds or thousands of years; there are cultural challenges that phasing out coal presents. Local efforts are vital to bring people along for the transition and upskill them for specific new job opportunities.

Addressing the concerns of workers, however, is tremendously challenging, and the numbers and complexities can be significant. In some regions of developing countries, there are hundreds of thousands of people working across the coal supply chain and several million working in the informal economy. (In developing countries, significant parts of the labor complexities of the transition involve informal labor.) There are also coal industry pensioners being partially paid by current workers. The issue is not just coal-fired power plants, but also coal-fueled heavy industry, which is very important in many developing countries. In the United States, there are tens of thousands fewer workers in coal mining than there were a few decades ago (largely due to automation, not climate policy), but a significant portion of the remaining coal mining workforce is located in West Virginia, whose political representatives currently wield substantial clout over energy policy.

There needs to be a public, heavy emphasis on explaining how workers will be part of the transition and what the path to economic success for communities and workers will be. The opportunities for renewables often are not located in the same communities as coal, which limits job retraining opportunities. Many of these workers are already skilled and do

not want to be retrained (though some worker skills may not be transferable). Many also do not want to move. While some might become economic refugees from the energy transition, just as others in history have done when major industries shut down, many people have lives and communities that they do not want to change. During the Obama Administration, when shale resources came on strong in the Appalachian region, there were efforts to help people transition from coal to gas jobs just a couple of counties over, but people still did not want to move. Especially in a time of worker shortages, there is a need — to the extent possible — to find industries that need the skills workers have, in the same communities where the workers already are, with equivalent pay.

**It is important to think of the transition as an opportunity, not as pure sacrifice.**

It is important to think of the transition as an opportunity, not as pure sacrifice. Communities need grants to plan for economic diversification and access to capital to execute the plans. The European Investment Bank plans to spend half of its investment dollars on climate-friendly economic diversification; the United States could use a similar kind of investment or infrastructure bank. In addition, the Biden Administration in 2021 stood up an interagency working group on economic revitalization for coal and power plant communities; the multi-agency approach is vital because these are not just energy issues.

Education is needed to prepare new workers for the workforce needs of the economically diversified future, in addition to retraining and vocational work. Scholarships will make it possible for people who want to be trained or retrained to get the training. In addition to investments in diversification of economies, skilling and re-skilling of workers, and social protection schemes, there is a need for more modeling and analysis on the distributional impacts of the transition. More work is needed to understand the opportunities and investments that will be needed to achieve a just transition.

The rest of the fossil industry workforce is watching what happens with coal. Individual oil and gas companies have more work to do with their own employees with respect to how they talk about the energy transition in order to de-escalate the fear employees are feeling; the sector needs to help employees understand and see opportunities in the transition. If the worker and community aspects are not put at the core of the energy transition agenda, though, the transition will face massive resistance and will fail. Worker and community resistance could spur populist, nationalist movements that will slow the commitment to clean energy and climate policy. Instead, worker and community concerns must be satisfied and their political power harnessed to keep the transition moving.

The transition will require substantial, tailored assistance for countries. The work has to involve going country by country, province by province, state by state to help each figure out how to get off coal — led by the jurisdiction. The work has to be really granular, even project by project or person by person, particularly in developing countries. Every country is different, including with respect to who owns the coal (the government/state-owned enterprises or the private sector), the scale of potential job losses, alternative opportunities, and financing. The feasibility and pace of a coal transition also depend on factors such as whether power demand in a country is flat, declining, or rising, whether coal is an export product, whether coal is part of the culture, and whether there are unions for coal workers. Pathways are needed for individual communities to leverage existing assets, develop supply chains for some of the replacement technologies, deploy CCS and other technologies, and pursue other strategies. The global problem will not be solved if the local, human aspects are not done right.

# DEPLOYING ZERO-CARBON ENERGY TECHNOLOGIES

Transitioning off emitting energy sources requires there to be affordable zero-carbon energy options that can scale quickly enough to address climate needs and growing global energy demand. Zero-carbon energy technology deployments and plans are growing around the world.

## RENEWABLES IN INDIA

India has committed to significant goals for non-fossil energy, nearly equivalent to replicating the entire existing power sector only with renewables by 2030. The added capacity will be going to meet power demand growth, which means coal is not replaced; indeed, even if India achieves its renewables targets, coal use in 2030 is still projected to be higher than today. More capital has to be allocated to India (and to all emerging market countries) to fund the growth in generation capacity, transmission buildout, and storage.

