



# **Advancing American Energy and Innovation in the Indo-Pacific Region:**

A Report of the Task Force on U.S.  
Indo-Pacific Energy Strategy

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**ENERGY INNOVATION REFORM PROJECT**

# Advancing American Energy and Innovation in the Indo-Pacific Region:

## A Report of the Task Force on U.S. Indo-Pacific Energy Strategy

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Energy Innovation Reform Project is a non-partisan non-profit organization dedicated to promoting policies that advance innovation in energy technologies and practices to improve the affordability, reliability, safety, and security of American energy supplies and our energy economy. EIRP was founded in Washington, DC in 2013. Its work combines policy reports, scholarly research, and economic modeling with creative efforts to bridge partisan differences over energy policy.



# Task Force on U.S. Indo-Pacific Energy Strategy

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Task force members endorse the general policy thrust and judgments of the group as reflected in this report, but do not necessarily endorse every finding or recommendation.

Energy Innovation Reform Project sponsored the Task Force on U.S. Indo-Pacific Energy Strategy.

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# Abbreviations

<b>ASEAN</b>	Association of Southeast Asian Nations
<b>CCUS</b>	carbon capture, utilization, and storage
<b>CO<sub>2</sub></b>	carbon dioxide
<b>EU</b>	European Union
<b>EV</b>	electric vehicle
<b>GWh</b>	gigawatt-hour
<b>IP</b>	intellectual property
<b>LCOE</b>	levelized cost of electricity
<b>LNG</b>	liquified natural gas
<b>MW</b>	megawatt
<b>MWh</b>	megawatt-hour
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>PV</b>	photovoltaic
<b>R&amp;D</b>	research and development

## Executive Summary

The United States is confronting complex challenges from a global energy transition occurring during an era of growing international competition. Yet even as this period tests our security and prosperity, it offers opportunities to renew America's role as an innovator, accelerate economic growth, deepen relationships with key allies and partners, and sustain U.S. international leadership.

These issues are especially visible—and significant—in the Indo-Pacific region, which spans South and Southeast Asia, East Asia and the Pacific, Russia, the United States, Canada, and other Pacific Rim nations. Together, these countries make up about two-thirds of the global economy and of global energy production and consumption. The region is also the focal point for escalating geopolitical competition between the United States and China, and a home to American allies and partners including Australia, Canada, Japan, South Korea, and India.

The global energy transition is a product of complex interactions among innovation, market dynamics, and policies to address climate change. Innovation is reducing the cost of clean energy, providing new energy supplies, and creating remarkable new possibilities for the global energy system. Market forces are shifting patterns of energy production and consumption, boosting demand for new materials (such as critical minerals used in manufacturing batteries for electric vehicles), and forcing policy makers to redefine energy security. National policies to address climate change are also driving the global energy transition, in part due to the Paris Agreement, but these policies appear insufficient to meet the agreement's goals. Many governments, including the Biden administration, have expressed concern about increasing climate change impacts and are considering additional policies, including efforts to further accelerate innovation and the energy transition.

Expanding geopolitical and economic competition with China and Russia makes U.S. efforts to manage the energy transition more demanding, while simultaneously raising the stakes for success or failure. Those stakes include jobs and economic growth but extend to a strong economic foundation for what could become long-term national security challenges as well as for America's 21st-century role in the Indo-Pacific region. Moreover, where past energy competition focused primarily on access to fuels, today's competition also encompasses critical minerals, energy-related information and communication technologies, energy networks and systems that are vulnerable to cyberattack, advanced technology production, and technical standards that could shape the global economy for decades to come. Complicating the matter further, some U.S. allies are reluctant to compete openly with China and Russia, while some are also economic competitors with the United States and one another.

While remaining a leading global innovator and energy producer, America is not sufficiently competitive in energy and energy technology markets, and it risks losing further ground, along with the political influence and military capabilities that derive from economic and technological leadership. China now dominates markets for solar panels and batteries, while Russia is the world's leading supplier of nuclear energy; both situations raise concerns about America's eroding influence, including on nonproliferation and other geostrategic interests. Liquefied natural gas (LNG) exports, as well as further development and commercialization of carbon capture, utilization, and storage (CCUS) and advanced nuclear technologies,

could contribute substantially to U.S. efforts to restore competitiveness and enhance America’s global influence. Moreover, energy technology competition is a component of wider technology competition that includes artificial intelligence, biotechnology, communications, cybersecurity, space, and weapons. Investing in innovation, and in U.S. relationships, will be essential for America’s success.

Members of this task force may differ on some issues, but agree strongly that the United States urgently needs new strategies and policies to manage the intersection of the global energy transition and increasing international competition—and they agree further that these strategies and policies must be bipartisan and sustainable in order to succeed.

## Principles, Interests, and Priorities

The following principles, interests, and priorities should shape U.S. energy strategy and policy in the Indo-Pacific region.

### Principles

Policy should **advance and defend American interests** (including globally competitive firms) **and values** (including democracy, human rights, and the rule of law, as well as environmental sustainability). U.S. leadership to address climate change, especially through policies facilitating a cost-effective transition to low- and zero-carbon technology, is consistent with America’s interests and values.

Policy should emphasize **positive goals**, such as energy innovation, rather than focusing excessively on competitive aims. Where consistent with U.S. interests, policy should seek to accommodate the interests of allies and key partners.

Policy should **support and leverage markets** through public-private collaborations that draw upon the private sector’s financial, informational, and human capital, while ensuring firms’ ability to determine their own goals and priorities. The energy sector is more regulated than most economic sectors, including in the United States, and America’s principal rivals each use government-dominated energy sectors to pursue their political, economic, and security goals. U.S. policy should rely upon markets, but also cannot ignore the reality that governments shape markets.

Policy should be **integrated** and **coordinated** to ensure that it reflects wider U.S. interests in other issue areas (such as strategies to address climate change, boost economic competitiveness, help allies reduce their vulnerabilities to U.S. rivals, and protect U.S. national security) and that it focuses the efforts of the U.S. government as a whole.

Policy should be **technology-inclusive**. In addition to respecting other governments’ dilemmas and decisions in reconciling competing policy priorities, the United States should not interfere unduly with individual firms’ energy and technology choices by foreclosing energy options that could contribute to achieving America’s energy, technology, and climate objectives. Relying on diverse energy sources and technologies promotes resilience, a key U.S. goal.

Policy should be carefully **tailored** in its goals and priorities with respect to current and expected future U.S. relationships with individual Indo-Pacific countries.

Policy should be **bipartisan** so that it is sustainable and coherent across multiple administrations and Congresses.

### Interests and priorities

**Creating jobs, boosting exports, and increasing competitiveness** to strengthen the economic foundation of U.S. prosperity and security

**Ensuring secure and resilient supply chains**, including for critical minerals and other essential high-tech manufacturing inputs

**Advancing and defending open markets and fair trade and investment practices**, including intellectual property (IP) protections

**Contributing to allies’ and partners’ energy security**, including **cybersecurity** and **resilience** of electric grids

Supporting efforts to **reduce greenhouse gas emissions** in the Indo-Pacific region

Leading efforts to **develop clean energy technologies and set related standards** to ensure America’s success in and beyond the global energy transition now underway

**Advancing energy innovation and accelerating deployment of U.S. and allied clean energy technologies** across the Indo-Pacific region

**Managing regional climate-related economic and security risks** and enhancing resilience in cooperation with allies, partners, and others

## Strategy and Policy

We see three strategic priorities for U.S. energy-related, inclusive multilateral diplomacy in the Indo-Pacific region, each of which can contribute uniquely to achieving America's aims:

- **The Quad**—the United States, Australia, India, and Japan—an emerging and strategically important regional alignment
- Allied governments with technologically advanced economies such as **Australia, Canada, Japan, South Korea, and Taiwan**
- **India, Association of Southeast Asian Nations (ASEAN) member states, and other developing countries**, including small island developing states

In addition, the United States should coordinate its Indo-Pacific energy policies with allies and partners outside the Indo-Pacific region, **especially America's European allies**, and should engage with **China and Russia** where possible in advancing (or managing risk to) U.S. interests.

We recommend the following policies and approaches to address U.S. objectives. While divided among economic, security, and clean energy policies to provide structure, these three categories overlap with one another significantly and thus are not mutually exclusive.

### Economic policies and approaches

1. Develop and execute a domestic strategy to **buttress U.S. competitiveness**, especially in high-value high-tech industries, including clean energy.
2. Launch negotiations to **establish a multilateral trade agreement for clean energy technology** in the Indo-Pacific region.
3. **Promote U.S. exports of commercial nuclear power** to contribute to net-zero efforts in the Indo-Pacific region, strengthen U.S. manufacturing, employment, and exports, and anchor multi-decadal cooperation with allies and partners across the region.
4. **Sustain and where possible expand U.S. LNG exports to Indo-Pacific customers**, especially to interested U.S. allies and countries where U.S. LNG can replace coal; expedite infrastructure permitting to support this objective.
5. In energy-related U.S.-China trade and investment, seek measurable reductions in **IP theft**, significant reduction in **subsidies to Chinese-owned enterprises**, compliance with **World Trade Organization subsidy disclosure rules**, and an end to **forced technology transfer**.

### Security policies and approaches

6. Catalyze **multilateral engagement on critical mineral supplies** (including coordinated stockpiles) **among U.S. allies** and other Organisation for Economic Co-operation and Development (OECD) members in the Indo-Pacific region and Europe, possibly through the International Energy Agency, which originated as a means to coordinate energy policy; **promote responsible development of domestic critical mineral resources within the United States**.
7. Explore creating an **"LNG alliance"** among the United States and interested Indo-Pacific LNG exporters and importers to reinforce security of the region's LNG trade, including maritime security.
8. **Negotiate new agreements on civil nuclear cooperation** (Section 123 agreements) in the Indo-Pacific region to extend the reach of U.S. nonproliferation conditions in the region and globally.



9. Assess **deep-sea critical mineral resources in the Indo-Pacific region and the international legal and regulatory framework** for their environmentally responsible collection.
10. **Lead regional cooperative efforts to assess and mitigate cybersecurity and other risks to energy systems**, and work with U.S. allies to develop and implement cybersecurity standards, including through joint action to assist third countries.
11. Collaborate with regional allies and partners to **develop a comprehensive assessment of climate-related risks to energy systems and supply chains** and to assist developing nations in building resilient energy infrastructure; where possible, engage China and Russia in joint assessments of regional climate risks to energy systems.
12. Cooperate with U.S. allies to **support energy-related emergency planning and resilience** in third countries.

### **Clean energy policies and approaches**

13. Increase **federal investments in clean energy innovation** in a portfolio of different technologies to \$25 billion per year or more.
14. Work with U.S. allies to **improve joint financing of clean energy and related infrastructure development projects in India, ASEAN member states, and other developing countries**, including joint financing of CCUS, nuclear power, and renewable energy.
15. Encourage and **support ASEAN governments in reducing greenhouse gas emissions** from coal use, through fuel switching, CCUS, and energy efficiency.
16. **Establish a technology partnerships office and create an energy science and technology fellowship program** based upon the American Association for the Advancement of Science fellowships in the Department of State.
17. Expand the Nuclear Regulatory Commission's capacity to **engage with nuclear regulators in the Indo-Pacific region**, including through joint research on nuclear safety and sharing of regulatory practices.
18. Consider amending the Atomic Energy Act of 1954 to **allow companies in allied countries in the Indo-Pacific region and elsewhere to own U.S. nuclear reactor licenses**, with appropriate review, as a means to stimulate investment in and accelerate deployment of advanced nuclear systems.
19. Support increased university-level **student exchanges with ASEAN nations** in energy and energy-related science and technology fields, including grid security.

# Introduction

As America works toward overcoming the COVID-19 pandemic, U.S. policy makers will increasingly confront a global energy transition occurring during an era of growing international competition. Alone, either the energy transition or growing competition would be sufficient to preoccupy U.S. officials and members of Congress across multiple administrations. Together, these two challenges will test the United States even as they offer opportunities to renew America’s role as an innovator, accelerate economic growth, strengthen national security, and sustain U.S. international leadership.

