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Enhancing US-Japan Cooperation on Clean Energy Technologies

By Reed Blakemore and David W. Yellen

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Cover: Transmission lines hang over a quiet street below Mount Fuji. Source: Unsplash/Clay Banks

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INTRODUCTION

Japan is one of the United States' closest allies, and energy is a central part of the relationship, which is underpinned by long-standing cooperation on civil nuclear energy, deeply interconnected energy research and development ecosystems, and strong liquefied natural gas (LNG) trade. However, with the need to decarbonize the global energy system becoming more urgent and mounting public pressure on both governments and industry to do so, the energy partnership between the two nations must expand and strengthen collaboration on new clean energy technologies, alongside existing pillars of cooperation focused on nuclear energy and natural gas. In doing so, Washington and Tokyo can help support the implementation of renewable energy sources and drive the energy transition forward, while also advancing both countries' interests in ensuring transparent and secure clean energy markets across the Indo-Pacific.

The need to expand the countries' energy partnership comes at a particularly uncertain and turbulent time. An important election year in the United States brings with it the possibility of a significant change in the US approach to climate action, advanced energy technologies, and hydrocarbon development, which might reframe the historical trajectory of US-Japan energy cooperation. On the one hand, a second Donald Trump administration would likely continue the energy dominance policies that have leveraged US oil and gas resources and nuclear technologies in its foreign policy. On the other hand, a Democratic administration, led by former Vice President Joe Biden, would likely be less interested in oil and gas development but would increase investment in clean energy technologies. Meanwhile, shifting congressional politics—including an emerging group of Republicans interested in climate mitigation and clean energy technologies—indicate that clean technologies could begin to play a larger role even under continued Republican control. The political uncertainty surrounding the existing pillars of partnership and the evolving energy policies on both sides of the aisle suggest that, under either electoral outcome, new opportunities for energy partnership can and should be unlocked to continue the robust relationship between Washington and Tokyo.

Ensuring future cooperation, therefore, requires an examination of how to foster politically sustainable energy partnerships—partnerships that can be cultivated under either of the above political pathways—between the United States and Japan, with particular attention paid to the role of clean energy technologies. With the nuclear and natural gas pillars of the energy partnership well established, a focus on new clean energy technologies—and, in particular, those that are broadly politically palatable and address shared security and resilience challenges—can serve two purposes. First, it can further expand and diversify a mutually beneficial partnership based on shared trade, technology-sharing, and sustainability goals; and second, expansion into new clean energy technologies can reinforce that partnership with elements that will remain politically durable, particularly as the bipartisan consensus on clean energy policy in Washington continues to evolve.

To this end, grid scalability and innovation, hydrogen, and battery storage technologies all represent a promising political middle ground and address the countries' shared interests in grid resilience and reliability, energy storage, and advanced fuels. These technologies can form the foundation for additional collaboration on clean energy technologies in the countries' already-robust energy partnership, a foundation that can weather political change and continue to expand in the future.

Both the nuclear and natural gas pillars will remain valuable components of the US-Japan energy partnership in an energy-hungry, decarbonizing world. Growing interest around the world in nuclear power and the expanding footprints of China and Russia in international nuclear markets highlight the geopolitical

Former US Energy Secretary Rick Perry meets Japan's Minister of Trade and Industry Hiroshige Seko in Tokyo, 2017.
SOURCE: REUTERS / Kim Kyung-Hoon TPX IMAGES OF THE DAY

value of close US-Japan nuclear partnership in the coming years.[1] A similar case should be made for natural gas and the value of carbon capture, utilization, and storage (CCUS)—a clean technology on which Japan and the United States have continued to cooperate under the Trump administration—given Japan's commitment to developing CCUS technologies and capacity in its 2019 "Long-term strategy under the Paris Agreement," and the recent momentum in the US Congress through 45Q tax code legislation to support CCUS financing.[2]

Yet, as Washington and Tokyo consider expanding their energy partnership, they should consider grid development, hydrogen, and battery storage for their growing value to the energy transition and for their political resiliency within a rapidly evolving energy policy landscape in the United States. These technologies offer a clear opportunity to push the US-Japan energy partnership forward by addressing the countries' shared energy challenges, advancing emissions reductions, and laying the groundwork for increasingly robust clean energy cooperation that will be resilient as the energy transition advances and through

1 Robert F. Ichord, *US Nuclear-Power Leadership and the Chinese and Russian Challenge,* Atlantic Council Global Energy Center, March 28, 2018, https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/us-nuclear-power-leadership-and-the-chinese-and-russian-challenge/.

2 Yukihiro Kawaguchi, "Overview of Japanese CCUS Policy: Saving Our Beautiful Planet with CCUS," Japan's Ministry of Economy, Trade and Industry, Global Environment Affairs Office, COP 25 presentation, December 2019, http://copjapan.env.go.jp/cop/cop25/assets/pdf/s30_JCCS/05_YukihiroKawaguchi_COP25_JAPANPAVILION_CCS_side_event_r1.pdf.

political change. With this in mind, the United States and Japan should take the following steps:

- Enhance collaboration on technological innovation, development, and deployment across grid development, hydrogen, and battery storage technologies, which can serve as the politically durable foundation for clean energy collaboration within their broader energy partnership. This effort should include cooperative research, development, and demonstration (RD&D) funding along with collaboration among the countries' national laboratories.

- Emphasize these technologies in the Japan-United States Strategic Energy Partnership (JUSEP) to enhance bilateral collaboration and create a forum for the countries' industries to collaborate on technological deployment and for their governments to collaborate on innovative policy that can drive technology development and deployment.

- Expand cooperation on clean energy technologies to launch a broader regional effort in the Indo-Pacific to build collaboration on and deployment of these critical technologies in the region. Along with renewables, grid development and energy storage technologies and hydrogen fuel will be critical to maintaining energy resilience and security in the region as the energy transition advances. Japan and the United States both want to ensure open, well-governed, and sustainable energy markets throughout the region. Through this effort, both countries can work together to build those markets.

This report examines the possible expansion of the US-Japan energy partnership to encompass additional clean energy technologies and focus on the potential for these developing industries to deepen the partnership. The two countries can build these new areas of clean energy collaboration by leveraging the institutions and building blocks of the existing partnership to create a strong and durable platform of energy cooperation. Not only would such an expansion enhance cooperation between the United States and Japan, but it would also offer an opportunity to engage more deeply with other regional actors that share the goal of ensuring clean, transparent, and secure energy markets throughout the Indo-Pacific.

THE US-JAPAN ENERGY RELATIONSHIP

History of Energy Cooperation Between the Two Countries

Japan and the United States have engaged on energy issues and technologies for decades and through a variety of partnerships. Almost three decades ago, the two countries created a forum for advanced energy cooperation through the US-Japan Science and Technology Agreement, which has facilitated cooperation on technological issues ranging from supercomputing to critical mineral access, in addition to new energy technologies.[3] But nuclear energy technology has, for the most part, been the focus of the countries' partnership, through regular bilateral cooperation and memoranda of understanding prioritizing nuclear energy cooperation.

Under the Barack Obama administration, the two countries worked to ensure safety and sufficient regulation in civil nuclear generation through the Bilateral Commission on Civil Nuclear Cooperation, but the countries' cooperation on nuclear energy security goes deeper and years earlier than the Commission. As the United States' oldest civil nuclear partner, Japan made the largest foreign contribution to US nuclear research and development in the 1960s and repeatedly paid licensing fees for US nuclear technology and fuel services thereafter.[4] Government agencies in both countries also work toward nuclear security goals as part of the Nuclear Security Working Group, as well as through the many multilateral nuclear energy regulatory and cooperative bodies.[5]

The Obama administration initiated some cooperation with Japan on clean energy technologies as well. The US-Japan Clean Energy Policy Dialogue, last held in 2015, involved the exchange of information and best practices in clean energy technology development with an eye toward technological cooperation on fuel cells, solar, and smart grid technologies.[6]

Cooperation under the Trump Administration

In recent years, however, the countries' energy relationship has emphasized nuclear energy and and natural gas, particularly the development of LNG infrastructure. Since 2017, the primary forum for bilateral energy cooperation and economic coordination within US-Japan energy collaboration has been JUSEP. The partnership has backed away from addressing climate change through clean energy measures and, instead, is now focused on energy security and developing a "free and open Indo-Pacific," through programs such as the US State Department's Asia Enhancing Development and Growth through Energy (Asia EDGE) program.[7] Longstanding US-Japan collaboration on nuclear energy and nascent collaboration on CCUS are exceptions to the limited nature of clean energy cooperation under JUSEP. However, cooperation on nuclear and

3 The White House, "Fact Sheet: U.S.-Japan Bilateral Cooperation," US Government, April 25, 2014, https://obamawhitehouse.archives.gov/the-press-office/2014/04/25/fact-sheet-us-japan-bilateral-cooperation.

4 Phyllis Yoshida, *U.S.-Japan Nuclear Cooperation: The Significance of July 2018,* Sasakawa Peace Foundation USA, March 26, 2018, https://spfusa.org/wp-content/uploads/2018/03/123-Agreement-Yoshida-032618.Final_.pdf.