A much larger share of renewables on the grid increases the need for significant amounts of ancillary services and balancing capacity. The Indian government is being proactive about the problem by announcing a large new bid for energy storage to help balance the system, but the distribution sector in India has never been reformed or opened to private parties. It is all controlled by state governments, and there has been significant underinvestment in the distribution side. Distribution utilities are constantly in financial difficulty and have to be reformed at some point.

India was early to undertake the renewables journey and has developed a good ecosystem, with lots of institutional capacity, people, and understanding of the business elements. Other countries in Southeast Asia have not done that; they have catching up to do, but they have the benefit of India's example and of starting with renewables costs already being fairly low. A lot of the technical solutions emerging in India related to managing the grid could be copied by others, and Indian companies could play a significant role in helping other countries set up capacity to expand renewables.

## HYDROGEN & AMMONIA

Climate-neutral molecules are also needed in the economy, and there has been an enormous increase in the attention paid to hydrogen. National policies and ambitions around clean energy manufacturing are emerging around hydrogen and electrolyzers, and that trend is likely to continue. Climate neutrality commitments in Germany and the EU, for example, are driving particular interest in hydrogen there, especially in harder-to-abate industrial sectors. Hydrogen is seen as potentially being at the heart of a new industrial revolution with greater system stability, and the EU is looking into industrial hydrogen clusters and repurposing European gas grids.

**There has been an enormous increase in the attention paid to hydrogen.**

The focus in German and European hydrogen strategies has been on green hydrogen, produced from renewables, and billions of euros have been dedicated to a massive expansion of green electrolyzer capacity by 2030. There are cleavages in Europe regarding blue hydrogen (made from steam methane reforming of fossil fuels with CCS added to the process), turquoise hydrogen (made from methane pyrolysis, which produces solid carbon as an output), and hydrogen produced using nuclear power.

**If there is a global trade, it is more likely to be in ammonia.**

German deployment of renewables has slowed, and renewables are needed to substitute for phaseouts of nuclear and coal, which means new renewables facilities will be needed to produce hydrogen from electrolyzers. There are limits to how much Germany can deploy, though; land is a constraint on solar and wind development in developed countries. That means Germany will need lots of hydrogen imports from the rest of the world. Indeed, scaling up green hydrogen globally will require a massive increase in the amount of wind and solar. Developing countries, which tend to have more open spaces than developed countries, could play significant roles in developing green hydrogen. Countries that import fossil fuels but have high renewables capacity could replace the fuels with green hydrogen in many use cases, improving energy security and independence, and they could also export it medium distances (e.g., Africa to Europe). Chile, for example, has lots of low-cost solar and launched a hydrogen strategy with the goal of being a leader in the export of green hydrogen. A global trade in hydrogen may not be likely, though, given the difficulty of shipping it.

If there is a global trade, it is more likely to be in ammonia. For long-distance transport, it may be better to convert hydrogen into ammonia, ship the ammonia over the oceans, and use it directly as the fuel. (At some point, cracking it back to hydrogen may make sense, but converting hydrogen to ammonia and then back again results in efficiency loss and cost.) Ammonia can be produced at massive scale and can be used in many applications, ranging from power plants to marine fuel. The existing LNG fleet is well-suited for moving ammonia; a lot of the existing infrastructure could be repurposed.

## ZERO-CARBON BASELOAD

Many analyses show that getting to a decarbonized electricity system while electrifying other sectors will be cheaper and easier if there is lots of firm generation in addition to greater renewables. While solar and wind face land constraints, baseload sources tend to have small land footprints. Solar projects can be physically built more quickly, but the larger footprint means there are more land issues to address (e.g., prior informed consent, affected people, land acquisition), which can take years. The smaller footprints for baseload sources can raise fewer land issues, even if the build time is longer.

Climate change is bringing a lot of attention back to nuclear power as a source of zero-carbon, firm power. The world has been doing fission for decades. The U.S. Navy has many nuclear vessels that produce zero-carbon power without error or flaw. (The U.S. government could perhaps build and direct floating reactors to bring power to where it is needed.) While some countries are phasing out nuclear, others are actively exploring it, including U.S. discussions and agreements with countries (e.g., Romania) to convert coal plants to small modular reactors. New advanced reactor designs under development are safer and better than existing technologies, but they are not operating yet. Fusion, meanwhile, is not available today to solve the climate problem, though there have been recent announcements of substantial investments in private fusion companies.

