CQ RESEARCHER
CQPRESS
In-depth reports on today's issues

Geopolitics of Green Energy

Nov. 18, 2022 • Volume 32 • Issue 39

Will some smaller countries become new power brokers?

By Edward DeMarco

The oil-dominated geopolitical order is changing as countries embrace carbon-free energy sources to reduce climate-warming greenhouse gas emissions. That transition has produced tensions, in part due to the need for rare earth minerals used in clean energy technologies, such as these wind turbines and solar panels near Klettwitz, Germany. (Getty Images/Sean Gallup)

The postwar, U.S.-dominated geopolitical order shaped by oil is yielding to a new system built on carbon-free renewable energy and electric vehicles. In the emerging international scramble for so-called green energy, China is leading, with its control over many supplies of minerals essential for batteries, wind turbines and other technologies. China is also key to addressing climate change because its coal-powered economy creates more planet-warming greenhouse gas emissions than any other country. To counter China, the United States is rallying allies and friendly mineral-rich countries to forge alternative supply chains that can enable green energy industries to scale up. And, faced with Russian aggression in Ukraine, Europe is shedding energy ties to Moscow and expanding its domestic wind and solar power sources. Clean hydrogen may also create new energy powers — from Australia to Chile and Africa — as industrial demand for fossil-free energy surges. Competition extends into the Arctic, where retreating ice is spurring the hunt for green energy minerals. While the transition will take decades, the rules of the game are being set now — in Beijing and Washington.

U.S. Secretary of State Antony Blinken, center, speaks at the Minerals Security Partnership meeting on the sidelines of the U.N. General Assembly in New York in September. Participants included ministers from Australia, Britain, Canada, France, Japan, South Korea and African mining nations. (AFP/Getty Images/Craig Ruttle)

The Issues

In late September, as Russia was calling up 300,000 military recruits to overcome battlefield losses in Ukraine, and Europe coped with shrinking Russian natural gas supplies due to the war there, U.S. Secretary of State Antony Blinken convened a little-noticed meeting in New York on the sidelines of the U.N. General Assembly.

Attending were ministers from mineral-rich U.S. allies Canada and Australia, along with Britain, France, Japan and South Korea — all among the world's 10 largest economies.

Alongside them sat envoys from other mining nations, including Brazil, Argentina and five African countries — Democratic Republic of Congo, Mozambique, Namibia, Tanzania and Zambia — whose mineral exports are needed for the coming transition from globe-warming fossil fuels to green energy. Those minerals range from lithium and copper used in electric vehicles, to platinum needed for batteries and neodymium required for wind turbine magnets. [1] (*See Short Feature.*)

The African and South American mining nations, along with Mongolia, joined members of the newly formed Minerals Security

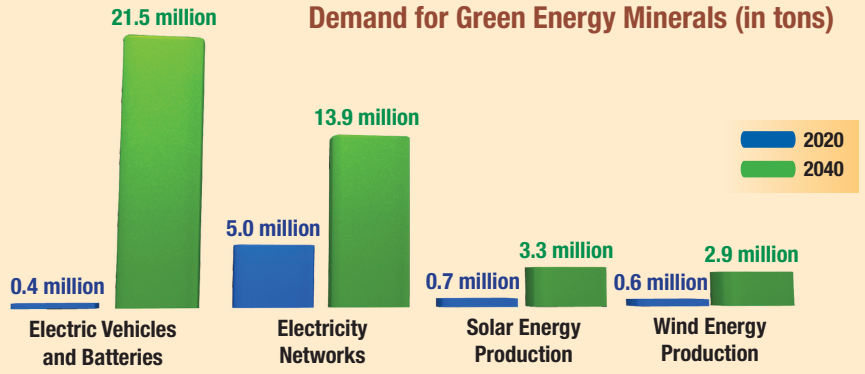
Partnership, which will offer financing, loan guarantees and technical assistance to accelerate the production of key minerals needed for electric vehicles and to boost solar and wind power. The initiative, said Blinken, is needed because "critical mineral supply chains are simply vital to our shared future." [2]

In his opening remarks, Blinken did not mention the biggest economy absent from the table — China — whose sizeable control over the global supply of minerals needed for green energy technologies has many of the ministers worried about the international security implications.

As countries deal with increasingly intense storms, droughts, rising seas, human migration and conflict caused by a warming planet, the transition to green energy to reduce emissions of carbon dioxide and other so-called greenhouse gases is reshaping the U.S.-dominated, post-World War II geopolitical system. That system is rooted in the use of fossil fuels — oil, natural gas and coal — the major sources of those emissions. The transition to a carbon-free economy has strengthened the power of China, which controls a large percentage of the world's green energy minerals and has massive investments in carbon-free technologies and electric cars. [3] Many governments worry that China could use its dominance in the green energy market for geopolitical leverage.

Demand for Green Energy Minerals Rising

While millions of tons of minerals are already used each year for clean energy purposes, demand is expected to increase significantly over the next two decades, according to the International Energy Agency. Electric vehicles, electric power networks and solar and wind energy production all require certain key minerals, such as copper, nickel, lithium and graphite, to function.



Source: "Total mineral demand for clean energy technologies by scenario, 2020 compared to 2040," executive summary, International Energy Agency, 2021, https://tinyurl.com/4sp22vwn

"We'll stand together with others against economic coercion and intimidation," Blinken said in May, explaining the new U.S. partnership during a China policy speech. "We'll boost supply chain security and resilience by reshoring production or sourcing materials from other countries in sensitive sectors like pharmaceuticals and critical minerals, so that we're not dependent on any one supplier." [4]

As Washington and Beijing race to establish a framework for that emerging green energy system, other countries — such as Australia, Chile and several African nations — could become consequential energy players.

The joining of economic and mining powers under U.S. leadership highlights the geopolitical shift under way as the world aims to reduce human-caused carbon emissions to "net zero" in the second half of this century, a goal established by the 2015 Paris climate agreement. To achieve that goal, 195 countries pledged to limit the increase in the global average temperature to "well below" 2 degrees Celsius (3.6 degrees Fahrenheit) above preindustrial levels. But even that 2-degree rise, the U.N.'s Intergovernmental Panel on Climate Change (IPCC) warned, would intensify heat, drought and rainfall, harm ocean life and double the share of plants, insects and vertebrates at risk of losing most of their habitat. [5]

In its 2022 update, the IPCC said achieving the net zero goal would require "a rapid acceleration of mitigation efforts after 2030," but some models say the world may not reach the goal until the early 2070s. For example, China, the world's largest carbon dioxide emitter, does not intend to reach its peak carbon emissions before 2030 and will not achieve net zero carbon emissions before 2060. [6]

Given this timeline, the uncoupling of international fossil fuel alliances will take longer than many green advocates and activist governments would like, experts say. As a result, the two geopolitical systems — one seven decades old and built on oil and an emerging one shaped by the sun, wind and key minerals — are likely to co-exist for some time.

The realization that oil and natural gas are likely to continue to play a major role in the energy economy is an unwelcome reality in many places, including Europe, says former U.S. Energy Secretary Ernest Moniz, chief executive of the Energy Futures Initiative, a clean energy advocacy group in Washington. It "has elevated the

importance of more seriously defining the multi-decadal clean energy transition, rather than a simple-minded focus by many on the net-zero end state."

For example, U.S. crude oil production is forecast to reach a record 12.3 million barrels a day in 2023, while the U.S. share of electrical power generated by renewable energy — solar, wind and hydropower — will increase from 20 percent in 2021 to 24 percent in 2023, according to the U.S. Energy Information Administration. [7]

And while renewable sources will generate more U.S. electricity than coal this year, China still depends on the fuel for more than 60 percent of its electricity and plans to increase that usage through 2030. Coal-generated electricity powers the growing number of electric vehicles on Chinese streets. This year, a quarter of all new cars bought in China will be electric or plug-in hybrids, served by about 4 million charging units, double the total a year ago. The United States is far behind, with about 140,000 charging units. [8]

Reaching net zero by 2050 "requires nothing short of a total transformation of the energy systems that underpin our economies," said the International Energy Agency, a research and coordination organization whose 31 member countries include the United States, Britain, France, Italy, Japan and Germany. [9]

A man charges an electric bus in Wuhan, China. Although a quarter of China's new cars are electric or plug-in hybrids, most of the electricity for the country's 4 million charging stations comes from coal-fired power plants. (Getty Images/Visual China Group)

Japan, the world's third largest economy, exemplifies the emerging choices at the intersection of energy and national security. Since the Fukushima nuclear power plant disaster in 2011 caused Japan to reduce its reliance on nuclear power, the country has depended on gas and coal to generate electricity, according to IEA data. Yet Japan is pivoting toward green energy, notably hydrogen, and collaborating with developing nations in Asia to accelerate its transition toward carbon neutrality. [10]

Concern about energy security is also forcing countries to recalculate the geopolitical equation in favor of renewables. Russia's war in Ukraine exposed Europe's dependence on Russian gas supplies and prompted a rapid shift of strategy toward renewables. Germany is expanding its wind energy to further displace fossil fuels. [11]

The war itself may have broken out in part due to international competition for green energy minerals. Some analysts cite the European Union's 2021 deal to access Ukrainian minerals used in electric vehicles — such as lithium, cobalt and so-called rare earth elements — as a possible factor in Russia's decision to invade. Rare earths are 15 lesser-known metals such as neodymium and terbium valued for their magnetic and optical properties. [12] (*See Short Feature.*)

As the effects of climate change intensify in developing countries, the United States by 2030 is likely to face a high risk of climate-related demands for financing and technology assistance, an influx of climate refugees and a greater need to supply aid and humanitarian relief, according to a U.S. national intelligence estimate. [13]

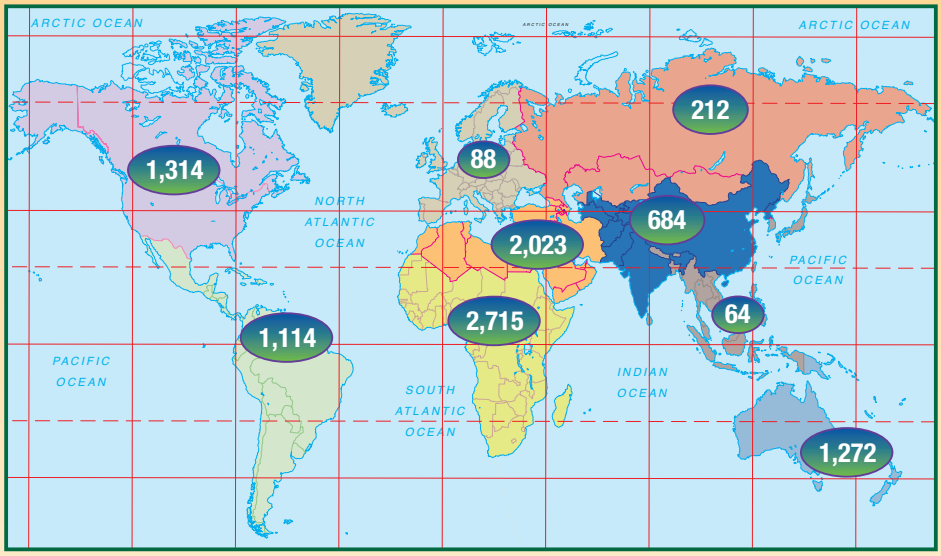
"Geopolitical tensions are likely to grow as countries increasingly argue about how to accelerate the reductions in net greenhouse gas emissions needed to meet Paris Agreement goals," the National Intelligence Council said last year. "Debate will center on who bears more responsibility to act and to pay — and how quickly — and countries will compete to control resources and dominate new technologies needed for the clean energy transition." [14]

At November's 27th conference of parties to the U.N. climate convention (COP27) in Egypt, debate centered on how industrialized countries that generate the bulk of greenhouse gas emissions should compensate developing nations — which spew far less carbon dioxide and methane into the atmosphere — for climate-related damages. Seventeen of the world's 20 most climate-vulnerable countries are in Africa.

Africa Has the Most Potential to Produce Green Hydrogen

Sub-Saharan Africa has the greatest potential of any region in the world to produce inexpensive "green" hydrogen fuel — extracted from water using renewable energy — by 2050, according to the International Renewable Energy Agency. In this map, the amount of energy potential is measured in exajoules, a unit of electrical energy.

Potential for Producing Green Hydrogen in Exajoules, by 2050
(for under $1.50/kg)



Source: "Geopolitics of the Energy Transformation: The Hydrogen Factor," International Renewable Energy Agency, 2022, p. 45, https://tinyurl.com/yuusz8ka

"The most valuable contribution that developed countries can make is to reduce their emissions faster while investing in Africa to build sustainable, green power," Rwanda President Paul Kagame said at the gathering. "Questioning whether Africa is ready to make use of climate finance should not be used as an excuse to justify inaction." [15]

Meanwhile, among the new arenas for global competition are mineral- and sun-rich Africa, as well as the Arctic, where shrinking seasonal ice is opening new shipping channels and aiding the hunt for green energy minerals and untapped oil and gas. (*See Short Feature.*)

With the world's largest solar energy potential, Africa could strengthen its geopolitical position as other countries jockey to access the continent's green energy minerals and seek to convince Africans to protect their carbon-absorbing rainforests. [16]

One encouraging sign: Hydrogen — the most abundant element in the universe — can be extracted from water to produce a clean fuel. The investment bank Goldman Sachs said $5 trillion may be needed to develop "clean" hydrogen as a fuel source, which could help cut greenhouse gas emissions about 15 percent "while becoming a key pillar of the energy mix." [17] And hydrogen production is arriving at commercial scale in countries as far-flung as Australia and Namibia.

Dozens of countries, including Germany and Japan, have rolled out strategies to harness hydrogen for industrial use and transportation, while stepping up diplomatic outreach to future exporters. The idea is to use renewables such as solar energy to extract "green" hydrogen gas from fresh or salt water through electrolysis, then transport the gas through pipelines or, in liquified form, by ship to industrial markets. The Hydrogen Council, a Brussels-based industry group promoting hydrogen-based energy, said 680 large-scale projects are planned worldwide in this decade, up 50 percent from a year ago. Based on planned hydrogen projects, global capacity could reach 134 gigawatts in 2030, from around 1 gigawatt this year, according to the International Energy Agency. [18]

As energy strategists, investors and policymakers strive to understand the scale, sources and sequencing of this transition and the countries poised to benefit, these are some of the questions on their agendas:

Will China dictate the pace of the world's transition to green energy?

In August, China suspended climate talks with U.S. presidential climate envoy John Kerry after House Speaker Nancy Pelosi arrived in self-governing Taiwan, a visit the Chinese government called an affront to its "one China" policy that claims Taiwan as part of China. [19]

An announcement that the talks would resume came on Nov. 14 after the first face-to-face meeting between U.S. President Biden and China's President Xi Jinping in Indonesia, a hopeful signal for advocates of more aggressive action on climate change who were meeting at the same time in Egypt at COP27. [20]

China and the United States had issued a joint declaration in late 2021 on the "seriousness and urgency of the climate crisis" and committed to accelerated actions and cooperation in the 2020s on

reducing greenhouse gases, especially methane, and speeding up the shift to renewable energy. [21]

"Methane is 80 times more potent than carbon, and it accounts for nearly half of the net warming we're experiencing now," Biden told the COP27 meeting on Nov. 11. "So, cutting methane by at least 30 percent by 2030 can be our best chance to keep within reach of 1.5 degrees Celsius target." [22]

The world's energy transition would be eased if the United States and China "cooperate substantially, including in technology transfers, both ways," but rising tensions between the two countries made that unlikely, says Henry Lee, director of the environment and natural resources program at Harvard University's Belfer Center for Science and International Affairs.

Lithium mines, such as this one in Chile's Atacama Desert, provide a key element needed for green technology such as electric vehicles. China currently has a lock on the lithium-ion battery supply chain, prompting the United States and others to seek alternate supplies. (Getty Images/John Moore)

Chinese control over key minerals used in electric vehicles and other green technologies sharpen the divide, as reflected in the aim of the U.S.-led Minerals Security Partnership to create alternative supplies. Currently, China refines 68 percent of the world's nickel, 40 percent of copper, 59 percent of lithium and 73 percent of cobalt, according to the Brookings Institution in Washington. China also controlled 79 percent of lithium-ion battery manufacturing in 2021. [23]

The United States relies totally on imports for 14 "critical" minerals, including graphite, manganese, niobium and rare earths, and depends on imports for more than 75 percent of 10 others, according to congressional researchers. [24]

"This is China's hegemonic weapon," says James Kennedy, a consultant on rare earth elements, such as dysprosium, used to strengthen magnets for vehicles and wind turbines. [25] "The U.S. uses oil and the dollar as hegemonic tools. China is using critical materials as a hegemonic tool."

In September 2020, President Donald Trump issued Executive Order 13953, which declared that U.S. dependence on "foreign adversaries" for critical minerals was a national emergency. Trump said China had used "aggressive economic practices to strategically flood the global market for rare earth elements and displace its competitors," while coercing industries that rely on these elements to locate in China. [26]

Countries key to the minerals-security initiative buttressed the U.S. stance. In June, Canada called for advanced economies to prioritize creation of critical mineral supply chain resilience for lithium, graphite, nickel, cobalt, copper and rare earths. Britain published a similar strategy document in July. [27]

In August, the European Union said China's control of critical minerals posed a risk of supplies being "used as a geopolitical leverage, for instance through export restrictions." [28]

"We are much more dependent on those critical minerals in comparison to oil and gas," raising concerns if relations with China deteriorate, says Sergey Paltsev, deputy director of the Joint Program on the Science and Policy of Global Change at the Massachusetts Institute of Technology (MIT).

As the green energy transition accelerates, Chinese companies are securing their international positions. CATL, the world's biggest electric-vehicle battery maker, last year bought a minority stake in a copper and cobalt mine in Congo. It is setting up factories in Germany and Hungary and reducing carbon emissions in its batteries to meet U.S. and European standards. [29]

However, says the Belfer Center's Lee, while China will have a major influence on the green transition, "I don't think any one country will dictate the pace" of it. "You're looking at a machine with many moving parts."