5 Ibid.

6 Ministry of Economy, Trade, and Industry, "Summary of the Sixth Japan-U.S. Clean Energy Policy Dialogue," Government of Japan, March 5, 2015, https://www.meti.go.jp/english/press/2015/0305_02.html; The White House, "Fact Sheet: U.S.-Japan Bilateral Cooperation."

7 US Congressional Research Service, "Japan-U.S. Relations: Issues for Congress," via EveryCRSReport.com, accessed March 16, 2020, https://www.everycrsreport.com/reports/RL33436.html#_Toc21621443; US Department of State, "2019 Japan-U.S. Strategic Energy Partnership Statement: Recent Major Developments," blog, November 4, 2019, https://www.state.gov/2019-japan-u-s-strategic-energy-partnership-statement-recent-major-developments/.

Former Japanese Prime Minister Shinzō Abe and Former US President Barack Obama's governments maintained and expanded their countries' robust energy partnership during President Obama's term. President Obama and PM Abe pose for photographers in Tokyo in March, 2018. SOURCE: Pool via Reuters / Shizuo Kambayashi

CCUS have not yet resulted in broader cooperation on renewable and clean energy technologies.[8]

Building off of the surge in US oil and gas exports since 2016, the incorporation of LNG as a pillar of energy cooperation between the two nations has been the primary outcome of this shift. Japan is the world's largest importer of LNG, making it the ideal partner for the United States, which has become the world's largest natural gas producer and has its sights set on increasing LNG exports.[9] Over that period, Japan has become the third-largest buyer of US LNG, second only to South Korea and Mexico, importing 83 million tons in 2018 at a value of $42.8 billion.[10] Yet, it is worth noting that this represents only a fraction of total Japanese LNG imports, with the United States only being Japan's tenth-largest supplier, behind Australia.[11] Cooperation has extended beyond LNG trade, however, with direct Japanese investments in US LNG projects in the Indo-Pacific, as well as LNG infrastructure and supply chain training programs for other countries in the region.[12]

Under the Trump administration, nuclear cooperation between the United States and Japan has persisted, primarily under the auspices of the US-Japan

8 Ministry of Economy, Trade and Industry, "METI and US DOE Conclude a Cooperation Document in the Field of CCUS," Government of Japan, October 2017, https://www.meti.go.jp/english/press/2017/1018_001.html.

9 "Japan - Market Overview," Export.gov, September 6, 2019, https://www.export.gov/apex/article2?series=a0pt0000000PAu7AAG&type=Country_Commercial__kav; US Energy Information Administration, "The U.S. Leads Global Petroleum and Natural Gas Production with Record Growth in 2018," August 20, 2019, https://www.eia.gov/todayinenergy/detail.php?id=40973.

10 "Japan - Liquefied Natural Gas (LNG)," Export.gov, September 6, 2019, https://www.export.gov/apex/article2?id=Japan-Liquefied-Natural-Gas-LNG.

11 Ibid.

12 US Congressional Research Service, "Japan-U.S. Relations: Issues for Congress."

Former Japanese Prime Minister Shinzō Abe and US President Donald Trump meet in the Oval Office, 2018.
SOURCE: Wikimedia Commons / Official White House Photo

Agreement for Cooperation between the Government of Japan and the Government of the United States on Peaceful Uses of Nuclear Energy, which automatically renewed in July 2018 and facilitates cooperation on nuclear energy plant operation and technology development.[13] But that relationship has also deepened through the November 2018 memorandum of cooperation, which acknowledged the need for cooperation on nuclear safety as well as new, innovative nuclear technology.[14]

In continuing the countries' nuclear energy relationship, adding major cooperative LNG efforts, and shifting JUSEP's priorities away from renewable energy, the Trump administration has largely erased the Obama administration's foundations for an energy partnership focused on non-nuclear clean energy technologies, with major renewable energy partnerships rolled back after the United States' withdrawal from the Paris Climate Agreement.[15] Nonetheless, while bilateral cooperation on emissions reductions and clean energy technologies has faded—with the exception of cooperation on nuclear and CCUS—the overall value of the US-Japan energy partnership has increased significantly, now representing billions of dollars in LNG imports alone, not to mention technological and other in-kind support for the nuclear industry, as well as other political and infrastructure investments.[16]

This is all to suggest that, while climate change and renewable energy technologies have taken a back seat, the relative US-Japan energy partnership overall remains quite strong. There is, therefore, significant potential to explore new opportunities for cooperation outside of nuclear, LNG, and regional energy security.

13 Yoshida, U.S.-Japan Nuclear Cooperation: The Significance of July 2018.

14 US Department of Energy, "Fact Sheet on the U.S.-Japan Civil Nuclear Memorandum of Cooperation," November 21, 2018, https://www.energy.gov/articles/fact-sheet-us-japan-civil-nuclear-memorandum-cooperation.

15 US Congressional Research Service, "Japan-U.S. Relations: Issues for Congress."

16 "Japan," USTradeNumbers, accessed March 16, 2020, https://www.ustradenumbers.com/country/japan/.

Energy Needs and Gaps in Each Country

As an island nation, Japan's energy priorities are shaped by a unique set of energy needs and challenges. Japan has very little domestic access to fossil-based energy resources, and is hugely reliant upon energy imports to meet its domestic energy demand. That reality spurred a robust nuclear energy program which, up until 2011, supplied over 24 percent of Japan's domestic electricity needs.[17] But after the Fukushima Daiichi accident, the Japanese government stepped back from plans to make nuclear the heart of the energy system, though nuclear energy continues to supply over 6 percent of electricity generation throughout the country, with continued plans to expand that share to at least 20 percent by 2030.[18]

Japan has also been relatively slow to turn toward renewables: hydroelectric power remains the largest renewable energy source in the country, and solar and wind have been slower to come online.[19] But as solar and offshore wind account for an increasing percentage of its energy mix, Japan will need to expand its grid by adding more interconnections and transmission lines to accommodate such new sources while also adapting it to accommodate intermittency. To this end, developing and deploying these new technologies at scale will be a further challenge. Japan is a global leader in energy technology development, but has often struggled to bring new technologies to market quickly.[20] Japan's investments in hydrogen technology—both in transport and in storage—are paradigmatic of this particular challenge. Both Japanese government and industry have been interested in developing hydrogen technology since the 1990s, but due to challenges of scale, demand, and cost reduction, it is only now reaching fruition with broader deployment of hydrogen cars domestically.[21]

The United States faces a far different set of energy challenges. But, like Japan, one of the most significant roadblocks to the US energy system over the next several years will be its grid infrastructure. The US grid is famously sprawling and aging (critically, in many cases), and the United States' fragile energy ecosystem is increasingly challenged by variable and distributed energy generation from a mixture of coal, gas, nuclear, and renewable energy sources. As renewables increase their share of energy generation in the United States, the grid will need to be supplemented, if not overhauled.[22]

In technological development, US renewable energy industries and the government have been effective at generating new technologies and bringing them to market, only to have Chinese companies compete with or outright supplant them. In Lithium-ion (Li-ion) batteries, for example, early technological breakthroughs in the United States laid the basis for the technology's development, and Sony brought the first Li-ion battery to market in 1991, after which American and Japanese companies led the industry. But since then, China has supplanted both to dominate the market with 77 percent of global Li-ion battery cell manufacturing capacity and 60 percent of global Li-ion battery component manufacturing.[23] In solar technology as well, US laboratories created the first photovoltaic cells, and American companies commercialized the first solar energy systems. Up to 1995, the United

17 Katharina Buchholz, "Infographic: How Fukushima Changed Japan's Energy Mix," Statista Infographics, March 10, 2020, https://www.statista.com/chart/18679/electricity-generated-in-japan-by-source/.

18 "Japan," International Energy Agency, accessed March 16, 2020, https://www.iea.org/countries/japan; "Plan Sets Out Japan's Energy Mix for 2030," *World Nuclear News*, June 3, 2015, https://www.world-nuclear-news.org/NP-Plan-sets-out-Japans-energy-mix-for-2030-0306154.html.

19 Gerhard Fasol, "Renewable Energy Japan: Solar, Wind, Geo-Thermal, and Bio-Mass," *Eurotechnology.com*, blog, July 15, 2013, https://www.eurotechnology.com/japan-energy/renewable/.

20 "Japan," International Energy Agency.

21 Shigeki Iida and Ko Sakata, "Hydrogen Technologies and Developments in Japan," *Clean Energy* vol. 3, no. 2 (May 25, 2019): 05–13, https://doi.org/10.1093/ce/zkz003.

22 The US Energy Information Administration projects that renewables will account for 31 percent of electricity generation in the United States by 2050. US Energy Information Administration, *Annual Energy Outlook 2019 with Projections to 2050*, January 24, 2019, https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf, 22; *BP's 2019 Energy Outlook* predicts that renewables could account for 18 percent of total energy consumption (which includes transportation) by 2040. BP, *BP Energy Outlook 2019*, 2019, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019-country-insight-us.pdf.

23 Bloomberg New Energy Finance, "China Dominates the Lithium-Ion Battery Supply Chain, but Europe Is on the Rise," September 16, 2020, https://about.bnef.com/blog/china-dominates-the-lithium-ion-battery-supply-chain-but-europe-is-on-the-rise/

States and Japan were the only countries with major solar manufacturing industries.[24] China supplanted both to become the dominant global solar producer in the 2000s, despite a lack of experience in the industry, wiping out both incumbents' industries.