Nuclear faces significant headwinds, though, many of which are not technical. Regulatory hurdles loom large. The U.S. Nuclear Regulatory Commission is seen as the gold standard of nuclear regulation, but like gold, its processes are heavy and expensive. An additional challenge is that the United States is a net importer of nuclear fuel, with Russia as the primary supplier. Russia controlling gas in Europe and uranium in the United States is not optimal in terms of energy security. Another nuclear headwind might be engineering capability. Some of the leading Western companies are out of the nuclear game, mostly leaving countries that want nuclear to choose between Russia and China. Still, there are plenty of new nuclear engineers, and there will be capital and financial incentives going towards nuclear, so once the demand for engineering capability is there, the supply should follow. If one advanced reactor comes online and proves economical, the success story will lead investors to pile in.

Nuclear is not the only zero-carbon baseload option. An additional technology to keep on the radar is advanced geothermal. Various efforts are applying oil and gas know-how to dig deep geothermal wells. It is also a way to transition oil field workers to new clean energy careers. Hydro is another important clean energy source, especially in some regions (e.g., Latin America), but it seems like it is harder now to get licensing for hydro than for a coal plant. Hydro could end up like nuclear might — squeezed out of the system before its time.

**Energy efficiency is another key part of the solution set.**

Energy efficiency is another key part of the solution set. The demand side often gets overlooked, but there are innovations happening on demand flexibility, energy efficiency, and other areas that could limit the amount of growth needed on the generation and transmission side.

## CRITICAL MINERALS

With companies and governments putting more emphasis on addressing climate change, there is a growing need for critical minerals to meet the expected growth in batteries, storage, and other clean energy components. Electric vehicles and their batteries, for example, require more copper than internal combustion vehicles, and solar photovoltaics require far more copper than fossil fuels. Lithium likewise has huge growth potential, with enormous demand expected for batteries for mobility.

The increased demand for these critical materials cannot be met through recycling alone. Realistically, there will be a need for more mining. There has been opposition to extractive mining around the world, mainly due to the impacts on local ecosystems and communities. Mining companies have been challenged in getting and maintaining their local social license to operate. Mining will have to be done as sustainably as possible, both in terms of local impacts and greenhouse gas emissions from mining operations. Operational efficiencies can achieve some emission reductions, and electrification is getting more popular for underground operations as batteries become more affordable, but most mining equipment is not electrified. Some companies have been considering alternative fuels, such as moving from diesel to hydrogen.

Chile is among the largest producers of copper and lithium, and Africa also has abundant minerals such as lithium, cobalt, and copper. In Congo, the Americans left, leaving the Chinese there. It is possible that the elements required for the clean energy revolution will be cornered by others, leaving the United States out. On the other hand, many parts of the world have critical minerals, and it is possible that actors such as the United States could try to encourage responsible and more environmentally tolerable mining, refining, and processing in its own hemisphere. If friendly-shoring can work, the United States may not be shut out of the critical minerals opportunity.

## FINANCIAL & POLICY SUPPORT FOR DEPLOYMENT

Pressure on governments and financial institutions seems aimed primarily at restricting investments in new dirty energy as opposed to scaling up investments in the transition, but more attention is still needed on the latter. Analyses of investments needed to achieve net-zero in 2050 show that the levels of investments in oil and gas are currently about where they should be, whereas there is significant underinvestment in clean energy.

Major developed country governments are more willing than in the past to write large checks and spend lots of money. This window of opportunity will not last forever, and it either could be used effectively or could crowd out private investments and waste taxpayer dollars. Structured discussions are not occurring between energy professionals and macroeconomists about how to optimize this opportunity. The focus in Washington, DC, for instance, has been more about the number of dollars spent on climate than on how they are spent. When macroeconomists approach the topic of climate change, it is usually through a lens of whether a given set of policies will be favorable or detrimental to economic

growth. An unaddressed aspect is that countries during the pandemic have accumulated high levels of public debt and fiscal deficits, yet the investments needed for the energy transition will require further increases in debt. It is not clear if that will be fiscally sustainable.

