EUI GLOBAL GOVERNANCE PROGRAMME

ROBERT SCHUMAN CENTRE

POLICY BRIEF

EU-Japan cooperation on renewable energy

Introduction

The European Union and Japan are the largest economies consistently committed to reducing greenhouse gas (GHG) emissions, which cause global warming, and to promoting renewable energy. China has also been an important partner, although it has adopted less ambitious targets, and the US has oscillated between committing to reducing GHG emissions during the Obama administration, abandoning this policy during the Trump administration and now re-embracing this goal with more fervour than ever during the Biden administration. Among the top four global economies, the EU and Japan have been the most consistent and important supporters of GHG emission reductions and renewable energy promotion.

In 2020 and 2021 both the EU and Japan significantly upped their targets for GHG emission reductions. In April 2021 during a global climate summit called by US President Joe Biden, Prime Minister Suga Yasuhide significantly raised Japan´s GHG target, pledging an ambitious 46% reduction by 2030. This was a big jump from the previous 26% target for the same year.[1]

The EU and Japan are also both trying to reduce their dependence on imported fossil fuels for reasons of both energy security and sustainability. Both have been heavily dependent on oil imports from the Middle East, and many EU states depend on Russian natural gas imports, a dependency that may grow with the

1 Shuichi Abe, "Yashin-teki"na yumemonogatari ka, jitsugen kanō ka onshitsu kōka gasu `46-pāsento-gen' no michisuji," *Mainichi Shimbun*, 31 May 2021. https://mainichi.jp/articles/20210529/k00/00m/040/013000c Accessed 6 June 2021; "EDITORIAL: Government must accelerate pace to go carbon neutral by 2050," *Asahi Shimbun*, June 2, 2021. http://www.asahi.com/ajw/articles/14363093 Accessed 9 June 2021.

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EU-Asia project
Issue 2021/52
November 2021

completion of the Nord Stream undersea pipeline in the Baltic that will connect Russia and Germany.

This paper argues that in addition to being two of the top four global economies, as the two most consistent champions of the liberal international order the EU and Japan must play a leading role in both combating climate change and promoting renewable energy. There is already significant cooperation between them on renewable energy, but huge untapped potential remains. There is still much the two sides can learn from each other in terms of promoting renewable energy domestically, and there is great potential for EU-Japan cooperation to enhance global connectivity in terms of promoting the rapid adoption of renewable energy in third countries, especially in developing countries in the Indo-Pacific region.

Renewable energy includes forms of energy that do not rely on either fossil or nuclear fuel to produce energy. The three leading forms are electricity produced from hydropower, photo voltaic solar panels (PV solar) and wind power. Other forms include direct solar (heating fluids with mirrors reflecting sun light to power turbines), tidal and geothermal (using heat from the earth's mantle to power turbines). Apart from geothermal and to a significant extent hydropower, these sources produce electricity at fluctuating and even unpredictable levels in real time, creating challenges when integrating them into existing electricity grids, which assume constant levels of electricity. Consequently, the energy transition to renewable energy also involves a fundamental restructuring of electricity grids and of the relationship between consumers and producers. It also involves the complete electrification of transportation, with batteries and hydrogen fuel-cell-powered automobiles, trucks, trains and, in the longer run, planes.[2] The EU and Japan are making progress in most of these areas but also face significant challenges. Through greater cooperation they have the opportunity to emerge as global leaders in renewable energy, thereby helping to slow down and stop, if not begin to reverse, human-caused climate change, while also emerging as commercial leaders in renewable energy, smart grids and the hydrogen economy. In doing so, it is important for them to cooperate with the two global superpowers, China and the US, as much as possible, even while building a long-term robust special relationship with each other that is not dependent on cooperation with China or even with the US.

The remainder of this paper consists of five sections. The next section outlines the GHG and renewable energy goals that the EU and Japan have set for themselves, the politics behind those goals and the progress they have made to date in making a transition to renewable energy. The subsequent section examines the framework for cooperation on promoting renewable energy that the two sides have realised to date. The third section addresses synergies between Europe and Japan in renewable energy technology development and deployment. The fourth section examines the potential benefits for renewable energy development that the EU and Japan can realise from continuing and deepening their partnership moving forward. The concluding section outlines some policy recommendations for EU-Japan cooperation to promote the renewable-energy transition domestically and in third countries.