As a result, the primary focus of the Trump administration has been to identify partnerships within the energy system with an eye to developing open, transparent, norms-based energy markets that allow the United States to more effectively compete. Initiatives such as the Energy Resource Governance Initiative and Asia EDGE both represent efforts to this end, and necessitate close collaboration with like-minded partners such as Japan.

Enhancing the US-Japan Energy Partnership

The above challenges facing both Japan and the United States will become only more acute as the energy transition advances, and given the successes of the energy partnership thus far, reincorporating clean energy technologies as a major focus of the bilateral energy partnership might be particularly fruitful. While natural gas and nuclear play critical roles in both Japan's and the United States' energy systems, neither can address the aforementioned energy challenges alone. The two countries' energy systems are of vastly different scales and compositions, and yet the two countries may have more in common—at least in terms of how they can meet their challenges—than appears at first glance.

Regardless of the extent of the United States' commitment to renewable energy technologies at home, efforts to reduce emissions will form one of the most important industries in the global economy, one in which Japan and the United States can offer each other important experience and resources. Not only do the two countries share common challenges, particularly in updating their grids and advancing their energy systems to accommodate renewable implementation, but they also have complementary comparative advantages in the industrial space that can be built upon to compete with technological heavyweights such as China.

24 Ethan Brown, "Climate at the Second Democratic Debate: What New Topics Were Introduced and How Did the Candidates Respond?" *Peril & Promise*, blog, August 6, 2019, https://www.pbs.org/wnet/peril-and-promise/2019/08/climate-second-democratic-debate/.

POLITICAL CLIMATE FOR COOPERATION ON CLEAN ENERGY TECHNOLOGIES

The expansion of the US-Japan energy partnership to include a broader suite of clean energy technologies depends on the policy approach to a low-carbon transition. In particular, the outcome of the 2020 elections in the United States is likely to have a significant impact, not only on how that collaboration might develop, but on whether or not it becomes a dominant part of the US-Japan energy partnership moving forward. This creates a challenge in not only identifying a politically viable set of partnership opportunities within Japan but also establishing a partnership that can act as a hedge against two different possible visions for energy and climate policy that might emerge in Washington come 2021.

Political Environment in Japan

The Japanese government, led until recently by Prime Minister Shinzō Abe, has prioritized renewable technologies and advanced energy since Fukushima in an effort to reduce dependence on nuclear and decrease carbon emissions. Japan's fifth Strategic Energy Plan, adopted in 2018, laid out Abe's approach to renewables and clean technologies in detail out to 2050, though its targets for renewable power generation remain far less ambitious than most countries'.[25] Abe's recent resignation has injected some uncertainty into Japan's political environment, but recently-inaugurated Prime Minister Suga's announcement of a new net-zero emissions target of 2050 suggests that the government will become even more committed to clean energy development going forward.[26]

Still, Japan faces the challenge of reducing dependence on imported fossil fuels to meet those commitments and respond to pressure from both the public and industry to clean power generation.[27] The government also faces public pressure to reduce its dependence on nuclear power and has been decommissioning existing nuclear plants following the crisis at the Fukushima Daiichi plant. This pressure has eased somewhat over the years, but it persists in polling on nuclear energy.[28] Yet preparing the grid for more intermittent renewable resources and ensuring reliable energy generation will require technological innovation. Further, the decline of nuclear power in the energy mix has led to a dominant role for natural gas; increased investment in technologies that can complement natural gas consumption while preparing for a more renewable future—such as grid development and hydrogen fuel—might be the most fruitful territory of advanced energy innovation in the near future.[29]

25 Ministry of Economy, Trade and Industry, "Structure of the 5th Strategic Energy Plan," Government of Japan, 2018, https://www.meti.go.jp/english/press/2018/pdf/0703_002b.pdf; "Japan," Climate Action Tracker, December 2, 2019, https://climateactiontracker.org/countries/japan/.

26 Japan to reduce greenhouse-gas emissions to net zero by 2050," *Nikkei Asia*, October 21, 2020, https://asia.nikkei.com/Spotlight/Environment/Japan-to-reduce-greenhouse-gas-emissions-to-net-zero-by-2050.

27 Daniel Merino, "Tokyo: The Global Climate Strike," Pulitzer Center, October 11, 2019, https://pulitzercenter.org/reporting/tokyo-global-climate-strike; Jan Erik Saugestad, "Japan Must Exit Coal," *Japan Times*, June 2, 2019, https://www.japantimes.co.jp/opinion/2019/06/02/commentary/world-commentary/japan-must-exit-coal/#.Xm-0WpNKhQJ.

28 Junko Ogura and Jethro Mullen, "Tens of Thousands Demonstrate against Nuclear Power in Japan," CNN, July 16, 2012, https://www.cnn.com/2012/07/16/world/asia/japan-nuclear-protest/index.html; Mizuho Aoki, "Down but Not Out: Japan's Anti-nuclear Movement Fights to Regain Momentum," Japan Times, March 11, 2016, https://www.japantimes.co.jp/news/2016/03/11/national/not-japans-anti-nuclear-movement-fights-regain-momentum/#.Xm-1FZNKhQJ.

29 Iain Wilson, "Wilson: Japan's Energy Transition - This Time It May Be for Real," BloombergNEF, March 18, 2019, https://about.bnef.com/blog/wilson-japans-energy-transition-time-may-real/.

The Political Environment in the United States

Due in part to the polarization of climate and renewable energy politics over the past several years, the likely outcome for US energy policy varies following either a Republican or Democratic victory in the 2020 US presidential elections.[30] Yet it would be incorrect to frame the outcome of the November elections as a referendum on clean energy technologies. An evolving set of energy innovation policy interests on the Republican side of the aisle suggests that building out clean energy cooperation within the US-Japan energy partnership is not limited to a Democratic administration, but rather is an exercise in identifying areas that appeal to both the "all-in" approach to climate action on the left and to the narrower approach of limited climate action on the right. Further, it is worth noting the extent of possible turnover in the United States Congress as a result of the November elections, and the potential that turnover will place additional pressure—or limit the hand—of either a Trump or Biden administration come 2021.

OUTCOME 1:

A SECOND TRUMP ADMINISTRATION: In general, the Trump administration has demonstrated little interest in including non-nuclear clean energy technologies in bilateral energy partnerships—including with Japan—but there is reason to believe that could change to some degree in the future, as congressional Republicans, in particular, begin to consider a climate action and clean technology platform of their own.[31] With a focus primarily on technological development, not deployment, several plans put forth in the past year to support clean energy innovation—including the American Energy Innovation Act introduced by Senators Lisa Murkowski (R-AK) and Joe Manchin (D-WV)—point to how Congress, even in a second Trump administration, might prove a valuable ally in building consensus around energy technology innovations considered to be low-hanging fruit. Even the administration's position has evolved; President Donald Trump himself has not tweeted about climate change or called it a "hoax" in over a year—though he has declined to link extreme weather events such as wildfires and hurricanes to broader climate change—and other members of the Trump administration are comfortable speaking on the issue. For example, US Secretary of Energy Dan Brouillette has repeatedly spoken publicly about reducing emissions.[32]

To this end, it is worth remembering the Trump administration's alignment of foreign policy with energy trade and investment in response to the vast reach China has secured through its Belt and Road Initiative (BRI). China's clean energy technology investment throughout the region as part of the BRI (excluding investment in China itself) is valued at more than $50 billion through 2019.[33] With antagonism between the Trump administration and China since Trump's election flaring for the past several months, this motivation may become increasingly relevant if Trump is reelected, but increasingly complicated from Japan's perspective if the cooperation is explicitly antagonistic toward China. Still, if presented as an additional balance against China in the region, adding clean technologies to the US-Japan energy partnership and platforms such as Asia EDGE and the US-led Free and Open Indo-Pacific (FOIP) strategy would be a reasonable extension of the Trump administration's existing focus on natural gas, coal exports, and nuclear partnerships.

OUTCOME 2:

POLITICAL TURNOVER AND A DEMOCRATIC ADMINISTRATION: The political environment if Biden wins the presidency in November remains unclear. Whether or not the Democratic Party secures the White House but suffers from limited success in down-ballot House and Senate races will affect the ability of a Democratic administration to deliver on the climate change and renewable energy platforms announced thus far during the nomination process. Perhaps even more uncertain is how nuclear and natural gas fit into the future.

30 David Goldwyn and Andrea Clabough, "What's at Stake for Energy in the 2020 Election: An Update," Atlantic Council Global Energy Center, August 17, 2020, https://www.atlanticcouncil.org/in-depth-research-reports/report/whats-at-stake-for-energy-in-the-2020-election-an-update/.

31 Zack Colman, Anthony Adragna, and Eric Wolff, "House Republicans Caught between Trump and Young Voters on Climate Change," *POLITICO*, January 26, 2020, https://www.politico.com/news/2020/01/26/climate-change-trump-republicans-104665.

32 "US Energy Priorities Abroad: A Conversation with US Secretary of Energy Dan Brouillette," Atlantic Council, February 7, 2020, https://www.atlanticcouncil.org/event/us-energy-priorities-abroad-a-conversation-with-us-secretary-of-energy-dan-brouillette/.