The checks that governments write can be vital in deploying clean technologies. For example, the investments in the Build Back Better bill, if it passes, could provide significant incentives to deploy available technologies and advance innovation to bring down the cost of technologies not yet available. Both are needed, but it is important to recognize that it can take decades from when something is discovered to when it becomes useful and applicable in the world. For climate purposes, that means that what exists today is what is available to solve the problem in the near term.

**The checks that governments write can be vital in deploying clean technologies.**

Finance is just one of the ways that governments have a role in creating the enabling environment that allows the energy transition to proceed. Another is ensuring that infrastructure can get the permits to be built. In the United States, it is as hard to get permits to build green infrastructure as it is for fossil infrastructure. Reforms in the environmental review and permitting processes are needed or little infrastructure of any kind is going to get built. This is not unique to the United States; democracies in general need legal and regulatory innovation to get clean energy projects built.

In undertaking efforts to spur clean energy technology deployment, there are important considerations that governments must keep in mind. For example, whether a jurisdiction is building out a hydrogen hub with CCS or is expanding mining for critical minerals, there is a human cost to consider in terms of impacts on the environment and communities. As these efforts scale up and accelerate, the goal should be to do them in ways that protect human health, well-being, equity, and justice better than the fossil system did. In addition, an underappreciated challenge of the energy transition is the need to accelerate the turnover of existing capital stock. Even if everything built from now on is zero-carbon, the existing stock of factories, power plants, cars, and so forth would still exceed the carbon budget. Clean energy deployment is only part of the challenge.

# THE GEOPOLITICS OF THE ENERGY TRANSITION

The geopolitics of energy are usually thought of largely with respect to oil and, more recently, gas. The energy transition, however, will create new risks and concerns. These geopolitics will involve new energy sources and actions by different countries and actors to hasten or thwart decarbonization. There will be transition geopolitics on top of oil and gas geopolitics for decades, and these will complicate, reinforce, and cancel each other out in various ways. Failure to seriously consider and anticipate the geopolitical, national security, and economic risks that will arise in the energy transition could undermine the pace and will to move ahead with the transition.

## THE GEOPOLITICS OF OIL & GAS

Counterintuitively, the geopolitics of oil and gas during the transition may intensify rather than diminish. The conventional wisdom is that oil-and-gas-producing states will be losers in the transition. There will likely be some of that, especially in countries that are higher-cost producers with weaker institutions and an inability to diversify their economies. What is more likely, though, is that certain oil and gas states will increase their geopolitical influence during the transition. As oil and gas volatility increases, more countries will be looking to oil and gas states for rescue, and that influence will intensify. The energy crisis in Europe demonstrates this, with Russia back in the business of gas geopolitics. Likewise, even as the world consumes less oil, more of that oil will be produced by countries such as Saudi Arabia, giving them more market share and influence.

**Counterintuitively, the geopolitics of oil and gas during the transition may intensify rather than diminish.**

The issue may be less about winners and losers than about strategic choices that oil-exporting countries have. Many exporters have strong competitive advantages in both traditional and new energies, and some oil exporters are evolving to respond to transition challenges. The most obvious strategy is to diversify economies, but this is not easy. Despite decades of trying, most countries in the Middle East have failed to reduce their reliance on oil revenues. Diversifying away from the oil and gas sector may not be realistic and may be suboptimal; exporters can leverage their core strengths and assets to capture the opportunities that will arise in traditional energy. There are very good returns to be had in the oil market over the next decade, and whoever has the cheapest oil will win out. Countries such as Saudi Arabia and the United Arab Emirates could decide not to invest or could increase investment to meet oil demand, and each choice has costs and benefits. Increasing investments could yield higher revenues in some scenarios, but increasing productive capacity could lead to stranded assets if demand turns out to be weaker. Given the low cost of production in the Gulf, though, the risks are low. The idea that countries will exit from a strategic sector that generates so much revenue and is a source of core competitive advantage is unrealistic. Oil and gas revenues have led Russia and Saudi Arabia to go into budget surpluses recently, and petrostates will protect what makes them rich.