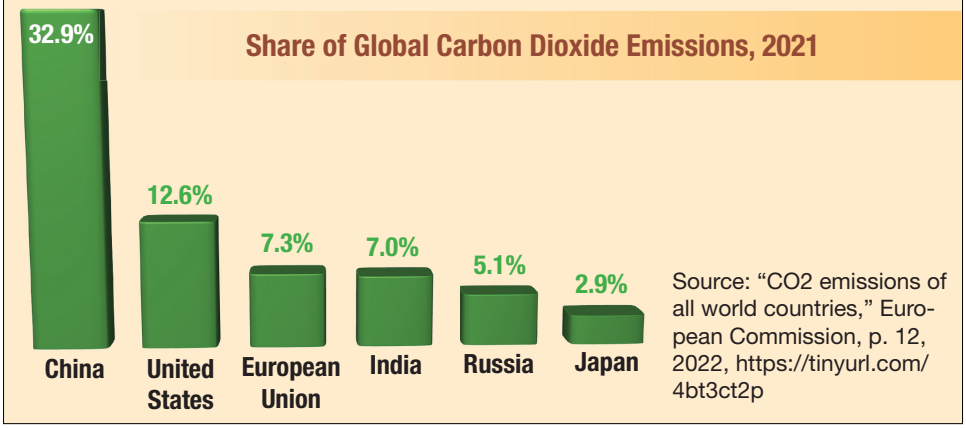
As China flexes its muscles in renewable energy and electric vehicles, it also depends on coal to provide electricity for those cars as it ramps up the use of wind and solar. During his Oct. 16 speech to the Chinese Communist Party congress, Xi pledged to "push forward the clean and low-carbon transition" in industry, transportation and construction, but admitted China would also need to step up its use of fossil fuels. "Coal will be used in a cleaner and more efficient way, and greater efforts will be made to explore and develop petroleum and natural gas, discover more untapped reserves, and increase production," Xi said. [30]

That tighter embrace of fossil fuels, however, could diminish China's influence over the transition from carbon-based fuels.

Stabilizing carbon emissions in 2030, says Neil Hirst, a senior policy fellow for energy and mitigation at Imperial College London, is "a tough call for the Chinese," because of economic growth and social progress considerations.

China Emits the Most Carbon Dioxide

The world's leading emitter of planet-warming carbon dioxide is China, followed distantly by the United States and the 27 countries that make up the European Union. In recent years, China has accounted for a growing share of the world's total carbon emissions.



Source: "CO2 emissions of all world countries," European Commission, p. 12, 2022, https://tinyurl.com/4bt3ct2p

The boost in coal use will raise China's carbon emissions by 1.5 to 2.5 percent by 2025 — above prior estimates — although long-term, carbon-reduction targets should still be viable, says Yang Fuqiang, a senior adviser on climate change and energy transition at Beijing University's Institute of Energy. "Coal will not go away very soon," he says. "It will last several decades." In his projections, coal will still account for 7 to 10 percent of total Chinese energy production in 2050.

China's renewed commitment to coal contrasts with Xi's 2021 announcement at the United Nations that China would no longer build coal projects abroad. [31]

The Climate Action Tracker, produced by German researchers, rates China's target for reduced greenhouse gas emissions as "highly insufficient" and said that "if all countries followed the level of ambition implicit in this development, it would lead to a warming of 3°C degrees globally," or 5.4 degrees Fahrenheit. [32] That is double the optimal Paris Agreement limit and would threaten a range of natural systems.

A study by the Australian Academy of Science found that just 3 degrees of warming would exacerbate heat waves and drought, diminish water supplies and have ecosystem-changing effects on forests, fisheries and ocean reefs. [33]

As climate worries escalate and energy goes green, China's neighbor and rival, India, may be the geopolitical wild card. Access to fossil fuels is crucial for India, the world's third-largest carbon dioxide emitter. As international pressure mounts to squeeze carbon out of the energy system, India will face challenges in energy-intensive industries such as iron and steel production, cement and chemicals, according to an MIT study. [34]

Still, India is accelerating its conversion to renewable energy, pushed by Prime Minister Narendra Modi's ambitions and tens of billions of dollars of planned investment from Indian billionaires. Solar and wind energy will become India's dominant power sources by 2050, while hydrogen use for transport will increase in this decade, according to The Energy and Resources Institute in New Delhi. [35]

The United States should "privately work behind the scenes to assist India with the larger policy dilemma about how to begin a transition into a cleaner, green economy and achieve it with American technology and private sector trade," said Tim Roemer, the former U.S. ambassador to India. "America needs to play this strategically for the long term — and not push India into the powerful gravitation of the China-Russia orbit." [36]

Can hydrogen diminish energy competition among nations?

At the World Hydrogen Summit, held in Rotterdam, Netherlands, in May, a futuristic city named Neom claimed a top prize for its plans to generate environmentally friendly hydrogen fuel. [37]

The accolade was less surprising than the place where Neom is being built: Saudi Arabia, one of the world's biggest producers of crude oil and natural gas. For decades, the Saudi kingdom has played a central role in the supply and pricing of the world's oil, making it a crucial geopolitical player.

During a July visit to Jeddah to confer with Crown Prince Mohammed bin Salman, President Biden and the Saudis signed a partnership to develop and finance clean energy sources, such as green hydrogen, nuclear and solar. [38]

Creating green hydrogen from water by using solar and wind energy to power electrolysis produces carbon-free energy that can be traded internationally. "By opening up the long-distance transport of sunlight and wind, hydrogen will become the new oil," energy executive Marco Alverá wrote in his 2021 book, *The Hydrogen Revolution.* [39]

Siemens Mobility unveils the first hydrogen-powered train in collaboration with German rail operator Deutsche Bahn in Krefeld, Germany, on May 5. Experts hope the use of hydrogen fuel, made from water, can reduce carbon emissions and ease global tensions spawned during the oil era. (AFP/Getty Images/Ina Fassbender)

"Green hydrogen is a huge growth area for us, and we believe it's going to be a contributor in the future economy and the future energy as we transition to a decarbonized world," Saudi Investment Minister Khalid al-Falih told *Bloomberg* in July. [40]

Saudi Arabia will be competing with a range of green energy newcomers. The United Arab Emirates, the world's seventh-largest oil producer, is forging a hydrogen partnership with the United

Kingdom. Hydrogen could enable the U.A.E. "to maintain or grow its geostrategic energy position despite global decarbonisation policies," said a study by the Dubai-based World Green Economy Organization. [41]

As an energy source that is created rather than extracted, hydrogen has raised hopes that it can dissipate global tensions spawned during the oil era. Italian energy researcher Marco Giuli said hydrogen is likely to "reduce the geopolitical sensitivity of energy trade" by focusing more on domestic needs than on "grabbing resources." [42]

Others are more cautious, however.

"Hydrogen will certainly play a significant role in decarbonizing multiple sectors of the energy economy," says Moniz, the former U.S. energy secretary. "However, arguing that it would eliminate geopolitical considerations is a step too far. Hydrogen should abate, but not eliminate, geopolitical competition."

Countries increasingly are focusing on building a global market for hydrogen and negotiating future trade deals. Germany has opened hydrogen offices in Nigeria and Saudi Arabia, with the goal, in part, of helping oil exporters adapt to the transition and reducing economic disruptions and security risks. [43]

Chile, which seeks to become a green hydrogen power in South America, is discussing with the Netherlands how to create "export-import corridors" between Chile and Europe. The European Union's energy strategy is to support three renewable hydrogen import corridors via the Mediterranean Sea, the North Sea and, "as soon as conditions allow, with Ukraine." [44]

Some say that hydrogen could "completely democratize global energy markets and let most countries self-produce," says Jeffrey Beyer, managing director of Zest Associates in Dubai, a clean-energy consultancy, and author of the U.A.E. study. "The reality is that some countries have lots of indigenous energy sources and others don't."

Japan, whose reliance on Middle East oil makes it susceptible to geopolitical jolts, is pursuing a regional hydrogen strategy that would support Asian markets. In September, Japan hosted a green energy meeting of 20 nations, including Southeast Asia's rising economies of Indonesia and Vietnam. [45]

"Currently, the international finance industry is rapidly withdrawing investments from fossil fuel projects," Japan's Minister of Economy, Trade and Industry Nishimura Yasutoshi told the Asia Green Growth Partnership on Sept. 26. "However, Asia is highly dependent on fossil fuels amid growing energy demand and its potential for renewable energy is not necessarily as high as it is in Europe." [46]

In February, the specially built ship *Suiso Frontier* arrived in Kobe, Japan, from Australia with the first cargo of liquified hydrogen in a pilot project, viewed as a milestone in the transition to green energy. [47]

Australia is also developing hydrogen ties with Germany. "If our current pipeline of clean hydrogen projects is completed on time, Australia could be one of the world's largest hydrogen suppliers by 2030," a 2021 Australian government report said. [48]

An analysis by the International Renewable Energy Agency, an Abu Dhabi-based intergovernmental organization, suggests that about one-third of hydrogen would be traded across borders by 2050, about half of that probably in pipelines, including those now used to transport natural gas. Exporting countries will gain in strategic importance and new shipping routes will shape security and defense plans, the agency said. [49]

Coastal countries might hold an advantage over dry, inland areas, because desalination of seawater adds only one U.S. cent per kilogram to the cost of hydrogen, energy executive Alverá wrote. [50]

Hydrogen "will change the dynamics of geopolitics in energy," says Jamie Speirs, a fellow in energy analysis and policy at the Sustainable Gas Institute at the Imperial College London. "Some countries will do this better than others, and those are the places where green hydrogen will be done at scale."

China is already the world's largest producer and consumer of hydrogen, but it is made using coal. China's new strategy calls for creating 50,000 hydrogen-fueled vehicles by 2025, using more hydrogen in industry and increasing the manufacture of electrolyzers for hydrogen production. [51]

While hydrogen is riding a wave of optimism, Speirs says it's "easy to get carried away by the hype" surrounding it. "We might find out that hydrogen isn't as low-carbon as we hope, or need it to be, to meet our targets," undercutting the confidence of governments and investors, he says.

Can Africa parlay its green assets into geopolitical influence?

On Africa's arid southwestern coast, Namibia boasts a population of only 2.7 million people in an area almost twice the size of California, which has nearly 40 million people. Namibia currently depends on electricity from South Africa. Yet, it has two assets of increasing international interest: high solar energy potential and metals coveted for electric vehicles. [52]

Germany, which is seeking hydrogen to decarbonize its industries, formed a partnership with Namibia last year, linked to a Namibian government initiative that has awarded 1,544 square miles of land to investors for a $9.4 billion green hydrogen project. The enterprise will convert Atlantic Ocean water into hydrogen, fueled by the country's abundant solar and wind power. [53]

"The global race for the best hydrogen technologies and the best sites for hydrogen production is already on," Germany's federal research minister at the time, Anja Karliczek, said during the signing of the partnership. Namibia could produce hydrogen "at the most competitive price in the world." [54]

A recent U.S. assessment described Namibia, which also has new lithium and cobalt mines, as "an up-and-coming source country for critical minerals" used in electric vehicles and battery storage. In October, Namibia Critical Metals said its Lofdal mine could produce significant amounts of dysprosium and terbium — rare earth metals used in the permanent magnets of electric vehicles — to supply Japan long term. China currently controls the world's supply of dysprosium and terbium. [55]

> **"Hydrogen 'will change the dynamics of geopolitics in energy.' "**
>
> ***— Jamie Speirs,***
> ***Fellow in energy analysis and policy,***
> ***Sustainable Gas Institute, Imperial College London***

Besides Namibia, other African regions are well-positioned to capitalize on the green energy transition — from the continent's vast, sun-washed deserts and savannas to its carbon-capturing Congo Basin rainforest and the vast supply of cobalt in the

Democratic Republic of Congo (DRC). Clean energy investments on the continent are projected to rise sixfold from 2026 to 2030, with total annual energy investment averaging about $190 billion, according to the International Energy Agency. [56]

Whether Africa can translate those assets into geopolitical clout hinges on tackling entrenched economic barriers.

"Much more needs to happen from African governments to be able to change the game completely" regarding critical minerals, says Alfonso Medinilla, head of climate and green transition geopolitics at ECDPM, a think tank on Africa-Europe relations. African countries need to get away from the current model of merely extracting raw materials and exporting them to be processed elsewhere, he says. Instead, he says, they should process the minerals domestically and export the higher value finished products.

James Mwangi, founder of the Kenya-based Climate Action Network Africa, agrees. Antiquated supply chains that export raw African materials without adding value incur a large carbon cost and concentrate poverty and instability in Africa, he says.

African Development Bank President Akinwumi Adesina told Norwegian investors in September that Africa's lithium deposits could "make Africa competitive with China and Chile in the race for supplying global value chains for electric cars." He also touted Africa's green hydrogen potential, along with a $20 billion "Desert to Power" plan to turn 11 countries in the Sahel — a transition belt between the Sahara Desert and tropical regions to the south — into the world's largest solar zone. [57]

Some hydrogen projects already emerging in Egypt, Mauritania, Morocco and South Africa are using renewable energy to make ammonia for fertilizer, which would strengthen Africa's food security, the International Energy Agency said. African farmers face a shortage of imported fertilizer due to the war in Ukraine. [58]

Experts say African countries must balance domestic needs and international interests as they strive to amass green geopolitical influence. The DRC illustrates the challenge, as Secretary of State Blinken highlighted during an August visit to its capital, Kinshasa. "On climate, the Democratic Republic of Congo is vital to the future of the planet," Blinken said. "It's as simple as that. The Congo Basin rainforest absorbs more carbon than is emitted by the entire continent of Africa." [59]

A large swath of flooded rainforest — a region the size of England — runs through the DRC and neighboring Republic of Congo. The peat under the water contains about 30 billion metric tons of carbon — as much as the world emits in about three years.

A moratorium on logging concessions in the DRC rainforest took effect in 2002. Germany, Norway and the United Kingdom have been funding a forest preservation and management initiative that could lead to the lifting of that moratorium in 2023. Western countries would like for the DRC and other Congo Basin nations to leave their rainforests undisturbed or for them to be sustainably developed.

But the African governments also are eyeing the sizeable oil deposits underneath the peat.

"The challenge is to find an equilibrium, a balance between the well-being of the Congolese people" and an ecological framework, said Congolese Foreign Minister Christophe Lutundula. [60]

A national audit of rainforest logging published this year found that six DRC government ministers in a row had violated forest-protection laws and illegally allocated at least 18 concessions to themselves. The environmental advocacy group Greenpeace Africa, which said the logging moratorium is routinely violated, found that a DRC environment minister had awarded a logging permit to Chinese and other companies covering an area equal to four times the size of Kinshasa. [61]

"On climate, the Democratic Republic of Congo is vital to the future of the planet."

— Antony Blinken, U.S. Secretary of State

Another Central African country, Gabon, has been trying to balance its domestic needs while helping in the global effort to slow climate change. The tiny nation aims to sustainably manage its abundant, carbon-absorbing rainforest by banning exports of logs, controlling and tracking tree harvesting and developing domestic manufacturing of wood products. [62]

Expanding renewable energy and helping to create an industrial base in Africa could position the United States more strongly against China, says Mwangi. Africa's projected population surge — estimated to represent 52 percent of world growth by 2050 — makes it an enticing alternative market to China's for U.S. companies, given current trade tensions between China and the United States, he says. [63]

"Don't think about Africa purely as a climate victim," Mwangi says. Instead, focus on the potential of the African economy to help lower the cost of meeting global net zero emissions targets, he says.

At COP27, Biden announced investments in climate adaptation and green energy in Africa, including early warning systems and disaster-risk protection. He said the United States is joining the EU and Germany in a $500-million effort to help Egypt add 10 gigawatts of renewable energy by 2030 while reducing 5 gigawatts of "inefficient" gas-powered facilities and capturing natural gas that flares or leaks from oil and gas operations. [64]

During the conference, countries such as Kenya and Nigeria announced the Africa Carbon Markets Initiative, designed to generate $6 billion by 2030 for African communities to invest in renewable energy and other efforts to curb climate change. It would set up a system for trading carbon credits, each representing one ton of carbon dioxide emissions that a polluter can purchase, with the funds being invested in carbon-reduction systems, such as a forest. [65]

Achieving a so-called African Green Deal would require bold, government-directed efforts to boost energy availability and reduce carbon emissions while expanding economic growth and ensuring social equity, according to the International Renewable Energy Agency. "African leaders must clearly articulate, map and assert their own climate transition and development agendas" with regional coordination, the agency said. [66]

Ethiopia also aims to become a major player in Africa's efforts to become a world leader in renewable energy. It seeks to boost its power output ninefold by 2037 by expanding its hydropower, wind, solar and geothermal resources. [67]

Africa's largest hydropower dam, the Grand Ethiopian Renaissance Dam on the Nile River, has begun to generate electricity amid tensions with downstream Egypt. [68]

Construction of the Grand Ethiopian Renaissance Dam, a massive hydropower plant on the Nile River that has begun to generate electricity, caused tension with downstream Egypt, which relies heavily on the Nile for its water. Ethiopia aims to become a major player in Africa's efforts to be a global renewable energy leader but that plan could be limited by the need for financing. (Getty Images/Anadolu Agency/Minasse Wondimu Hailu)

But Ethiopia's potential is limited by investment risks and the need for "prohibitively costly" energy-delivery infrastructure, says Mikael Alemu, an Ethiopian-Israeli entrepreneur and co-founder of 10 Green Gigawatt for Ethiopia, a solar energy development company.

"My partners and myself believe in [the] enormous potential of solar energy in Ethiopia, and we know hundreds of investors who share this belief," he says. "But very few investors today can accept the country and currency risks of Ethiopia, and therefore there is just a handful of private energy developers."

Some activists say that as the green energy transition gathers momentum, some African countries, such as Mozambique, continue to bet too much on new oil and gas production, where European and Japanese investors are tapping major gas discoveries for export. [69]

Background

Early Efforts

Archeologists in China have discovered curved bronze mirrors called yang suis in 3,000-year-old tombs, confirming literary references to "burning mirrors" used to concentrate the sun's rays and light cooking fires. [70]

While wind has filled sails and pushed boats across lakes and seas for thousands of years, wind power has also found uses on land. By the 7th century, windmills were being used in Iran to grind corn and pump water. In the 1100s similar wind-powered machines appeared in northwestern Europe. [71]

Advances in sail design by Portugal helped that country project economic and political power across the globe in the 1400s. The caravel, a light vessel rigged with triangular sails, could harness the wind for high speed and range. Portugal used the ship to explore the coast of Africa, an early step toward European exploitation of the continent. [72]

Until the 1800s, societies relied on wood as a primary energy source. Wood fuel comprised about two-thirds of U.S. energy consumption in 1875. By 1900, wood's share dropped to about 20 percent as coal usage surged. [73]

Oil Boom

Oil arrived on the scene after U.S. economic power expanded following the Civil War. In January 1901, prospectors drilling at Spindletop Hill in Jefferson County, Texas, struck a crude oil geyser that produced more barrels than all the other wells in the United States combined, setting off an oil boom. [74]

That same year, the United States issued a postage stamp depicting an electric car driving past the U.S. Capitol. Electric vehicles powered by rechargeable batteries had gained traction in the 1890s in the United States. A fleet of 600 electric taxis operated in New York City, and the *New-York Tribune* newspaper touted electric vehicles in 1897 as "cheaper than horses." [75]

However, Henry Ford's creation of a moving assembly line in 1913, able to produce a gasoline-powered Model T in about 90 minutes,

made such cars more affordable. And while electric cars had proved popular in cities in the 1910s, the expansion of roads during the 1920s into rural areas, where electricity was scarce, shifted the advantage to oil. [76]

Meanwhile, on the world's oceans, coal and petroleum competed as the primary energy source for warships.