33 Thomas S. Eder and Jacob Mardell, "Powering the Belt and Road: China Supports Its Energy Companies' Global Expansion and Prepares the Ground for Potential New Supply Chains," Mercator Institute for China Studies, June 27, 2019, https://www.merics.org/en/bri-tracker/powering-the-belt-and-road.

At this stage, Biden's climate and energy plans—which are more moderate than that of the progressive wing of the party—are forming the foundation of the Democratic Party's energy platform. Biden's climate and energy plans favor aggressive development of new clean technologies, with continued engagement on nuclear power and a more gradualist approach to reducing natural gas production. This pathway also incorporates more gradual emissions reduction targets than those favored by far left members of the party, with domestic net-zero emissions targeted for 2050 instead of 2030, the year targeted in the Green New Deal.[34] While support for LNG and nuclear cooperation may be weak among some Democrats, US natural gas production and LNG exports would continue—at least in the short term—and nuclear energy has support within the Biden campaign as a zero-emissions power source.[35] Still, the priority would become policies that support rapid emissions reductions, which would further spur the development of a partnership between the United States and Japan around the advanced technologies needed to make that happen.

Biden would nonetheless face pressure from the progressive wing of his party to incorporate elements of their energy policies if he is elected. That suite of policies includes a more aggressive timeline on reaching net-zero, a rapid de-escalation of natural gas production (or, at the very least, national energy policy that turns away from natural gas promotion), and, for some members of the progressive wing, the closure of most nuclear power plants in the United States.[36] This would pull the rug out from under both central pillars of the current US-Japan energy relationship, opening the door for additional partnerships around (non-nuclear) clean energy technologies, but possibly at the expense of essentially all current major cooperation.

It is unlikely that Biden would adopt these policies, however. Nuclear energy has increasing support from the center left, boosting the possibility that it can sustain broad political support. Many voters in battleground states such as Ohio and Pennsylvania—where natural gas production is key to the economy—may balk at a move toward the anti-natural gas demands of the far left. Since accepting the nomination, Biden has resisted the most aggressive policy proposals from the left: nuclear energy remains an important piece of his climate and energy plans, which prioritize pricing pollution and regulating the oil and gas industry, rather than phasing the industry out altogether.[37] Continuing to balance these pressures will be a challenge throughout a Biden administration should he win the presidency.

Yet, similar to a Republican administration, US leadership in a Democratic administration on clean energy technologies vis-à-vis China will be an important opportunity upon which to build an expanded clean energy partnership within the broader US-Japan energy partnership. A Democratic administration would approach this within the context of the Paris Agreement, which Biden has made clear he intends to rejoin should he win in November. The desire to balance against Chinese success in these industries would be less direct, but still a valuable geopolitical point to drive a broader regional partnership between the United States and Japan.

34 Both Democratic pathways have ambitious decarbonization targets, to be sure. The moderate wing has thus far not expressed support for banning fracking from public lands (or, as some have proposed, on any lands) or for shutting down nuclear power. Both wings also commit to rejoining the Paris Agreement—though have different deadlines for sectoral decarbonization. See David L. Goldwyn and Andrea Clabough, *Election 2020: What's at Stake for Energy?,* Atlantic Council, January 9, 2020, https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/election-2020-whats-at-stake-for-energy/; Biden for President, "The Biden Plan to Secure Environmental Justice and Equitable Economic Opportunity in a Clean Energy Future," accessed August 10, 2020, https://joebiden.com/climate-plan/; Warren Democrats, "Tackling the Climate Crisis Head On," accessed August 10, 2020, https://elizabethwarren.com/plans/climate-change.

35 Biden for President, "Climate: Joe Biden's Plan for a Clean Energy Revolution and Environmental Justice," accessed June 23, 2020, https://joebiden.com/climate/; Biden for President, "The Biden Plan to Build a Modern, Sustainable Infrastructure and an Equitable Clean Energy Future," accessed September 28, 2020, https://joebiden.com/clean-energy/.

36 Umair Irfan, "A Guide to How 2020 Democrats Plan to Fight Climate Change," Vox, September 10, 2019, https://www.vox.com/2019/9/10/20851109/2020-democrats-climate-change-plan-president.

37 The plan does include a ban on oil and gas development on US public lands, but does not include any outright limit or ban on general production. Biden for President, "Climate: Joe Biden's Plan for a Clean Energy Revolution and Environmental Justice;" Biden for President, "The Biden Plan to Build a Modern, Sustainable Infrastructure and an Equitable Clean Energy Future."

The US government has faced increasing pressure from the left to end hydrocarbon production and consumption and to decarbonize its economy quickly using clean energy technologies. Large-scale demonstrations in support of progressive climate policy—like this "Fire Drill Friday" protest in Washington, DC in November 2019—could gain traction and place more pressure on a potential Biden Administration. SOURCE: REUTERS / Siphiwe Sibeko

Building a Clean Energy Partnership to Fit Multiple Political Pathways

The variance of these political possibilities makes it difficult to prescribe a partnership around clean energy technologies that sits at the intersection of emerging Republican climate action and Democratic energy policy. A Democratic administration presents the potential for a broad partnership that targets clean energy technologies across a range of applications, though those opportunities would possibly take priority over the nuclear and natural gas elements of the current US-Japan energy partnership. A more conservative pathway would, on the other hand, sustain (if not prioritize) the existing elements of the partnership, while a clean energy technology partnership would likely be focused on innovation in a more limited class of technologies.

Grid development, hydrogen fuel, and battery storage technologies offer that flexibility. They will be essential to Democratic plans for balancing renewable generation increases and stabilizing the grid by distributing intermittent generation throughout the day, but also fit in well with traditional Republican approaches to energy policy, including an emphasis on technological leadership and innovation, trade balances, and (currently) the role of China.[38] As an effective middle ground, cooperation on these technologies could also provide a basis for a more broad-based partnership around clean energy technologies in the future, both as the Republican platform on clean energy technologies continues to evolve and should a Democrat win the White House. Such a crosscutting partnership would also be more politically durable, lasting beyond one presidential administration or congressional term.

38 "Historical Energy Policy in the United States," Ballotpedia, accessed March 16, 2020, https://ballotpedia.org/Historical_energy_policy_in_the_United_States; Brendan Murray, "Trump's Solar Tariffs Turn 2 Years Old, Blistering an Industry," *Bloomberg*, January 22, 2020, https://www.bloomberg.com/news/articles/2020-01-22/trade-war-latest-trump-s-solar-tariffs-turn-2-years-old.

ENHANCING CLEAN ENERGY COLLABORATION THROUGH GRID DEVELOPMENT, HYDROGEN, AND BATTERY TECHNOLOGIES

Intermittent resources deployed in both the United States and Japan necessitate the development of energy technologies that can weather, accommodate, and even take advantage of that variable generation. The two countries have resources already dedicated to the development of grid, hydrogen, and battery storage technologies, and together they can draw upon these resources and history of energy partnership to accelerate the development and deployment of these critical technologies. To get across the finish line, these technologies will require novel policies and markets, as well as innovation at the grid-wide level, needs that can serve as a nexus of cooperation between the countries. There are three avenues that take advantage of both countries' strengths and experiences. First, smart grid and grid development technologies can make the countries' energy systems more resilient and tap into latent storage capacity in addition to enhancing grid-wide energy efficiency. Second, hydrogen as a storage solution and a clean fuel can leverage Japanese experience in the industry and the United States' research capacity and markets to reach scale. Finally, Li-ion battery technology can serve as a large-scale storage solution on the grid and in transportation, with sufficient technological development.

Avenue 1: Grid Development

The increasing penetration of variable and distributed energy generation creates an enormous challenge for power grids in both countries. For Japan, connecting growing offshore wind resources to the grid will be particularly difficult, while scaling the production of hydrogen, which the government has signaled as a priority alternative fuel, will also add significant energy demand. For the United States, coordinating increasing intermittent generation over a sprawling grid will require significant innovation in grid technology. Additionally, both countries must consider the importance of grid resilience in their energy strategies as weather impacts become more severe and disruptive, as well as the need for an evolving ecosystem of power and utility companies as more energy sources plug into the grid. An innovative, flexible suite of grid policies and technologies can help meet that need.

Smart grid technologies can be overlaid on or replace an electrical grid to better monitor or adjust electricity flows—at both the supply and demand ends—through the grid. A network of such technologies would integrate digital functionality into the electric grid, allowing it not just to monitor but to respond to changes in supply or demand, potentially making the grid more flexible in responding to supply disruptions or fluctuations, and thus more resilient. As both countries' grids age and host more intermittent resources, the flexibility that smart grid technology can provide will become increasingly valuable. Smart grid implementation would also significantly enhance the energy efficiency of the system, potentially reducing consumption and thus emissions. A smart grid also theoretically has enormous advantages over the current one-directional grid infrastructure. A disruption in one part of the grid would not necessarily spell collapse elsewhere, mitigating some of the physical security risks —natural disasters in particular—that have long been prioritized in Japan's resiliency planning.

Further innovation in smart grid technology can help make a flexible, resilient, and responsive grid a reality, contributing to distributed battery storage and integrating additional renewables without requiring as much utility-scale storage technology. But the most important innovation to smart grid technology will be in making it more deployable and cost effective, which will require not just technological innovation but also

As Japan installs more and more variable solar and wind capacity—like this Mount Komekura solar field—grid innovation will become even more critical to resilience and energy security.
SOURCE: Wikimedia Commons / Sakaori

policy innovation, particularly in the United States, where thousands of utilities use the same power grids.