Affordable, clean, reliable, and safe energy supplies are an essential foundation for security and prosperity. Energy literally powers economies and societies as well as modern mobile and interconnected military forces. In the 21st century—as throughout human history—nations with more energy can do more for their citizens. Those with less energy may struggle to meet their people’s basic needs. Consequently, competition over access to energy has been an enduring feature in international relations.

During periods of transition like today, U.S. energy interests require special attention to ensure that strategies remain aligned with changing circumstances, implementing policies, and available tools and means. Because transitions inherently generate new uncertainties, building and maintaining resilience is especially important in securing America’s future.

Figure 1. The Indo-Pacific Region



The Indo-Pacific region is central to both the global energy transition and to growing international competition. Indo-Pacific countries—spanning South and Southeast Asia, East Asia and the Pacific, and Russia, as well as the United States, Canada, and other Pacific Rim nations in the Western Hemisphere—comprise 65% of the global economy, 64% of global energy production, and 70% of global energy consumption.<sup>1</sup> The region is also a hub of global technological innovation that includes the world's top three investors in government-funded energy research, development, and demonstration (China, the United States, and Japan) and three of the top four major economies ranked by share of gross domestic product (GDP) devoted to research spending (South Korea, Japan, and the United States).<sup>2</sup> The region is also the focal point of escalating U.S.-China political, economic, and security competition, and home to key U.S. allies and partners such as Australia, Canada, Japan, South Korea, and India.

While the members of this task force may differ on some issues, we agree strongly that the United States needs new strategies and policies to manage the intersection of the global energy transition and increasing international competition, that this need is particularly great in the Indo-Pacific region, and that sustained bipartisan cooperation will be necessary for the United States to succeed.

The following section describes the challenges for America that emerge from the intersection of the global energy transition and escalating international competition, with special attention to the Indo-Pacific. Subsequent sections set out guiding principles for U.S. strategy and policy as well as America's energy-related national interests in and priorities for the region. Our recommended strategies and policies conclude the report.

# America's New Energy Challenges

A complex and multidimensional transition is reshaping the global energy system. Three interrelated forces are driving it: innovation, market dynamics, and policies to address climate change. These factors are intertwined, in that innovation alters market dynamics and shapes new policies, market dynamics both ease and complicate innovation and climate policy, and climate policies can spur (or slow) innovation and drive markets.

At the same time, international competition is deepening, posing new foreign policy, economic, and national security challenges to the United States. Effectively managing the simultaneous challenges of the global energy transition and escalating international competition requires realistic assessments of each of these processes and the forces that will define America's future prosperity and security.

## Innovation

Innovation across multiple energy technologies is providing the United States and the world with increasing quantities of energy, supplying cleaner energy, and reshaping the global energy system, though much more innovation is still needed.

Improvements in solar panel manufacturing contributed to an 82% decline in the global weighted average levelized cost of energy (LCOE) from solar photovoltaic (PV) projects between 2010 and 2019.<sup>3</sup> Over the same period, technological advances that improved capacity factors and cut operations and maintenance costs helped to reduce the global weighted average LCOE of onshore wind by 24% and offshore wind by 18%.<sup>4</sup> In the United States, the LCOE of solar PV and wind projects fell by 89% and 70% respectively between 2009 and 2019, though tax credits contributed substantially to this.<sup>5</sup> While solar and wind power generation have grown rapidly as costs have dropped, higher levels of variable solar and wind penetration will increase grid-level costs for transmission, storage, and balancing. Moreover, this growth in solar and wind power began from a very low base, and the overall share of solar and wind in U.S. electric generation remains modest, with 2.3% of utility-scale generation from solar facilities and 8.4% from wind.<sup>6</sup> Small-scale solar generation, such as rooftop solar systems, produce electricity equivalent to about 1% of U.S. power generation.

New battery technologies have achieved greater energy density (the ratio of a battery's energy content to its mass) at a rapid rate. Between 2010 and 2019, the energy density of lithium-ion batteries nearly tripled<sup>7</sup> and the per kilowatt-hour real price of batteries dropped by 87%.<sup>8</sup> Prices declined further in 2020.<sup>9</sup> Smaller, lighter, and more powerful batteries have broad applications across multiple industries, ranging from the transportation and power sectors to military and consumer electronics. Electric vehicles



*Deepwater Wind's Block Island Wind Farm, off Rhode Island, was America's first commercial offshore wind project.*

Credit: Associated Press

(EVs) have been an important source of innovation in batteries, with firms like Tesla investing heavily in new and better designs.<sup>10</sup>

Much less widespread than solar or wind power and EV batteries, fuel cell technologies have also progressed considerably, with a fourfold increase in durability since 2006 and a 60% decrease in the cost of high-volume automotive fuel cells in the same period.<sup>11</sup> Fuel cell buses and ships have already been demonstrated; firms are developing fuel cell trucks in the United States.<sup>12</sup> Still, as of March 2021, cumulative sales of hydrogen fuel cell vehicles in America remain under 10,000.<sup>13</sup>

Hydrogen is also under study as an option to blend with or replace natural gas—itsself a leading source of clean hydrogen if combined with carbon capture, utilization, and storage (CCUS) technologies—and to store excess solar and wind power, though questions endure regarding its commercial viability.<sup>14</sup> In early steps, developers in three U.S. states have ordered gas turbines from Japan’s Mitsubishi Heavy Industries that are capable of burning 30% hydrogen and 70% natural gas.<sup>15</sup> Notwithstanding these moves, large-scale hydrogen power is an energy technology of the future, not the present.

Nuclear energy technologies are advancing as numerous large and small American firms explore alternatives to existing light-water reactors. One new design—NuScale’s small modular reactor—has secured preliminary approval from the Nuclear Regulatory Commission.<sup>16</sup> The U.S. Department of Energy has selected two other companies, TerraPower and X-energy, to demonstrate advanced reactor designs within seven years.<sup>17</sup> Among the smallest of the innovative reactors is Oklo’s Aurora, a 1.5 MW system that the company plans to demonstrate at the Idaho National Laboratory.<sup>18</sup> Several other U.S. firms are advancing other designs toward commercialization. Many of these designs offer attractive safety features and minimize proliferation risks.



*An artist's rendering of Oklo's 1.5 MW nuclear power plant.*

Credit: Oklo and Gensler

Finally, in the fossil fuel sector, America’s development and deployment of extraction technologies like horizontal drilling and hydraulic fracturing revolutionized the oil and gas industry by unlocking vast additional supplies of these two commodities,<sup>19</sup> allowing the United States to emerge as a net exporter of oil and gas and helping to stabilize international markets. Meanwhile, though challenges remain for large-scale commercial deployment, firms have demonstrated CCUS technologies at coal-fired power stations, such as NRG’s Petra Nova plant,<sup>20</sup> and at NET Power’s zero-emission natural gas plant,<sup>21</sup> opening new possibilities for clean power. Without wide access to cheaper CCUS, it will be difficult to achieve goals for global greenhouse gas emissions reduction in both the electricity and industrial sectors.<sup>22</sup> Table 1 demonstrates coal’s significant role in the Indo-Pacific region and its contribution to CO<sub>2</sub> emissions.

Table 1. Coal and coke use and CO<sub>2</sub> emissions in select countries, 2018

	Share of global consumption of coal and coke, all sectors	Share of coal in electric power generation	Share of global CO <sub>2</sub> emissions	Share of global CO <sub>2</sub> emissions from coal and coke consumption
China	51%	65%	30%	54%
India	11%	74%	6%	10%
United States	8%	37%	15%	8%
ASEAN	4%	42%	5%	4%
Japan	2%	31%	3%	3%
South Korea	2%	40%	2%	2%
Australia	1%	58%	1%	1%

Sources: U.S. Energy Information Administration; International Energy Agency.

Notes: ASEAN = Association of Southeast Asian Nations. Coal's share in U.S. electric power generation has fallen significantly since 2018.

## Market Conditions

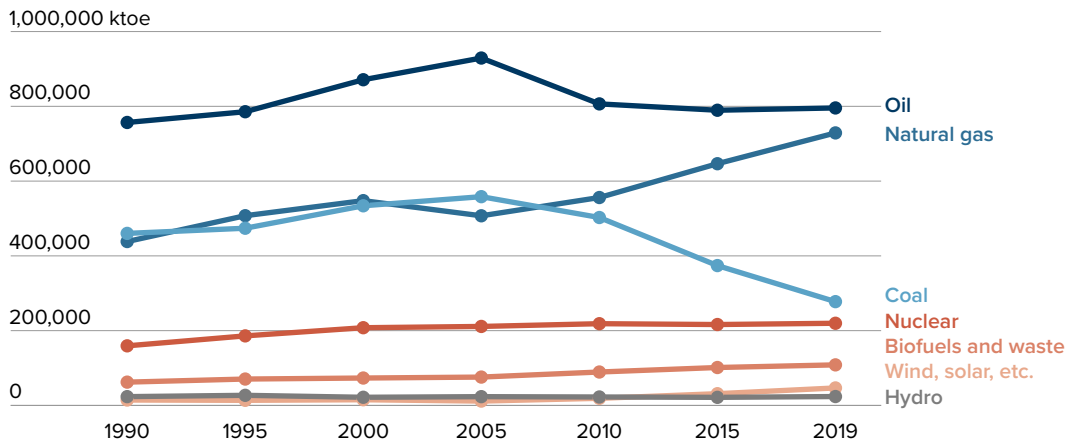
The most visible indicators of the global energy transition are in global energy markets, which represent the aggregated choices and expectations of the world's energy producers and consumers. Energy markets are indeed evolving, though not as rapidly as many might hope or expect; the scale of the global energy system ensures evolution at best, not revolution. Understanding this fact as well as existing market trends is essential in developing strategy and policy.

The COVID-19 pandemic has affected energy markets, cutting 5% from global energy demand in 2020, with deeper reductions of 8% and 7% in oil and coal demand, a 3% decline in demand for natural gas, and a slight increase in demand for renewable energy.<sup>23</sup> Future energy demand will depend heavily upon international efforts to overcome the pandemic and resume pre-COVID-19 levels of economic activity. Moreover, how governments seek to stimulate growth—and the extent to which these programs favor some forms of energy over others—could have powerful and lasting implications. As a result, COVID-19's longer-term economic and energy impacts remain uncertain.

Nevertheless, several broad trends in international energy markets seem likely to endure in the foreseeable future.

- **Cheaper renewables:** As prices for solar and wind power have fallen, these two renewable electricity generation technologies have become competitive with coal-fired power plants globally,<sup>24</sup> although most such comparisons exclude grid-level costs of variable renewable power such as complementary generation, battery or other storage, and additional transmission requirements. These comparisons also typically include policy-driven incentives that help renewables to compete. With this in mind, some analysis suggests that coal could fade from the U.S. power grid by 2033.<sup>25</sup> However, as figure 2 demonstrates, natural gas and not renewable power has largely replaced coal in the United States. Coal is likely to remain a significant fuel in Indo-Pacific power generation for some time.<sup>26</sup>

Figure 1. Contributions to U.S. Total Energy Supply



Source: International Energy Agency, “Data and Statistics,” <https://www.iea.org/data-and-statistics?country=USA&fuel=Energy%20supply&indicator=TPESbySource>.

Note: ktoe = kilotonne of oil equivalent.