In Britain, Winston Churchill, then first lord of the Admiralty, in 1912 organized the Royal Commission on Fuel and Engines to support his plan to expand the use of oil to fuel the British Navy, which patrolled a global empire. Oil would boost the Navy's "relative fighting strength" by enabling faster speeds, a wider range of action and refueling at sea, Churchill told the House of Commons in 1913. But Britain faced a scarcity of oil throughout its empire, he said. World War I broke off Anglo-German cooperation to secure oil supplies in present-day Iraq. [77]

In the 1930s oil exploration turned to the deserts of Saudi Arabia. After three years of searching, geologists from Standard Oil of California discovered crude in March 1938 at a drilling site later dubbed "Prosperity Well." [78]

President Franklin D. Roosevelt (right) meets with Saudi King Abdul Aziz Ibn Saud (center) aboard the *USS Quincy* in February 1945. They sealed a long-term deal that gave the United States access to affordable oil in exchange for providing security to the Saudis. (Getty Images/Bettmann/Contributor)

As tensions escalated in East Asia during this period, Japan also fixated on finding oil supplies to fuel its military forces. When

Japan invaded French Indochina — today's Vietnam — the United States and its allies responded by cutting off Japan's access to oil. Japan reacted by continuing its push for oil in the East Indies, and, eventually, attacking the U.S. Pacific Fleet at Pearl Harbor, Hawaii, in 1941. [79]

Near the end of World War II, President Franklin D. Roosevelt met Saudi King Abdul Aziz Ibn Saud on a U.S. warship in the Suez Canal in February 1945. The leaders established a long-term deal: access to affordable Saudi oil in return for U.S.-backed security for the Saudis. [80]

During the 1950s, oil became entangled in colonialism and Cold War politics. The refusal of Britain to share revenue with Iran from the Anglo-Iranian Oil Company stoked a political crisis. The United States grew concerned about potential Soviet designs on Iranian oil and the possible pro-Moscow stance of Iranian Prime Minister Mohammad Mosaddegh. In 1953, the CIA and British foreign intelligence orchestrated the overthrow of Mosaddegh, who had moved to nationalize Anglo-Iranian (renamed British Petroleum in 1954). [81]

French commandos make an amphibious assault at Port Fuad, Egypt, during the 1956 Suez Canal Crisis. The conflict, which created tension between the United States and Britain and France, erupted when Egyptian President Gamal Abdel Nasser nationalized the canal after Britain and the United States withdrew funding for a major Egyptian hydropower project. (Getty Images/Universal History Archive/Universal Images Group)

The Suez crisis of 1956, in which President Dwight D. Eisenhower opposed British and French military action against Egypt to thwart

the Egyptian takeover of the Suez Canal, had its roots in carbon-free energy — a rift over a major hydropower project. [82]

U.S. intelligence agencies said Egyptian President Gamal Abdel Nasser had nationalized the canal after the United States and Britain withdrew offers to finance the Aswan High Dam on the Nile River, a source of Arab prestige for Nasser. Nasser said he would use revenue from operating the canal to fund the dam. Eisenhower warned British Prime Minister Anthony Eden to resolve the dispute through an international conference rather than force or face the wrath of world public opinion because "the legal rights of a sovereign nation were ruthlessly flouted." [83]

The United States also warned the Soviet Union not to intervene, and under threat of U.S. economic sanctions, Britain and France withdrew their forces in December 1956. After the crisis, Eisenhower told Congress in 1957 that protecting Middle East oil from domination by the Soviet Union was a national security priority. [84]

Faced with U.S. sway over the global oil market, exporters Iran, Iraq, Kuwait, Saudi Arabia and Venezuela formed the Organization of the Petroleum Exporting Countries (OPEC) in 1960 to coordinate policies, prices and production.

In 1973, OPEC embargoed exports to the United States and allied countries that had supported Israel in the conflict with Arab countries that broke out that year. The price of oil quadrupled. [85]

After the Berlin Wall fell in 1989 and the Soviet bloc began disintegrating, the United States confronted a military crisis in the Middle East over oil. When Iraqi dictator Saddam Hussein invaded Kuwait and its oil fields in August 1990, President George H. W. Bush organized an international military force to drive the Iraqis out. As Iraqi forces retreated in 1991, they left behind an environmental disaster and searing images: hundreds of Kuwaiti oil wells set ablaze, choking the skies with thick, dark smoke. [86]

The dissolution of the Soviet Union in 1991 enabled the transformation of Russia's oil and gas industry, as privatization opened it up for foreign investment. Since 2000, oil revenue has helped Russia pay off debt and build a financial cushion against price shocks. By 2021, Russia was the world's third-largest oil producer. [87]

Renewable Energy

Albert Einstein showed in 1905 that sunlight could be transformed into electricity, earning him the Nobel Prize in Physics in 1921. In 1954, scientists at Bell Labs in the United States invented the silicon photovoltaic cell, capable of converting solar energy to power electrical equipment. [88]

The 1973 oil embargo had prompted the United States and Europe to reassess their dependence on imported energy. In November 1974 the United States joined Japan, West Germany and other European governments to establish the International Energy Agency, designed to ensure secure supplies and coordinate energy policies. [89]

In November 1979, Islamic revolutionaries in oil-producing Iran took 50 U.S. Embassy employees hostage, and the Soviet military invaded neighboring Afghanistan in December. President Jimmy Carter said any attempt to seize the oil-rich Persian Gulf region would be "repelled by any means necessary, including military force." [90]

President Jimmy Carter calls for new, renewable energy sources in 1979 while standing on the roof of the White House, where new solar panels had been installed. Instability in the oil-rich Persian Gulf region, which triggered two oil crises in the 1970s, prompted the United States and Europe to reassess their dependence on Mideast oil. (Getty Images/Bettmann/Contributor)

The Iranian revolution, which overthrew pro-Western Shah Mohammad Reza Pahlavi, caused oil production there to plummet and global oil prices to spike, triggering the second U.S. oil crisis

of the decade. In his State of the Union speech in 1980, President Jimmy Carter called the "excessive" U.S. dependence on foreign oil "a clear and present danger to our Nation's security" and championed the National Energy Act, which called for investments in energy conservation and development of solar energy and other green energy measures. [91]

Later that year, Republican presidential nominee Ronald Reagan defeated Carter. Shortly after taking office, Reagan removed the solar panels Carter had installed on the White House and slashed spending on Carter's federal clean energy programs. During his campaign, Reagan had said, "America must get to work producing more energy. . . . Large amounts of oil and natural gas lay [untouched] beneath our land and off our shores." [92]

Climate activists, such as Joseph Romm, a senior fellow at the Center for American Progress, said Reagan "almost single-handedly killed America's global leadership in renewable energy." [93]

Another factor that slowed energy conservation in the early 1980s: plummeting world prices for oil due to excess supply. After the two oil shocks of the 1970s, consumers had begun to conserve energy, and new supplies came online from Alaska, the North Sea and other non-OPEC countries. As global oil prices collapsed, consumers became less interested in buying small cars or conserving energy and investors less interested in alternative energy projects. [94]

As a result, the use of solar on a scale that could electrify towns did not begin until the late 1980s and early 1990s. Government action began scaling up green energy. California set stringent zero-emission rules beginning in 1990, which required automakers to phase in cleaner-burning and higher-mileage vehicles each year. In Germany, the Renewable Energy Sources Act of 2000 created incentives for expansion of wind and solar power. [95]

In China, a 1995 law set the stage for development of wind and solar energy, and solar and wind projects began there in 1999 with aid from the World Bank. In 2005, China began a 12-year expansion of its green energy program, making it a world leader in renewables. [96]

Climate Crisis

Scientific investigation of human-generated carbon dioxide emissions began as far back as the 1950s, in an era when sales

of cars and trucks were soaring — the number of registered vehicles in the United States doubled between 1945 and 1955 to 62.6 million — and the use of coal to generate electricity had begun a five-decade climb. [97]

At the Scripps Institution of Oceanography in California, Roger Revelle and Hans E. Suess wondered in 1956 how much excess carbon dioxide from the industrialized economies was ending up in the atmosphere and how much it would increase if fossil fuel use continued to "rise exponentially." [98]

The scientists wrote that "human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor be reproduced in the future. Within a few centuries we are returning to the atmosphere and oceans the concentrated organic carbon stored in sedimentary rocks over hundreds of millions of years." [99]

In 1959, Swedish atmospheric scientist Bert Bolin warned about escalating carbon dioxide concentrations in the atmosphere by 2000 if emissions were not controlled. Bolin became a leading figure in climate science and the first chairman of the U.N.'s Intergovernmental Panel on Climate Change. [100]

Questions about climate change were emerging as the United States was dominating the postwar fossil fuel economy. In 1955, major U.S. oil companies produced 70 percent of oil worldwide. [101] Coal was the primary fuel for generating electricity. The effects of carbon emissions on climate were poorly understood.

However, recently uncovered oil industry files show that the industry's own studies predicted as early as the 1960s that fossil fuel emissions would produce disastrous effects on the environment by the mid-2000s. But the industry increased production and financed climate-denial research that spread doubt about climate science, according to researchers and documents released by the U.S. House's Oversight and Reform Committee. At the panel's 2021 hearing on the issue, oil executives denied that their predecessors had lied about the negative impact of fossil fuel use. [102]

Those internal documents were not available to environmentalists in the 1960s and '70s. Greenhouse gases were not a major focus of the first U.N. environmental conference in Stockholm in

1972. Only one of the 109 recommendations from the conference related to monitoring the environmental effects of carbon dioxide emissions from energy use. [103]

That changed in 1985, after a major scientific meeting in Austria put global warming on the international political and economic agenda. With Bolin playing a key organizing role, scientists from Africa, China, Europe, Japan, the Soviet Union and the United States issued a report projecting that global warming could affect farming, water supplies, sea ice and global ecosystems in the 21st century. [104]

"While some warming of climate now appears inevitable due to past actions, the rate and degree of future warming could be profoundly affected by governmental policies on energy conservation, use of fossil fuels, and the emission of some greenhouse gases," the conference concluded. [105]

The IPCC, founded in 1988 to advance climate knowledge, issued its first report in 1990. Two years later, an "Earth Summit" in Brazil produced the treaty known as the U.N. Framework Convention on Climate Change. Dozens of nations, including the United States, committed to stabilizing greenhouse gases "at a level that would prevent dangerous anthropogenic interference with the climate system." [106]

In December 1997, 41 governments and the European Union agreed in Kyoto, Japan, to limit emissions of six greenhouse gases. At the time, China was still a rising economic power, with an $825 billion economy — just slightly larger than Brazil's. Its per capita consumption of electricity was one-seventh that of the city of Hong Kong. Yet China's almost 3.6 billion tons of carbon emissions from its industrializing economy were second only to the U.S. output that year. [107]

Within a decade, China began flexing its strength in critical minerals in what author Guillaume Pitron called "the first embargo of the energy and digital transition." After a Chinese fishing boat collided with a Japanese Coast Guard patrol near disputed islands, China halted deliveries of its rare earth metals to Japan for about six months. Concerns spread to the United States and Europe. [108]

In 2012, the United States, the EU and Japan filed a complaint with the World Trade Organization (WTO) over export duties and

restrictions on rare earth minerals imposed by China. A WTO panel found that China's restrictions were inconsistent with the agreement it had signed upon joining the free trade organization. [109]

By 2015, China had become the world's second largest economy and the largest emitter of carbon dioxide. [110] In the Paris Agreement that year, 195 countries pledged to limit carbon emissions so that the increase in global average temperatures remained "well below" 2 degrees Celsius over preindustrial levels.

As climate change began to affect energy policies worldwide, the oil and gas industry witnessed dramatic change in the new century: The market absorbed two shocks — the international financial crisis in 2008 and the COVID-19 pandemic in 2020 — which slashed energy demand. [111]

A third shock came from the supply side: the U.S. oil boom enabled by "fracking" — using pressurized liquid to fracture shale formations deep in the ground and release oil and gas deposits. As a result, since 2018 the United States has produced more oil and gas than any other country. [112]

Russia's invasion of Ukraine in February provoked a powerful response by the United States and its allies: economic sanctions against Russian banks, oil and gas imports, and restricted Russian access to certain technology. Europe's moves to reduce Russian natural gas imports led those countries to expand their plans for solar, wind, hydrogen and other green energy. [113]

By the 2020s, two decades of Chinese investments in green energy technologies had made the country the global leader in key alternative energy sectors. China controlled at least 75 percent of manufacturing capacity of the four major elements of solar photovoltaic panel manufacturing. In wind energy, China accounted for 51 percent of the world's increased capacity in 2021. And in 2022, Shenzhen, China-based BYD became the world's largest electric vehicle manufacturer based on sales. [114]

In August, Congress passed sweeping incentives to promote a U.S. industrial response to Chinese dominance in minerals, electric vehicles and other technologies of the energy transition. [115] ■

Current Situation

Europe Pivots

While Germany investigates explosions in the Baltic Sea on Sept. 26 that ruptured Russia's Nord Stream natural gas pipelines, work is starting on an energy connection between the United Kingdom and Germany, drawing on wind and other renewable sources. [116]

NeuConnect, a subsea link extending 450 miles, will allow excess electricity from carbon-free sources to flow between those countries. [117] It is one of several European energy security initiatives announced or accelerated since the Russian invasion of Ukraine.

The war "has awakened everybody to the centrality of energy to everything on the political, social and economic agenda," says Griffin Thompson, former director of the U.S. State Department's Office of Renewable Energy and Energy Efficiency and now an adjunct professor at Loyola University in Chicago.

European Union President Ursula von der Leyen said on Sept. 14 that Baltic countries have shown how to end reliance on Russian oil and gas by investing in renewable energy, liquified natural gas and regional connections. "This costs a lot," she said. "But dependency on Russian fossil fuels comes at a much higher price. We have to get rid of this dependency all over Europe." [118]

Von der Leyen said a new European Hydrogen Bank will invest 3 billion euros ($2.9 billion) to create a market to replace fossil fuels, especially in industrial uses. Under a plan announced in May, the European Union also plans to spend an extra 210 billion euros ($203 billion) by 2027 on initiatives, such as scaling up renewable energy use in power generation, industry, buildings and transport. [119]

The EU intends to double solar photovoltaic capacity by 2025. China, the world's largest manufacturer of solar panels, is benefiting from the shift. From January through August, the value of panels imported by the EU from China more than doubled — to $16 billion — compared to the same period in 2021. [120]

In July, German lawmakers approved a major expansion of wind power and increased the country's target for the renewable share of electricity generation from 65 percent to 80 percent by 2030.

The law more than doubles the land area that must be allocated for wind turbines, to 2 percent of the country. [121]

NeuConnect attracted broad interest. Investors from France, Germany and Japan — and lenders ranging from European insurers to the Bank of China — completed financing of the $2.8 billion project in late July. [122]

Machines bring coal ashore in China's Jiangsu province. China is the world's largest emitter of carbon dioxide, due largely to its reliance on coal to power its growth. (Getty Images/Costfoto/Future Publishing/Contributor)

Season of Extremes

As Europe confronts Russian President Vladimir Putin and his war in Ukraine, threats from extreme weather exacerbated by climate change are roiling the continent and nations across the globe.

In France, wildfires in 22 administrative departments consumed 10 times more land this year than the average since 2008. On July 19, a heat wave in Britain produced the country's highest-ever-recorded temperature, 40.3 Celsius (104.5 Fahrenheit). One of Europe's largest rivers, the Danube, flowed at less than half its usual volume. [123]

Von der Leyen noted that the situation remains serious because melting Alpine glaciers hold water reserves for major European rivers, such as the Rhine and the Rhone. [124]

Between July and September, extreme weather beyond Europe provided advocates of net zero carbon reduction with ample

evidence of a global climate crisis. In Pakistan, floods caused by heavy monsoon rains displaced almost 8 million people, swept away homes, schools and health facilities, and left vast areas of Balochistan Province inundated. In the Horn of Africa, communities from Kenya to Somalia are facing the worst drought in 40 years, putting millions at risk of hunger. [125]

"In my view, climate and environmental security are now totally interlinked with energy and national security as well," said Alok Sharma, a former British government minister who led the 2021 Glasgow U.N. Climate Change Conference, COP26. [126]

In China, an unprecedented summer heat wave blanketed almost half of the country. "There is nothing in world climatic history which is even minimally comparable to what is happening in China," historian Maximiliano Herrera said. On Aug. 18, the city of Chongqing recorded 45 degrees Celsius (113 degrees Fahrenheit), the highest temperature observed in China outside desert regions. As the country's waterways dried up, agricultural production suffered. [127]

In the United States, rapidly intensifying Hurricane Ian struck the southwest coast of Florida on Sept. 28 and left devastation in its wake across about a third of the state. The storm surge and inland flooding caused an estimated $67 billion in losses to those covered by private insurance, which typically covers only 20 percent of homes, according to the risk-modeling company RMS. [128]

An MIT study of hurricane intensity, published by the American Meteorological Society in 2017, concluded that "the incidence of storms that intensify rapidly just before landfall increases substantially as a result of global warming." [129]

Meanwhile, countries are falling short in their promises to reduce carbon emissions under the Paris Agreement and subsequent revisions. The secretariat of the U.N. Framework Convention on Climate Change said in October that by 2100, peak temperature increases are now projected to range from 2.1 to 2.9 degrees Celsius, far above the 1.5-to-2.0-degree goals. [130]

The report described an urgent need for a "significant increase in the level of ambition" of national carbon cuts. "If emissions are not reduced by 2030, they will need to be substantially reduced thereafter to compensate for the slow start on the path to net zero emissions," the secretariat said. [131]

Canada, Japan, the United States and European countries said they would provide $20 billion in public and private financing to help Indonesia boost its renewable power generation capabilities, helping Southeast Asia's largest economy reach net zero power emissions a decade faster than planned. [132]

Challenging China

On Aug. 16, President Biden signed the Inflation Reduction Act into law, which included extensive provisions aimed at reducing greenhouse gas emissions while strengthening the U.S. position in renewable energy in relation to China.