Japan has already invested in smart grid technology deployment—including more than $100 billion in the 1990s alone—primarily aimed at making the grid more reliable and effective at using increasing amounts of renewable energy.[39] These investments have not only made the grid more reliable but have also helped better integrate distributed solar power by increasing the number of smart meters that can facilitate better grid-wide demand response. One of the country's largest utilities, Tokyo Electric Power Company (TEPCO), is a world leader in smart-meter deployment to support smart grid development, and it has also pushed the innovation envelope through partnerships on blockchain technology to enable peer-to-peer energy trading on the grid using smart technology.[40] Microgrids are also becoming more common throughout the country, as localities seek smarter and more resilient alternatives to the broader electric grid—including through battery installations attached to those microgrids to maintain a power supply in case a natural disaster disconnects them from the main grid—motivated in part by the earthquake and tsunami in 2011.[41] The deployment of smart meters was an early and still prominent part of Japan's grid modernization effort; there is still much yet to do to develop a national smart grid system that uses those smart meters fully and can flexibly respond to demand and supply fluctuations and disruptions.[42]

39 Amy Poh Ai Ling, Sugihara Kokichi, and Mukaidono Masao, "The Japanese Smart Grid Initiatives, Investments, and Collaborations," *International Journal of Advanced Computer Science and Applications* vol. 3, no. 7 (August 24, 2012), http://arxiv.org/abs/1208.5394.

40 Motoaki, "TEPCO: A Quiet Emergence of Smart-Grid in Japan (Digitization)," Harvard Business School Technology and Operations Management, November 15, 2017, https://digital.hbs.edu/platform-rctom/submission/tepco-a-quiet-emergence-of-smart-grid-in-japan-digitization/.

41 Aaron Sheldrick and Osamu Tsukimori, "Quiet Energy Revolution Underway in Japan as Dozens of Towns Go Off the Grid," *Reuters*, September 19, 2017, https://www.reuters.com/article/us-japan-energy-revolution-idUSKCN1BU0UT.

42 Ling et al., "The Japanese Smart Grid Initiatives, Investments, and Collaborations."

The United States, on the other hand, has made a less-focused effort to implement smart grid technology across the country, though some utilities have taken such measures on their own. Still, the US government does have several smart grid-focused initiatives through the US Department of Energy (DOE) that work to "accelerate discovery and innovation in electric transmission and distribution technologies and create 'next generation' devices, software, tools, and techniques to help modernize the electric grid."[43] And despite less smart grid-specific policy in the United States, utilities have installed huge numbers of smart meters: the Institute for Electric Innovation estimates that electric companies have installed 98 million smart meters covering over 70 percent of households.[44] Smart meter deployment alone is far from the full potential of smart grid technologies, however, in both the United States and Japan.

To meet the challenge of a rapidly changing demand picture coupled with more severe weather events—and to potentially take advantage of the distributed energy storage those fleets offer—both countries need to invest in grid technology innovation and deployment in addition to infrastructure resilience. They have each thus demonstrated a desire to integrate smart grid technology into their power systems and have at least begun to lay the foundations for that integration through smart meter deployment and some government-led innovation research.

Because of that shared challenge and the countries' global leadership in the technology, this is a rich area for collaboration. Japan's experience in microgrid implementation and attempts at smart grid implementation—including, but not limited to, research into blockchain applications in energy distribution—can help inform US smart grid policies and utilities' attempts to roll out smart grid applications, partly by seeing how policies have shaped the rollout of such applications in a more integrated power market. And the United States' investment in smart grid research and development (R&D), through both the DOE and various power companies, can drive collaborative innovation research forward. The two countries have some experience collaborating on smart grid technology: under the Hawaii-Okinawa Memorandum of Cooperation for Clean and Efficient Energy Development and Deployment, Japan's Ministry of Economy, Trade and Industry (METI) and the United States' DOE worked together to develop smart grids for island communities.[45] Japan can also apply lessons learned by some US states' integration of high levels of both utility-scale and distributed renewable resources; for instance, how those states have effectively (or ineffectively) connected those resources and accommodated for their intermittency. An exchange of policy and technology—coupled with a commitment to collaborate on innovation in both spaces—could spur the future development of both countries' grids.

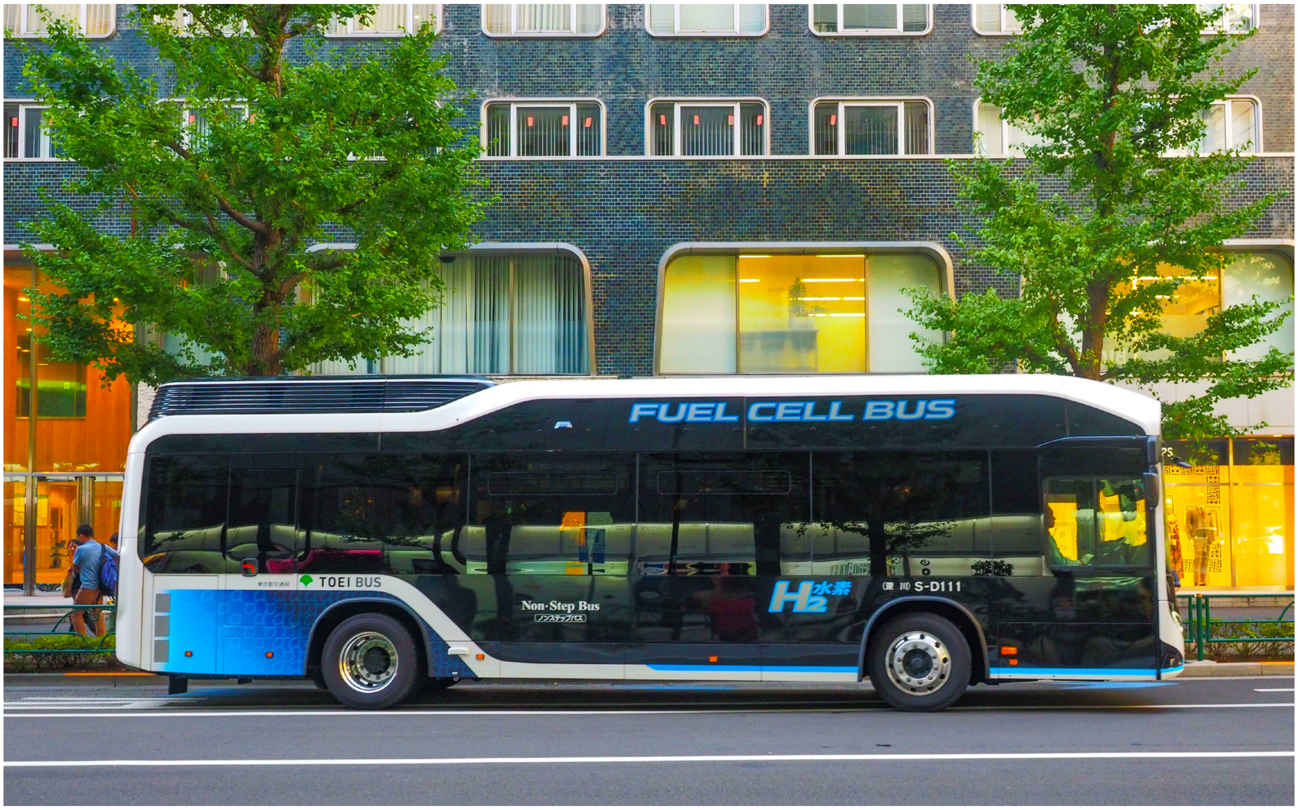
Avenue 2: Hydrogen

Hydrogen's high energy density makes it a potential solution for a range of decarbonizing sectors, from transportation to heavy industry to energy storage, and a potential tool for increased adoption of advanced energy technologies. Hydrogen production can absorb excess energy production at peak solar and wind production hours and store it for power generation when those sources are underproducing, or store it for use in transportation while also providing the long-heralded emission benefits of hydrogen fuel cell-powered vehicles. It is also uniquely well-suited to producing the high heat needed for heavy industry and to decarbonizing the buildings sector by blending into existing natural gas infrastructure. However, serving as a large-scale solution would require massive efficiency and cost improvements in hydrogen production and fuel cell technology. Costs of production, a lack of transport and distribution infrastructure, and a lack of low-emission "green" (using renewable energy) and "blue" (using natural gas with CCUS) hydrogen production facilities are the current barriers to large-scale hydrogen technology deployment. This is the case particularly in countries that view its potential as primarily in transportation but have decided to commit

43 US Department of Energy, "Initiatives that Catalyze the Industry to Modernize the Grid," December 16, 2019, https://www.smartgrid.gov/.

44 Adam Cooper and Mike Shuster, *Electric Company Smart Meter Deployments: Foundation for a Smart Grid (2019 Update)*, The Edison Foundation Institute for Electric Innovation, December 2019, https://www.edisonfoundation.net/iei/publications/Documents/IEI_Smart%20Meter%20Report_2019_FINAL.pdf.

45 Meredith Kuba, "Hawai'i, Okinawa Commit to Clean Energy Future," *Hawai'i Herald,* August 28, 2015, https://www.thehawaiiherald.com/2015/08/28/hawaii-okinawa-commit-to-clean-energy-feature/.