- Cheaper electric vehicles:** As prices for batteries have fallen, electric vehicles have become more competitive with gasoline-powered vehicles.<sup>27</sup> Some see global peak in demand for passenger vehicles with gasoline-powered internal combustion engines occurring in the 2020s as EVs take hold.<sup>28</sup> Others forecast that EVs will comprise over half of new vehicle sales only in the mid-2040s.<sup>29</sup> Whichever projection proves accurate, demand for batteries is booming, with U.S. manufacturing capacity alone expected to increase 500% by 2030.<sup>30</sup> Nevertheless, better and cheaper batteries will be necessary for EVs to displace internal combustion engine vehicles.
- More storage—but still not much:** Despite their role in transportation, batteries make a limited contribution to power grids, both in time and in scale. In 2018, California’s large-scale battery systems had an average duration of 3.5 hours and an energy capacity of 502 MWh,<sup>31</sup> a miniscule share of the state’s 195,265,408 MWh in net generation that year.<sup>32</sup> While battery deployment skyrocketed in the United States in 2020—reaching a level greater than that in 2013 through 2019 combined—it amounted to 3.5 GWh, or not quite 0.00002 of California’s total 2018 electric generation.<sup>33</sup> California added approximately 2.7 GWh of this new battery capacity. After its explosive growth in 2020, California’s total 3.2 GWh in battery storage capacity remains somewhat more than half a percent of its average daily electricity generation.<sup>34</sup> In other words, even if all of California’s battery storage is utilized every day, or multiple times per day, batteries would have a small role in the state’s power market. A wide range of electricity and other storage technologies are also under development, though it remains unclear which if any will yield significant cost reductions. Longer-duration electricity storage (necessary when solar or wind power generation is low for several consecutive days) remains inadequate and requires further research and development (R&D).
- Rising demand for critical minerals:** As production of solar panels, wind turbines, batteries, and high-tech electronic devices has expanded, demand for rare earth elements and other critical minerals has soared, creating new supply chains, new political relationships, and new vulnerabilities. Due to its abundant resources, cheap labor, and weak environmental standards, China holds a leading role in supply markets for many critical minerals in addition to having a large share in global manufacturing.<sup>35</sup> Because renewable energy systems are more material-intensive than nuclear and fossil fuel systems, demand for steel and base metals is growing as well.<sup>36</sup>

- **New nuclear energy:** As electricity demand has increased, many governments have been exploring nuclear energy as a source of clean and reliable electricity. In addition to 440 existing reactors in 32 countries and Taiwan, about 50 are under construction and roughly another 100 are on order or planned.<sup>37</sup> Around 30 countries are considering, planning, or starting their first nuclear power programs. America once dominated the market for civil nuclear technology outside the former Soviet bloc, but in today's global nuclear power market, Russia, China and other nations have taken the lead at the expense of U.S. leadership and influence in nonproliferation, where American standards are second to none.<sup>38</sup>
- **Uncertain oil markets:** As new fossil fuel extraction technologies have improved, oil and gas supplies have grown, earlier supply fears have eased, and competition among oil and gas suppliers has intensified, as in the 2020 oil price war between Russia and Saudi Arabia. Business-as-usual scenarios from the International Energy Agency and oil major BP differ somewhat over when oil demand will plateau—the 2030s in the former case, and 2025 in the latter—but each places this event in the foreseeable future.<sup>39</sup> Still, after the COVID-19 pandemic, the IEA has expressed concern that softer demand has led to decreased investment that could significantly reduce global spare oil production capacity by 2026.<sup>40</sup>
- **Booming natural gas:** As U.S. domestic natural gas supplies have grown, prices have fallen, making natural gas-fired power plants highly competitive in America and elsewhere. Cheap natural gas power—which is also well-suited to balancing the variability inherent in solar and wind and has facilitated their growth—has profoundly challenged coal-fired power plants in the United States<sup>41</sup> and some other countries. As natural gas became America's leading source of electric power generation between 2005 and 2019, U.S. energy-related CO<sub>2</sub> emissions fell by 14.5%.<sup>42</sup>
- **Declining but continuing coal demand:** Relatively higher natural gas prices in South Asia and East Asia, and other factors such as energy security, have supported a substantial continuing role for coal-fired power in those regions and elsewhere.<sup>43</sup> Demand for coal in the United States and the European Union (EU) is declining but makes up only about 10% of global coal consumption, so further consumption decreases in these places will have modest impact at the global level.<sup>44</sup> Though coal use appears unlikely to return to pre-pandemic levels, forecasts show stable global demand between 2020 and 2030.<sup>45</sup>



The Tennessee Valley Authority's Paradise Gas Plant in Drakesboro, KY opened in 2017.

Credit: Associated Press

## Policies to Address Climate Change

Many national governments are increasingly developing and implementing policies to address climate change, with significant but varied long-term implications for energy markets. In addition to roughly two dozen nations with existing laws or declared policies establishing net-zero emissions targets, nearly 100 countries reportedly have targets under discussion.<sup>46</sup> These discussions reflect voluntary and nationally determined efforts to pursue the Paris Agreement's goals, though most remain hopeful aspirations that need concerted action if they are to put the world on track to net-zero. Notwithstanding President Joe Biden's reentry into the agreement, the administration's stated commitment to climate diplomacy, and its April 2021 Leaders Summit on Climate, the future extent of international cooperation to reduce greenhouse gas emissions remains uncertain. Overlapping and persistent disagreements among major emitting countries and between developed and developing nations remain a significant constraint, as does insufficient investment in clean energy. As of 2019, nations participating in the Mission Innovation initiative remained far short of the group's goal for clean energy R&D spending.<sup>47</sup>



At the global level, aggregated efforts to limit fossil fuel consumption have thus far had limited impact, though fuel switching—from coal to natural gas—has been important. The share of fossil fuels in world energy consumption hovered between 79% and 81% for over three decades between the early 1980s and 2015, as developed countries reduced and large developing nations increased their fossil fuel use as a share of their overall energy consumption.<sup>48</sup> Fossil fuels maintained a similar role in global energy through 2019,<sup>49</sup> and as global energy demand grew, greenhouse gas emissions from fossil fuels increased 63% between 1990 and 2018.<sup>50</sup> If governments follow stated policies, growth in global oil and gas demand will probably exceed decreases in coal demand between 2019 and 2030,<sup>51</sup> though the latter two fuels—especially natural gas—produce substantially less CO<sub>2</sub> than coal when burned.<sup>52</sup> Continued global population growth and per capita GDP growth will also contribute to growing energy demand, especially in developing Asia.<sup>53</sup>

Among major economies, the EU and its member states have made the most aggressive plans to reduce greenhouse gas emissions, with a commitment to reduce emissions by at least 40% from 1990 levels by 2030.<sup>54</sup> The European Environment Agency reports that the EU met its goal to reduce 1990 emissions by 20% by 2020.<sup>55</sup> While each EU member government is taking a different approach to reaching this goal based on its national circumstances, and while deeper reductions are likely to be more difficult than earlier steps, the policies have already had significant effects. Between 2010 and 2019, the EU reduced its coal consumption by 31%,<sup>56</sup> its oil consumption by almost 5%,<sup>57</sup> and its natural gas consumption by 10%.<sup>58</sup> Overall energy consumption fell by about 4% during this period.<sup>59</sup> Forecasts show continued declines in European fossil fuel demand by 2030 and beyond.<sup>60</sup>

The European Union is currently developing a Carbon Border Adjustment Mechanism (CBAM) to tax greenhouse gas emissions embedded in EU imports; such a policy could have significant consequences for supply chains in the Indo-Pacific region. The European effort seeks to reduce the EU's industrial emissions, some of which currently receive free emissions allocations through the EU's Emissions Trading System, while helping to protect emissions-intensive EU industries in competition with lower-price but higher-emissions imports. Net imports into the EU comprise over 20% of its CO<sub>2</sub> emissions.<sup>61</sup>

More narrowly, Germany's feed-in tariff for solar energy (a government program that guaranteed a fixed price for solar power delivered into the country's electricity grid) has been credited with inadvertently subsidizing China's successful effort to dominate global solar panel manufacturing.<sup>62</sup> (Germany and the United States subsidized demand for solar panels; China subsidized domestic production.) Between 2006 and 2013, China's share of worldwide solar PV production increased from 14% to 60%; Germany and Japan suffered the most from this, losing 17% and 29% in global market share, respectively.<sup>63</sup> By 2019, Chinese firms controlled over 70% of the international market for solar panels.<sup>64</sup> Researchers have found that Germany's post-Fukushima decision to phase out nuclear power increased carbon dioxide emissions by around 5% between 2011 and 2017—contributing 36 million tons of CO<sub>2</sub> per year—and likely added 1,100 deaths per year from respiratory and cardiovascular illnesses during that period.<sup>65</sup>



*The former Solarworld facility in Freiburg, Germany. Solarworld filed for insolvency in 2017.*

Credit: Sebastian Kahnert/picture-alliance/dpa/AP Images

Chinese President Xi Jinping recently announced that China would seek carbon neutrality by 2060,<sup>66</sup> though some observers have questioned Beijing's ability to achieve the goal.<sup>67</sup> If China succeeds, it will make a substantial contribution to transforming the global energy system, likely not only through its domestic actions, but also through its position as a global provider of clean energy technology, including solar panels, wind turbines, and lithium-ion batteries. Beijing could also win considerable geopolitical influence through its global energy business.

However, some of China's policies, such as those related to solar panels, may have undermined global innovation by taking market share from more innovative non-Chinese firms.<sup>68</sup> Likewise, China's programs to deploy its energy technologies elsewhere, including some projects under its Belt and Road Initiative, have prompted concerns among U.S. and allied policy makers and analysts.<sup>69</sup> China has been particularly active as an exporter of coal-fired power plants.<sup>70</sup> Some see the main aim of China's policies as politically important improvements in domestic air and water quality, reductions in dependence on imported energy, and global market dominance in clean energy technologies rather than reductions in global greenhouse gas emissions.

Indeed, research has demonstrated that citizens in China want their government to address air pollution and other environmental concerns distinct from climate change;<sup>71</sup> given how visible pollution impacts may be, citizens in other countries likely want the same from their governments. In addition to capturing CO<sub>2</sub>, CCUS technologies typically reduce emissions of other pollutants, especially sulfur dioxide and particulate matter. Separately from providing climate benefits, switching electricity generation from coal to natural gas also reduces emissions of these pollutants, as well as nitrogen oxides, even without using CCUS.<sup>72</sup>

The United States federal government has taken a variety of steps to promote clean energy, including sponsoring clean energy research, development, and demonstration and enacting a broad range of tax incentives to accelerate deployment. In 2017, 65% of all tax-related support for energy went to renewables, notably through the solar Investment Tax Credit and the wind Production Tax Credit.<sup>73</sup> States, localities, and companies have worked to reduce greenhouse gas emissions too, typically through programs to accelerate adoption of solar and wind power as well as other sources of renewable energy.

The World Bank and other international development organizations are assisting developing nations in tackling climate change, including small island developing states in the Indo-Pacific region, which are especially vulnerable due to their low elevation and limited resources. In December 2020, the World Bank Group announced its intent to ensure that over the next five years, an average of 35% of its financing will have climate benefits, with half of that amount contributing to adaptation and resilience.<sup>74</sup> The United States, its allies, and other development donors have also individually and jointly supported mitigation, adaptation, and resilience in developing nations.

## Escalating Competition

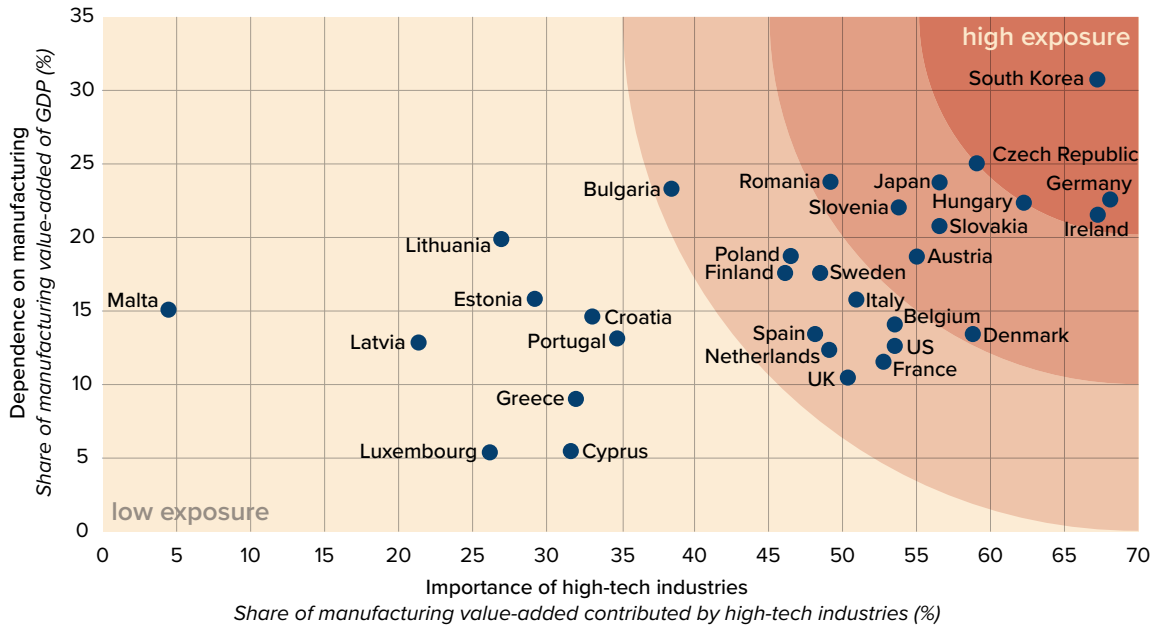
U.S. officials and members of Congress increasingly describe competition from China and Russia as leading national security dangers to the United States. This competition is multidimensional and largely beyond the scope of this report, which concentrates on energy and energy-related technologies. In broad terms, however, China and Russia have each become more assertive in pursuing their aims across several dimensions, including diplomacy, trade, investment, information, security, and values.