The energy transition poses economic and geopolitical challenges, but Gulf exporters are not standing still. Petrostates have been continuing what makes them rich while also investing in new technologies, with oil and gas revenues providing the capital to invest in diversification and the transition. There is great potential in the Gulf to invest in solar and wind, and investment there should accelerate, though the margins cannot fully substitute for hydrocarbon rents. There

have also been recent announcements in the Gulf of large hydrogen and ammonia projects that leverage existing expertise on liquids and export infrastructure. In addition, exporters should work toward ensuring production of their core hydrocarbon products can compete on the emissions front. This means investments in CCS to prove it at scale, reduce costs, and develop business models around it. There have also been investments in chemicals manufacturing and other technologies to convert hydrocarbons into highly valued things with no emissions. Decoupling growth in oil and gas from growth in emissions is essential to increasing the competitiveness of the sector.

The picture is less clear for developed countries, such as the United States, that are producers and want to be leaders on the climate agenda. It is hard to imagine that the United States would voluntarily decide to put itself back in the early 2000s, when a large majority of the oil it consumed came from abroad, but it is possible that politics and pressure to decarbonize could outweigh national security considerations. In a world of declining oil demand, those that continue to produce could be those with the lowest cost and lowest carbon intensity whose politics and markets still allow production. Already, U.S. shale has seen significant underinvestment in upstream hydrocarbon production over the past few years due to investor pressure for greater returns. The new model taking hold in U.S. shale is a focus on giving money back to investors, and the shift from growth investors to dividend investors means companies that would have once invested all of their returns are now only investing a portion, with the rest going to dividends and buybacks. In addition, activist shareholders are forcing Western companies to divest from oil and gas producing assets, and those producing assets are often being taken over by local entrepreneurs, private actors, and national oil companies, which will produce and refine the oil at low cost — probably with less ethical concern and certainly with less transparency.

**As Western companies divest their oil and gas assets, global energy geopolitics shift.**

As Western companies divest their oil and gas assets, global energy geopolitics shift. For example, over the past decade, U.S. and Canadian oil and U.S. and Australian gas played big roles in constraining the power of Russia. If those countries limit production, the global market structure and the strategies of OPEC+ change. If it is known that no new Western oil or gas is coming into the market, the other players do not have to bother pushing prices down. The effects of that on the energy transition are unclear. High prices may accelerate the transition by making alternatives more competitive (and would also have big macroeconomic implications and hinder energy access), or they may slow the transition if they spur greater consumer and political pushback against the transition.

## GEOPOLITICS OF CLIMATE CHANGE & CLEAN ENERGY

As the world decarbonizes, energy-related global trade is likely to shift away from fossil fuels and more towards critical minerals and alternative fuels. The conventional wisdom is that China will be a big geopolitical winner of the transition, but China's many advantages may be overstated. China's ability to manufacture clean energy technologies cheaply and its dominance in the critical minerals supply chain will give it the ability to create global headaches, but not disruptive control over the ability of economies to function in the same way that the daily flow of oil and gas currently can. That said, critical minerals can be relevant in geopolitical strategies and relationships. China, for instance, has been a big investor in Latin America, especially in the critical minerals space. At the same time, more and more countries and companies are reacting to China's dominance, creating new opportunities for substitutes. India, for example, is working to develop its renewables manufacturing ecosystem to become less reliant on imports from China.

Beyond China, clean energy trade could create shifts in geopolitical influence. Decarbonizing shipping and aviation, for example, will require alternative fuels such as hydrogen, and developing countries may have advantages in production of those fuels and could become net exporters. There could be geopolitical vulnerability for countries reliant on a small number of producers and shippers of green hydrogen, especially since a world with a well-supplied global integrated market for trade in ammonia is still a long way off.

Increased tensions between the developed and the developing worlds are likely during the transition. This is not just because the developed world is letting down the developing world on climate finance and urging the developing world to "leapfrog" to cleaner sources, but also because of the unequal speed of the energy transition in advanced and developing economies. The developed world is likely to move in the direction of using more tools to compel others to decarbonize — penalties, in addition to incentives — which will exacerbate relationships with the developing world. The geopolitics of a coal phaseout globally, for instance, could depend on how rapid the phaseout is, how it is managed, how countries such as China and India are induced, whether coercive measures are utilized, and so forth. Border carbon adjustments are already gaining traction and could theoretically evolve into economic sanctions for countries that are not strong enough on climate.