Biden said in Egypt that his administration's climate and green-energy investments will enable the United States to meet its greenhouse gas emissions targets by 2030. [133]

The law offers a new tax credit, worth about $30.6 billion through 2031, for domestic production and sale of wind and solar components. It also included $50.8 billion over the next decade for a new investment tax credit for zero-emissions electricity-generating or energy storage facilities. And $13.1 billion would fund a new clean hydrogen production credit. [134]

The measure and two other laws combined will inject more than $135 billion "to build America's electric vehicle future," including the sourcing and processing of critical minerals and battery manufacturing, the White House said. The separate Bipartisan Infrastructure Law sets aside $7.5 billion to create a national network of 500,000 electric vehicle chargers. [135]

The Inflation Reduction Act also prohibits the application of electric vehicle (EV) tax credits if any components or critical minerals are sourced from a "foreign entity of concern," such as China, Russia, Iran or North Korea, said Jane Nakano, a senior fellow in the energy security program at the Center for Strategic & International Studies in Washington. "The U.S. vision for secure EV supply chains has an undeniable dose of geopolitical assertiveness," Nakano said. [136]

In a precursor to the Inflation Reduction Act, Biden in June had authorized use of the Defense Production Act for U.S. companies to produce solar panel parts in an effort to triple domestic solar manufacturing capacity by 2024. The law empowers the president to direct companies to prioritize orders from the

federal government; the president may also offer loans and allow companies to coordinate efforts. [137]

Biden seeks to increase U.S. production of solar photovoltaic modules and equipment for making "clean electricity-generated fuels," including hydrogen electrolyzers and fuel cells. [138]

In a letter to the EU president, the industry group Hydrogen Europe said the Inflation Reduction Act's incentives and roadmap for hydrogen production amount to "the most impressive incentive any policymaker has undertaken" to support the industry. The group urged the EU to clarify its strategy and rules or face "a mass exodus of companies towards the U.S. market." [139]

But some experts warn there may be speed bumps along the way, including some winners and some losers. Ian Lange, a former senior economist on Trump's White House Council of Economic Advisers, wonders how quickly viable green energy companies will emerge. "How many Teslas do we get out of this — and how many Solyndras?" Lange asks, referring to the electric-car maker and a solar manufacturer that failed in 2011 after receiving $535 million in U.S. government loan guarantees. [140]

Outlook

New Chokepoints

As the green energy transition advances, a world of decentralized, expanded energy supplies and more concentrated mineral sources looms. Rather than vulnerable strategic shipping routes, such as the Strait of Hormuz or the Strait of Malacca, the new chokepoints will be the geological map of minerals needed for electric vehicles, wind turbines and other facets of the new energy economy.

The globalized energy system will be transformed over time to less vulnerable cross-border networks for fuel and electricity.

"The American era that started in the '80s, that we want globalization and free trade everywhere, has been declining for a while and will continue to do so," says John Bowlus, an energy transport researcher at Kadir Has University in Istanbul.

"Especially when you have the infrastructure for green energy, hydrogen, across borders."

Proximity to markets will shape renewable energy links. For example, Egyptian President Abdel Fattah El-Sisi in September authorized a Greek company's plan to build a subsea cable to transport electricity from Egypt's wind and solar energy sites to Europe. [141]

Griffin Thompson, a former U.S. climate negotiator, says an intriguing geopolitical question is how these new ties will shape international relations.

"Energy connections can accelerate the potential for conflict or potential for cooperation," Thompson says. "I'm going to make sure I'm on good terms with you if you are selling me electrons — maybe I expand trade with you in agriculture" or work cooperatively to ensure domestic tensions do not spill over.

Supply chains also will be affected, experts say. As electric vehicle markets expand, the critical-minerals map becomes more consequential.

Even green hydrogen requires iridium, found mostly in South Africa, as a catalyst for electrolysis, says MIT's Paltsev. "So here is another dependency, talking about big scale-up on the supply side," he says. Europe's projected hydrogen demand for iridium amounts to several times the current global supply. [142]

China also has concerns. "Up until now, China has been very competitive for access to minerals, and they are extremely worried about the vulnerability they have in terms of their supply chain," says Harvard's Lee.

Cobalt is of highest concern, he says. An electric vehicle requires almost 30 pounds of the metal. China was the world's leading producer of refined cobalt in 2021, mostly sourced from the Democratic Republic of Congo, which produced more than 70 percent of the world's mined cobalt in 2021. [143]

In the "clear best-case scenario," the United States and Europe will build critical mineral supply chains that rival China's, creating an abundance of "cleaner and greener" minerals that are mined with attention to reducing labor and environmental harms. This will result in less price volatility and a lower risk of supply chain disruptions due to geopolitical tensions, said researchers at the Brookings Institution. [144]

Meanwhile, as it protects strategic sources and trade routes for fossil fuels, the U.S. military is envisioning ways to take advantage of carbon-free energy on the battlefield, such as electric combat vehicles. While reducing fuel consumption and emissions, this switch will also lower the vehicles' thermal and acoustic signatures, making them harder for adversaries to find, said the U.S. Army's climate resilience strategy. A prototype "Electric Light Reconnaissance Vehicle" will enter testing in 2023. [145]

In addition, scientists and entrepreneurs are seeking ways to work around China's supply chain dominance in rare earth minerals. "Accessible alternatives to 'critical materials' can make excellent EV batteries, solar cells, and wind turbines," wrote Amory Lovins, co-founder of RMI, an advocacy group for carbon-free energy. He cited versions of super-magnets for cars and wind turbines that do not require rare earth elements. [146]

Researchers at the University of Cambridge said in October that tetrataenite, found in meteorites, might be a substitute for rare earths used in magnets. [147]

The "National Blueprint for Lithium Batteries," issued in June 2021, calls for the United States to "discover alternatives for critical minerals for commercial and defense applications." It sets the goal of eliminating cobalt and nickel from lithium-ion batteries by 2030. U.S. reserves of the two metals are less than 1 percent of the world total. [148]

The Biden administration's investments promise to accelerate innovation in green energy, according to U.S. climate envoy Kerry. He told the Washington-based Council on Foreign Relations in October: "By the time 2030 approaches, folks, we're going to have made clean technologies much more accessible, much more affordable, for the rest of the world." [149]

Notes

[1] "Gross Domestic Product 2021," World Bank, https://databankfiles.worldbank.org/data/download/GDP.pdf; "Minerals Security Partnership Convening Supports Robust Supply Chains for Clean Energy Technologies," news release, U.S. Department of State, Sept. 22, 2022,

https://www.state.gov/minerals-security-partnership-convening-supports-robust-supply-chains-for-clean-energy-technologies/#:~:text=The; and "Ngualla Rare Earth Project, Tanzania," Peak Rare Earths, https://peakrareearths.com/ngualla-project/.

[2] "Secretary Antony J. Blinken at the Ministerial Meeting of the Minerals Security Partnership," news release, U.S. Department of State, Sept. 22, 2022, https://www.state.gov/secretary-antony-j-blinken-at-the-ministerial-meeting-of-the-minerals-security-partnership/.

[3] "Climate Change and Conflict: Impact on Displacement," International Committee of the Red Cross, April 20, 2021, https://www.icrc.org/en/document/climate-conflict-and-displacement.

[4] "The Administration's Approach to the People's Republic of China," speech, Antony J. Blinken, Secretary of State, May 26, 2022, https://www.state.gov/the-administrations-approach-to-the-peoples-republic-of-china/.

[5] "Paris Agreement, Article 4" and "Article 2," United Nations Framework Convention on Climate Change Secretariat, 2015, https://unfccc.int/sites/default/files/english_paris_agreement.pdf; "Global Warming of 1.5C, Summary for Policymakers," Intergovernmental Panel on Climate Change, 2018, pp. 7-8, https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SPM_version_report_LR.pdf; and Jason Mark, "Fahrenheit > Celsius," Sierra Club, June 3, 2019, https://www.sierraclub.org/sierra/fahrenheit-celsius.

[6] "Climate Change 2022, Mitigation of Climate Change, Summary for Policymakers," Sixth Assessment Report, Intergovernmental Panel on Climate Change, 2022, pgs. 18, 27, https://report.ipcc.ch/ar6/wg3/IPCC_AR6_WGIII_Full_Report.pdf; "China Has a Clear Pathway to Build a More Sustainable, Secure and Inclusive Energy Future," International Energy Agency, Sept. 29, 2021, https://www.iea.org/news/china-s-clean-energy-strengths-can-help-it-reach-a-peak-in-emissions-by-the-mid-2020s.

[7] "Short-Term Energy Outlook," U.S. Energy Information Administration, November 2022, p. 2, and Table 7d, Part 1, https://www.eia.gov/outlooks/steo/pdf/steo_full.pdf.

[8] "Country Analysis Executive Summary: China," U.S. Energy Information Administration, Aug. 8, 2022, pp. 1-3 and 6, https://www.eia.gov/international/content/analysis/countries_long/China/china.pdf; "An Energy Sector Roadmap to Carbon Neutrality in China," International Energy Agency, September 2021, p. 13, https://iea.blob.core.windows.net/assets/9448bd6e-670e-4cfd-953c-32e822a80f77/AnenergysectorroadmaptocarbonneutralityinChina.pdf; Daisuke Wakabayashi and Claire Fu, "For China's Auto Market, Electric Isn't the Future. It's the Present," *The New York Times*, Sept. 27, 2022, https://www.nytimes.com/2022/09/26/business/china-electric-vehicles.html?searchResultPosition=1; and "EV Charging Stations Across the U.S. Mapped," Visual Capitalist, Oct. 25, 2022, https://www.visualcapitalist.com/interactive-ev-charging-stations-across-the-u-s-mapped/.

[9] "Net Zero by 2050: A Roadmap for the Global Energy Sector," International Energy Agency, 2021, p. 3, https://iea.blob.core.windows.net/assets/7ebafc81-74ed-412b-9c60-5cc32c8396e4/NetZeroby2050-ARoadmapfortheGlobalEnergySector-SummaryforPolicyMakers_CORR.pdf; "About," International Energy Agency, https://www.iea.org/about/membership.

[10] "Japan Electricity Security Policy," International Energy Agency, Aug. 18, 2022, https://www.iea.org/articles/japan-electricity-security-policy; "Asia Green Growth Partnership Ministerial Meeting Chairman's Summary," Sept. 26, 2022, https://www.meti.go.jp/press/2022/09/20220926008/20220926008-2.pdf.

[11] "REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition," European Commission, Brussels, May 18, 2022, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131; Robin Whitlock, "Germany approves largest renewable energy expansion plan in history," *Renewable Energy Magazine*, July 8, 2022, https://www.renewableenergymagazine.com/panorama/germany-approves-largest-renewable-energy-expansion-plan-20220708.

[12] Andrei Covatariu, "Ukraine's critical minerals and Europe's energy transition: A motivation for Russian aggression?" Middle East Institute, July 21, 2022, https://www.mei.edu/publications/ukraines-critical-minerals-and-europes-energy-transition-motivation-russian-aggression; "The Rare-Earth Elements — Vital to Modern Technologies and Lifestyles," U.S. Geological Survey, November 2014, https://pubs.usgs.gov/fs/2014/3078/pdf/fs2014-3078.pdf.

[13] "National Intelligence Estimate: Climate Change and International Responses Increasing Challenges to US National Security Through 2040," Office of the Director of National Intelligence, National Intelligence Council, Oct. 21, 2021, https://www.dni.gov/index.php/newsroom/reports-publications/reports-publications-2021/item/2253-national-intelligence-estimate-on-climate-change.

[14] *Ibid.*

[15] "Developing countries at COP27 call for 'climate justice' in the form of adaptation and loss and damage funds," *UN News*, Nov. 8, 2022, https://news.un.org/en/story/2022/11/1130347.

[16] "The future looks bright for Africa's solar energy output," World Economic Forum, July 12, 2022, https://www.weforum.org/agenda/2022/07/africa-solar-power-energy-sustainability-climate-change/.

[17] "Hydrogen," Britannica, https://www.britannica.com/science/hydrogen; "Geopolitics of the Energy Transformation, The Hydrogen Factor," International Renewable Energy Agency, 2022, pp. 10-17, https://www.irena.org/publications/2022/Jan/Geopolitics-of-the-Energy-Transformation-

Hydrogen; and "Carbonomics, The clean hydrogen revolution," Goldman Sachs, Feb. 4, 2022, pp. 7-8 and 12, https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-the-clean-hydrogen-revolution/carbonomics-the-clean-hydrogen-revolution.pdf.

[18] *Ibid.*; "The National Hydrogen Strategy," German Federal Ministry of Economic Affairs and Energy, June 2020, p. 7, https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/the-national-hydrogen-strategy.pdf?__blob=publicationFile&v=6; "Hydrogen Insights 2022," Hydrogen Council, September 2022, p. 2, https://hydrogencouncil.com/en/hydrogen-insights-2022/; and "Global Hydrogen Review 2022, Hydrogen Production," International Energy Agency, September 2022, p. 75, https://www.iea.org/reports/global-hydrogen-review-2022.

[19] "Statement by the Ministry of Foreign Affairs of the People's Republic of China," China Ministry of Foreign Affairs, Aug. 2, 2022, https://www.fmprc.gov.cn/eng/zxxx_662805/202208/t20220802_10732293.html; "The Ministry of Foreign Affairs Announces Countermeasures in Response to Nancy Pelosi's Visit to Taiwan," China Ministry of Foreign Affairs, Aug. 5, 2022, https://www.fmprc.gov.cn/eng/zxxx_662805/202208/t20220805_10735706.html.

[20] Jim Tankersley and Lisa Friedman, "U.S. and China Restart Climate Talks," *The New York Times*, Nov. 14, 2022, https://www.nytimes.com/2022/11/14/business/china-us-climate-change.html.

[21] "U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s," U.S. Department of State, Nov. 10, 2021, https://www.state.gov/u-s-china-joint-glasgow-declaration-on-enhancing-climate-action-in-the-2020s/; "Methane emissions are driving climate change. Here's how to reduce them," U.N. Environment Programme, Aug. 20, 2021, https://www.unep.org/news-and-stories/story/methane-emissions-are-driving-climate-change-heres-how-reduce-them; and Steven Mufson and Sarah Kaplan, "Climate-warming methane emissions rising faster than ever," *The Washington Post*, Oct. 26, 2022, https://tinyurl.com/5y8t26zn.

[22] "Remarks by President Biden at the 27th Conference of the Parties to the Framework Convention on Climate Change (COP27)," The White House, Nov. 11, 2022, https://www.whitehouse.gov/briefing-room/speeches-remarks/2022/11/11/remarks-by-president-biden-at-the-27th-conference-of-the-parties-to-the-framework-convention-on-climate-change-cop27-sharm-el-sheikh-egypt/.

[23] Rodrigo Castillo and Caitlin Purdy, "China's Role in Supplying Critical Minerals for the Global Energy Transition," Brookings Institution, July 2022, https://www.brookings.edu/wp-content/uploads/2022/08/LTRC_ChinaSupplyChain.pdf; "Share of the global lithium-ion battery manufacturing capacity in 2021 with a forecast for 2025, by country," Statista, https://www.statista.com/statistics/1249871/share-of-the-global-lithium-ion-battery-manufacturing-capacity-by-country/.

[24] Marc Humphries, "Critical Minerals and U.S. Public Policy," Summary, Congressional Research Service, June 28, 2019, https://crsreports.congress.gov/product/details?prodcode=R45810.

[25] "The Important Role of Dysprosium in Modern Permanent Magnets," Arnold Magnetic Technologies, September 2015, https://www.arnoldmagnetics.com/wp-content/uploads/2017/10/Important-Role-of-Dysprosium-in-Modern-Permanent-Magnets-150906.pdf.

[26] "Executive Order 13953: Addressing the Threat to the Domestic Supply Chain From Reliance on Critical Minerals From Foreign Adversaries and Supporting the Domestic Mining and Processing Industries," Executive Office of the President, Oct. 5, 2020, https://www.federalregister.gov/documents/2020/10/05/2020-22064/addressing-the-threat-to-the-domestic-supply-chain-from-reliance-on-critical-minerals-from-foreign.

[27] "Canada's Critical Minerals Strategy: Discussion Paper," Government of Canada, 2022, https://www.canada.ca/en/campaign/critical-minerals-in-canada/canada-critical-minerals-strategy-discussion-paper.html; "Resilience for the Future: The UK's critical minerals strategy," U.K. Government, July 22, 2022, https://www.gov.uk/government/publications/uk-critical-mineral-strategy/resilience-for-the-future-the-uks-critical-minerals-strategy#contents.

[28] "Note on Critical Raw Materials," Council of the European Union, Aug. 4, 2022, https://data.consilium.europa.eu/doc/document/ST-11669-2022-INIT/en/pdf.

[29] Tom Daly, "CATL takes stake in China moly cobalt mine for $137.5 million," *Reuters*, April 21, 2021, https://www.reuters.com/article/us-cmoc-catl-mine-idUSKBN2BY0BZ; "Robin Zeng: Advanced Green Battery Is the Inevitable Trend of Comprehensive Electrification," speech, CATL, Aug. 28, 2022, https://www.catl.com/en/news/1015.html.

[30] Xi Jinping, "Hold High the Great Banner of Socialism with Chinese Characteristics and Strive in Unity to Build a Modern Socialist Country in All Respects, Report to the 20th National Congress of the Communist Party of China," Ministry of Foreign Affairs of the People's Republic of China, Oct. 16, 2022, https://www.fmprc.gov.cn/eng/zxxx_662805/202210/t20221025_10791908.html.

[31] "Xi Jinping Attends the General Debate of the 76th Session of the United Nations General Assembly and Delivers an Important Speech," Ministry of Foreign Affairs of the People's Republic of China, Sept. 22, 2021, https://www.fmprc.gov.cn/mfa_eng/wjb_663304/zzjg_663340/gjs_665170/gjsxw_665172/202109/t20210923_9580159.html#:~:text=On%20September%2021%2C%202021%2C%20President,to%20Build%20a%20Better%20World%22.

[32] "China," Climate Action Tracker, Climate Analytics and New Climate Institute, May 19, 2022, https://climateactiontracker.org/countries/china/.

[33] "The Risks to Australia of a 3C Warmer World," Australian Academy of Science, March 2021, pp. 6-11, https://www.science.org.au/files/userfiles/support/reports-and-plans/2021/risks-australia-three-deg-warmer-world-report.pdf.

[34] Dominic Ellis, "Top 10 Countries for Carbon Dioxide Emissions," Energy Digital, April 25, 2022, https://energydigital.com/top10/top-10-countries-for-carbon-dioxide-emissions; Mark Dwortzan, "Getting the carbon out of India's heavy industries," *MIT News*, July 5, 2022, https://news.mit.edu/2022/getting-carbon-out-india-heavy-industries-0705.

[35] "Will India become a green superpower?" *The Economist*, Oct. 20, 2022, https://www.economist.com/briefing/2022/10/20/will-india-become-a-green-superpower; "India: Transforming to a Net-Zero Emissions Energy System," Shell International and The Energy and Resources Institute, 2021, pp. 15-16, https://www.teriin.org/sites/default/files/2021-03/India_Transforming_to_a_net-zero_emissions_energy_system.pdf.

[36] Tim Roemer, "National Security Strategy: India Is a Growing World Power and Partner," *The Hill*, Oct. 26, 2022, https://thehill.com/opinion/national-security/3704952-national-security-strategy-india-is-a-growing-world-power-and-partner/.

[37] "World Hydrogen Awards 2022," Sustainable Energy Council, May 9, 2022, https://www.world-hydrogen-summit.com/winners-announced-for-world-hydrogen-2022-awards/.

[38] "Fact Sheet: Results of Bilateral Meeting Between the United States and the Kingdom of Saudi Arabia," The White House, July 15, 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2022/07/15/fact-sheet-results-of-bilateral-meeting-between-the-united-states-and-the-kingdom-of-saudi-arabia/.

[39] Marco Alverá, *The Hydrogen Revolution: The Blueprint for the Future of Clean Energy* (2021), Ch. 13.