In China's case, this has included efforts to declare and legitimize territorial claims in the South China Sea and the East China Sea; to intimidate Australia and others with economic pressure and threatening rhetoric; to expand the country's global influence through investment, trade, and development projects such as the Belt and Road Initiative; and to build new regional institutions like the Asian Infrastructure Investment Bank while seeking to reshape existing global bodies. Russia has occupied Crimea, supported an insurgency

in eastern Ukraine, and intervened in Syria. Moscow has also sought political leverage through the dependencies of its energy customers, employed cyberattacks on critical infrastructure to intimidate its neighbors, and used social media to deepen political tensions in the U.S. and allied countries. Recently both China and Russia have competed with the United States to shape global narratives surrounding the COVID-19 pandemic, including its origins, management, and consequences.

China’s economic challenge to America has attracted growing concern, particularly with respect to unfair trade and investment practices, such as subsidies to state enterprises, forced technology transfer, and theft of intellectual property (IP). A highly visible 2013 report of the Commission on the Theft of American Intellectual Property estimated that China alone was responsible for 50% to 80% of international IP theft and that total losses to the U.S. economy from international IP theft were likely over \$300 billion at that time.<sup>75</sup> Others have described China’s “Made in China 2025” and other policies as “innovation mercantilism” that not only unfairly rewards Chinese firms, but also harms firms and slows innovation in the United States, Europe, Japan, and elsewhere.<sup>76</sup> Figure 3 illustrates the potential exposure of the United States and some of its allies and partners to this policy.

Figure 3. Exposure to China’s “Made in China 2025” Policy



Source: Jost Wübbeke et. al, “Made in China 2025: The Making of a High-Tech Superpower and Consequences for Industrial Countries,” MERICS Papers on China 2, Mercator Institute for China Studies

China and Russia have at times worked together to limit the influence of the United States, its allies, and Western institutions like the European Union, NATO, and the G7. In the process, they have created parallel institutions and associations such as the Shanghai Cooperation Organization and the BRICS (Brazil, Russia, India, China, and South Africa) group. Beijing and Moscow have also suggested that long-term shifts in the global economy, especially the rise of large developing economies and broader growth among developing economies, show that the United States and the West are in decline. On the contrary, these developments reflect the success of U.S. and allied policies to establish and sustain a stable international security system and an open and prosperous international economy. Nevertheless, without more effective policies to strengthen U.S. competitiveness, including investment in energy innovation, America’s global economic role is likely to suffer.

## U.S. Allies and Partners

America is not alone in contending with escalating competition. In the Indo-Pacific region, the United States has formal alliances with Australia, Canada, Japan, the Philippines, South Korea, and Thailand, and a deep security relationship with Taiwan. These relationships have formed the core of U.S. regional security engagement. In addition, America has many bilateral partnerships—like its deepening strategic cooperation with India—and works with formal and informal multilateral groups, such as the Association of Southeast Asian Nations (ASEAN, a formal 10-member organization including Indonesia, one of the region’s largest countries, as well as Singapore, among its smallest) and the Quad (an informal group including the United States, Australia, India and Japan).

Many have correctly stated that United States will be more effective in managing key challenges when working closely with allies, partners, and others. The Biden administration’s early steps to signal its commitment to the region, including President Biden’s participation in the first-ever Quad leaders’ virtual summit and a joint trip to Japan and South Korea by Secretary of State Antony Blinken and Secretary of Defense Lloyd Austin, have been constructive. Indeed, to the extent that Tokyo and Seoul can reconcile their differences, these two clusters of governments—the Quad and the U.S.-Japan-South Korea triangle—could be important building blocks not only for U.S. security and diplomacy, but also for America’s energy strategy and policy in the Indo-Pacific region. With a combined economy that would be the world’s fourth largest in purchasing power parity terms,<sup>77</sup> ASEAN could become a more important energy and energy technology partner as well. States outside the Indo-Pacific region, especially America’s European allies and Middle East energy exporters, also have important roles. On a bilateral basis, India is a strategically valuable partner that can also contribute substantially to U.S. clean energy goals, including through the newly-announced U.S.-India Climate and Clean Energy Agenda 2030 Partnership.

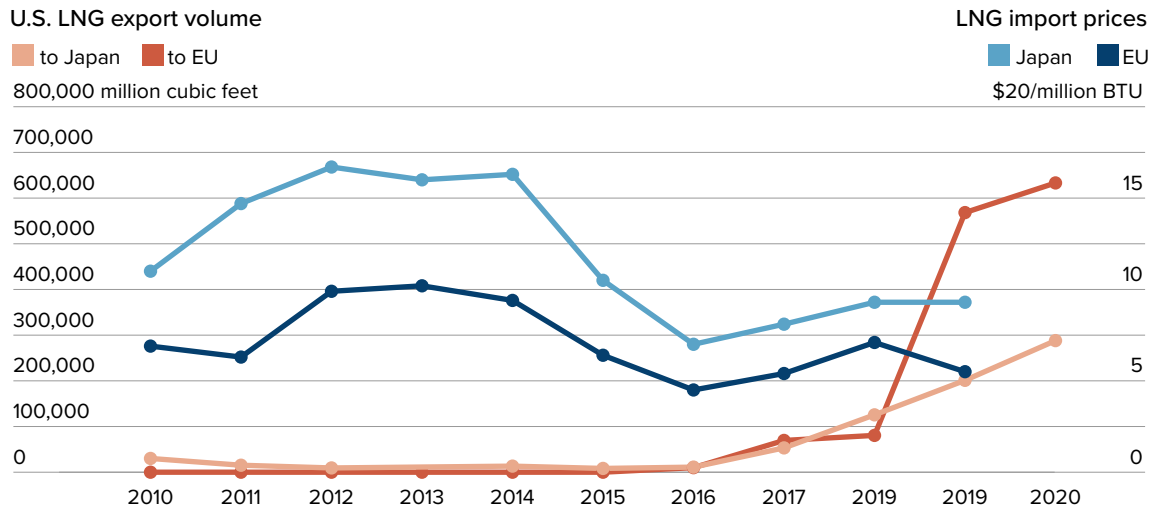
America faces two important challenges in coordinating policies toward China and Russia. The first is that some allies may be more reluctant than the United States to compete openly, due to their greater security and economic vulnerabilities. The second is that despite their shared interests, the United States and its allies are often economic competitors. America is in constant and wide-ranging economic competition with other nations, especially those with large and/or advanced economies, like Japan and South Korea (automobile, electronics, and other manufacturing), and those exporting energy resources, like Australia and Indonesia (coal and LNG). In some sectors, such as nuclear power, consolidation has produced multinational companies that can more closely align U.S. commercial interests with those of key allies (such as Japan).

Multilateral trade agreements have been valuable not only in expanding trade, but also in establishing rules for international economic competition in energy, technology, and many other sectors. However, recent public and political skepticism toward multilateral trade agreements like the Trans-Pacific Partnership has undermined the prospects for American participation in new global and regional trade pacts. Beijing recently strengthened its trade position in the Indo-Pacific relative to the United States through its membership in the Regional Comprehensive Economic Partnership (RCEP), which unites China with 14 other countries totaling 29% of global GDP.<sup>78</sup>

## America’s Energy Role in the Indo-Pacific Region

The United States is not a major energy supplier to the Indo-Pacific region in comparison with leading Middle East energy exporters. Nevertheless, U.S. energy exports have benefited U.S. allies while also conveying economic benefits to America, U.S. companies, and U.S. energy sector workers. For example, partly in anticipation of expanding U.S. LNG exports (and during a period that included the modest global economic downturn of 2014–2015),<sup>79</sup> Japan’s average LNG import price declined by almost half between 2014 and 2019, as did the EU’s average price.<sup>80</sup> As a result, America’s LNG exports to allied nations not only created jobs and growth in the United States, but also provided allies with greater energy security and contributed to cost savings for buyers in allied countries—a U.S. LNG dividend. Figure 4 illustrates increasing U.S. LNG exports and decreasing import prices in the European Union and Japan.

Figure 4. U.S. LNG Exports and Average LNG Import Prices in the EU and Japan



Source: International Energy Agency, U.S. Energy Information Administration

The United States exports natural gas overwhelmingly to other democracies with market economies. In 2020, some 86% of U.S. natural gas exports and 69% of LNG exports went to member states of the Organisation for Economic Co-operation and Development (OECD).<sup>81</sup> Looking ahead, U.S. LNG exports to allies and partners in the Indo-Pacific region and elsewhere can continue to help to diversify their energy supplies and moderate their energy costs. Whether processed in the United States or elsewhere, America’s natural gas could also become an important source of hydrogen for a future clean Indo-Pacific economy. Russia is already exploring using nuclear power and its extensive natural gas reserves to produce green hydrogen for export to Europe, China, Japan, and South Korea.<sup>82</sup> Governments in Japan and South Korea have assigned high priority to hydrogen as a future source of clean energy.

“Fugitive” methane emissions—primarily leaks from wells and pipelines—are a key driver of the life-cycle greenhouse gas emissions from the extraction, processing, transportation, and combustion of natural gas. Concerns regarding methane emissions from U.S. natural gas production reportedly undercut a major LNG export contract with France’s Engie in late 2020,<sup>83</sup> and reducing these emissions should be an important goal of U.S. policy and America’s energy producers. Nevertheless, in 2020, the methane intensity of U.S. oil and gas production was below that of 9 of the world’s 12 major methane emitters: Algeria, China, Iran, Iraq, Libya, Nigeria, Russia, Turkmenistan, and Venezuela. Only Canada and Saudi Arabia had lower methane intensity of production.<sup>84</sup>



Credit: Bloomberg

These natural gas pipelines are on Russia’s Yamal Peninsula. Life-cycle emissions of U.S. LNG exports to Asia are likely below those of Russian pipeline gas.

Research demonstrates that U.S. LNG exports likely produce significantly lower life-cycle emissions than many of their principal energy alternatives in the Indo-Pacific region, including coal and Russian natural gas,<sup>85</sup> though with somewhat higher emissions than Australia’s LNG.<sup>86</sup> Further reducing fugitive methane emissions would improve the life-cycle emissions of U.S. LNG relative to other sources.

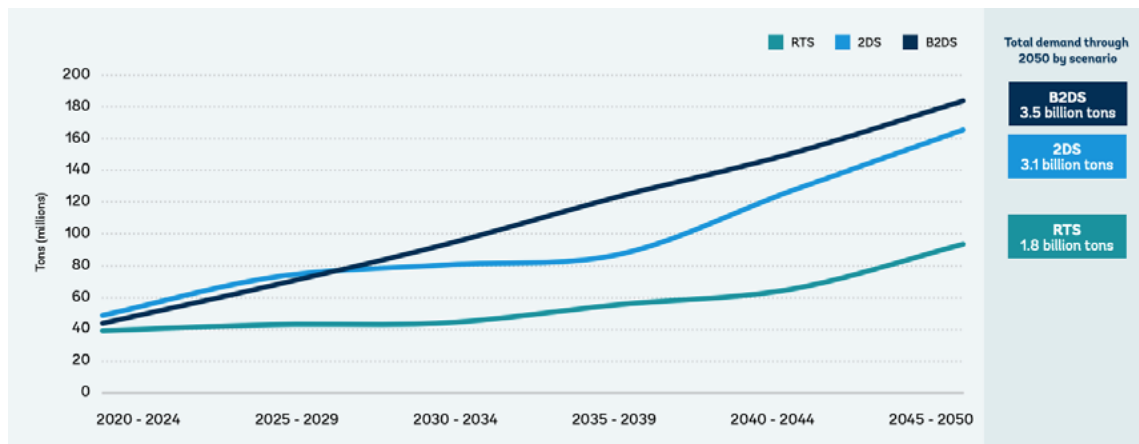
## Energy and Energy Technology Competition

Historically, energy-related competition has often emphasized access to fuels. This was visible in the early 21st century, when oil and natural gas prices were high and increasing, and both governments and companies sought to ensure reliable long-term energy supplies. While fuels remain objects of competition today, energy technologies and some of the critical materials that support them have joined fuels at the center of geopolitical and geoeconomic rivalry. This shift reflects not only energy’s strategic role and the perceived economic and political advantages to leadership or even dominance in international markets, but also the pace, scale, and impact of technological change in the modern world.