**Those not part of the solution may pay a significant penalty in their international relationships.**

That idea seems far-fetched today, but it may not in the future. Oil, gas, and coal use are going up globally, as are emissions. There is no meaningful energy transition yet. The pace of change today is totally insufficient to achieve climate goals, but the story may change, with significant implications for when, how, and how much energy geopolitics change. People tend to exaggerate the pace and scale of the energy transition in the short run but underestimate the pace and scale in the longer term. If one imagines a pathway even close to achieving a net-zero world by 2050, that means something fundamental has changed that leads to different politics and possibilities.

It is also important to recognize the geopolitical risks for the United States and other countries if they are not part of the solution on climate change. Those not part of the solution may pay a significant penalty in their international relationships. Part of America's geopolitical position depends on its perceived credibility as an international actor; being absent on one of the biggest issues is deeply harmful to its geopolitical position.

The rise of nationalism globally could also have significant impacts on geopolitics and the energy transition. It is a very strong global trend that may be accelerating. It may be that the world is moving to a place where being anti-green is a winning populist position. That may disrupt global supply chains and erode support for the international cooperation needed to address both energy poverty and climate change.

# APPENDICES: PARTICIPANT LIST

**Jason Bordoff**, Founding Director, Center on Global Energy Policy, Columbia University (*Co-Chair*)

**Damilola Ogunbiyi**, CEO and Special Representative of the UN Secretary General, Sustainable Energy for All (SEforALL) (*Co-Chair*)

**Brian Anderson**, Director, National Energy Technology Laboratory, U.S. Department of Energy

**Morgan Bazilian**, Professor of Public Policy, Payne Institute For Public Policy At The Colorado School Of Mines

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**Chris Chijiutomi**, Head of Infrastructure Equity, CDC Group PLC

**Anne-Sophie Corbeau**, Senior Research Scholar, Center on Global Energy Policy, Columbia University

**Adam Czetwertyński- Guibourge**, Undersecretary of State, Ministry of Climate and Environment, Republic of Poland

**Skye D'Almeida**, Investor Coverage, Generate Capital

**Kaushik Deb**, Senior Research Scholar, Center on Global Energy Policy, Columbia University

**Daniela Desormeaux**, Director, Minerals & Sustainability, Vantaz Group

**Renwick DeVille**, Senior Advisor, Public & Governmental Affairs, Golden Pass LNG

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**Mark Gallogly**, Co-Founder, Three Cairns Group

**Paula Gant**, Senior Vice President, Strategy & Innovation, Gas Technology Institute

**Greg Gershuny**, Executive Director, Energy and Environment Program, The Aspen Institute

**Sherri Goodman**, Secretary General, International Military Council on Climate & Security

**Deborah Gordon**, Senior Principal, Rocky Mountain Institute

**Tim Gould**, Chief Energy Economist, International Energy Agency

**Kevin Greene**, Senior Analyst, Strategy, Tellurian Inc.

**Dave Grossman**, Principal, Green Light Consulting (*Rapporteur*)

**Meade Harris**, CEO, The Hawthorn Club

**Matthew Harris**, Co-Founder, Global Infrastructure Partners

**Britney Head**, Safety, Health, and Environmental Manager, Golden Pass LNG

**Lucy Heintz**, Partner, Head of Energy Infrastructure, Atcis

**Heidi Heitkamp,** Founder, One Country Project

**Andrew Herscowitz**, Chief Development Officer, U.S. International Development Finance Corporation

**Sharon Ikeazor**, Minister of State for Environment, Federal Ministry of Environment Nigeria

**Amy Jaffe**, Managing Director, The Fletcher School at Tufts University

**Maria Jelescu**, Founder and CEO, Ardinall Investment Management

**Andrew Kamau**, Principal Secretary, State Department of Petroleum, Ministry of Petroleum and Mining, Republic of Kenya

**Brian Kelly**, Vice President Global Public Policy and Government Affairs

**Randall Kempner,** Senior Advisor, Energy & Environment Program, The Aspen Institute

**Chris Kendall**, President & CEO, Denbury Inc.

**Jake Levine,** Chief Climate Officer, U.S. International Development Finance Corporation

**Melissa Lott**, Director of Research and Senior Research Scholar, Center on Global Energy Policy, Columbia University

**Mark Lundstrom**, Founder & CEO, Radia, Inc.

**Ajay Mathur**, Director General, International Solar Alliance

**Zodwa Mbele**, Group Executive, Transacting, Development Bank of Southern Africa

**Catherine McKenna**, CEO, Climate and Nature Solutions

**Espen Mehlum**, Head of Energy, Materials and Infrastructure Program, Benchmarking and Regional Action, World Economic Forum