Japan has been a leader in deploying hydrogen fuel technologies, including hydrogen bus fleets in its cities, like this fuel cell bus operated by the Tokyo metropolitan bus company. SOURCE: Shutterstock /oasis2me

to electric vehicles instead.[46] Because hydrogen can address issues of energy security through enhanced grid resilience as an advanced fuel and in energy storage, hydrogen should have lasting appeal across the political spectrum. Including blue hydrogen can make this pathway even more politically durable and crosscutting while enabling hydrogen's broader transportation and industrial applications, which are already presenting opportunities for collaboration over the long term. Hydrogen as a storage solution and advanced fuel best addresses the United States' and Japan's grid resilience and energy security goals and is the most politically durable of these pathways. These applications enhance reliability and resilience on the grid—and make renewable investment more attractive because hydrogen can be produced using otherwise-curtailed power—while enhancing Japan's energy security by reducing reliance on imported fuel.

Japan is a world leader in hydrogen technology and investment, and the country's government and industry have long viewed hydrogen fuel—not batteries—as the clean energy fuel of the future. Before stepping down, Abe announced that the Japanese government plans to make hydrogen fuel at least 90 percent cheaper by 2050—cheap enough to compete with natural gas—and the government more broadly foresees a future in which it purchases cheap coal from Australia and uses it to produce hydrogen while capturing all emissions, essentially employing coal-based blue hydrogen production.[47] The government

46 Pure hydrogen production accounts for 6 percent of global natural gas consumption (and 2 percent of global coal consumption) and 830 million metric tons of carbon dioxide each year. Blue and green hydrogen development could cut into that carbon footprint. Blue hydrogen is pure hydrogen produced using natural gas but with carbon capture equipped to reduce emissions from production. Green hydrogen is produced through electrolysis using electricity from renewable sources (or other zero-carbon sources like nuclear). Iain Staffell, Daniel Scamman, Anthony Velazquez Abad, Paul Balcombe, Paul E. Dodds, Paul Ekins, Nilay Shahd, et al., "The Role of Hydrogen and Fuel Cells in the Global Energy System," *Energy & Environmental Science* vol. 12, no. 2 (2019): 463–91, https://doi.org/10.1039/C8EE01157E.

47 Robin Harding, "Japan's Hydrogen Dream: Game-Changer or a Lot of Hot Air?" *Financial Times*, June 17, 2019, https://www.ft.com/content/c586475e-7260-11e9-bf5c-6eeb837566c5.

has poured enormous resources into making that vision a reality, particularly after the Fukushima accident, through the "hydrogen society" plan approved in 2014.[48]

As of 2020, the country has about 160 hydrogen refueling stations for fuel cell cars and it plans to double that number by 2026, with a goal of two hundred thousand hydrogen-powered cars on the road by that year (there are currently about three thousand).[49] The Japanese government aims for all hydrogen production to be completely carbon free, through the use of renewable energy or full carbon capture deployment, by 2040.[50]

The United States has not committed as much to a hydrogen future, but some states still target broader hydrogen deployment, and production remains important for industrial applications. DOE has dedicated R&D funding to hydrogen and fuel cell technologies for years through the Fuel Cell Technologies Office, with funds for R&D across the hydrogen value chain, from hydrogen production to storage to fuel cells and vehicles (as well as toward process innovation to drive down manufacturing costs).[51] Though the United States does not plan for hydrogen to become the bedrock of the transportation sector, as Japan does, government and industry have nonetheless committed significant resources to developing the technology and supporting the development of infrastructure. DOE launched a partnership with industry, called H2USA, targeted specifically at the development of hydrogen transport and refueling infrastructure to "support more transportation energy options for US consumers."[52] Still, there are only forty-one active hydrogen refueling stations in the entire country, albeit with thirty-six more in various stages of planning.[53] Most of those stations are in California, which in collaboration with industry is planning to expand the hydrogen industry, with a target of one million hydrogen vehicles on the road by 2050.[54]

Yet, at this stage, hydrogen's value to the energy transition remains a question of innovation to enable cost reductions and scale, both in product and process. Among the necessary developments for hydrogen scalability are increased efficiency of hydrogen production and use, as well as development of the infrastructure needed to ensure reliable, low-cost delivery and sufficient physical storage and fuel cells for the fuel to serve as energy storage on the grid. Particularly to compete in the transportation sector, fuel cell costs will need to decline significantly, an effort that has largely been spearheaded by Japan.[55]

The product and process innovation needed for hydrogen is a space uniquely suited to collaboration between the United States and Japan. Japan's long experience in developing the industry and its more developed transport and refueling infrastructure can inform the United States' own development, while the United States' experience in bringing advanced technologies quickly to market can help accelerate Japan's hydrogen industry growth. R&D collaboration can push innovation in the industry forward more quickly and make hydrogen as a storage solution on the grid or as a transportation fuel—not just in cars, but in longer distance travel (potentially even aviation)—viable sooner. The United States can also serve as a larger market for Japanese hydrogen technology companies, including fuel cell manufacturers and automakers, if Japan helps the United States on policy and infrastructure innovation to support hydrogen deployment.

The foundation for a hydrogen energy partnership already exists, as Japan's METI signed a joint statement of future cooperation in hydrogen and fuel cell technologies with the US DOE and the European

48 Shigeki Iida and Ko Sakata, "Hydrogen Technologies and Developments in Japan," *Clean Energy* vol. 3, no. 2 (May 25, 2019): 105–13, https://doi.org/10.1093/ce/zkz003.

49 "Japan Aiming for 160 Hydrogen Charging Station Locations by Fiscal 2020," *Japan Times*, February 21, 2019, https://www.japantimes.co.jp/news/2019/02/21/business/corporate-business/japan-aiming-160-hydrogen-charging-station-locations-fiscal-2020/.

50 Iida and Sakata, "Hydrogen Technologies and Developments in Japan."

51 US Department of Energy, "Alternative Fuels Data Center: Hydrogen Research and Development," Energy Efficiency and Renewable Energy, accessed March 16, 2020, https://afdc.energy.gov/fuels/hydrogen_research.html.

52 Ibid.

53 Ibid.

54 Harding, "Japan's Hydrogen Dream: Game-Changer or a Lot of Hot Air?"

55 International Energy Agency, "The Future of Hydrogen – Analysis," June 2019, https://www.iea.org/reports/the-future-of-hydrogen.

Commission Directorate-General for Energy in 2019.[56] The joint statement recognized the importance of hydrogen in the energy transition and expressed commitments to innovating in the area and increasing deployment to help reduce emissions. While the joint statement did not establish concrete avenues of cooperation, merely expressing a broad desire to collaborate on technology innovation and policies that can spur the development of the global hydrogen industry, it certainly laid the groundwork for more concrete bilateral cooperation. Both countries are also members of the International Partnership for a Hydrogen Economy, a broader international forum for hydrogen cooperation.

Politically, blue hydrogen would be particularly appealing to the conservative end of the political spectrum because it decreases emissions while stimulating natural gas demand, perhaps offsetting demand losses as renewables replace gas in the power sector and thus keeping a booming US industry above water. Even with continued Republican control, blue hydrogen could thus serve as an extension of the existing natural gas priorities, making collaboration all the more durable as well. Cooperation on blue hydrogen would also necessarily include cooperation on CCUS technologies, on which Japan and the United States have already collaborated, most recently through a 2017 memorandum of cooperation to support collaboration in both R&D and project development. [57] Building on the existing CCUS partnership can help advance blue hydrogen and thus provide an additional route of clean energy collaboration that is politically crosscutting.

Hydrogen has enormous potential beyond serving as an energy storage solution, and early success in advanced fuels and energy storage can help unlock that potential. As mentioned, it can also be used as a substitute for fossil fuels in industrial applications and in buildings and has the potential to grow into its own pillar of the US-Japan energy partnership. Cooperation on hydrogen for energy storage in the short term is essential to enabling that broader partnership of the future. Its use as an energy storage medium is politically more broadly appealing in the short term as both countries seek to complement the intermittent renewables on their grids and achieve short-term emissions reductions, whether through storage on the grid or for transportation. Storage would also serve as a necessary first step in infrastructure financing, market development, and unlocking key technologies necessary to reach scale for broader commercial and industrial emissions reductions. But in the medium and long terms, as hydrogen production is scaled and its potential as a clean solution in heavy industry and transportation increases—or if Biden wins the presidency in November and decarbonization becomes the priority rather than a benefit on top of resilience and security—hydrogen could indeed grow to become its own pillar of the energy partnership.

Avenue 3: Battery Technology Supply Chains

Part and parcel with possible grid development and advanced fuel innovations, continued collaboration on traditional battery technologies remains a valuable area of interest within both the United States and Japan. Li-ion batteries in particular are becoming the go-to energy storage technology both for electric vehicles and utility-scale applications in homes and businesses, with electric vehicle (EV) deployment increasing by 40 percent and surpassing 2.1 million new vehicle sales in 2019, and utility-scale battery capacity projected to increase sixfold by 2022.[58] The supply chains associated with these technologies represent not just areas where US-Japan energy innovation ecosystems could improve efficiency and reduce costs, but also where both countries should be working together to improve transparency, sustainability, and open markets in a supply chain that is highly siloed, diffuse, and subject to poor environmental practices. From the production and processing of necessary lithium and cobalt components to the manufacturing of the batteries themselves, the suite of collaboration opportunities available in this space adds energy security as well as geopolitical opportunities to a new focus on non-nuclear clean energy technologies within the US-Japan energy partnership.