The EU and Japan's GHG and Renewable Energy Goals

The EU pledged to reduce GHG emissions in the Kyoto Protocol's second commitment period by 20% by 2020. In fact, it exceeded this target with a 23% reduction in emissions. Europe's share of global emissions has already declined from 14% to 8%, and it is now able to simultaneously cut GHG emissions and realise economic growth. The EU initially aimed to achieve a 40% reduction from 1990 levels in GHG emissions by 2030, 60% by 2040 and 80% by 2050. However, in 2020 it upped its commitment to zero net emissions by 2050, and in April 2021, in advance of Biden´s virtual global climate summit, it committed to increasing its emissions reduction target for 2030 from 40% to 55%.[3]

The EU is implementing these GHG reductions under a set of policies known as 'Europe´s Green Deal,' starting with targets for renewable energy. It set a goal of covering 20% of its total energy consumption with energy from renewable sources by 2020, up from 8.5% in 2005. By 2013 it had already raised the share of energy produced from renewable sources to 15%. For 2030 it initially set a target of producing 27% of the total energy consumed from renewable sources, with 45% of electricity

2 Sarmad Khan, "Electric passenger jets could be in service by 2030," The National, September 12, 2018. https∫ØØwwwÆthenationalÆaeØbusinessØaviationØelectric≠passenger≠jets≠could≠be≠in≠service≠by≠2030≠1Æ769585 Accessed 10 December 2020.

3 BBC, "Climate change: EU to cut CO2 emissions by 55%," 21 April 2021. https://www.bbc.com/news/world-europe-56828383 Accessed 10 August 2021; Steven Erlanger, "Europe Rolls Out Plan to Shift From Fossil Fuels, an Effort That Could Impact Trade," *New York Times*, 14 July 2021. https://www.nytimes.com/2021/07/14/world/europe/climate-change-carbon-green-new-deal.html?searchResultPosition=2 Accessed 15 July 2021.

generated from renewables. However, along with the new 55% GHG reduction target the EU upped its renewable energy target to cover 40% of energy consumption by 2030. It further announced a ban on new fossil fuel car sales by 2035 and a target of cutting energy consumption by 9% through conservation measures.[4]

As part of facilitating the shift to renewable energy, the EU set a goal of 15% of national grid capacity interconnectivity with other national grids.[5] Expanding ties between national grids is important for integrating variable renewable energy because the variability can be more easily managed over a larger grid. For example, excess German solar electricity on sunny days can be exported to the UK and Norway, and on windy nights the UK can export offshore wind power to Germany, and Norway can act as a green battery by ramping up its hydropower generation when the sun sets on German solar or the wind dies down in the UK. Related to greater grid interconnectivity, the EU has also set a 2030 target of promoting transnational short-term markets such as next day and intra-day markets for grid balancing. These markets arguably should be modelled on Nord Pool, which is the electricity market already linking the Nordic countries.

The politics behind the latest new targets have been contentious. The European parliament and environmental groups unsuccessfully pushed for a more ambitious target of 60% GHG reduction by 2030. The EU's enhanced targets have been motivated in part by a desire to consolidate its environmental leadership role. This motivation is evident in EU Commission President Ursula von der Leyen´s statement that "Europe was the first continent to declare to be climate neutral in 2050, and now we are the very first ones to put a concrete road map on the table."[6] On the other hand, these plans have provoked a considerable backlash from industry and some less wealthy EU members in central and eastern Europe, indicating that the process of getting all 27 member states to agree on the final set of policies will be difficult. Ensuring the costs do not fall disproportionately on less wealthy countries and populations will be key to making these plans politically acceptable. Plans for a 'carbon border-adjustment tax,' which would impose taxes on countries with less stringent rules limiting GHG emissions would be likely to provoke WTO suits from other states, if not unilateral retaliation.[7] Fortunately for the EU-Japan energy partnership, Japan´s targets and rules are likely to be close enough to the EU targets that it is unlikely this tax will be imposed on imports from Japan.