**Tatiana Mitrova**, Professor, Energy Centre, Skolkovo Moscow School of Management

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**Kelly Sims Gallagher**, Academic Dean & Professor, The Fletcher School at Tufts University

**Gauri Singh**, Deputy Director-General, International Renewable Energy Agency

**Sumant Sinha**, CEO, ReNew Power

**Kirsten Smith**, Research Associate, Center on Global Energy Policy, Columbia University

**Vera Songwe**, Executive Secretary, United Nations Economic Commission for Africa

**Charif Souki**, Executive Chairman, Tellurian Inc.

**Beth Trask**, Associate Vice President, Energy Transition, Environmental Defense Fund

**Jessica Uhl**, Chief Financial Officer, Royal Dutch Shell

**Zainab Usman**, Director of the Africa Program, Carnegie Endowment for International Peace

**Dymphna Van Der Lans**, CEO, UN Foundation - the Clean Cooking Alliance

**László Varró**, Vice President, Global Business Environment, Royal Dutch Shell

**Clint Vince**, Chair, US Energy Practice, Dentons

**Jim Walker**, Senior Director, SEforALL

**Kirsten Westphal**, Senior Associate, Stiftung Wissenschaft und Politik

**Priyantha Wijayatunga**, Chief of Energy Sector Group, Asian Development Bank

# APPENDICES: AGENDA

## TUESDAY, NOVEMBER 30

**Welcome: Greg Gershuny**, Aspen Institute Energy and Environment Program
**Introduction:**
**Damilola Ogunbiyi,** Sustainable Energy for All (SEforALL)
**Jason Bordoff**, Columbia University Center on Global Energy Policy (CGEP)

**SESSION ONE: Making Progress for People and the Planet**
The year 2020 will be remembered forever as the year when Covid-19 (coronavirus) dominated the world stage, amplifying the effects of the oil price war initiated by Saudi Arabia and Russia. How will markets respond in 2021 as supply and demand re-balance after 2020's crash in global oil prices, as well as uncertainty about economic recovery? How profound will be the financial reckoning in the US shale patch? What will 2021 bring for OPEC? Will the OPEC+ collaboration persist?

**Moderator: Jason Bordoff** and **Damilola Ogunbiyi**

**Discussants:**

**Charif Souki**, Tellurian Inc.
**Gauri Singh**, International Renewable Energy Agency
**Tim Gould**, International Energy Agency
**Vera Songwe**, United Nations

**SESSION TWO: Understanding the Current Energy Supply Crisis**
A confluence of demand recovery, supply constraints, weather impacts, political factors, production issues, and other factors have turned the second half of 2021 into a time of dramatic energy price rises around the globe, and significant concerns over the adequacy of supply. Prices for natural gas, coal, and electricity have risen precipitously, creating acute stresses for consumers, especially those reliant on spot markets. Is this sudden tension an aberration or the new normal? Will the current supply crisis subside in the northern hemisphere's springtime, or not so quickly?

**Moderator: Jason Bordoff** and **Damilola Ogunbiyi**

**Discussants:**

**Edward Morse**, Citigroup, Inc.
**Anne-Sophie Corbeau**, Columbia University Center on Global Energy Policy
**Tatiana Mitrova**, Skolkovo Moscow School of Management

**SESSION THREE: The Role of Natural Gas in a Time of Surging Prices and Net-Zero Targets**
In the autumn of 2021, a variety of market, policy, political, and other factors has triggered a dramatic run-up in prices for natural gas all across the world. Seemingly overnight, public concern has started shifting from whether there is enough room remaining in the global "carbon budget" to permit natural gas usage to whether there is enough global natural gas supply to keep the lights and heat on. Can natural gas prices be expected to return to more typical gas prices in 2022? Will concerns such as methane leakage return to the fore in OECD countries? Will poorer countries have access to natural gas-fired power as a key element of their clean energy transitions?