While some of America’s principal fossil fuel suppliers are Western Hemisphere countries that fall within our broad definition of the Indo-Pacific region,<sup>87</sup> their proximity to the United States—especially their location on the same side of the Pacific Ocean—limits the exposure of U.S. energy supply security interests in the Indo-Pacific. However, the United States is 100% import-dependent for 14 critical minerals; China is the top producer of 16 critical minerals and supplies over 80% of 6 critical minerals in global markets.<sup>88</sup> From a supply security perspective, there are likely greater risks to critical mineral supply chains than to U.S. energy supply chains.

Using International Energy Agency data, the World Bank has projected that average annual demand for 17 key minerals (including base metals like aluminum and copper, as well as some critical minerals) will increase roughly 2.5 to 4.5 times between 2020 and 2050.<sup>89</sup> Solar, wind, and geothermal power are the main drivers of this; efforts to accelerate reliance on those technologies to meet global climate goals are pushing demand projections toward the higher end of this range. Figure 5 illustrates the difference in materials requirements between the IEA’s reference technology scenario (RTS) and its beyond 2-degree scenario (B2DS).

Figure 5. Projected Annual Average Demand for 17 Key Minerals and Steel to 2050



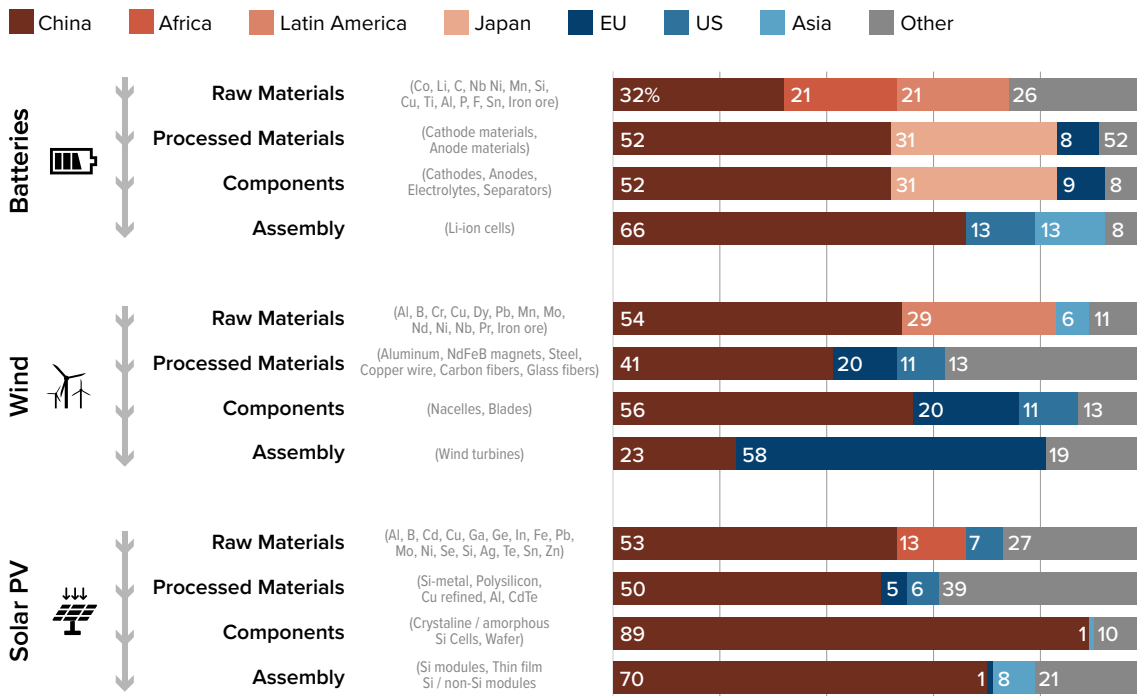
Source: World Bank, “Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition,” <https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf>

Note: The 17 minerals included in the study are aluminum, chromium, cobalt, copper, graphite, indium, iron, lead, lithium, manganese, molybdenum, neodymium, nickel, silver, titanium, vanadium and zinc; World Bank analysts also included increased steel requirements in this chart. RTS, 2DS, and B2DS refer to the IEA’s reference technology scenario, 2-degree scenario, and beyond 2-degree scenario.

Some critical mineral producers (in addition to China) are Indo-Pacific nations, and others are African.<sup>90</sup> There may be other sources of critical minerals as well. For example, the Canadian firm Deep Green is developing plans to collect polymetallic nodules containing cobalt, nickel, copper, and manganese from the deep ocean floor in the Pacific Ocean; the company estimates that one of its three existing exploration contract areas could supply battery metals for up to 140 million EVs.<sup>91</sup> Figure 6 illustrates the existing global distribution of mining and refining of many of these minerals, as well as distribution of battery, wind turbine, and solar panel manufacturing. China has the leading role in all but one area—assembling wind turbines.

Rare earth elements and other critical minerals necessary in fabricating batteries, strong permanent magnets, and many modern electronic devices—including military electronics—have drawn special scrutiny from the U.S. executive and legislative branches as well as from authorities in Europe, Japan, and elsewhere. While the United States established a National Defense Stockpile including some critical minerals during the Cold War, the catalyst for much of the recent concern was China’s 2010 suspension of rare earth exports to Japan amid a dispute over Japan’s detention of the captain of a Chinese fishing vessel that collided with two Japanese coast guard ships while fishing in Japanese waters.<sup>92</sup> Since then, the United States has added some rare earth elements to existing stockpiles and developed a government-wide list of critical minerals.<sup>93</sup> The Trump administration’s Energy Resources Governance Initiative was a useful step toward engaging countries producing critical minerals; President Biden’s Executive Order on America’s Supply Chains is helpful in assessing critical mineral and other supply chains.

Figure 6. Global Supply Chains for Raw Materials and Manufacturing of Batteries, Wind Turbines, and Solar Panels



Source: Jane Nakano, “The Geopolitics of Critical Minerals Supply Chains,” Center for Strategic and International Studies, March 2021, [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/210311\\_Nakano\\_Critical\\_Minerals.pdf?DR03x5jlrwLnNjnPDD3SZjEkGEZFEcgt](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/210311_Nakano_Critical_Minerals.pdf?DR03x5jlrwLnNjnPDD3SZjEkGEZFEcgt)

Note: Asia excludes China and Japan, which are presented separately.

While Russia is not a leader in energy innovation in most fields, it retains significant civil nuclear capabilities and was the first country to develop a floating nuclear power station, the *Akademik Lomonosov*, which began commercial operation off Russia’s Arctic coast in May 2020.<sup>94</sup> Russia is gaining political influence through its export of nuclear reactors, something that requires deep engagement across the decades-long life cycles of nuclear plants. Russian nuclear power plants are under construction in Belarus, Bangladesh, India, Iran, Slovakia, Turkey, and Ukraine, with construction set to commence in Egypt.<sup>95</sup> U.S. firms currently have no international orders for nuclear power plants, which severely limits America’s influence in shaping global nonproliferation norms. Figure 7 shows countries that have pursued civil nuclear engagement with Russia and/or China.

Figure 7. Nuclear Engagement by Russia and China in the Indo-Pacific Region



Source: Nuclear Energy Institute

The March 2011 Fukushima nuclear accident—following an earthquake and tsunami that shut down power to the plant’s cooling systems—undermined public trust in nuclear energy in Japan, South Korea, and Taiwan and gave many other nations pause in their pursuit of nuclear energy. However, some Indo-Pacific countries are likely to struggle in achieving their clean energy goals—and their clean air goals—without access to the reliable and firm emission-free power that nuclear energy provides. In addition, some advanced nuclear designs have strong safety features that passively shut down reactors before radiation releases could occur, while offering other attractive cost, waste, and nonproliferation advantages. These advanced generation designs are prompting renewed interest in nuclear energy as a major contributor to achieving net-zero emissions. Reaping the greatest economic, geopolitical, and clean energy benefits from advanced nuclear technologies requires not only accelerating innovation, but also working proactively with regulators in other nations to speed permitting and deployment. In 2019, the U.S. Nuclear Regulatory Commission agreed to collaborate with the Canadian Nuclear Safety Commission in technical reviews of advanced and small modular reactor designs.<sup>96</sup>

Within the region, the United States has concluded peaceful nuclear cooperation agreements (“123 agreements”) with Australia, Canada, India, Indonesia, Japan, South Korea, Taiwan, and Vietnam as well as with China and Russia. The U.S. Department of Energy has engaged especially deeply with Japan and South Korea on civil nuclear issues.<sup>97</sup> If the complex political and security issues surrounding nuclear



energy are recognized, nuclear can be a valuable component of the energy mix in many countries, and an essential element of net-zero strategies; it deserves support, which is critical in maintaining and promoting the highest safety and nonproliferation standards in the global marketplace. Easing investment in the U.S. nuclear sector by firms in allied nations could provide additional funding for domestic innovation while also building trust in U.S. advanced nuclear technologies in other nations.

## Technology, Security and Standards

Competition in energy technologies is a component of wider technological competition that includes areas such as artificial intelligence, biotechnology, communications, cybersecurity, space, and weapons and other military technologies. Some of these technologies intersect importantly with energy technologies, as in the artificial intelligence and communications systems that manage power grids (especially emerging smart grids) and the cybersecurity systems that protect them. In the Indo-Pacific, Japan and South Korea may be especially vulnerable to energy-related cyber threats, as each has emphasized developing networked smart grids in their strategies to manage electricity demand.

In addition to competing in development and selling of new technologies and in cyberspace, governments are also striving to shape standards favorable to their national interests, such as those favorable to domestic manufacturers. As the global economy moves toward cleaner energy, leaders in clean energy technology and standards, as well as other related technology standards, may win substantial economic gains and possibly political influence. Conversely, ceding leadership to other nations may have not only economic costs, but also political and security costs through possible impacts on America's global image and the establishment of technology dependencies and insecure or disadvantageous standards. China has used its Belt and Road Initiative projects to press its partners to adopt Chinese standards, including in power transmission.<sup>98</sup> Over 30% of 5G cell phone standard proposals originated with Chinese companies; roughly another 30% are from Swedish and Finnish firms, with about 10% coming from U.S. businesses.<sup>99</sup> Over three dozen countries, including some of America's NATO allies, are already using or planning to use equipment from China's Huawei in their 5G networks.<sup>100</sup>

The United States retains important advantages in international technology competition, including an innovative market economy, rigorous intellectual property protections, and impressive research capabilities, including at the Department of Energy's National Laboratories and at U.S. research universities. Nevertheless, federal R&D funding as a share of GDP is at a 60-year low<sup>101</sup> even as the United States has lost ground to rivals like China and Russia in global energy technology markets, including markets in nuclear energy, solar and wind power, batteries, and others. In some areas, such as gas turbines, America remains an important international supplier.

Winning markets, jobs, and influence—and setting standards that protect U.S. technology and manufacturing—will require sustained effort from U.S. firms, the administration, and the Congress. Strong federal policies to accelerate innovation will be especially significant; the American Energy Innovation Council has recommended tripling U.S. investment in clean energy innovation.<sup>102</sup> According to the International Energy Agency, China's energy research, development, and demonstration budget exceeded America's in 2019.<sup>103</sup>

# Principles

In thinking about U.S. strategy, we have proceeded from several core principles, which we set out briefly below. We believe that these principles should serve as a foundation for America's energy strategy and policy in the Indo-Pacific region—and elsewhere.