Turning to Japan's GHG goals, as mentioned in the introduction Japan has also recently upped its game significantly. In October 2020 Prime Minister Suga replaced Japan´s previous 2015 target of an 80% reduction in GHG emissions by 2050 from 2013 baseline emissions with a pledge to achieve net carbon neutrality (net zero emissions) by 2050, matching the latest EU goal. And during Biden´s environmental summit in April 2021 Suga announced that Japan was increasing its GHG reduction target for 2030 from the Abe administration´s previous 26% to 46%. Japan has also set a target of reducing transportation sector GHG emissions by 90% by 2050 through greater electrification, a goal that assumes near 100% use of electric passenger vehicles by then. In the short run this will require greater efforts from the Japanese government as the electric vehicle market in Japan has stalled, and even contracted, since 2017.[8]

Japan's 2018 Basic Energy Plan called for renewable energy to make up 22-24% of electricity production by 2030, a figure significantly lower than the EU's target for that year. Indeed, Japan's 2030 goal was so low that it was on track to achieve it by 2022, including traditional hydropower. The figure realised for 2020 was 21.7%, with a 12.7% increase in electricity generation from renewables (including 14.6% from solar) compared with 2019. The 2018 Basic Energy Plan also called for Japan to produce 20-22% of its electricity from nuclear power by 2030, a target that looks unrealistically high, even though Japan had produced nearly 30% of its electricity from nuclear power before the great east Japan earthquake, tsunami and Fukushima Daichi nuclear accident of 11 March 2011. In 2019 Japan generated only 6.6% of its electricity from nuclear

4 Erlanger, "Europe rolls out plan to shift from fossil fuels;" and Nina Chestney, "EU unveils plan to increase renewables share in energy mix to 40% by 2030," *Reuters,* 15 July 2021. https://www.reuters.com/business/environment/eu-unveils-plan-increase-renewables-share-energy-mix-40-by-2030-2021-07-14/ Accessed 10 August 2021.

5 European Council for an Energy Efficient Economy, "EU´s 2030 policy framework." https://www.eceee.org/policy-areas/2030-policy-framework/ Accessed 10 August 2021; Planete energies, "The European Commission: Electrical Interconnectors." https://www.planete-energies.com/en/medias/close/european-commission-electrical-interconnectors#form_id=media_node_form Accessed 11 August 2021.

6 Erlanger, "Europe Rolls Out Plan to Shift from Fossil Fuels."

7 Ibid.

8 The Mainichi, "Decarbonization drive creates supply chain challenges for Japan Inc," June 4, 2021. https://mainichi.jp/english/articles/20210604/p2g/00m/0bu/030000c Accessed 6 June 2021.

power, before falling to 4.3% in 2020, as several nuclear plants had to shut down for further safety retrofitting measures (this time counter-terrorism measures) that were ordered by the Nuclear Regulatory Authority (NRA). To reach the 20-22% electricity generation target 30 nuclear power plants would have to be restarted, three times more than the total number restarted since the NRA´s establishment and imposition of new safety measures following the Fukushima Daiichi nuclear accident. This number is even higher than the 27 reactors that operators have applied to restart. Consequently, experts consider the Ministry of Economy, Trade and Industry's (METI) target for nuclear power unrealistically high, with 15% being floated as a more realistic goal.[9] With no new nuclear builds currently envisaged, Japan´s shrinking stock of ageing reactors reaching their 40- or 60-year legal operating limits and a lack of sufficient even short-term nuclear waste storage options, Japan is de facto heading toward 'zero nuclear' power generation by the 2050s, if not earlier.[10] What is missing is a national debate recognising this fact and considering how to respond.