**Moderator: Damilola Ogunbiyi**

**Discussants:**

**Sharon Ikeazor,** Federal Republic of Nigeria
**László Varró**, Royal Dutch Shell
**Deborah Gordon**, RMI
**Brian Kelly**, Sempra

## WEDNESDAY, DECEMBER 1

**SESSION FOUR: Getting Past Coal – The Practicalities**
Recent global energy supply tensions have underscored that, whether we like it or not, many parts of the world and especially non-OECD countries rely on coal as a pillar of the energy economy. Coal employs millions of people in mines, rail transport, and power plants. Coal also plays important roles today in heavy industry, such as steel, but from mine mouth to smokestack, coal results in methane emissions from mines, local air pollution, and CO2 emissions that are warming the planet. Transitioning beyond coal will therefore entail addressing a mix of environmental, financial, technological, economic, and socio-political challenges. What specific tools and approaches are being employed most effectively to facilitate the sunsetting of the global coal sector and to do so without leaving the coal-related workforce as collateral victims? Do we need to preserve some coal capacity to provide security in times of unforeseen energy market instability?

**Moderator: Jason Bordoff**

**Discussants:**

**Adam Czetwertyński-Guibourge**, Ministry of Climate and Environment, Republic of Poland
**Catherine McKenna**, Former Minister of Infrastructure and Communities, Canada
**Priyantha Wijayatunga,** Asian Development Bank
**Kelly Sims Gallagher**, The Fletcher School at Tufts University

**SESSION FIVE: Deployment at Scale – Key Clean Energy Technologies**
The quest for climate solutions can be seen as a footrace: Can countries deploy a range of zero-carbon technologies quickly enough – and at costs that are affordable to people all around the globe? Predicting today what the energy resource mix will be at mid-century is a tough task – especially given widely varied conditions and requirements in different countries and regions. Some key zero-carbon sources, including wind and solar technologies, are competitive in many markets today though they may require companion investments in grid development and/or storage. Other clean energy technologies are pre-commercial today and sustained investments if they are to deliver material climate benefits. What are the prospects for the build-out of renewable power systems and the development of hubs and other market features to enable the scaling of carbon capture, utilization, and sequestration, as well as zero-carbon hydrogen and advanced nuclear power?

**Moderator: Jason Bordoff**

**Discussants:**

**Sumant Sinha**, ReNew Power
**Kirsten Westphal**, German National Hydrogen Council
**Daniela Desormeaux**, Vantaz Group
**Ray Rothrock**, RedSeal Inc.

**SESSION SIX: Growing Clean Energy Investment in Developing Countries**
Developing countries need to achieve much greater levels of clean energy investment in order to facilitate job creation, poverty reduction, and economic growth in concert with climate protection. What combinations of policies, institutional structures, financial tools, and both domestic and international sources of capital can enable clean energy development in developing countries? What obstacles must and are being addressed most effectively, and by whom? What essential steps are not currently taking place quickly enough to enable investment at scale?

**Moderator: Damilola Ogunbiyi** and **Jason Bordoff**

**Discussants:**

**Matthew Harris**, Global Infrastructure Partners
**Chris Chijiutomi**, CDC Group plc
**Zodwa Mbele**, Development Bank of Southern Africa
**Jake Levine**, U.S. International Development Finance Corporation

**SESSION SEVEN: The New Geopolitics of the Energy Transition**
The political and security ramifications of the global energy economy – and especially the global oil market -- have occupied a central role in international security since the 1970s. As countries chart a course to mid-century climate goals, a time of fundamental change awaits for the global energy economy, and these changes will play out in terms of the political and security relationships related to energy. How will the goal of reduced reliance on petroleum affect energy geopolitics? How will the growth in demand for critical minerals (from rare earth elements to copper) translate into new power relationships? How will the pace of the clean energy transition affect those geopolitics? Can policymakers pursue the clean energy transition in a manner that diminishes market volatility, and therefore reduces geopolitical uncertainty?

**Moderator: Jason Bordoff**

**Discussants:**

**Meghan O'Sullivan**, Harvard Kennedy School of Government
**Bassam Fattouh**, Oxford Institute of Energy Studies

## THURSDAY, DECEMBER 2

**9:00 – 10:30 AM MST** **WRAP UP - Putting it all together**
**Moderators: Jason Bordoff**

**11:00 AM MST** **FORUM ADJOURNS**

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