[40] "Saudi's Investment Minister on Oil Demand, Economic Growth, Green Energy," *Bloomberg TV*, July 18, 2022, https://www.bloomberg.com/news/videos/2022-07-18/saudi-s-investment-minister-on-oil-demand-economic-growth-green-energy.

[41] "UAE-UK Clean Hydrogen Collaboration," World Green Economy Organization and Zest Associates, 2022, p. 13, https://worldgreeneconomy.org/hydrogen-report.pdf; "What countries are the top producers and consumers of oil?" U.S. Energy Information Administration, May 10, 2022, https://www.eia.gov/tools/faqs/faq.php?id=709&t=6.

[42] Marco Giuli, "The Geopolitics of Clean Hydrogen — Opportunities and Challenges for Italy," *Abstract*, Istituto Affari Internazionali, June 2022, https://www.iai.it/sites/default/files/iaip2217.pdf.

[43] "Hydrogen diplomacy office opening in Saudi Arabia," German Federal Foreign Office, Feb. 27, 2022, https://www.auswaertiges-amt.de/en/aussenpolitik/themen/hydrogen-diplomacy-office/2513802; Nikolaus Kurmayer, "Germany's Hydrogen Diplomacy Is a Lifeline for Russia," Euractiv, Feb. 1, 2022, https://www.euractiv.com/section/energy-environment/news/niko-germanys-hydrogen-diplomacy-is-a-lifeline-for-russia/.

[44] "Joint Statement of Chile and The Netherlands on Collaboration in the Field of Green Hydrogen Import and Export," Government of the Netherlands, July 1, 2021, https://www.government.nl/documents/diplomatic-statements/2021/07/01/joint-statement-of-chile-and-the-netherlands-on-collaboration-in-the-field-of-green-hydrogen-import-and-export; "REPowerEU Plan," European Commission, May 18, 2022, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN&qid=1653033742483&print=true.

[45] "Japan Oil Security Policy," International Energy Agency, Aug. 18, 2022, https://www.iea.org/articles/japan-oil-security-policy; "Chairman's Summary," Asia Green Growth Partnership Ministerial Meeting. Sept. 26, 2022, https://www.meti.go.jp/press/2022/09/20220926008/20220926008-2.pdf.

[46] "Welcome Keynote Speech from H.E. Mr. Nishimura Yasutoshi," Minister of Economy, Trade and Industry of Japan, 2nd Asia Green Growth Partnership Ministerial Meeting, Sept. 26, 2022, https://www.meti.go.jp/english/press/2022/pdf/0928_001a.pdf.

[47] Sanja Pekic, "Suiso Frontier Brings World's 1st LH2 Shipment to Japan," Offshore Energy, Feb. 25, 2022, https://www.offshore-energy.biz/suiso-frontier-brings-worlds-1st-lh2-shipment-to-japan/.

[48] "Australia and Germany partner on hydrogen initiatives," The Hon Angus Taylor MP, Minister for Energy and Emissions Reduction, June 13, 2021, https://www.minister.industry.gov.au/ministers/taylor/media-releases/australia-and-germany-partner-hydrogen-initiatives; "State of Hydrogen 2021," Australian Department of Industry, Science, Energy and Resources, p. v, https://www.dcceew.gov.au/sites/default/files/documents/state-of-hydrogen-2021.pdf.

[49] "Geopolitics of the Energy Transformation: The Hydrogen Factor," International Renewable Energy Agency, 2022, pgs. 37, 80, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Geopolitics_Hydrogen_2022.pdf.

[50] Alverá, *op. cit.*, ch. 12.

[51] "Geopolitics of the Energy Transformation: The Hydrogen Factor, *op. cit.*, p. 40; Jane Nakano, "China Unveils its First Long-Term Hydrogen Plan," Center for Strategic & International Studies, March 28, 2022, https://www.csis.org/analysis/china-unveils-its-first-long-term-hydrogen-plan.

[52] "Namibia — Country Summary," The World Factbook, Central Intelligence Agency, https://www.cia.gov/the-world-factbook/countries/namibia/summaries/#geography; "About Generation," *NamPower*, https://www.nampower.com.na/Page.aspx?p=182; and "Renewable Energy Market Analysis, Africa and Its Regions," International Renewable Energy Agency, 2022, p. 41, https://www.irena.org/publications/2022/Jan/Renewable-Energy-Market-Analysis-Africa.

[53] "Southern Corridor Development Initiative, Namibian Green Hydrogen Project," Hyphen Africa, https://hyphenafrica.com/projects/; "Karliczek: Germany and Namibia form partnership for green hydrogen," German Federal Ministry of Education and Research, Aug. 25, 2021, https://www.bmbf.de/bmbf/shareddocs/kurzmeldungen/en/Karliczek-Germany-and-Namibia.html; and "Hyphen: First Gigawatt-scale Green Ammonia Project in Namibia," *Hyphen*, May 24, 2022, https://hyphenafrica.com/wp-content/uploads/2022/05/Hyphen-World-Economic-Forum-Presentation-24-May-2022.pdf.

[54] *Ibid.*

[55] "Namibia — Country Commercial Guide," International Trade Administration, U.S. Department of Commerce, Oct. 3, 2022, https://www.trade.gov/country-commercial-guides/namibia-mining-and-minerals#:~:text=Namibia%20is%20an%20up%2Dand,projects%20for%20cobalt%20and%20lithium; "Namibia Critical Metals Inc. Announces Positive Preliminary Economic Assessment for the Significantly Expanded Lofdal Heavy Rare Earth Project '2B-4' With $632.7 Million Pre-Tax NPV," Namibia Critical Metals Inc., Oct. 3, 2022, https://7d03x1obx342arqt2uv5626l-wpengine.netdna-ssl.com/wp-content/uploads/2022/10/031022-NMI-Press-Release-PEA-Release-SEDAR.pdf; and "The Role of Critical Minerals in Clean Energy Transitions," *op. cit.*, p. 108, https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

[56] "Africa Energy Outlook 2022," International Energy Agency, 2022, p. 156, https://www.iea.org/reports/africa-energy-outlook-2022.

[57] "Speech Delivered by Dr. Akinwumi A. Adesina, President, African Development Bank Group — Norwegian-African Business Association (NABA) Summit," African Development Bank, Sept. 29, 2022, https://www.afdb.org/en/news-and-events/speeches/speech-delivered-dr-akinwumi-adesina-president-african-development-bank-group-norwegian-african-business-association-naba-summit-september-29-2022-oslo-norway-55144.

[58] "Africa Energy Outlook 2022," *op. cit.*, pp. 18, 100-101 and 218; Soraya Ali and Sara Adam, "Fertiliser Shortage Hits African Farmers Battling Food Crisis," *BBC*, June 28, 2022, https://www.bbc.com/news/world-africa-61901074.

[59] "Secretary Antony J. Blinken and Democratic Republic of Congo Vice Prime Minister and Foreign Minister Christophe Lutundula at a Joint Press Availability," U.S. Department of State, Aug. 9, 2022, https://www.state.gov/secretary-antony-j-blinken-and-democratic-republic-of-congo-vice-prime-minister-and-foreign-minister-christophe-lutundula-at-a-joint-press-availability/.

[60] "Congo Basin peatlands have trapped years' worth of carbon. How can they be protected?" *NPR*, Jan. 14, 2022, https://www.npr.org/2022/01/14/1073215461/congo-basin-peatlands-have-trapped-years-worth-of-carbon-how-can-they-be-protect; "Blinken and Lutundula Joint Press Availability," *op. cit.*

[61] Chloé Farand, "DR Congo audit exposes 'lawless' logging sector, implicating six former ministers," *Climate Home News*, April 7, 2022, https://climatechangenews.com/2022/04/07/dr-congo-audit-exposes-lawless-logging-sector-implicating-six-former-ministers/; Tal Harris, "5 Points to Understand Congo's Logging Moratorium," Greenpeace, March 10, 2021, https://www.greenpeace.org/africa/en/blogs/13258/5-points-to-understand-congos-logging-moratorium/.

[62] Dionne Searcey, "Can a Nation Replace Its Oil Wealth With Trees?" *The New York Times*, Nov. 10, 2022, https://www.nytimes.com/2022/11/03/climate/gabon-logging-oil-economy.html?searchResultPosition=1.

[63] "World Population Prospects 2019," United Nations Department of Economic and Social Affairs, 2019, https://population.un.org/wpp/Publications/.

[64] "Remarks by President Biden at the 27th Conference of the Parties to the Framework Convention on Climate Change (COP27)," *op. cit.*

[65] "Africa Carbon Markets Initiative launched to dramatically expand africa's participation in voluntary carbon market," Climate Champions, Nov. 8, 2022, https://climatechampions.unfccc.int/africa-carbon-markets-initiative/; Kyle Peterdy, "Carbon Credits," Corporate Finance Institute, Oct. 19, 2022, https://corporatefinanceinstitute.com/resources/esg/carbon-credit/.

[66] "Renewable Energy Market Analysis, Africa and Its Regions," *op. cit.*, pp. 292-293.

[67] Seth Onyango, "Ethiopia makes plans to become Africa's clean energy hub," *The Africa Report*, Sept. 9, 2021, https://www.theafricareport.com/125472/ethiopia-makes-plans-to-become-africas-clean-energy-hub/.

[68] Giulio Boccaletti, "When Climate Change Meets Geopolitics," Africa Up Close, Wilson Center, Jan. 5, 2022, https://africaupclose.wilsoncenter.org/when-climate-change-meets-geopolitics/; Declan Walsh, "After Secret U.S. Talks Fail, A Hidden War in Africa Rapidly Escalates," *The New York Times*, Oct. 9, 2022, https://www.nytimes.com/2022/10/08/world/africa/ethiopia-tigray-war-talks-us.html.

[69] "The Sky's Limit Africa: The Case for a Just Energy Transition from Fossil Fuel Production in Africa," Oil Change International, Oct. 2021, pp. 12-16,

https://priceofoil.org/2021/10/14/the-skys-limit-africa/; "About the Mozambique Liquified Natural Gas Project," Mozambique LNG, https://mzlng.totalenergies.co.mz/en/about-mozambique-liquefied-natural-gas-project.

[70] Glenn Meyers, "The Oldest Solar Device in the World," *Clean Technica*, Dec. 4, 2014, https://cleantechnica.com/2014/12/04/just-found-oldest-solar-device-world/.

[71] Zachary Shahan, "History of Wind Turbines," *Renewable Energy World*, Nov. 21, 2014, https://www.renewableenergyworld.com/storage/history-of-wind-turbines/#gref.

[72] "Caravel," Britannica, https://www.britannica.com/technology/caravel.

[73] Richard Rhodes, "Chapter 1: No Wood, No Kingdom," in *Energy: A Human History* (2018); "Share of total U.S. energy consumption by major sources in selected years (1776-2021)," in "Renewable Energy Explained," U.S. Energy Information Administration, https://www.eia.gov/energyexplained/renewable-sources/.

[74] "Chapter 4: An Era of Expansion," in Francis Russell, *American Heritage History of the Confident Years: 1866-1914* (1969); "Spindletop," History.com, June 10, 2019, https://www.history.com/topics/landmarks/spindletop.

[75] "1901 4c Pan-American Exposition: Electric Automobile," Mystic Stamp Company, https://www.mysticstamp.com/Products/United-States/296/USA/; Kevin A. Wilson, "Worth the Watt: A Brief History of the Electric Car, 1830 to Present," *Car and Driver*, Aug. 17, 2022, https://www.caranddriver.com/features/g15378765/worth-the-watt-a-brief-history-of-the-electric-car-1830-to-present/; and "Cheaper Than Horses: Horseless Carriages Do More Work and Cost Less Money," *New York Tribune*, Dec. 5, 1897, https://chroniclingamerica.loc.gov/lccn/sn83030214/1897-12-05/ed-1/seq-25/#words=cab+electric+electricity+New+New-York+vehicle+Vehicle+vehicles+York.

[76] "The Moving Assembly Line and the Five-Dollar Workday," Ford Motor Company, https://corporate.ford.com/articles/history/moving-assembly-line.html#:~:text=Henry%20Ford%20famously%20remarked%20that,built%20step%2Dby%2Dstep; "The History of the Electric Car," U.S. Department of Energy, Sept. 15, 2014, https://www.energy.gov/articles/history-electric-car.

[77] "Mr. Churchill's Statement," U.K. House of Commons, March 26, 1913, https://api.parliament.uk/historic-hansard/commons/1913/mar/26/mr-churchills-statement; James A. Paul, "Great Power Conflict over Iraqi Oil: The World War I Era," Global Policy Forum, October 2002, https://archive.globalpolicy.org/component/content/article/185-general/40479-great-power-conflict-over-iraqi-oil-the-world-war-i-era.html.

[78] "Our history: driven by the curiosity to explore," Aramco, https://www.aramco.com/en/who-we-are/overview/our-history#.

[79] Daniel Yergin, "Blood and Oil: Why Japan Attacked Pearl," *The Washington Post*, Dec. 1, 1991, https://www.washingtonpost.com/archive/opinions/1991/12/01/blood-and-oil-why-japan-attacked-pearl/1238a2e3-6055-4d73-817d-baf67d3a9db8/.

[80] Bruce Riedel, "75 years after a historic meeting on the USS Quincy, U.S.-Saudi relations are in need of a true re-think," The Brookings Institution, Feb. 10, 2020, https://www.brookings.edu/blog/order-from-chaos/2020/02/10/75-years-after-a-historic-meeting-on-the-uss-quincy-us-saudi-relations-are-in-need-of-a-true-re-think/; "Our History," *op. cit.*

[81] Odd Arne Westad, *The Global Cold War* (2005), pp. 120-123; "Anglo-Iranian Oil Company," New World Encyclopedia, https://www.newworldencyclopedia.org/entry/Anglo-Iranian_Oil_Company.

[82] "Letter from President Eisenhower to Prime Minister Eden" and "Letter from President Eisenhower to Prime Minister Mollet," *Washington*, July 31, 1956 in "Foreign Relations of the United States, 1955-1957, Suez Crisis, July 26-December 31, 1956," Vol. XVI, https://history.state.gov/historicaldocuments/frus1955-57v16/d35; https://history.state.gov/historicaldocuments/frus1955-57v16/d39.

[83] "Special National Intelligence Estimate, Nasser and the Middle East Situation," Department of State, July 31, 1956, in "Foreign Relations of the United States, 1955-1957, Suez Crisis, July 26-December 31, 1956," Vol. XVI, https://history.state.gov/historicaldocuments/frus1955-57v16/d40; "Letter from President Eisenhower to Prime Minister Eden," *op. cit.*

[84] "Suez Crisis," History.com, Sept. 13, 2022, https://www.history.com/topics/cold-war/suez-crisis#america-intervenes; "Special Message to the Congress on the Situation in the Middle East," President Dwight D. Eisenhower, Jan. 5, 1957, in The American Presidency Project, https://www.presidency.ucsb.edu/documents/special-message-the-congress-the-situation-the-middle-east.

[85] "Oil Embargo 1973-1974," Office of the Historian, U.S. Department of State, https://history.state.gov/milestones/1969-1976/oil-embargo.

[86] "Persian Gulf War," Britannica, https://www.britannica.com/event/Persian-Gulf-War; Sabastiao Salgado, "When the Oil Fields Burned," *The New York Times*, April 8, 2016, https://www.nytimes.com/interactive/2016/04/08/sunday-review/exposures-kuwait-salgado.html#:~:text=Twenty%2Dfive%20years%20ago%2C%20as,environmental%20disasters%20in%20recent%20memory.

[87] Rosemary Griffin, "30 years on: how the collapse of the Soviet Union transformed Russia into a global oil and gas powerhouse," S&P Global Commodity Insights, Aug. 25, 2021, https://www.spglobal.com/commodityinsights/en/market-insights/blogs/oil/082521-russia-oil-gas-infrastructure-30-years; "What countries are the top producers and consumers of oil?" U.S. Energy Information Administration, May 10, 2022, https://www.eia.gov/tools/faqs/faq.php?id=709&t=6.

[88] "The Nobel Prize in Physics 1921," The Nobel Foundation, https://www.nobelprize.org/prizes/physics/1921/summary/; "The History of Solar," U.S. Department of Energy, https://www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf.

[89] "From oil security to steering the world toward secure and sustainable energy transitions," International Energy Agency, https://www.iea.org/about/history.

[90] "Jimmy Carter, State of the Union Address 1980," The Jimmy Carter Presidential Library and Museum, Jan. 23, 1980, https://www.jimmycarterlibrary.gov/assets/documents/speeches/su80jec.phtml.

[91] *Ibid.*

[92] Ronald Reagan, "Acceptance Speech at the 1980 Republican Convention," National Center for Public Policy Research, July 17, 1980, https://nationalcenter.org/ncppr/2001/11/04/ronald-reagans-acceptance-of-republican-presidential-nomination-1980/.

[93] Joseph Romm, "Reagan helped save the ozone layer but ruined America's leadership in clean energy," *Grist*, Feb. 8, 2011, https://grist.org/article/2011-02-07-reagan-helped-save-the-ozone-layer-but-ruined-americas/.

[94] Dermot Gately, "Lessons from the 1986 Oil Price Collapse," The Brookings Institution, https://www.brookings.edu/wp-content/uploads/1986/06/1986b_bpea_gately_adelman_griffin.pdf; Robert D. Hershey Jr., "Worrying Anew Over Oil Imports," *The New York Times*, Dec. 30, 1989.

[95] "Low-Emission Vehicle Program," California Air Resources Board, https://ww2.arb.ca.gov/our-work/programs/low-emission-vehicle-program/about; "Renewable Energy," German Federal Ministry for Economic Affairs and Climate Action, https://www.bmwk.de/Redaktion/EN/Dossier/renewable-energy.html#:~:text=The%20Renewable%20Energy%20Sources%20Act%20(EEG)%2C%20which%20entered%20into,on%20a%20path%20to%20success.

[96] "Renewable Energy Development in China," The World Bank, 2021, https://openknowledge.worldbank.org/bitstream/handle/10986/36666/Renewable-Energy-Development-in-China-A-40-Year-China-World-Bank-Partnership.pdf?sequence=1&isAllowed=y.

[97] "State Motor Vehicle Registrations, By Years, 1900-1995," U.S. Department of Transportation, https://www.fhwa.dot.gov/ohim/summary95/mv200.pdf; Mike Hightower and Dave Borns, "U.S. Energy History, 1945 to Present, History of Coal Use by Sector," Sandia National Laboratories, p. 15, https://www.osti.gov/servlets/purl/1721391.

[98] Roger Revelle and Hans E. Suess, "Carbon Dioxide Exchange Between Atmosphere and Ocean and the Question of an Increase of

Atmospheric CO2 during the Past Decades," Tellus, 1957, https://www.tandfonline.com/doi/abs/10.3402/tellusa.v9i1.9075?src=recsys.

[99] *Ibid.*, p. 19.