First and most important, the goal of U.S. international energy policy is to **advance and defend America's interests and values** in the global system. America's interests include globally competitive firms that create jobs and drive growth. American values include good governance—including democracy, human rights, and the rule of law—and environmental sustainability. Continued U.S. leadership in efforts to address climate change, especially those facilitating a cost-effective transition to low- and zero-carbon technology, is consistent with both America's interests and its values.

Second, U.S. energy policy should emphasize **positive goals**. U.S. policy is more likely to succeed in advancing America's interests and values if it is not solely competitive but instead establishes positive goals for the United States, the Indo-Pacific region, and the international energy system. U.S. strategy should also balance attention to competition with rivals with broader efforts to engage allies, partners, and others in a manner that does not focus exclusively or excessively on competitive aims. Where possible, the United States should also seek to engage its rivals. Where consistent with U.S. interests, policy should seek to accommodate the interests of allies and key partners.

Third, U.S. energy policy should **support and leverage markets** through public-private collaborations that draw upon the private sector's financial, informational, and human capital, while ensuring firms' ability to determine their own goals and priorities. The energy sector is more regulated than most economic sectors, including in the United States, and America's principal rivals each use government-dominated energy sectors to pursue their political, economic, and security goals. U.S. policy should rely upon markets, but also cannot ignore the reality that governments shape markets.

Fourth, energy policy should be **integrated** and **coordinated** to ensure that it reflects wider U.S. interests in other issue areas (such as strategies to address climate change, boost economic competitiveness, help allies reduce their vulnerabilities to U.S. rivals, and protect U.S. national security) and that it focuses the efforts of the U.S. government as a whole.

Fifth, energy policy should be **technology-inclusive**. In addition to respecting other governments' dilemmas and decisions in reconciling competing policy priorities, the United States should not interfere unduly with individual firms' energy and technology choices by foreclosing energy options that could contribute to achieving America's energy, technology, and climate objectives. Relying on diverse energy sources and technologies promotes resilience, a key U.S. goal.

Sixth, energy policy should be carefully **tailored** in its goals and priorities with respect to current and expected future U.S. relationships with individual Indo-Pacific countries. For example, in today's increasingly competitive environment, deeper clean energy research, development, and deployment cooperation with U.S. allies may be a valuable strategy to pursue some U.S. energy interests. Expanding this cooperation with America's rivals is likely less suited to U.S. interests.

Finally, energy policy should be **bipartisan**. To succeed, U.S. regional energy strategy will require effective and sustained action across multiple administrations and Congresses. Strategies without bipartisan support will be inconsistent and incoherent. In preparing this report, we have sought to identify interests and strategies that we believe could secure bipartisan backing.

# Interests and Priorities

The United States has extensive and diverse interests in the Indo-Pacific. Without attempting to identify all U.S. interests in the region, we found nearly two dozen energy-related U.S. interests touching on economic, security, and diplomatic goals. Facing this complex landscape, the United States will require clear priorities to succeed. We see the following as especially important U.S. priorities for energy strategy and policy in the Indo-Pacific region:



Creating jobs, boosting net exports, and increasing competitiveness to strengthen the economic foundation of U.S. prosperity and security



Ensuring secure and resilient supply chains, including for supplies of critical minerals and other essential high-tech manufacturing inputs



Advancing and defending open markets and fair trade and investment practices, including intellectual property protections



Contributing to allies' and partners' energy security, including cybersecurity and resilience of electric grids



Supporting efforts to reduce greenhouse gas emissions in the Indo-Pacific region



Leading in developing clean energy technologies and setting related standards to ensure America's success in and beyond the global energy transition now underway



Advancing energy innovation and accelerating deployment of U.S. and allied clean energy technologies across the Indo-Pacific region



Managing regional climate-related economic and security risks and enhancing resilience in cooperation with allies, partners, and others

The strategies and policies that follow reflect these priorities.

## Strategy and Policy Recommendations

Energy is fundamental to America's security and prosperity. Nevertheless, like many other aspects of the global economy, the global energy system has established an intricate and delicate network of supply chains for energy resources, critical minerals, and key equipment. As a result, the United States cannot successfully pursue its energy-related interests alone. In an environment of escalating competition, alliances and partnerships will be only more important to achieving America's energy goals.

However, alliances and partnerships are means rather than ends; their purpose is to improve America's ability to achieve its aims. They will be most valuable when founded on shared interests and values that support common goals. Engaging U.S. allies successfully requires not merely persuading allies and partners that they should share U.S. interests and values, but also considering how they define their interests and values and, where necessary and possible, assessing whether and how the United States can be responsive to their goals. Successful U.S. leadership rests upon this balance between persuasion and responsiveness.

We see three strategic priorities for U.S. energy-related, inclusive multilateral diplomacy in the Indo-Pacific region, each of which can contribute uniquely to achieving America's aims:


- The Quad—the United States, Australia, India and Japan—an emerging and strategically important regional alignment
- Allied governments with technologically advanced economies such as Australia, Canada, Japan, South Korea, and Taiwan
- India, ASEAN member states and other developing countries, including small island developing states.

The United States should also continue to engage China and Russia bilaterally and in multilateral groups, including the G20, the Clean Energy Ministerial, and (in the Indo-Pacific region) Asia-Pacific Economic Cooperation (APEC) processes. Ongoing discussions of energy, energy technology, climate change, and other issues with these two U.S. competitors is important in exploring opportunities for cooperation in areas of common interest as well as in pursuing a “risk management” approach to maintaining regional security and stability.<sup>104</sup>

Finally, for America to succeed in energy- and technology-related diplomacy, the Department of State will require greater energy science and technology capacity, including for communicating U.S. goals and actions to regional audiences.

We propose the following policies and approaches:

	Policy Recommendations	Interests and priorities
<b>ECONOMIC</b>	Develop and execute a domestic strategy to buttress U.S. competitiveness, especially in high-value high-tech industries, including clean energy.	
	Launch negotiations to establish a multilateral clean energy technology trade agreement in the Indo-Pacific region.	
	Promote U.S. exports of commercial nuclear power to contribute to net-zero efforts in the Indo-Pacific region, strengthen U.S. manufacturing, employment, and exports, and anchor multi-decadal cooperation with allies and partners across the region.	
	Sustain and where possible expand U.S. LNG exports to Indo-Pacific customers, especially to interested U.S. allies and countries where U.S. LNG can replace coal; expedite infrastructure permitting to support this objective.	
	In energy-related U.S.-China trade, seek measurable reductions in IP theft, significant reduction in subsidies to Chinese-owned enterprises, compliance with World Trade Organization subsidy disclosure rules, and an end to forced technology transfer.	
<b>SECURITY</b>	Catalyze multilateral engagement on critical mineral supplies among U.S. allies and other OECD members in the Indo-Pacific region and Europe, including in coordinated stockpiles, possibly through the International Energy Agency, which originated as a means to coordinate energy policy; promote responsible development of domestic critical mineral resources.	
	Explore creating an “LNG alliance” among the United States and interested Indo-Pacific LNG exporters and importers to reinforce security of the region’s LNG trade, including maritime security.	
	Negotiate new agreements on civil nuclear cooperation (Section 123 agreements) in the Indo-Pacific region to extend the reach of U.S. nonproliferation conditions in the region and globally.	
	Assess deep-sea critical mineral resources and the international legal and regulatory framework for their environmentally responsible collection.	
	Lead regional cooperative efforts to assess and mitigate cybersecurity and other risks to energy systems, and work with U.S. allies to develop and implement cybersecurity standards, including through joint action to assist third countries.	
	Collaborate with regional allies and partners to develop a comprehensive assessment of climate-related risks to energy systems and supply chains and to assist developing nations in building resilient energy infrastructure; where possible, engage China and Russia in joint assessments of regional climate risks to energy systems.	
	Cooperate with U.S. allies to support energy-related emergency planning and resilience in third countries.	

<b>CLEAN ENERGY</b>	Increase federal investments in clean energy innovation to levels at or above \$25 billion per year.	
	Work with U.S. allies to improve joint financing of clean energy and related infrastructure development projects in India, ASEAN states, and other developing countries, including joint financing of CCUS, nuclear power, and renewable energy.	
	Encourage and support ASEAN governments in reducing greenhouse gas emissions from coal use, through fuel switching, CCUS, and energy efficiency.	
	Establish a technology partnerships office and create an energy science and technology fellowship program based upon the American Association for the Advancement of Science fellowships in the Department of State.	
	Expand the Nuclear Regulatory Commission’s capacity to engage with nuclear regulators in the Indo-Pacific region, including through joint research on nuclear safety and sharing of regulatory practices.	
	Consider amending the Atomic Energy Act of 1954 to allow companies in allied countries in the Indo-Pacific region and elsewhere to own U.S. nuclear reactor licenses, with appropriate review, as a means to stimulate investment in and accelerate deployment of advanced nuclear systems.	
	Support increased university-level student exchanges with ASEAN nations, including in energy-related and other science and technology fields.	

## Conclusion

The present moment could be a defining one for America's role in the world. The future of the United States will be shaped in the coming decades by U.S. efforts to strengthen the country's social cohesion, recommit to economic opportunity for all, and sustain international leadership—but also by the U.S. response to the convergence of the global energy transition with escalating international competition.

In such times, when the nation faces considerable challenges as well as great opportunities, America's tradition of bipartisanship in its foreign policy is critical in developing and implementing successful strategy and policy. The desire to advance bipartisan solutions motivated us to produce this document; given the need for such solutions, we hope that our perspectives and recommendations make a contribution in public debates. Whatever course the United States pursues, we hope that it will rest upon an enduring bipartisan foundation.



# Endnotes

- 1 For regional and national shares of the global economy, see World Bank, “GDP (current US\$),” <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD>. For shares of energy production and consumption, see U.S. Energy Information Administration, “Primary Energy,” <https://www.eia.gov/international/data/world>.
- 2 Paul J. Saunders, *Energy Technology in an Era of Great Power Competition: Challenges and Opportunities in U.S.-Japan and U.S.–South Korea Cooperation* (Arlington, VA: Energy Innovation Reform Project, 2020), p. 14, <https://www.innovationreform.org/wp-content/uploads/2020/12/Energy-Technology-in-an-Era-of-Great-Power-Competition.pdf>. Germany ranks third among major economies in its share of GDP dedicated to research, behind Japan and ahead of the United States.
- 3 International Renewable Energy Agency, *Renewable Power Generation Costs in 2019* (Abu Dhabi: International Renewable Energy Agency, 2020), p. 21, <https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019>.
- 4 Ibid., p. 22.
- 5 Lazard, “Lazard’s Levelized Cost of Energy Analysis—Version 13.0,” Lazard, 2019, p. 7, <https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf>. LCOE values in the United States include tax credits.
- 6 U.S. Energy Information Administration, “What Is U.S. Electricity Generation by Energy Source?” <https://www.eia.gov/tools/faqs/faq.php?id=427&t=3>. The shares of solar and wind in total primary energy (that is, all U.S. energy production, not limited to electricity) are not merely modest but small. See U.S. Energy Information Administration, “Table 1.2, Primary Energy Production by Source,” <https://www.eia.gov/totalenergy/data/browser/xls.php?tbl=T01.02&freq=a>.
- 7 Kyle Field, “Bloomberg NEF: Lithium-Ion Battery Cell Densities Have Almost Tripled Since 2010,” CleanTechnica, February 19, 2020, <https://cleantechnica.com/2020/02/19/bloombergnef-lithium-ion-battery-cell-densities-have-almost-tripled-since-2010/>.
- 8 Bloomberg NEF, “Battery Pack Prices Fall as Market Ramps Up with Market Average at \$156/kWh In 2019,” December 3, 2019, <https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/>.
- 9 Bloomberg NEF, “Battery Pack Prices Cited below \$100/kWh for the First Time in 2020, While Market Average Sits at \$137/kWh,” December 16, 2020, <https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/>.
- 10 Michael Dobuski and Leighton Schneider, “Tesla’s New Battery Technology Could Drive Down Cost of Electric Cars, Company Says,” ABC News, September 26, 2020, <https://abcnews.go.com/US/teslas-battery-technology-drive-cost-electric-cars-company/story?id=73222745>.
- 11 U.S. Department of Energy, “Progress in Hydrogen and Fuel Cells,” June 2020, <https://www.energy.gov/sites/prod/files/2020/07/f77/hfto-progress-fact-sheet-june-2020-1.pdf>.
- 12 International Renewable Energy Agency, *Hydrogen from Renewable Power: Technology Outlook for the Energy Transition* (Abu Dhabi: International Renewable Energy Agency, 2018), pp. 33–34, <https://www.irena.org/publications/2018/Sep/Hydrogen-from-renewable-power>.
- 13 Argonne National Laboratory, “Light Duty Electric Drive Vehicles Monthly Sales Updates,” <https://www.anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates>.
- 14 Jeffrey McDonald and Andrew Moore, “Source and Scale Are Biggest Challenges as Hydrogen Interest Grows,” S&P Global Platts, December 23, 2019, <https://www.spglobal.com/en/research-insights/articles/source-and-scale-are-biggest-challenges-as-hydrogen-interest-grows>.
- 15 S&P Global Platts, “Mitsubishi Lands 3.3 GW of New US Hydrogen-Compatible Gas Turbine Orders,” September 3, 2020, <https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/090320-mitsubishi-lands-33-gw-of-new-us-hydrogen-compatible-gas-turbine-orders>.
- 16 NuScale Power, “U.S. Nuclear Regulatory Commission Issues Standard Design Approval for NuScale’s SMR Design,” September 14, 2020, <https://newsroom.nuscalepower.com/press-releases/news-details/2020/U.S.-Nuclear-Regulatory-Commission-issues-Standard-Design-Approval-for-NuScales-SMR-design/default.aspx>.
- 17 Department of Energy, “Energy Department’s Advance Reactor Demonstration Program Awards \$20 Million for Advanced Reactor Concepts,” December 22, 2020, <https://www.energy.gov/ne/articles/energy-department-s-advanced-reactor-demonstration-program-awards-20-million-advanced>.
- 18 INL Media Relations, “INL Selects Oklo Inc. for Opportunity to Demonstrate Reuse of Fuel Material,” Idaho National Laboratory, February 19, 2020, <https://inl.gov/article/inl-selects-oklo-inc-for-opportunity-to-demonstrate-reuse-of-fuel-material/>.
- 19 In the United States alone, proved reserves of oil and gas doubled in the decade between 2009 and 2019. See U.S. Energy Information Administration, “U.S. Crude Oil and Natural Gas Proved Reserves, Year-End 2019,” January 11, 2021, <https://www.eia.gov/naturalgas/crudeoilreserves/>.