Over the last decade, the rise of lithium-ion batteries has profoundly reshaped the available applications of electrified storage. Indeed, a projected quintupling of

56 US Department of Energy, "Joint Statement of Future Cooperation on Hydrogen and Fuel Cell Technologies among the Ministry of Economy, Trade and Industry of Japan (METI), the European Commission Directorate-General for Energy (ENER) and the United States Department of Energy (DOE)," June 18, 2019, https://www.energy.gov/articles/joint-statement-future-cooperation-hydrogen-and-fuel-cell-technologies-among-ministry.

57 Ministry of Economy, Trade and Industry, "METI and US DOE Conclude a Cooperation Document in the Field of CCUS."

58 International Energy Agency, *Global EV Outlook 2019*, May 2019, https://www.iea.org/reports/global-ev-outlook-2019; Julian Spector, "Lithium-Ion Storage Installs Could Grow 55% Every Year through 2022," *Greentech Media*, August 22, 2018, https://www.greentechmedia.com/articles/read/lithium-ion-storage-installations-could-grow-by-55-percent-annually.

A Tesla PowerPack battery storage project on display during its unveiling in Mira Loma, California, in 2017. SOURCE: REUTERS / Nichola Groom

Li-ion battery production can largely be attributed to using batteries in the following applications: (1) electric vehicles, sales of which grew by 193 percent in the United States, 168 percent in Europe, 513 percent in China, and 153 percent in Japan between 2015 and 2019; (2) home storage, for which, in addition to being popularized in the United States by Tesla's "Powerwall," Li-ion batteries continue to be the best-performing battery in support of local power generation such as solar; and (3) backups for data centers and grid-scale utilities such as solar and wind.[59]

However, despite the Li-on battery's role in facilitating electric vehicle deployment and at-home energy storage, it introduces several new energy security challenges that must be overcome. Washigton and Tokyo are well-positioned to address these challenges together.

The first of these challenges is improving efficiency and deployment while reducing costs. Though the Li-ion battery is a significant improvement from its predecessor in energy density, power, lifespan, and safety, there remains much work to be done should the Li-ion battery meet grid-scale demands, grow into

59 Roland Irle, "USA Plug-in Sales for 2019 YTD October," accessed March 16, 2020, http://www.ev-volumes.com/country/usa/; "Quarterly Sales Volume of Battery Electric (BEV) and Plug-In Hybrid Electric Vehicles (PHEV) in Europe from Q1 2014 to Q2 2019," *Statista*, January 31, 2020, https://www.statista.com/statistics/642799/eu-total-sales-electric-vehicles/; "China NEV Sales for 2019 Q3 + October," EV Volumes: The Electric Vehicle World Sales Database, accessed March 16, 2020, http://www.ev-volumes.com/country/china/; "Electric Vehicles in Japan," *Statista*, 2019, https://www.statista.com/study/68038/electric-vehicles-in-japan/; Akshat Rathi, "The Complete Guide to the Battery Revolution," Quartz, accessed March 16, 2020, https://qz.com/1582811/the-complete-guide-to-the-battery-revolution/; Danielle Muoio, "10 Home Batteries that Rival Tesla's Powerwall 2," *Business Insider*, May 18, 2017, https://www.businessinsider.com/rechargeable-battery-options-compete-tesla-2017-5; "How to Choose the Best Battery for a Solar Energy System," *EnergySage*, March 5, 2020, https://www.energysage.com/solar/solar-energy-storage/what-are-the-best-batteries-for-solar-panels/.

high-density areas of transportation such as long-haul trucking, and improve end-of-lifecycle concerns associated with recycling. Current Li-ion technology begins to lose charge immediately after charging stops and cannot store energy for significant lengths of time; the batteries' inefficiency over longer periods also makes them economically infeasible depending upon the necessary storage time (right now, grid-scale storage becomes uneconomical if storage over four hours is required).[60] For Li-on batteries to meet technical demands, they must be improved to limit energy loss after charging and, relatedly, extend the possible lifetime of storage.

The second challenge is one of supply chains. This begins with the core components of a lithium-ion battery, a lithium anode and cobalt cathode. Demand for each metal is projected to grow considerably, with lithium demand alone projected to grow from just over 0.2 million metric tons to over 1.4 million metric tons in 2030.[61] The supply chains to which these minerals contribute are opaque, siloed, and deeply misunderstood. Mining for lithium is dominated by only two countries—Australia and Chile—while cobalt mining is led by the Democratic Republic of the Congo.[62] The processing of these ores into usable materials predominantly takes place in China, which has a 57 and 67 percent share of global lithium and cobalt processing, respectively.[63] The manufacturing of these batteries is only mildly more diffuse, though it is of note that neither Japan nor the United States have significant domestic planned battery manufacturing activities of their own compared with China and Europe, for example.[64]

Resolving both cost efficiency and supply chain challenges is a technological and governance problem. Improvements in battery chemistry (such as reducing or eliminating the necessary amount of cobalt) will help ease supply chain bottlenecks, while also supporting increased energy density and reliability. As significant demand centers, both countries have shared incentives to improve supply chain fundamentals, reduce bottlenecks, and ensure market transparency should the Li-ion battery market continue to grow as expected.

Though competitors in the early development of Li-ion battery technologies, Japan and the United States are well-positioned to consider an expansion of existing science and technology partnerships to address these technological challenges together. Japanese companies have seen some early success experimenting with solid-state batteries, which are more scalable and offer increased safety.[65] Japan also recently became home to the only naval force in the world with a high-density Li-ion-powered submarine in its fleet.[66] In the United States, automotive manufacturer GM recently announced a significant new electric vehicle battery that uses less cobalt and offers four hundred

60 Akshat Rathi, "Batteries Can't Solve the World's Biggest Energy-Storage Problem. One Startup Has a Solution," *Quartz*, December 11, 2017, https://qz.com/1133123/batteries-cant-solve-the-worlds-biggest-energy-storage-problem-one-startup-has-a-solution/; Katie Brigham, "These New Battery Technologies Could Be the Future of Energy Storage," CNBC, March 14, 2020, https://www.cnbc.com/2020/03/13/lithium-ion-batteries-heres-whats-coming-to-replace-them.html.

61 "Will the Real Lithium Demand Please Stand Up? Challenging the 1Mt-by-2025 Orthodoxy," BloombergNEF, October 28, 2019, https://about.bnef.com/blog/will-the-real-lithium-demand-please-stand-up-challenging-the-1mt-by-2025-orthodoxy/.

62 Investing News Network, "Top Lithium Production by Country," blog, August 12, 2019, https://investingnews.com/daily/resource-investing/battery-metals-investing/lithium-investing/lithium-producing-countries/; Investing News Network, "Top Cobalt Production by Country," blog, February 17, 2020, https://investingnews.com/daily/resource-investing/battery-metals-investing/cobalt-investing/top-cobalt-producing-countries-congo-china-canada-russia-australia/.

63 Benchmark Mineral Intelligence, "Battery Megafactories Assessment," 2019.

64 China dominates with about 73 percent of the global battery production capacity, with the United States in a distant second with 12 percent. Major players include corporations in China (CATL, BYD), Japan (Panasonic), and South Korea (LG Chem)—with China most primed for future manufacturing capacity growth. The United States and Japan are set to fall even further behind—of the dozen "gigafactories" planned, only one is slated for operation in the United States, and none are planned in Japan. China leads the way, with several companies—foreign and domestic—planning gigafactory construction; Europe is second in such planned factories. Rathi, "The Complete Guide to the Battery Revolution"; Jason Deign, "10 Battery Gigafactories Are Now in the Works. And Elon Musk May Add 4 More," *Greentech Media*, June 29, 2017, https://www.greentechmedia.com/articles/read/10-battery-gigafactories-are-now-in-progress-and-musk-may-add-4-more; "Large Lithium Battery Plants to Dominate Capacity," *Argus Media*, March 28, 2019, https://www.argusmedia.com/en/news/1874627-large-lithium-battery-plants-to-dominate-capacity.

65 River Davis, "A Smaller, More Powerful Battery Begins to Charge Devices," *Wall Street Journal*, March 15, 2020, https://www.wsj.com/articles/a-smaller-more-powerful-battery-begins-to-charge-devices-11584280800.

66 Franz-Stefan Gady, "Japan Commissions First Soryu-Class Attack Sub Fitted with Lithium-Ion Batteries," *The Diplomat*, March 6, 2020, https://thediplomat.com/2020/03/japan-commissions-first-soryu-class-attack-sub-fitted-with-lithium-ion-batteries/.

miles of range, part of a declared $3 billion annual investment in electric vehicles.[67] This follows similar commitments from Tesla, which, in addition to its line of Powerwalls, has begun to expand its EV capacity to include heavy transportation and consumer trucking, both areas where lithium-ion batteries have struggled to gain traction due to traditional energy density issues.[68] Given the technological momentum on either side of the partnership, advanced battery technologies should not be discounted either. Lithium-sulfur batteries and improved anode/cathode chemistries show promise and provide additional areas for technological cooperation, as well as utility-scale innovations such as flow batteries, which might further unlock storage opportunities.