[100] Henning Rodhe, "Bert Bolin (1925-2007) — a World Leading Climate Scientist and Science Organiser," Tellus B: Chemical and Physical Meteorology, April 10, 2013, pp. 2-3, https://www.tandfonline.com/doi/full/10.3402/tellusb.v65i0.20583.

[101] "U.S. Energy History, History of Oil Issues and Trends in the U.S.," *op. cit.*, p. 7.

[102] Benjamin Franta, "What Big Oil knew about climate change in 1959," *GreenBiz*, Nov. 3, 2021, https://www.greenbiz.com/article/what-big-oil-knew-about-climate-change-1959#:~:text=Exxon%20had%20a%20secretive%20research,of%20the%20earth's%20population).%22; https://oversight.house.gov/legislation/hearings/fueling-the-climate-crisis-exposing-big-oil-s-disinformation-campaign-to; "Fueling the Climate Crisis: Exposing Big Oil's Disinformation Campaign to Prevent Climate Action," House Oversight Committee, Oct. 28, 2021, https://www.congress.gov/event/117th-congress/house-event/LC67716/text?s=1&r=99.

[103] "United Nations Conference on the Human Environment, 5-16 June 1972, Stockholm," United Nations, 1972, https://www.un.org/en/conferences/environment/stockholm1972#:~:text=The%201972%20United%20Nations%20Conference,the%20environment%20a%20major%20issue.&text=One%20of%20the%20major%20results,Nations%20Environment%20Programme%20(UNEP); "Environmental Moments: A UNEP@50 timeline," U.N. Environment Programme, https://www.unep.org/environmental-moments-unep50-timeline#:~:text=Founded%20in%201972%20following%20the,to%20the%20world's%20environmental%20challenges; and "Recommendation 57" in "Report of the United Nations Conference on the Human Environment, Stockholm, 5-16 June 1972, pp. 18-19, *op. cit.*

[104] "Report of the International Conference on the Assessment of the Role of Carbon Dioxide and of Other Greenhouse Gases in Climate Variations and Associated Impacts," Villach, Austria, World Climate Programme, Oct. 9-15, 1985, https://library.wmo.int/doc_num.php?explnum_id=8512.

[105] "Conference Statement," *op. cit.*, p. 1.

[106] "History of the IPCC," https://www.ipcc.ch/about/history/; "United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, 3-14 June 1992," United Nations, 1992, https://www.un.org/en/conferences/environment/rio1992; and "Article 2: Objective" in "United Nations Framework Convention on Climate Change," 1992, p. 9, https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf.

[107] "Kyoto Protocol," Britannica, https://www.britannica.com/event/Kyoto-Protocol; "World Development Report 1998/1999, Table 12: Structure of Output," World Bank, p. 221, https://openknowledge.worldbank.org/bitstream/handle/10986/5981/WDR%201998_99%20-%20English.pdf?sequence=1&isAllowed=y; "World Development Report 2000/2001, Table 18: Power and Transportation," World Bank, p. 224, https://documents1.worldbank.org/curated/en/230351468332946759/pdf/226840WDR00PUB0ng0poverty0200002001.pdf; and "World Development Report 2002, Table 1: Key Indicators of Development," World Bank, pp. 232-233, https://openknowledge.worldbank.org/bitstream/handle/10986/5984/WDR%202002%20-%20English.pdf?sequence=1&isAllowed=y.

[108] Guillaume Pitron, *The Rare Metals War* (2020) pp. 83-86.

[109] "Dispute Settlement 431, China — Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum," World Trade Organization, May 26, 2015, https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds431_e.htm.

[110] David Barboza, "China Passes Japan as Second-Largest Economy," *The New York Times*, Aug. 15, 2010, https://www.nytimes.com/2010/08/16/business/global/16yuan.html; John Vidal and David Adam, "China Overtakes US as World's Biggest CO2 Emitter," *The Guardian*, June 19, 2007, https://www.theguardian.com/environment/2007/jun/19/china.usnews.

[111] Mark Kolakowski, "History of Oil Prices," Investopedia, Aug. 31, 2021, https://www.investopedia.com/history-of-oil-prices-4842834.

[112] Robinson Meyer, "America Is the World's Largest Oil Producer. So Why Is Losing Russia's Oil Such a Big Deal?" *The Atlantic*, March 8, 2022, https://www.theatlantic.com/science/archive/2022/03/us-oil-natural-gas-price-surge-energy-independence/626979/.

[113] "Sanctions In Response to the February 2022 Russian Invasion of Ukraine," U.S. International Trade Administration, July 21, 2022, https://www.trade.gov/country-commercial-guides/russia-sanctions-framework; "REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition," European Commission, Brussels, May 18, 2022, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131.

[114] Nicolo Conte, "Visualizing China's Dominance in the Solar Panel Supply Chain," *Visual Capitalist*, Aug. 30, 2022, https://www.visualcapitalist.com/visualizing-chinas-dominance-in-the-solar-panel-supply-chain/; "Global Wind Energy Report 2022," Global Wind Energy Council, https://gwec.net/global-wind-report-2022/; and Peggy Sito and Daniel Ren, "China's BYD Takes Tesla's Crown as the World's Biggest Electric Vehicle Producer by Sales," *South China Morning Post*, July 5, 2022, https://www.scmp.com/business/china-business/article/3184241/chinas-byd-takes-teslas-crown-worlds-biggest-electric.

[115] "Inflation Reduction Act of 2022 (IRA): Provisions Related to Climate Change," Congressional Research Service, Oct. 3, 2022, https://crsreports.congress.gov/product/pdf/R/R47262#:~:text=Background-,On%20August%2016%2C%202022%2C%20President%20Biden%20signed%20H.R.%205376%20(,climate%20change%2C%20including%20reduction%20of.

[116] "Germany launches probe into suspected Nord Stream 'sabotage,' " *DW*, Oct. 10, 2022, https://www.dw.com/en/germany-launches-probe-into-suspected-nord-stream-sabotage/a-63397922; Melissa Eddy, "Three Inquiries, but No Answers to Who Blew Holes in Nord Stream Pipelines," *The New York Times*, Oct. 25, 2022, https://www.nytimes.com/2022/10/25/world/europe/nord-stream-pipeline-explosions.html.

[117] "First ever UK-German energy link moves ahead as [GBP] 2.4 billion/[euros] 2.8 billion NeuConnect project reaches financial close," Meridiam, July 21, 2022, https://www.meridiam.com/news/first-ever-uk-german-energy-link-moves-ahead-as-2-4bn-e2-8bn-neuconnect-project-reaches-financial-close/.

[118] "2022 State of the Union Address by President von der Leyen," Strasbourg, Sept. 14, 2022, https://ec.europa.eu/commission/presscorner/detail/ov/speech_22_5493.

[119] *Ibid.*; "REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition," European Commission, Brussels, May 18, 2022, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131.

[120] *Ibid.*; Mary Hui, "Europe Is Replacing Energy Dependence on Russia With Solar Reliance on China," *Quartz*, Sept. 22, 2022, https://qz.com/europe-russia-energy-dependence-china-solar-1849566759.

[121] "Germany approves the expansion of wind energy and solar power," REVE, *Wind Energy and Electric Vehicle Magazine*, July 9, 2022, https://www.evwind.es/2022/07/09/germany-approves-the-expansion-of-wind-energy-and-solar-power/86911.

[122] "First ever UK-German Energy link moves ahead," *op. cit.*

[123] Romain Imbach, Manon Romain and Pierre Breteau, "France's Unprecedented Summer of Wildfires, in Maps and Graphs," *Le Monde*, Aug. 25, 2022, https://www.lemonde.fr/en/les-decodeurs/article/2022/08/25/fires-in-france-maps-and-graphs-to-visualize-an-unprecedented-summer_5994672_8.html; "Record high temperatures verified," U.K. Met Office, July 28, 2022, https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2022/record-high-temperatures-verified#:~:text=The%20UK's%20new%20record%2Dhigh,of%20analysis%20and%20quality%20control; and Paul Hockends, "The Drying Up of Europe's Great Rivers Could Be the New Normal," *Wired*, Oct. 1, 2022, https://www.wired.com/story/the-drying-up-of-europes-great-rivers-could-be-the-new-normal/.

[124] "2022 State of the Union Address by President von der Leyen," *op. cit.*

[125] "Pakistan: Floods — July 2022," United Nations Office for the Coordination of Humanitarian Affairs, https://reliefweb.int/disaster/fl-2022-000254-pak; "WMO: Greater Horn of Africa drought forecast to continue for fifth year," *UN News*, Aug. 26, 2022, https://news.un.org/en/story/2022/08/1125552.

[126] "Q&A, Alok Sharma, "There's Been Some Progress on Climate But Nations Must Fast-Track Local Actions," *The East African*, Oct. 15-21, 2022.

[127] "Extreme Weather in China Highlights Climate Change Impacts and Need for Early Warnings," World Meteorological Organization, Aug. 24, 2022, https://public.wmo.int/en/media/news/extreme-weather-china-highlights-climate-change-impacts-and-need-early-warnings; "Heatwave in China is the Most Severe Ever Recorded in the World," *New Scientist*, Aug. 23, 2022, https://www.newscientist.com/article/2334921-heatwave-in-china-is-the-most-severe-ever-recorded-in-the-world/.

[128] "RMS Estimates US$67 Billion in Insured Losses from Hurricane Ian," RMS, Oct. 7, 2022, https://www.rms.com/newsroom/press-releases/press-detail/2022-10-07/rms-estimates-us67-billion-in-insured-losses-from-hurricane-ian.

[129] Kerry Emanuel, "Will Global Warming Make Hurricane Forecasting More Difficult?" American Meteorological Society, March 2017, p. 500, https://journals.ametsoc.org/view/journals/bams/98/3/bams-d-16-0134.1.xml.

[130] "Nationally Determined Contributions Under the Paris Agreement, Synthesis Report by the Secretariat," United Nations Framework Convention on Climate Change, Oct. 26, 2022, pp. 5-6, https://unfccc.int/documents/619180.

[131] *Ibid.*, p. 7.

[132] "Indonesia and International Partners Secure Groundbreaking Climate Targets and Associated Financing," news release, The White House, Nov. 15, 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2022/11/15/indonesia-and-international-partners-secure-groundbreaking-climate-targets-and-associated-financing/.

[133] "Inflation Reduction Act of 2022 (IRA): Provisions Related to Climate Change," pp. 7-13, *op. cit.*

[134] "Remarks by President Biden at the 27th Conference of the Parties to the Framework Convention on Climate Change (COP27)," *op. cit.*

[135] "Fact Sheet: Biden-Harris Administration Driving U.S. Battery Manufacturing and Good-Paying Jobs," The White House, Oct. 19, 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2022/10/19/fact-sheet-biden-harris-administration-driving-u-s-battery-manufacturing-and-good-paying-jobs/; "Fact Sheet: The Biden-Harris Electric Vehicle Charging Action Plan," The White House, Dec. 13, 2021, https://www.

whitehouse.gov/briefing-room/statements-releases/2021/12/13/fact-sheet-the-biden-harris-electric-vehicle-charging-action-plan/.

[136] Jane Nakano, "IRA and the EV Tax Credits: Can We Kill Multiple Birds with One Stone?" Center for Strategic & International Studies, Sept. 15, 2022, https://www.csis.org/analysis/ira-and-ev-tax-credits%E2%80%94can-we-kill-multiple-birds-one-stone-0.

[137] Anshu Siripurapu, "What Is the Defense Production Act?" Council on Foreign Relations, Dec. 22, 2021, https://www.cfr.org/in-brief/what-defense-production-act.

[138] "Fact Sheet: President Biden Takes Bold Executive Action to Spur Domestic Clean Energy Manufacturing," The White House, June 6, 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2022/06/06/fact-sheet-president-biden-takes-bold-executive-action-to-spur-domestic-clean-energy-manufacturing/.

[139] "Letter to the EU President," Hydrogen Europe, Aug. 25, 2022, https://hydrogeneurope.eu/wp-content/uploads/2022/09/Letter-VDL-b5ee6db11da31699752b81615f88fe41.pdf.

[140] Sarah Perez, "Why Did Solyndra Fail So Spectacularly?" *TechCrunch*, Oct. 4, 2011, https://techcrunch.com/2011/10/04/why-did-solyndra-fail-so-spectacularly/.

[141] "President Sisi orders crystalizing cooperation with Greek Copelouzos Group," Egypt State Information Service, Sept. 1, 2022, https://sis.gov.eg/Story/171049/President-Sisi-orders-crystalizing-cooperation-with-Greek-Copelouzos-Group?lang=en-us.

[142] Ed Crooks, "Why iridium could put a damper on the green hydrogen boom," Wood Mackenzie, July 15, 2022, https://www.woodmac.com/news/opinion/why-iridium-could-put-a-damper-on-the-green-hydrogen-boom/.

[143] "Minerals used in electric cars compared to conventional cars," International Energy Agency, May 4, 2021, https://www.iea.org/data-and-statistics/charts/minerals-used-in-electric-cars-compared-to-conventional-cars; "Mineral Commodity Summaries: Cobalt," U.S. Geological Survey, January 2022, https://pubs.usgs.gov/periodicals/mcs2022/mcs2022-cobalt.pdf.

[144] Rodrigo Castillo and Caitlin Purdy, "China's Role in Supplying Critical Minerals for the Global Energy Transition: What Could the Future Hold?" Brookings Institution, July 2022, p. 20, https://www.brookings.edu/wp-content/uploads/2022/08/LTRC_ChinaSupplyChain.pdf.

[145] "United States Army Climate Strategy," Department of the Army, Feb. 2022, p. 11, https://www.army.mil/e2/downloads/rv7/about/2022_army_climate_strategy.pdf.

[146] Amory Lovins,"Greener, Friendlier Alternatives Exist for Rare Minerals in EV Batteries," RMI, Dec. 8, 2021, https://rmi.org/rmi-reality-check-greener-friendlier-alternatives-exist-for-rare-minerals-in-batteries/.

[147] Steve Hanley, "Researchers Discover Substitutes for Rare Earth Materials in Magnets," CleanTechnica, Oct. 29, 2022, https://cleantechnica.com/2022/10/29/researchers-discover-substitutes-for-rare-earth-materials-in-magnets/.

[148] "National Blueprint for Lithium Batteries, 2021-2030, Executive Summary," U.S. Department of Energy, June 2021, pp. 6 and 18, https://www.energy.gov/sites/default/files/2021-06/FCAB%20National%20Blueprint%20Lithium%20Batteries%200621_0.pdf.

[149] "COP27 and International Climate Action: A Conversation With John Kerry," Council on Foreign Relations, Oct. 25, 2022, https://www.cfr.org/event/cop27-and-international-climate-action-conversation-john-kerry.

Bibliography

Books

Alverá, Marco, *The Hydrogen Revolution: A Blueprint for the Future of Clean Energy*, Basic Books, 2021.

A European energy executive explains how the clean fuel derived from water can decarbonize transport and industry and reshape energy geopolitics.

Epstein, Alex, *Fossil Future: Why Global Human Flourishing Requires More Oil, Coal, and Natural Gas — Not Less*, Penguin Random House, 2022.

A libertarian intellectual counters the narrative that oil and natural gas use must be eliminated, arguing that fossil fuels are low-cost, reliable sources of fuel, essential for improving life in the developing world.

Mirtchev, Alexander V., *The Prologue: The Alternative Energy Megatrend in the Age of Great Power Competition*, Post Hill Press, 2021.

An academic and global economic security adviser explains how the transition to alternative energy sources will shape defense strategy, environmental security and geopolitics.

Nahm, Jonas, *Collaborative Advantage: Forging Green Industries in the New Global Economy*, Oxford University Press, 2021.

International collaboration will have a central role in scaling up industries built on renewable energy, along with lessons learned from Germany and China.

Pitron, Guillaume, *The Rare Metals War: The Dark Side of Clean Energy and Digital Technologies*, Scribe, 2020.

A French journalist exposes the environmental damage and political risks posed by the mining of specialized metals needed in massive quantities to expand the use of electric vehicles and renewable energy.

Sanderson, Henry, *Volt Rush: The Winners and Losers in the Race to Go Green*, Oneworld, 2022.

A journalist explores the complex global supply chains, dominated by China, that are behind the transition away from fossil fuels, and the rise of electric vehicles.

Van de Graaf, Thijs, and Benjamin K. Sovacool, *Global Energy Politics*, Polity, 2020.

Academics examine the upheaval in international relations and domestic energy politics as renewables and climate change rise to the top of the world's agenda.

Yergin, Daniel, *The New Map: Energy, Climate, and the Clash of Nations*, Penguin Press, 2020.

An American energy expert surveys the profound changes under way due to China's rise, the U.S. oil shale revolution, climate change and Russia's calculations.

Articles

"State-run oil giants will make or break the energy transition," *The Economist*, July 25, 2022, https://tinyurl.com/sk7mhz8m.

State-controlled oil companies dominate energy production in many countries and thus will determine how the transition to a low-carbon future will play out.

"Will India Become a Green Superpower?" *The Economist*, Oct. 20, 2022, https://tinyurl.com/49fsstj4.

While India still depends heavily on coal, it is rapidly scaling up renewable energy, in what might become the energy equivalent of its agricultural green revolution.

Beech, Hannah, "Can a Tiny Territory in the South Pacific Power Tesla's Ambitions?" *The New York Times*, Dec. 30, 2021, https://tinyurl.com/yak7pxc3.

Tesla's plan to buy nickel for its electric batteries directly from a mine on a South Pacific island and introduce environmental and social safeguards could provide a test of sustainability.

Schmall, Emily, and Jack Ewing, "India's Electric Vehicle Push Is Riding on Mopeds and Rickshaws," *The New York Times*, Sept. 4, 2022, https://tinyurl.com/4nzyf462.

India's electrification of basic transport could become a template for other developing countries trying to expand carbon-free energy uses.

Tyler, Melissa Conley, "Imagine it's 2030 and Australia is a renewable energy superpower in Southeast Asia," *The Conversation*, May 10, 2022, https://tinyurl.com/nwf32ekp.

Australia could become a key energy supplier to Southeast Asia in the transition to green energy.

Wakabayashi, Daisuke, and Claire Fu, "For China's Auto Market, Electric Isn't the Future. It's the Present," *The New York Times*, Sept. 26, 2022, https://tinyurl.com/2h69kbkw.

Chinese consumers are embracing electric vehicles as a viable transportation option, offering a glimpse of the future of carbon-free mobility.

Reports and Studies

"Africa Energy Outlook 2022," International Energy Agency, June 2022, https://tinyurl.com/52au7j9m.

An intergovernmental organization looks at Africa's advantages in the shifting global energy landscape and how leaders can help capture the continent's energy potential.

"Critical Minerals and U.S. Public Policy," Congressional Research Service, June 28, 2019, https://tinyurl.com/yc2u32dj.

Researchers say the United States is over-dependent on China for minerals needed for the green energy transition.

"Geopolitics of the Energy Transformation: The Hydrogen Factor," International Renewable Energy Agency, 2022, https://tinyurl.com/4fyxv7uf.