## ADVANCING AMERICAN ENERGY AND INNOVATION IN THE INDO-PACIFIC REGION

- 20 Petra Nova operated from 2016 to 2020; NRG put the facility in reserve shutdown status in May 2020 because low oil prices had decreased the value of the plant's captured CO<sub>2</sub>, which had been injected underground for enhanced oil recovery. See NRG, "Carbon Capture and the Future of Coal Power," <https://www.nrg.com/case-studies/petra-nova.html>.
- 21 NET Power, "Making Environmental Economical," <https://netpower.com/about/>.
- 22 International Energy Agency, *CCUS in Clean Energy Transitions* (Paris: International Energy Agency, 2020), p. 3, <https://www.iea.org/reports/ccus-in-clean-energy-transitions/a-new-era-for-ccus#growing-ccus-momentum>.
- 23 International Energy Agency, *World Energy Outlook 2020* (Paris: International Energy Agency, 2020), <https://www.iea.org/reports/world-energy-outlook-2020#>.
- 24 International Renewable Energy Agency, *Renewable Power Generation Costs in 2019*, p. 3.
- 25 Will Wade, "Coal to Exit from U.S. Power System by 2033, Morgan Stanley Says," Bloomberg Green, February 1, 2021, <https://www.bloomberg.com/news/articles/2021-02-01/coal-to-exit-from-u-s-power-system-by-2033-morgan-stanley-says>.
- 26 International Energy Agency, *World Energy Outlook 2020*, pp. 34–35.
- 27 Bloomberg NEF, "Battery Pack Prices Cited Below \$100/kWh for the First Time in 2020."
- 28 Tom Randall and Hayley Warren, "Peak Oil Is Suddenly Upon Us," Bloomberg Green, December 1, 2020, <https://www.bloomberg.com/graphics/2020-peak-oil-era-is-suddenly-upon-us/>.
- 29 Brad Plumer, Nadja Popovich, and Blacki Migliozi, "Electric Cars Are Coming. How Long Until They Rule the Road?" *New York Times*, March 10, 2021, <https://www.nytimes.com/interactive/2021/03/10/climate/electric-vehicle-fleet-turnover.html>.
- 30 Ben Foldy and Rebecca Elliott, "Shift to Electric Vehicles Spurs Bid to Make More Batteries in U.S.," *Wall Street Journal*, January 26, 2021, <https://www.wsj.com/articles/u-s-mounts-a-charge-to-take-on-china-the-king-of-electric-vehicle-batteries-11611658235>.
- 31 U.S. Energy Information Administration, "Battery Storage in the United States: An Update on Market Trends," July 2020, pp. 11–12, [https://www.eia.gov/analysis/studies/electricity/batterystorage/pdf/battery\\_storage.pdf](https://www.eia.gov/analysis/studies/electricity/batterystorage/pdf/battery_storage.pdf).
- 32 U.S. Energy Information Administration, "State Electricity Profile: California," <https://www.eia.gov/electricity/state/california/xls/CA.xlsx>.
- 33 Energy Storage Association and Wood Mackenzie, "U.S. Energy Storage Monitor," March 2021, p. 5, <https://www.woodmac.com/research/products/power-and-renewables/us-energy-storage-monitor/>.
- 34 As a practical matter, managing the variability of solar and wind power requires some combination of (1) substantial excess solar and wind capacity, to ensure adequate electricity supplies even when solar and/or wind generation is low, (2) extensive deployment of battery or other storage, including long-term storage to address seasonal variability in solar and wind, and (3) sources of firm, dispatchable power such as natural gas turbines or advanced nuclear reactors that will operate intermittently and thus with low capacity factors.
- 35 China Power Team, "Does China Pose a Threat to Global Rare Earth Supply Chains?" China Power, July 17, 2020; updated September 24, 2020, <https://chinapower.csis.org/china-rare-earth/>.
- 36 World Bank, "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition," World Bank, Washington, DC, 2020, p. 11, <http://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climat-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf>.
- 37 World Nuclear Association, "Plans for New Reactors Worldwide," March 2021, <https://www.world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx>.
- 38 Robbie Hayunga, "Russia and China Are Expanding Nuclear Energy Exports. Can the U.S. Keep Up?" Nuclear Energy Institute, October 6, 2020, <https://www.nei.org/news/2020/russia-china-expanding-nuclear-exports-us-keep-up>.
- 39 See International Energy Agency, *World Energy Outlook 2020*, p. 38, and BP, "Energy Outlook: Oil," <https://www.bp.com/en/global/corporate/energy-economics/energy-outlook/demand-by-fuel/oil.html>. Alternative BP and International Energy Agency scenarios, driven by differing policy and technology assumptions, accelerate this timeline and, in BP's case, create a peak (in 2019) rather than a plateau.
- 40 International Energy Agency, "Oil 2021," March 2021, <https://www.iea.org/reports/oil-2021>.
- 41 Paul J. Saunders, *Land Use Requirements of Solar and Wind Power: Understanding a Decade of Academic Research* (Arlington, VA: Energy Innovation Reform Project), 2020, p. 8, [https://www.innovationreform.org/wp-content/uploads/2020/10/1909-Energy-Reform-Land-Use-Requirements\\_digital.pdf](https://www.innovationreform.org/wp-content/uploads/2020/10/1909-Energy-Reform-Land-Use-Requirements_digital.pdf).
- 42 U.S. Energy Information Administration, "U.S. Energy-Related Carbon Dioxide Emissions, 2019," September 30, 2020, <https://www.eia.gov/environment/emissions/carbon/>.
- 43 Sambit Mohanty, Jenny Ma, and Fred Wang, "Analysis: Low Gas Prices Not Enough for Asia to Move Away from Coal," S&P Global Platts, June 19, 2020, <https://www.spglobal.com/platts/en/market-insights/latest-news/natural-gas/061920-analysis-low-gas-prices-not-enough-for-asia-to-move-away-from-coal>.
- 44 International Energy Agency, *Coal 2020: Analysis and Forecast to 2025* (Paris: International Energy Agency, 2020), <https://www.iea.org/reports/coal-2020>.
- 45 International Energy Agency, *World Energy Outlook 2020*, p. 195.
- 46 Energy & Climate Intelligence Unit, "Net Zero Tracker—2020 Scorecard," <https://eciu.net/netzerotracker>.
- 47 Colin Cunliff, "Omission Innovation 2.0: Diagnosing the Global Clean Energy Innovation System," Information Technology and Innovation Foundation, September 23, 2019, <https://itif.org/publications/2019/09/23/omission-innovation-20-diagnosing-global-clean-energy-innovation-system>.
- 48 World Bank, "Fossil Fuel Energy Consumption (% of total)—World," <https://data.worldbank.org/indicator/EG.USE.COMM.FO.ZS?view=chart&locations=1W-CN-IN-US-DE>.