The impetus for such collaboration can build from mutual recognition by both Washington and Tokyo of the risks within the battery supply chain. In the fall of 2019, the 9th Trilateral EU-US-Japan Conference focused on critical minerals.[69] In September 2019, the United States launched the Energy Resource Governance Initiative, of which Japan is a member, to serve as a valuable platform for sharing best practices for mineral resource development and market governance, including the lithium and cobalt in lithium-ion batteries.[70] In the United States, the exposure of US industry and defense to China's dominance in the critical minerals supply chain has garnered attention on both sides of the aisle, with the Murkowski-Manchin bill announced in early 2019 seeking to improve resource access and the inclusion of a $454 billion plan to develop domestic battery manufacturing capacity for electric vehicle development launched in December 2019 by Sen. Chuck Schumer (D-NY).[71]

Provided conventional battery technology continues to hold true as the low-carbon transition proceeds, there will be significant value in continued collaboration between the United States and Japan on traditional energy storage. Expected EV growth notwithstanding, Japan has learned the hard way how severe the consequences of outsourced critical minerals supply chains can be, with a 2010 dispute with China causing an alleged embargo of Chinese minerals to Japan. Moreover, battery storage cuts across US political discourse in a number of ways, as it is a necessary component of any prospective Democratic plans to increase EV penetration and grid development, and is a major geopolitical concern for Republicans given Chinese preponderance throughout the supply chain.

67 Bill Howard, "GM Unveils New Lithium-Ion Battery Tech, Vows 400-Mile Cars," *ExtremeTech*, March 5, 2020, https://www.extremetech.com/extreme/307027-gm-unveils-new-lithium-ion-battery-tech-vows-400-mile-cars.

68 "Tesla Semi," *Electrek*, February 24, 2020, https://electrek.co/guides/tesla-semi/.

69 Ministry of Economy, Trade and Industry, "The 9th Trilateral EU-US-Japan Conference on Critical Materials Held," Government of Japan, November 19, 2019, https://www.meti.go.jp/english/press/2019/1120_002.html.

70 "Nine Countries Join U.S. Strategic Minerals Initiative in Bid to Cut Reliance on China," *Japan Times*, September 29, 2019, https://www.japantimes.co.jp/news/2019/09/28/business/nine-countries-join-u-s-strategic-minerals-initiative-bid-cut-reliance-china/#.Xm_D4ZNKj-Z.

71 Chuck Schumer, "Chuck Schumer: A Bold Plan for Clean Cars," *New York Times*, October 24, 2019, https://www.nytimes.com/2019/10/24/opinion/chuck-schumer-electric-car.html.

CONCLUSION: A US-JAPAN PARTNERSHIP

In expanding the US-Japan energy partnership to include an enhanced focus on clean energy technologies—specifically grid development, hydrogen fuel, and battery storage technologies—the two countries would do well to adopt some of the structures already in place that have supported the existing energy relationship over the past several years. As the nuclear energy pillar of the relationship has shown, technology sharing, coordination of innovation ecosystems, and industry partnerships are all easily facilitated by Tokyo and Washington, and lay important groundwork for partnership elsewhere.

However, considering how broad the balance of the nuclear and natural gas components of the energy partnership have become as they have matured (to now include elements of foreign policy and trade policy), the organization of new partnerships around these clean energy technologies should focus on two distinct but interconnected principles.

1 TECHNOLOGY DEVELOPMENT, INNOVATION, AND DEPLOYMENT: Given the need for continued technological development across these clean technologies and industries, how can innovation, human capital, and best policies and practices be shared to support technology development, scalability, and deployment? The US system of national laboratories run by DOE continues to examine the possibilities for energy storage and smart grid technologies while simultaneously receiving strong support from both political parties.[72] Its Japanese counterpart, led by METI, has several of its own bodies devoted to innovation in hydrogen, battery storage, and grid development, in addition to those of Japan's National Institute of Advanced Industrial Science and Technology and its National Institute for Materials Science.[73] There are a number of areas of technology development where both parties are already cooperating, from the aforementioned nuclear technologies at the heart of the energy relationship to new technologies, such as quantum computing. Extending these shared technology development platforms to include grid development, hydrogen, and battery technologies would be a natural evolution, especially considering the interest from all participating parties. Both countries should also commit to cooperative funding for technology development and deployment initiatives to avoid funding issues that have plagued past cooperative efforts due to the countries' distinct funding cycles.

2 FOLDING CLEAN ENERGY TECHNOLOGIES INTO A FREE AND OPEN INDO-PACIFIC STRATEGY: A second component would be to assess the role that these clean energy technologies have in FOIP alongside existing nuclear energy and natural gas pillars. JUSEP is currently contextualized within FOIP and—from the US perspective—plays a valuable but largely supporting role. However, with the addition of energy storage cooperation, it seems natural for the US-Japan energy partnership to underpin—rather than simply complement—the baseload energy development and

72 "National Renewable Energy Laboratory Optimistic in Face of Trump's Budget Cuts," *Denver Post*, July 15, 2017, https://www.denverpost.com/2017/07/15/national-renewable-energy-laboratory-budget-cuts/; Cory Gardner United States Senator for Colorado, "Gardner Votes for Bipartisan Measure that Supports Wind Energy, Secures Funding for NREL," press release, April 26, 2016, https://www.gardner.senate.gov/newsroom/press-releases/gardner-votes-for-bipartisan-measure-that-supports-wind-energy-secures-funding-for-nrel.

73 Most prominent among these bodies is the Central Research Institute of Electric Power Industry (CRIEPI), which collaborates with a number of other research bodies, including the Energy Innovation Center and eight specialized research laboratories. These are couched within the METI portfolio and collaborate with METI on natural resources and energy. Energy storage has been a major research priority for CRIEPI in recent years, with energy storage research initiatives a common technological thread across research areas. See: "About CRIEPI-History," Central Research Institute of the Electric Power Industry, accessed March 17, 2020, https://criepi.denken.or.jp/en/aboutcriepi/history.html; Central Research Institute of the Electric Power Industry, "CRIEPI Research Subjects (FY2018)," 2018; Ministry of Economy, Trade, and Industry, "Natural Resources and Energy," Government of Japan, accessed March 17, 2020, https://www.meti.go.jp/english/network/naturalresources.html.

renewables deployment needs of the Indo-Pacific. Japan is one of the United States' most steadfast partners, and the two countries share broad goals for open, well-governed, and sustainable energy markets throughout the region. A new focus on these clean energy technologies within the US-Japan energy partnership should thus not be considered within a vacuum, but instead as an opportunity to rethink how that partnership folds into a broader geopolitical strategy to shape energy development in the region. To this end, an energy partnership that includes natural gas, nuclear energy, and additional clean energy technologies is a valuable starting point. The United States and Japan can together use that trio to work with regional partners and meet critical short-term energy needs, including by helping countries upgrade or construct resilient and adaptive grids, while preparing the region for a low-carbon future, shaping energy markets, and strengthening regional ties through broader cooperation.

Looking Ahead

The US-Japan energy partnership remains strong and—from the perspective of the United States—an essential part of broader energy engagement in Asia. Nuclear energy and natural gas development represent hugely successful pillars of a relationship that has yielded benefits that cut across energy policy, foreign policy, and trade policy goals. And both of these pillars should continue to foster cooperation going forward, particularly as CCUS technologies become increasingly essential to long-term natural gas deployment and as growing international interest in nuclear power throws long-standing geopolitical and economic competition with Russia and China in the nuclear export market into sharp relief.

Yet, in a year of uncertainties, from major elections to a market-disrupting pandemic, one certainty is that energy needs are shifting, and a consideration of how this partnership may also need to shift is critical. With the need to reduce carbon emissions quickly to respond to climate change, aging grid infrastructure, and increasing amounts of intermittent energy resources, the United States and Japan are both re-evaluating which current and emerging technologies can meet the challenges facing their energy systems.

This re-evaluation poses both an opportunity and a challenge. The challenge is in how it alters the landscape for a possible evolution and expansion of the US-Japan energy partnership, particularly in the United States, where an election year has introduced two disparate visions for how (or which) new technologies should be introduced and for how the existing components of the partnership should be advanced. The opportunity lies in the potential for such evolution to resolve imminent challenges to the emerging energy needs currently being confronted in both countries.

Grid development, hydrogen fuel, and battery storage technologies offer a way to thread that needle. Across both Republican and Democratic Party platforms, this suite of technologies appeals to a number of visions for the future of energy systems, from game-changing renewables to natural gas-supported infrastructure and scaled deployment of electric vehicles. Partnership on these technologies fits into each of these visions and would address the shared challenges facing the United States and Japan, while also preparing for further collaboration as clean energy development grows increasingly urgent. Targeting hydrogen as a storage technology and fuel, for instance, would lay the groundwork for the countries to collaborate on deploying it in heavy industry and beyond in the longer term.

Organizing a new clean energy partnership around grid development, hydrogen fuel, and battery storage technologies thus not only complements the existing nuclear and natural gas components of the partnership but also positions the partnership to grow, both to include a broader suite of clean and renewable technologies, and to serve as the foundation for broader US-Japan energy engagement throughout the Indo-Pacific. Doing so would further enshrine the role of energy development within the already deep relationship between Washington and Tokyo.

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