As hydrogen energy projects proliferate worldwide, new trading relationships will affect security, industrial development and the future of the developing world.

"Hearing on China's Energy Plans and Practices," U.S.-China Economic and Security Review Commission, March 17, 2022, https://tinyurl.com/yfr8j9x2.

Experts on China's energy policies offer perspectives on how the United States should respond as China expands its use of green energy.

"India: Transforming to a Net-Zero Emissions Energy System," Shell International and The Energy and Resources Institute, 2021, https://tinyurl.com/4ekrec7y.

India is beginning a "technically possible but highly challenging" three-decade journey to overhaul its energy system in favor of renewables.

"A New World: The Geopolitics of the Energy Transformation," Global Commission on the Geopolitics of Energy Transformation, International Renewable Energy Agency, 2019, https://tinyurl.com/2p8hz59y.

Political leaders and economists say countries will increase their energy independence as decentralized renewables become "a powerful vehicle for democratization."

Castillo, Rodrigo and Caitlin Purdy, "China's Role in Supplying Critical Minerals for the Global Energy Transition," Brookings Institution, July 2022, https://tinyurl.com/ycknawnp.

Chinese control over minerals critical to a transition to green energy poses geopolitical risks for the United States and Europe, which must create more competitive, secure and stable supply chains.

Clarke, Zoe, *et al.*, "Carbonomics: The Clean Hydrogen Revolution," Goldman Sachs, Feb. 4, 2022, https://tinyurl.com/2p9y2c37.

One of the world's biggest investment banks examines the potential for clean hydrogen and says $5 trillion in investment is needed.

Kahn, Matthew E. and Somik Lall, "Will the Developing World's Growing Middle Class Support Low-Carbon Policies?" Policy Research Working Paper 10125, World Bank, July 2022, https://tinyurl.com/44u7zxay.

Researchers say policymakers in low- and middle-income countries must encourage middle-class consumers to support a cleaner environment while catering to their demand for energy-intensive products — or face rising political opposition.

The Next Step

Africa

Chutel, Lynsey, and John Eligon, "These Farmers Tried to Stop Yet Another Coal Mine. What Happened Next?" *The New York Times*, Nov. 8, 2022, https://tinyurl.com/4p2mh87k.
Most of South Africa's electricity comes from coal, and the transition to clean energy could cost jobs.

"Africa renewable energy investment at 11-year low: research," *Tech Explore*, Nov. 9, 2022, https://tinyurl.com/mrxscjph.
Investment in renewable energy in Africa fell to its lowest level in more than a decade last year despite the continent's huge potential.

Ibukun, Yika, "G20 Seat to Help Africa Push Rich on Climate Pledges, Sall Says," *Bloomberg*, Nov. 9, 2022, https://tinyurl.com/5n8ds25m.
The African Union expects to officially join the Group of 20 nations this month, providing the continent with another seat at the table with some of the world's biggest polluters as it confronts the fallout from global warming.

Arctic

Adomaitis, Nerijus, "Plans for world's northernmost oilfield in doubt as costs soar," *Reuters*, Nov. 10, 2022, https://tinyurl.com/4d4h9jkh.
Soaring costs dissuaded the Norwegian government from investing in a new hydrocarbon field in the Arctic Circle.

Magill, Bobby, "EV Mineral Bonanza on Alaska Tribal Land Turns on Disputed Road," *Bloomberg Law*, Nov. 7, 2022, https://tinyurl.com/5n8bycp5.
Alaska Natives are concerned drilling for minerals for electric vehicles in their homelands will disrupt their way of life.

Schmidt, Doug, "Windsor company sells High Arctic hamlet on solar power," *Windsor Star*, Oct. 31, 2022, https://tinyurl.com/4cwjwncf.
In an isolated community in Canada's High Arctic, where the sun does not shine three months a year, a company has installed a solar power installation to supply renewable energy in a land of ice and rock.

Hydrogen

Lawson, Alex, "The great hydrogen gamble: hot air or net zero's holy grail?" *The Guardian*, Oct. 25, 2022, https://tinyurl.com/fa9c5vy2.
Lobbyists are trying to persuade the British government that hydrogen gas will be a valuable weapon in the climate crisis, but questions remain.

Lipton, Eric, "New Tax Break for Clean Energy Draws Scrutiny," *The New York Times*, Nov. 3, 2022, https://tinyurl.com/y55jerfm.
The asset manager Blackstone is receiving a massive tax break to convert a coal plant into a facility that converts natural gas into hydrogen.

Siegel-Itzkovich, Judy, "Israeli scientists make breakthrough on producing 'green' hydrogen fuel," *The Jerusalem Post*, Nov. 7, 2022, https://tinyurl.com/4p3aduv2.
Researchers in Israel developed a new process to break the chemical bonds in the water molecule to generate hydrogen and oxygen.

Russia and China

Nilsen, Ella, "The US-China climate deal was a rare bright spot in an otherwise thorny relationship. Should it be mended?" *CNN*, Nov. 10, 2022, https://tinyurl.com/yckjky2z.
China, which last year installed 80 percent of the world's new offshore wind capacity, doubts the United States can meet its commitments on green energy.

Russel, Karl, and Jason Karain, "How Russian Gas in Europe Is Dwindling," *The New York Times*, Sept. 7, 2022, https://tinyurl.com/2wtmzwhb.
China and India are taking advantage of Europe's boycott of Russian natural gas, pushing Moscow for lower prices.

Wong, Jacky, "The Sun Will Keep Shining on Chinese Solar," *The Wall Street Journal*, Aug. 30, 2022, https://tinyurl.com/2528dpr7.
China's solar firms face some long-term threats from U.S. policy but may benefit from the global energy crisis and higher U.S. spending.

At Issue:

Should the U.S. cooperate with China in the global transition to green energy?

Yes

MERRITT T. COOKE

Founder and President, ReGen250; Author, *Sustaining Clean Energy Cooperation with China*

WRITTEN FOR *CQ RESEARCHER*, NOVEMBER 2022

The United States should continue to seek cooperation with China in the global transition to green energy for four principal reasons.

Scientifically, the knowledge basis on which the transition depends has no political boundaries. Just as an accurate understanding of human evolution requires archaeological digs in every country, as well as international scientific exchange to synthesize those findings, the scientific foundation for a global low-carbon future is strengthened by U.S.-Chinese scientific cooperation. Of course, that exchange must be conducted on the basis of stringent academic standards and strict safeguards for intellectual property. But scientists recognize that a molecule of any greenhouse gas produced anywhere is bad for our future everywhere.

Commercially, the logic for continued engagement in developing green energy products and services — through trade and investment — outweighs any arguments for decoupling. The U.S. comparative advantage is in basic research and development, technology innovation and the efficiency of our capital markets to bring breakthrough products to scale. China's comparative advantage is in the size of its market and the market certainty fostered by its top-down political model. It is far more advantageous for the United States to be smart and vigilant in protecting its core assets from unfair trade practices than to forgo access to the world's largest and still dynamically growing green energy market.

Politically, it is a harder call to make, but there is no reason to turn our backs on political cooperation entirely. From 2009 through 2019, there was a formal program of U.S.-Chinese cooperation on energy and the environment (read "green energy") signed at the presidential level (and, in its early days, supported on a bipartisan basis in Washington). That framework expired several years ago and, following House Speaker Nancy Pelosi's visit to Taiwan in August, China formally terminated all national programs of U.S.-Chinese cooperation. However, cooperation at the level of states, cities and businesses can and should proceed when it is in the interest of those entities to do so. The absence of a binational framework makes that subnational cooperation more difficult but is not a reason to forgo it.

Morally, the issue could not be clearer. Transition to a green energy future is not an option, it is a necessity. The current moment presents us — as a species — with an existential threat of our own making and forces us again to prove our species' resilience and ability to adapt. Cooperation, not conflict, improves our odds for pulling that off.

No

LAURI MYLLYVIRTA

Lead Analyst, Centre for Research on Energy and Clean Air

WRITTEN FOR *CQ RESEARCHER*, NOVEMBER 2022

The idea that cooperation is needed between the United States and China, the world's largest energy consumers, to tackle global energy challenges sounds almost tautological.

The high point of such cooperation was 2014, when Presidents Xi Jinping and Barack Obama jointly announced their new climate commitments, winning support for their proposals in both countries while adding crucial momentum to the process leading up to the 2015 Paris agreement. Since then, the political dynamics in both countries have changed in a way that would make such a joint announcement politically unattractive. This was clear when China announced in 2020 that it would reach carbon neutrality in 2060 and when it pledged last year to stop building coal power plants overseas. Both announcements were unilateral.

The two countries do not need technology or financing from one another. Rather, both are keen to ensure that they have decoupled their supply chains for key strategic technologies and resources.

Xi has set low-carbon development as a strategic priority for China, for obvious reasons: China's food security, water resources and the regional security environment — all key strategic issues — would be jeopardized by runaway climate change. Clean energy technology is thus now firmly positioned as a strategic sector for national security.

Xi's announcement of the carbon neutrality goal triggered a dramatic expansion in domestic deployment of clean energy and manufacturing of clean energy technology, particularly solar power equipment, batteries and electric vehicles. China is positioning itself to supply the vast majority of the equipment and technology for the global green energy transition.

The best thing the United States can do is to scale up clean energy deployment and manufacturing at home and increase financing and support for clean energy in developing countries.

China's leaders have been skeptical of the ability of the often-unruly processes in democratic countries to deliver and implement, scorning their climate pledges as "vague promises." If Chinese leaders were to see the United States and the European Union pulling ahead with 100 percent clean

electricity, smart grids, electrified transport, zero-carbon manufacturing and major financing and technology partnerships with the developing world, China would accelerate its own transition.

The United States and China do still have a shared interest in the success of international climate talks. There are opportunities for coordination and dialogue, but they need to be based on a clear-eyed appreciation of shared and conflicting interests.

Discussion Questions

Here are some issues to consider regarding the changing geopolitics of green energy:

• Some experts fear that China, which controls a large percentage of the world's green energy resources and markets, could use its dominance for geopolitical leverage. How can other governments protect themselves from that possibility?

• Clean hydrogen could enable the emergence of new energy powers, such as Australia, Chile and some African countries. Can those countries prevent their hydrogen industries and resources from being taken over by foreign companies?

• The new green energy world order is likely to be much more diverse and will not be monopolized by a handful of countries or companies. Is that a good thing? What negative consequences might that have?

• Many countries have reserves of rare earth minerals and other critical elements needed for the development of wind and solar energy technologies. But mining those resources can damage the environment and use large amounts of scarce water. Do you think these resources can — or will — be sustainably exploited?

• Countries and mining companies are eying the deep seabed under the Arctic and other oceans for the minerals needed to develop green energy technologies. Environmentalists say doing so could harm vulnerable underwater habitats. Should such resources be developed? If so, who should regulate the process and how should those regulations be enforced?

Greenland Is Epicenter in Race for Control of the Arctic

But as ice cap melts, tensions with Russia block cooperation.

Just as Berlin became the focal point of Cold War tensions between the United States and the Soviet Union after World War II, geography and climate change have made Greenland a major geopolitical arena as world powers compete for the once-remote Arctic region's riches in their transition to green energy.

The self-governing Danish territory sits at the heart of that competition, as the United States, China and Russia scramble for access to the region's renewable energy minerals, expanding maritime routes and undersea oil and gas. Greenland is home to the world's second largest ice sheet, after Antarctica, and two-thirds of its land lies within the Arctic Circle, which has been warming nearly four times faster than the rest of the planet. [1]

Speaking at a regional conference, Greenland's leader warned in September that competition for the Arctic's resources must be managed cordially. "The Arctic must be an area of low tension," Prime Minister Múte Egede said. "Conflicts must be resolved in a peaceful manner." [2]

That task will prove challenging because the war in Ukraine has sidelined Russia, whose shores cover 53 percent of Arctic Ocean coasts and which is currently chair of the intergovernmental Arctic Council. "Russia's continued aggression makes most cooperation unlikely for the foreseeable future," the United States said in a 10-year Arctic strategy document issued in October. [3]

Established in 1996 to coordinate actions as melting ice opens the region to development, the council includes seven other member nations — Canada, Denmark, Finland, Iceland, Norway, Sweden and the United States — along with representatives of Indigenous and scientific groups and 13 near-Arctic observer countries, including China. [4]

In response to Russia's attack on Ukraine in February, the other council members condemned the invasion, suspended their involvement in the council's work and refused to send

representatives to Russia for meetings. Council members Finland and Sweden also asked to join NATO. [5]

Russians were absent when Arctic specialists gathered in Iceland for a conference in October to discuss what to do about thawing permafrost, expanding shipping routes as ice recedes and rising military tensions. In recent decades, Russia has built dozens of new military bases and airfields and modernized Soviet-era military outposts in its Arctic region. [6]

"Now we're in a very difficult place when it comes to Arctic issues," says Rebecca Pincus, director of the Polar Institute at the Wilson Center, a policy institute in Washington, and formerly a Pentagon adviser on the Arctic.

Greenland Has Wealth of Green Energy Resources

The self-governing Danish territory, home to the world's second largest ice sheet, sits at the center of the international scramble for access to renewable-energy minerals in the Arctic Circle.

Source: *CQ Researcher* staff

Tensions with Moscow had already been heightened after Russian Foreign Minister Sergei Lavrov declared in 2021 about the Arctic: "It has been absolutely clear for everyone for a long time that this is our territory." [7]

Meanwhile, Canada, with the second-longest Arctic shoreline, has said it is "firmly asserting its presence" in the region, including defining the outer limits of its continental shelf under the Arctic Ocean and strengthening coordination with the United States. [8]

Amid these frictions, coping with the implications of Greenland's massive melting ice cap is a high priority, according to a study conducted by Jason E. Box, a professor in glaciology at the Geologic Survey of Denmark and Greenland, and European and U.S. colleagues. If 3.3 percent of Greenland's ice cap melts — an amount that "is already committed, regardless of future climate warming scenarios" — the world's oceans will rise by nearly 11 inches, according to the study. It did not give a timeline for that rise. [9]

Russia's estrangement complicates the international response to the emergency. "The longer this goes on, the bigger the data gaps are, when it comes to climate and ecosystems," says Pincus.

On the positive side, however, Greenland's shrinking ice could also expose key minerals needed to produce electric vehicles and batteries for renewable energy storage. California-based KoBold Metals is prospecting on the country's west coast for what it hopes will be "the first- or second-largest and most significant nickel or cobalt deposit in the world," according to Chief Executive Kurt House. And an Australian company exploring Greenland's southern tip said the area could "become the most significant western world producer of critical rare earths" — minerals that are critical for the development of green energy. [10]

Egede has called Russia's invasion of Ukraine "unacceptable" and welcomed increased U.S. investment in Greenland mining, as long as the projects are sensitive to environmental and social impacts. [11]

While the region could supply raw materials needed for the global switch to alternative energy, it could also help meet demand for fossil fuels needed during the transition. The Arctic Circle may hold 30 percent of the world's undiscovered gas and 13 percent of its undiscovered oil, mostly offshore under 1,640 feet of water, according to the U.S. Geological Survey. [12]

But environmental groups say expanded hydrocarbon production in the Arctic would be "environmentally catastrophic," because of the risks of oil spills, damage to wildlife and accelerated warming of the planet from continued use of fossil fuels. [13]

With so much at stake, U.S. policymakers are focusing on China's ambitions and Russia's expanding military capabilities. In August, President Biden elevated U.S. engagement in the region by announcing he would name an ambassador-at-large for the Arctic region to further national security and economic interests and promote cooperation with other Arctic states. [14]

According to the U.S. National Strategy for the Arctic Region, Russia — in addition to modernizing its regional military bases — has been deploying air defense missile systems and upgrading submarines in the Arctic. [15]

"The Arctic is a good place to hide submarines because it's really noisy" due to shifting sea ice, says Pincus, the Polar Institute director.

Missile defense is also high on the U.S. agenda in the region. Thule Air Force Base in northwestern Greenland, America's northernmost military facility, focuses on ballistic missile early warning systems. It also features the northernmost deep-water port in the world. [16]

In September 2018, the Pentagon issued a "statement of intent," saying it would explore building civilian and military airport infrastructure in Greenland "in order to address the changing security environment in the Arctic." [17]

Meanwhile, China is investing in nuclear-powered icebreakers, port facilities and joint efforts with Russia to improve access to the Arctic, according to the U.S. strategy document. And mineral extraction is also on China's agenda, the White House has said. [18]

In its strategic blueprint for the Arctic, the U.S. Navy warned that China aims to "gain access and influence over Arctic States, control key maritime ports and remake the international rules-based order," goals that the blueprint says pose "a threat to people and nations" in the region. [19]

Tensions over China's role in the Arctic and its relationship with Russia erupted at the conference in Iceland, indicating that the multilateral approach to governing the Arctic might be in jeopardy. China's ambassador to Iceland and a Dutch admiral who chairs

NATO's military committee sparred over China's Arctic role and its decision not to condemn Russia on Ukraine. China's Arctic Council envoy, Gao Feng, said excluding Russia from the Arctic Council might affect China's future involvement in the organization. [20]

Pincus says Chinese state-owned enterprises have complied with international sanctions on Russia, and she is watching to see whether Chinese investment starts flowing back into the Arctic.

— Edward DeMarco

---

[1] "Greenland," Britannica, https://www.britannica.com/place/Greenland; Mika Rantanen *et al.*, "The Arctic has warmed nearly four times faster than the globe since 1979," *Nature.com*, Aug. 11, 2022, https://www.nature.com/articles/s43247-022-00498-3#:~:text=In%20recent%20decades%2C%20the%20warming,as%20the%20globe%20on%20average.

[2] "Historic Speech by the Prime Minister of Greenland," Greenland Forum, Arctic Circle, Sept. 13, 2022, https://www.arcticcircle.org/journal/opening-speech-at-the-arctic-circle-greenland-forum.

[3] "National Strategy for the Arctic Region," The White House, October 2022, https://www.whitehouse.gov/wp-content/uploads/2022/10/National-Strategy-for-the-Arctic-Region.pdf.

[4] "Arctic Council," https://www.arctic-council.org.

[5] "Joint Statement on Arctic Council Cooperation Following Russia's Invasion of Ukraine," U.S. Department of State, March 3, 2022, https://www.state.gov/joint-statement-on-arctic-council-cooperation-following-russias-invasion-of-ukraine/; "Finland and Sweden complete NATO accession talks," NATO, July 5, 2022, https://www.nato.int/cps/en/natohq/news_197737.htm.

[6] "Russia's first Senior Arctic Officials' meeting strengthened connections between people and regions of the Arctic," Arctic Council, Dec. 2, 2021, https://us11.campaign-archive.com/?u=274ca09fc8d82dc42a5dfad22&id=da9f9b7a06.

[7] "Who controls the Arctic?" *The Economist*, June 14, 2021, https://www.economist.com/the-economist-explains/2021/06/14/who-controls-the-arctic.