## ADVANCING AMERICAN ENERGY AND INNOVATION IN THE INDO-PACIFIC REGION

- 49 BP, “Statistical Review of World Energy—All Data, 1965–2019,” 2020, <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/xlsx/energy-economics/statistical-review/bp-stats-review-2020-all-data.xlsx>.
- 50 International Energy Agency, “Data and Statistics,” <https://www.iea.org/data-and-statistics/?country=WORLD&fuel=CO2%20emissions&indicator=CO2BySource>.
- 51 International Energy Agency, *World Energy Outlook 2020*, p. 172.
- 52 U.S. Energy Information Administration, “How Much Carbon Dioxide Is Produced When Different Fuels Are Burned?” June 17, 2020, <https://www.eia.gov/tools/faqs/faq.php?id=73&t=11>.
- 53 U.S. Energy Information Administration, “EIA Projects Nearly 50% Increase in World Energy Usage by 2050, Led by Growth in Asia,” September 24, 2019, <https://www.eia.gov/todayinenergy/detail.php?id=41433>.
- 54 For information on national plans submitted through the Paris Agreement’s system of Intended Nationally Determined Contributions to combating climate change, see World Resources Institute, “CAIT Climate Data Explorer,” <https://cait.wri.org/indc/>.
- 55 European Environment Agency, “Total Greenhouse Gas Emission Trends and Projections in Europe,” December 18, 2020, <https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-7/assessment>.
- 56 Eurostat, “Supply, Transformation and Consumption of Solid Fossil Fuels,” [https://ec.europa.eu/eurostat/databrowser/view/nrg\\_cb\\_sff/default/table?lang=en](https://ec.europa.eu/eurostat/databrowser/view/nrg_cb_sff/default/table?lang=en).
- 57 Eurostat, “Supply, Transformation and Consumption of Oil and Petroleum Products,” [https://ec.europa.eu/eurostat/databrowser/view/nrg\\_cb\\_oil/default/table?lang=en](https://ec.europa.eu/eurostat/databrowser/view/nrg_cb_oil/default/table?lang=en).
- 58 Eurostat, “Supply, Transformation and Consumption of Gas,” [https://ec.europa.eu/eurostat/databrowser/view/nrg\\_cb\\_gas/default/table?lang=en](https://ec.europa.eu/eurostat/databrowser/view/nrg_cb_gas/default/table?lang=en).
- 59 Eurostat, “Final Energy Consumption by Sector,” <https://ec.europa.eu/eurostat/databrowser/view/ten00124/default/table?lang=en>.
- 60 International Energy Agency, *World Energy Outlook 2020*, p. 169.
- 61 European Parliament, “Report: Towards a WTO-Compatible EU Carbon Border Adjustment Mechanism (2020/2043(INI)),” A9-0019/2021, February 15, 2021, [https://www.europarl.europa.eu/doceo/document/A-9-2021-0019\\_EN.pdf](https://www.europarl.europa.eu/doceo/document/A-9-2021-0019_EN.pdf).
- 62 For example, see Gregory F. Nemet, *How Solar Energy Became Cheap: A Model for Low-Carbon Innovation* (Abingdon, UK: Routledge, 2019).
- 63 David M. Hart, “The Impact of China’s Production Surge on Innovation in the Global Solar Photovoltaic Industry,” Information Technology and Innovation Foundation, October 5, 2020, <https://itif.org/publications/2020/10/05/impact-chinas-production-surge-innovation-global-solar-photovoltaics>. The United States lost about 5% of the global market, with American producers’ share falling from 7.22% to 1.95%.
- 64 Yukinori Hanada, “China’s Solar Panel Makers Top Global Field but Challenges Loom,” Nikkei Asia, July 31, 2019, <https://asia.nikkei.com/Business/Business-trends/China-s-solar-panel-makers-top-global-field-but-challenges-loom>.
- 65 Daniel Oberhaus, “Germany Rejected Nuclear Power—and Deadly Emissions Spiked,” Wired, January 23, 2020, <https://www.wired.com/story/germany-rejected-nuclear-power-and-deadly-emissions-spiked/>.
- 66 China Daily, “Full Text: Statement by Xi Jinping at General Debate of 75th UNGA,” September 23, 2020, <https://www.chinadaily.com.cn/a/202009/23/WS5f6a640ba31024ad0ba7b1e7.html>.
- 67 Eric Yep, “China’s Long March to Zero Carbon,” S&P Global Platts, December 10, 2020, <https://www.spglobal.com/platts/en/market-insights/blogs/energy-transition/121020-china-zero-carbon-target-2060-emissions-fossil-fuels>.
- 68 Hart, “Impact of China’s Production Surge on Innovation in the Global Solar Photovoltaic Industry.”
- 69 Sarah Ladislaw and Nikos Tsafois, *Race to the Top: The Case for a New U.S. International Energy Policy* (Washington, DC: Center for Strategic and International Studies, 2020), p. 24, [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/200706\\_SRF\\_Racetothetop\\_WEB\\_v2%20FINAL.pdf](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/200706_SRF_Racetothetop_WEB_v2%20FINAL.pdf).
- 70 Steve Inskeep and Ashley Westerman, “Why Is China Placing a Global Bet on Coal?” NPR, April 29, 2019, <https://www.npr.org/2019/04/29/716347646/why-is-china-placing-a-global-bet-on-coal>.
- 71 Binbin Wang and Qinnan Zhou, “Climate Change in the Chinese Mind: An Overview of Public Perceptions at Macro and Micro Levels,” *WIREs Climate Change* 11, no. 3 (May/June 2020), <https://onlinelibrary.wiley.com/doi/full/10.1002/wcc.639>.
- 72 Tim Gould and Christopher McGlade, “The Environmental Case for Natural Gas,” International Energy Agency, October 23, 2017, <https://www.iea.org/commentaries/the-environmental-case-for-natural-gas>.
- 73 Molly F. Sherlock, “The Value of Energy Tax Incentives for Different Types of Energy Resources,” Congressional Research Service, March 19, 2019, p. 7, <https://crsreports.congress.gov/product/pdf/R/R44852>.
- 74 World Bank, “World Bank Group Announces Ambitious 35% Finance Target to Support Countries’ Climate Action,” December 9, 2020, <https://www.worldbank.org/en/news/press-release/2020/12/09/world-bank-group-announces-ambitious-35-finance-target-to-support-countries-climate-action>.
- 75 Commission on the Theft of American Intellectual Property, “The Report of the Commission on the Theft of American Intellectual Property,” National Bureau of Asian Research, May 2013, pp. 2–3, [https://www.nbr.org/wp-content/uploads/pdfs/publications/IP\\_Commission\\_Report.pdf](https://www.nbr.org/wp-content/uploads/pdfs/publications/IP_Commission_Report.pdf).
- 76 Nigel Cory and Robert D. Atkinson, “Why and How to Mount a Strong, Trilateral Response to China’s Innovation Mercantilism,” Information Technology and Innovation Foundation, January 13, 2020, <https://itif.org/publications/2020/01/13/why-and-how-mount-strong-trilateral-response-chinas-innovation-mercantilism>.
- 77 World Bank, “GDP, PPP (current international \$),” [https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD?most\\_recent\\_value\\_desc=true](https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD?most_recent_value_desc=true).

## ADVANCING AMERICAN ENERGY AND INNOVATION IN THE INDO-PACIFIC REGION

- 78 Charles W. Boustany, "Challenges for U.S. Trade Policy in 2021: A Brief Look Ahead," National Bureau of Asian Research, December 9, 2020, <https://www.nbr.org/publication/challenges-for-u-s-trade-policy-in-2021-a-brief-look-ahead/>.
- 79 U.S. Energy Information Administration, "U.S. Natural Gas Exports and Re-exports by Country," January 29, 2021, [https://www.eia.gov/dnav/ng/ng\\_move\\_expc\\_s1\\_a.htm](https://www.eia.gov/dnav/ng/ng_move_expc_s1_a.htm).
- 80 International Energy Agency, "LNG Import Prices in Selected Countries, 2010–2019," July 27, 2020, <https://www.iea.org/data-and-statistics/charts/lng-import-prices-in-selected-countries-2010-2019>.
- 81 U.S. Energy Information Administration, "U.S. Natural Gas Exports and Re-exports by Country."
- 82 Yohei Ishikawa, "Russia Plans to Export Hydrogen to Asia in Green Shift," Nikkei Asia, November 4, 2020, <https://asia.nikkei.com/Editor-s-Picks/Interview/Russia-plans-to-export-hydrogen-to-Asia-in-green-shift>. Green hydrogen is hydrogen produced using clean energy, unlike gray hydrogen (produced without capturing carbon dioxide) or blue hydrogen (produced while capturing carbon dioxide).
- 83 Collin Eaton and Sarah McFarlane, "France's Engie Backs Out of U.S. LNG Deal," *Wall Street Journal*, November 3, 2020, <https://www.wsj.com/articles/frances-engie-backs-out-of-u-s-lng-deal-11604435609>.
- 84 International Energy Agency, "Total Methane Emissions and Methane Intensity of Production in Selected Oil and Gas Producers in 2020," January 18, 2021, <https://www.iea.org/data-and-statistics/charts/total-methane-emissions-and-methane-intensity-of-production-in-selected-oil-and-gas-producers-in-2020>.
- 85 Leslie S. Abrahams, Constantine Samaras, W. Michael Griffin, and H. Scott Matthews, "Life Cycle Greenhouse Gas Emissions from U.S. Liquefied Natural Gas Exports: Implications for End Uses," *Environmental Science & Technology* 49 (2015): 3237–45, <https://pubs.acs.org/doi/pdf/10.1021/es505617p>.
- 86 Timothy Skone, Gregory Cooney, Matthew Jamieson, James Littlefield, and Joe Marriott, "Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States," U.S. Department of Energy National Energy Technology Laboratory, May 29, 2014, p. 10, <https://www.energy.gov/sites/prod/files/2014/05/f16/Life%20Cycle%20GHG%20Perspective%20Report.pdf>.
- 87 See U.S. Energy Information Administration, "U.S. Imports by Country of Origin," [https://www.eia.gov/dnav/pet/pet\\_move\\_impcus\\_a2\\_nus\\_ep00\\_im0\\_mbbldp\\_a.htm](https://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbldp_a.htm); U.S. Energy Information Administration, "U.S. Natural Gas Imports by Country," [https://www.eia.gov/dnav/ng/ng\\_move\\_imp\\_c\\_s1\\_a.htm](https://www.eia.gov/dnav/ng/ng_move_imp_c_s1_a.htm); and U.S. Energy Information Administration, "Import Quantity from Total World of All Coal Q3 2020," [https://www.eia.gov/coal/data/browser/#/topic/39?agg=2,1,0&rank=ok&linechart=COAL\\_IMPORT\\_QTY.TOT-TOT-TOT.Q&columnchart=COAL\\_IMPORT\\_QTY.TOT-TOT-TOT.Q&map=COAL\\_EXPORT\\_QTY.TOT-TOT-TOT.Q&freq=Q&ctype=map&type=pin&rtype=s&maptype=0&rse=0&pin=](https://www.eia.gov/coal/data/browser/#/topic/39?agg=2,1,0&rank=ok&linechart=COAL_IMPORT_QTY.TOT-TOT-TOT.Q&columnchart=COAL_IMPORT_QTY.TOT-TOT-TOT.Q&map=COAL_EXPORT_QTY.TOT-TOT-TOT.Q&freq=Q&ctype=map&type=pin&rtype=s&maptype=0&rse=0&pin=).
- 88 Mark Humphries, "Critical Minerals and U.S. Public Policy," Congressional Research Service, June 28, 2019, pp. 12, 20, <https://crsreports.congress.gov/product/pdf/R/R45810>.
- 89 World Bank, "Minerals for Climate Action," p. 11.
- 90 Ibid., p. 17.
- 91 Deep Green, "Polymetallic Nodules," <https://deep.green/nodules/>.
- 92 Keith Bradsher, "Amid Tension, China Blocks Vital Exports to Japan," *New York Times*, September 22, 2010, <https://www.nytimes.com/2010/09/23/business/global/23rare.html>.
- 93 Jane Nakano, "The Geopolitics of Critical Minerals Supply Chains," Center for Strategic and International Studies, March 2021, pp. 7–11, [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/210311\\_Nakano\\_Critical\\_Minerals.pdf?DR03x5jlrwLnNmPDD3SZ-jEkGEZFecgt](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/210311_Nakano_Critical_Minerals.pdf?DR03x5jlrwLnNmPDD3SZ-jEkGEZFecgt).
- 94 *Nuclear Engineering International*, "Akademik Lomonosov Begins Commercial Operation," May 25, 2020, <https://www.neimagazine.com/news/newsakademik-lomonosov-begins-commercial-operation-7938482/>.
- 95 World Nuclear Association, "World Nuclear Performance Report 2020," August 2020, p. 46, <https://world-nuclear.org/getmedia/3418bf4a-5891-4ba1-b6c2-d83d8907264d/performance-report-2020-v1.pdf.aspx>.
- 96 U.S. Nuclear Regulatory Commission, "NRC and CNSC Sign Historic Memorandum to Enhance Technical Reviews of Advanced/Small Modular Reactor Technologies," August 15, 2019, <https://www.nrc.gov/reading-rm/doc-collections/news/2019/19-037.pdf>.
- 97 U.S. Department of Energy, "IEC Documents Database," <https://www.energy.gov/ia/iec-documents>.
- 98 Valentina Pop, Sha Hua, and Daniel Michaels, "From Lightbulbs to 5G, China Battles West for Control of Vital Technology Standards," *Wall Street Journal*, February 8, 2021, [https://www.wsj.com/articles/from-lightbulbs-to-5g-china-battles-west-for-control-of-vital-technology-standards-11612722698?st=12c8sbclbhpfpz&reflink=share\\_mobilewebshare](https://www.wsj.com/articles/from-lightbulbs-to-5g-china-battles-west-for-control-of-vital-technology-standards-11612722698?st=12c8sbclbhpfpz&reflink=share_mobilewebshare).
- 99 Ibid.
- 100 David Sacks, "China's Huawei Is Winning the 5G Race. Here's What the United States Should Do To Respond," Council on Foreign Relations, March 29, 2021, <https://www.cfr.org/blog/china-huawei-5g>.
- 101 Abby Joseph Cohen and Michael Hao Wu, "The Coronavirus Pandemic and US Federal Investment in Science," Goldman Sachs, April 29, 2020, <https://www.gspublishing.com/content/research/en/reports/2020/04/29/67c9cada-68a2-48af-b25c-0f5416c0c0c8.html>.
- 102 American Energy Innovation Council, "Energy Innovation: Developing the Technologies for Decarbonization," December 2020, [http://americanenergyinnovation.org/wp-content/uploads/2020/12/BPC\\_AEIC-Policy-Memo\\_RV4.pdf](http://americanenergyinnovation.org/wp-content/uploads/2020/12/BPC_AEIC-Policy-Memo_RV4.pdf).
- 103 International Energy Agency, "Energy Technology RD&D Budgets 2020," October 2020, <https://www.iea.org/reports/energy-technology-rdd-budgets-2020>.
- 104 Evan Medeiros, "How to Craft a Durable China Strategy," *Foreign Affairs*, March 17, 2021, <https://www.foreignaffairs.com/articles/unit-ed-states/2021-03-17/how-craft-durable-china-strategy>.

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