[8] "Arctic and Northern Policy Framework," Government of Canada, https://www.rcaanc-cirnac.gc.ca/eng/1562867415721/1562867459588.

[9] Jason E. Box *et al.*, "Greenland ice sheet climate disequilibrium and committed sea-level rise," *Nature Climate Change*, Aug. 29, 2022, pgs. 808 and 812, https://www.nature.com/articles/s41558-022-01441-2.

[10] René Marsh, "Billionaires are funding a massive treasure hunt in Greenland as ice vanishes," *CNN*, Aug. 8, 2022, https://edition.cnn.com/2022/08/08/world/greenland-melting-mineral-mining-climate/index.html; "Kfanefjeld Project," Greenland Minerals Ltd., https://ggg.gl/kvanefjeld-project/.

[11] "Trade, Minerals, and the Green Transition in Greenland: A Conversation with Prime Minister Múte B. Egede," Wilson Center, June 15, 2022, https://www.wilsoncenter.org/event/trade-green-transition-greenland-prime-minister-mute-b-egede.

[12] "Assessment of Undiscovered Oil and Gas in the Arctic," "Abstract," *Science*, May 29, 2009, https://www.science.org/doi/10.1126/science.1169467.

[13] "Arctic Oil and Gas: The Wrong Solution to the World's Energy Crisis," World Wildlife Fund Arctic Programme, April 6, 2022, https://www.arcticwwf.org/newsroom/news/arctic-oil-and-gas-the-wrong-solution-to-the-worlds-energy-crisis/.

[14] Vedant Patel, "Establishing an Ambassador-at-Large for the Arctic Region," press statement, U.S. Department of State, Aug. 16, 2022, https://www.state.gov/establishing-an-ambassador-at-large-for-the-arctic-region/#:~:text=The%20Ambassador%2Dat%2DLarge%20for,%2C%20academic%20institutions%2C%20non%2Dprofit.

[15] "National Strategy for the Arctic Region," *op. cit.*, p. 6.

[16] "Thule Air Force Base," U.S. Embassy and Consulate in the Kingdom of Denmark, https://dk.usembassy.gov/our-relationship/u-s-greenland/thule-air-force-base/.

[17] "Statement of Intent on Defense Investments in Greenland by the Department of Defense of the United States of America," U.S. Embassy in Denmark, Sept. 16, 2018, https://twitter.com/usembdenmark/status/1041695240686632960/photo/1.

[18] "National Strategy for the Arctic Region," *op. cit.*, p. 6.

[19] "A Strategic Blueprint for the Arctic," U.S. Department of the Navy, January 2021, p. 8, https://media.defense.gov/2021/Jan/05/2002560338/-1/-1/0/ARCTIC%20BLUEPRINT%202021%20FINAL.PDF/ARCTIC%20BLUEPRINT%202021%20FINAL.PDF.

[20] Marc Lanteigne, "China and the 'Two Arctics,' " *The Diplomat*, Oct. 18, 2022, https://thediplomat.com/2022/10/china-and-the-two-arctics/; "China: Will Not Acknowledge Arctic Council Without Russia," *High North News*, Oct. 18, 2022, https://www.highnorthnews.com/en/china-will-not-acknowledge-arctic-council-without-russia.

'Green' Energy Technologies Raise Environmental Alarms

"These mines and processing facilities are really dirty."

One mineral essential to the green energy transition so far has eluded China's control.

Lithium, the world's lightest metal, is increasingly in demand for electric car batteries and electric power grid storage. The largest known untapped supplies rest beneath vast salt flats in Bolivia, where Chinese and Russian companies — and an American firm financed by Microsoft founder Bill Gates — are vying to extract the treasure. [1]

Neighboring Argentina is another major source. In fact, 91 percent of U.S. lithium imports between 2017 and 2020 came from Argentina or Chile. [2]

However, 500,000 gallons of salt water typically are needed to extract one ton of lithium, which then settles out in huge evaporation pools. (The Gates-backed company Lilac Solutions says its technology eliminates the need for pools.) [3]

As electric vehicle sales rise, demand for lithium to use in batteries could expand by a factor of 30 by 2030, the International Energy Agency said last year. But the need for huge amounts of water is a major obstacle: Of the 435 lithium mining projects worldwide, 189 are in arid regions expected to face "medium to high" water stress by 2030, according to an analysis by the consulting firm S&P Global Market Intelligence. [4]

Neighbors of lithium mines also say they are drying out the land. In Fiambalá, a town in northern Argentina, residents have opposed construction of a new lithium project, saying it is significantly affecting local water supplies. [5]

Lithium exists all over the United States, but there is only one U.S. mine operating now, in the Nevada desert. Native American tribes, environmentalists and ranchers are fighting in federal court to stop a second open-pit lithium mine, also in Nevada, from opening. [6]

While the green energy revolution thrives on its reputation for using sustainable, benign technologies that aim to reduce planet-warming emissions, the world is beginning to understand the major environmental costs of such technologies — and not just the use of lithium.

Environmentalists also worry about worldwide plans to increase the mining of so-called rare earth elements (REEs), prized for their magnetic and optical properties and which are essential parts of flat panel displays, magnets and batteries. Mining REEs can also produce environmental damage, risks that could determine what is achievable and by which countries in the geopolitical competition for green energy, especially as global warming exacerbates drought and water shortages worldwide. [7]

While China is a major source of rare earth elements, it has also been investing in such mines in other countries, having realized the toxic legacy of its own domestic mining operations. Chinese scientists said in May that the environmental damage from mining

has been so severe in China that a new, green approach must be adopted. “At present, China’s mining consumption of water resources, low recycling efficiency, heavy metal pollution, and other problems are very prominent, which not only further aggravates the local water shortage dilemma but will also cause serious damage to local drinking water sources, crops, and ecological environments,” the scientists wrote. [8]

Artisanal cobalt mining areas, such as this one in the Democratic Republic of Congo, can have toxic effects on the local environment. Cobalt is used in green-energy technologies. (AFP/Getty Images/Junior Kannah)

Such environmental risks — along with the need to establish REE supply chains outside China’s control — worry U.S. officials aiming to scale up the transition to green energy. Secretary of State Antony Blinken, who convened a group of partner governments in September to create secure supplies of critical green energy minerals to compete with China, said the transition cannot devolve into a “race to the bottom.”

“Too often, the relationship between minerals-producing and minerals-purchasing countries has been extractive and characterized by abusive working conditions,” Blinken told those attending the Minerals Security Partnership meeting. “Often, it’s left behind environmental degradation and devastated communities.” [9]

The potential environmental impact from such mining could be substantial. For example, informal “artisanal” miners in the DRC

confront deadly pollution and cave-ins, along with corrupt officials demanding bribes, and child labor is rampant. [10]

President Biden's target for 50 percent of U.S. car sales to be electric vehicles by 2030 would by itself require an increase of up to 700 percent in global production of rare earth minerals, according to James Kennedy, a consultant on these specialized minerals. [11]

That would not only be environmentally destructive, he says, but due to regulatory hurdles, "The prospect of opening a new [rare earth] mine in that time frame in the United States, generally speaking, is zero."

Henry Lee, director of the environment and natural resources program at Harvard's Belfer Center for Science and International Affairs, agrees. "It's really hard in a developed country to open a new mine or set up new processing facilities," he says. "These mines and processing facilities are really dirty, and people don't want them anywhere near them, legitimately."

For example, a dangerous byproduct of some rare earth mining — the radioactive element thorium — must be stored according to national and international radiation protection standards, according to the International Atomic Energy Agency. Public concern about radioactivity associated with mining rare earth elements "can derail any REE development," the agency cautioned. [12]

Demand for critical minerals is rising so fast that some entrepreneurs are planning to head into the deep ocean to find them. Among the targeted sources: iron and manganese crusts found on the flanks and tops of undersea mountains, which contain cobalt, nickel, tellurium and rare earth elements. About 1,200 seamounts and flat-top mountains under the western Pacific "may be of commercial interest," according to the United Nations Environment Programme. [13]

However, the agency warned banks, investors and insurance companies in June against funding such ventures, saying they would be inconsistent with a "sustainable blue economy," because the ecosystems where the minerals are found "make them particularly sensitive to anthropogenic disturbance." Most are, so far, "largely pristine, highly structured, very diverse [and] dominated by rare species" that would be slow to recover after a disturbance, the agency said. [14]

— Edward DeMarco

[1] "Lithium," Britannica, https://www.britannica.com/science/lithium-chemical-element; Thomas Graham, "Chinese and Russian Companies Dominate in Race to Tap Bolivia's Lithium," *Financial Times*, Oct. 17, 2022, https://www.ft.com/content/7c12bb7e-26fe-49b3-939f-376cc1ee76e2; and "Two funds led by Bill Gates and MIT invest $20 million to reduce water consumption for lithium exploitation," *SMM News*, Feb. 24, 2020, https://news.metal.com/newscontent/101031037/two-funds-led-by-bill-gates-and-mit-invest-20-million-to-reduce-water-consumption-for-lithium-exploitation/.

[2] "Lithium," Mineral Commodity Surveys 2022, U.S. Geological Survey, https://pubs.usgs.gov/periodicals/mcs2022/mcs2022-lithium.pdf.

[3] Amit Katwala, "The Spiraling Environmental Cost of Our Lithium Battery Addiction," *Wired UK*, Aug. 5, 2018, https://www.wired.co.uk/article/lithium-batteries-environment-impact; "A New Process," Lilac Solutions, https://lilacsolutions.com/technology/.

[4] "Net Zero by 2050: A Roadmap for the Global Energy Sector," International Energy Agency, May 2021, p. 162, https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf; Taylor Kuykendall, "CO2 reduction meets water-use tension in hunt for lithium," S&P Global Market Intelligence, Sept. 7, 2022, https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/co2-reduction-meets-water-use-tension-in-hunt-for-lithium-71742617.

[5] Natalie Alcoba, "A race for lithium is sparking fears of water shortages in northern Argentina," *Climate Home News*, Jan. 7, 2022, https://climatechangenews.com/2022/01/07/race-lithium-sparking-fears-water-shortages-northern-argentina/.

[6] Chris Aadland, "Proposed Lithium Mine in Nevada Would Damage Ancestral Lands, Critics Say," *Boise State Public Radio*, April 12, 2022, https://www.boisestatepublicradio.org/environment/2022-04-12/proposed-lithium-mine-in-nevada-would-damage-ancestral-lands-critics-say.

[7] "The Rare-Earth Elements — Vital to Modern Technologies and Lifestyles," U.S. Geological Survey, November 2014, https://pubs.usgs.gov/fs/2014/3078/pdf/fs2014-3078.pdf.

[8] Shuai Li *et al.*, "The Recent Progress China Has Made in Green Mine Construction, Part 1: Mining Groundwater Pollution and Sustainable Mining," *International Journal of Environmental Research and Public Health*, May 2022, p. 13, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9101011/pdf/ijerph-19-05673.pdf.

[9] "Secretary Antony J. Blinken at the Ministerial Meeting of the Minerals Security Partnership," *op. cit.*

[10] "How the world depends on small cobalt miners," *The Economist*, July 5, 2022, https://www.economist.com/middle-east-and-africa/2022/07/05/how-the-world-depends-on-small-cobalt-miners.

[11] "The Biden-Harris Electric Vehicle Charging Action Plan," fact sheet, The White House, Dec. 13, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/13/fact-sheet-the-biden-harris-electric-vehicle-charging-action-plan/#:~:text=President%20Biden%20has%20united%20automakers,in%20the%20U.S.%20by%202030.

[12] "Thorium Resources as Co- and By-Products of Rare Earth Deposits," International Atomic Energy Agency, 2019, pgs. 36, 38, https://www-pub.iaea.org/MTCD/Publications/PDF/TE-1892web.pdf.

[13] "Harmful Marine Extractives: Understanding The Risks & Impacts of Financing Non-renewable Extractive Industries, Deep Sea Mining," United Nations Environment Programme, May 2022, https://wedocs.unep.org/handle/20.500.11822/40147; Zarrín Caldwell, "Preserving the Seas," *CQ Researcher*, Sept. 2, 2022, https://library.cqpress.com/cqresearcher/document.php?id=cqresrre2022090200.

[14] *Ibid.*

Chronology

1830s-Early 1940s Britain's coal fuels its industrial might and global naval power, and oil discoveries open new energy era.

1859

Crude oil discovered in Titusville, Pa.

1901

The Spindletop gusher in Texas sets off U.S. oil boom.

1895-1910

Electric cars prove popular in U.S. cities as gasoline-powered models also begin to arrive.

1912

Winston Churchill, then Britain's first lord of the admiralty, pushes for expanded use of oil for the British Navy, replacing coal and giving the Navy "fighting strength."

1913

Henry Ford introduces a moving assembly line that speeds up production of affordable, gasoline-powered cars.

1921

Albert Einstein is awarded the Nobel Prize in Physics for discovering how sunlight can be converted into electricity.

1938

Standard Oil of California discovers commercial quantities of crude oil in the kingdom of Saudi Arabia.

1941

Japan's quest for oil to power its military campaign in Asia leads to the attack on the U.S. Pacific Fleet in Hawaii, plunging the United States into World War II.

1945-1980 Postwar U.S. economic boom boosts demand for oil.

1945

Saudi King Abdul Aziz Ibn Saud meets President Franklin D. Roosevelt and agrees to supply affordable oil in exchange for U.S. security guarantees.

1954

Scientists at Bell Labs in the United States invent the silicon photovoltaic cell, capable of converting solar energy to power for electrical equipment.

1956

The United States opposes the use of military force by Britain and France to end Egypt's seizure of the Suez Canal, forcing them to back down and accept Egyptian control of the vital waterway. . . . U.S. and European researchers begin to explore the effects of human-made carbon emissions in the atmosphere.

1957

President Dwight D. Eisenhower says protecting Middle East oil producers from Soviet domination is a national security interest.

1960

Iraq, Iran, Kuwait, Saudi Arabia and Venezuela form the Organization of the Petroleum Exporting Countries (OPEC) to coordinate policies on oil prices and production.

1973

OPEC embargoes shipments of oil to the United States and other countries that had supported Israel in a war with Arab states, ending the era of cheap, reliable crude.

1980

President Jimmy Carter declares that "excessive" dependence on foreign oil is a threat to U.S. national security and calls for conservation and solar energy development. . . . He is defeated for re-election by Ronald Reagan, who reverses many of Carter's conservation policies just as global oil prices begin to plummet due to oversupply.

1985-Present Climate science challenges postwar fossil fuel geopolitics; China aims for global leadership in the drive for green energy.

1985

Climate scientists from China, Europe, the Soviet Union and the United States call for government intervention to counter global warming.

1991

The Soviet Union collapses and subsequent economic liberalization opens Russia's oil and gas industry to international investment and technology, increasing output and wealth.

1992

In the U.N. Framework Convention on Climate Change, dozens of nations agree to stabilize greenhouse gas emissions to prevent "dangerous" effects on the world's climate.

1995

China sets strategy to become a leader in wind and solar energy.

2000

Germany's Renewable Energy Sources Act creates incentives for expansion of wind and solar energy.

2005-2020

Hydrofracturing, or "fracking," to extract oil from shale turns the United States into the world's biggest oil and gas producer.

2010

A maritime dispute with Japan prompts China to halt exports of rare earth elements, raising concerns that China may intend to use control of green energy mineral supplies as geopolitical leverage.

2015

At a climate change conference in Paris, 195 countries commit to limit global average surface temperature to less than 2 degrees Celsius above pre-industrial levels.

2020

Oil demand plummets as the COVID-19 pandemic causes shutdowns that disrupt the global economy. . . . President Donald Trump declares a national emergency due to the U.S. dependence on China for critical minerals used in green energy.

2021

Chinese President Xi Jinping announces that his country will no longer build coal-fired power plants in other countries.

2022

Russia's invasion of Ukraine prompts Europe to reduce its reliance on Russian natural gas and speed up expansion of wind, solar and other renewable energy. . . . The Biden administration counters China's dominance of the green energy minerals market by forming the Minerals Security Partnership with allies and wins congressional passage of a measure to massively increase U.S. investments in green energy.

For More Information

Arctic Council, Fram Centre, Postboks 6606, Stakkevollan 9296, Tromsø, Norway; +47-911-20-370; arctic-council.org. Intergovernmental forum for the eight Arctic countries – Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States – to promote cooperation on issues affecting the region.

Directorate-General for Energy, European Commission, 1049 Brussels, Belgium; +32-2-299-11-11; ec.europa.eu/info/departments/energy_en. Develops and carries out the European Union's policies on energy.

Hydrogen Council, Schumanplein 6, 1040 Brussels, Belgium; hydrogencouncil.com. An industry organization that promotes hydrogen as a green fuel to help limit carbon emissions.

Institute of Energy, Beijing University, Beijing, China; +86-010-62755216; energy.pku.edu.cn/en/index.htm. A leading energy research institute in China that collaborates with U.S. experts in studying the transition to renewable energy.

Intergovernmental Panel on Climate Change, c/o World Meteorological Organization, 7 bis Avenue de la Paix, C.P. 2300, CH-1211, Geneva 2, Switzerland; +41-22-730-8208; ipcc.ch. The U.N. body that assesses the scientific evidence on climate change and advises policymakers on economic and environmental effects of global warming.

International Energy Agency, 9 Rue de la Fédération, 75739 Paris Cedex 15, France; +33-(0)1-40-57-65-00; iea.org. Founded in 1974 to respond to global oil disruptions, an agency that provides energy policy analysis and research on the use of "clean energy" technologies.

International Renewable Energy Agency, Masdar City, P.O. Box 236, Abu Dhabi, United Arab Emirates; +97124179000; irena.org. A multilateral organization that studies and promotes all forms of renewable energy and advises policymakers.

Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy, Forrestal Building, 1000 Independence Ave., S.W., Washington, DC 20585; 202-586-9220; energy.gov/eere/office-energy-efficiency-renewable-energy. Conducts research and promotes adoption of solar, wind and hydropower energy.

Organization of the Petroleum Exporting Countries, Helferstorferstrasse 17, A-1010, Vienna, Austria; +43-1-21-11-20; opec.org. Coordinates production and pricing among most of the world's largest oil exporters, including Angola, Iran, Iraq, Nigeria, Saudi Arabia and Venezuela.

U.N. Framework Convention on Climate Change, Secretariat, Platz der Vereinten Nationen 1, 53113 Bonn, Germany; (49-228) 815-1000; unfccc.int. Hub for country commitments to the international treaty to limit greenhouse gas emissions; organizes annual U.N. climate change conferences.

About the Author

Edward DeMarco is a writer on African affairs and a former U.S. Agency for International Development democratic governance strategist in Ethiopia and Zambia. In Ethiopia, he led U.S. government human rights monitoring that shaped the U.S. policy on Indigenous rights in global development, the basis of his memoir, *Last Days in Naked Valley.* Before moving to Africa a decade ago, he was a *Bloomberg* international politics editor in Washington. His most recent report for *CQ Researcher* was on Africa in transition.