The difficulty in restarting nuclear power plants was a driving factor behind a post-Fukushima Japanese government policy that contradicts Japan's GHG reduction targets, namely plans to install up to 15 GW of coal-fired electricity generating plants. However, due to local, national, and international opposition, and perhaps the rapid spread of renewables, it has long been in doubt whether most of this new capacity would ever be built. A large majority of the Japanese public is willing to support expanding use of renewable energy even if electricity prices increase as a result: 65% favour increasing the use of renewables even if electricity becomes more expensive, versus 19% who do not favour expanded use if it raises prices.[11] Moreover, in the light of Suga´s new ambitious GHG reduction targets, the coal expansion plan is now being scrapped. In the new Basic Energy Plan that METI will publish in autumn 2021, the 2030 target for renewable generation is scheduled to be raised from the current 22-24% to 36-38%. Corresponding to this increase in renewables the target for fossil fuel use will likely be reduced from 56% of Japan´s electricity production down to 40%, a change that clearly indicates a reversal of Japan´s coal-fired plant expansion policy to one of shrinking Japan´s stock of coal-burning power stations[12] and other facilities generating electricity from fossil fuel.[13]

Behind Japan´s more ambitious targets are several factors. Internationally, the EU´s global leadership in setting new and more ambitious GHG reduction and renewable energy expansion targets clearly encouraged if not pressured Japan to follow suit. The shift from the climate-change-denying Trump administration to the Biden administration that has brought the US back into the Paris accord and reasserted US leadership in combating climate change is another important factor. At his April 2021 summit Biden pledged the US would reduce its GHG emissions by 40% to 43% by 2030, putting even more pressure on Japan to significantly increase its target from 26% GHG emissions reductions by 2030 to a target that at least matched the US target, and even slightly exceeded the US target to demonstrate global leadership. Japan felt this pressure even though China has only promised to reach peak emissions before 2030.[14] The Suga administration has also been facing new pressure from Japanese industry to up its renewable energy targets as major multinational corporations, such as Apple, Microsoft, T-Mobile and General Motors, have been setting renewable energy targets for their suppliers

9 Rintaro Sakurai, "Japan on track to soon reach its target for renewable power," *The Asahi Shimbun*, 17 March 2021. http://www.asahi.com/ajw/articles/14276590 Accessed 6 July 2021; Florentine Koppenborg, "Japan´s Nuclear Safety Regulation Policy," in Paul Midford and Espen Moe, eds., *New Challenges and Solutions for Renewable Energy: Japan, East Asia and Northern Europe* (Cham, Switzerland: Palgrave Macmillan), pp. 77-100.

10 Paul Midford, "The Politics of Nuclear Power Plant Restarts Versus Renewable Energy Promotion," in Paul Midford and Espen Moe, eds., *New Challenges and Solutions for Renewable Energy: Japan, East Asia and Northern Europe* (Cham, Switzerland: Palgrave Macmillan), pp. 101-134.

11 *Asahi Shimbun*, June 13, 2011.

12 METI has formed a council to promote the conversion of coal-fired power plants to burn ammonia, an energy carrier that can be cleanly manufactured from renewable electricity as hydrogen can. See Hiroki Ito, "Japan promoting ammonia as fuel source to achieve its net zero goal," *The Asahi Shimbun*, 28 October http://www.asahi.com/ajw/articles/13878707. Regarding the process of creating ammonia from renewables, see Robert F. Service, "Ammonia – a renewable fuel made from sun, air and water – could power the globe without carbon," *Science*, 18 July 2018. https://www.sciencemag.org/news/2018/07/ammonia-renewable-fuel-made-sun-air-and-water-could-power-globe-without-carbon Accessed 11 August 2021.

13 Junichiro Nagasaki and Toshio Kawada, "Japan seeks to double ratio of renewable power by fiscal 2030," *The Asahi Shimbun*, 14 May 2021. http://www.asahi.com/ajw/articles/14349712 Accessed 6 July 2021; Junichiro Nagasaki and Satoshi Shinden, "Japan eyes 10% power output cut by FY 2030 with more renewables," *The Asahi Shimbun*, 20 July 2021. https://www.asahi.com/ajw/articles/14399451 Accessed 11 August 2021.

14 Erlanger, "Europe Rolls Out Plan to Shift From Fossil Fuels."

(members of the RE100), putting Japanese suppliers at risk of losing lucrative contracts if they do not comply with these targets.[15]

Although they appear comparable, Japan´s targets nonetheless remain less ambitious that Europe´s. Europe´s GHG emissions baseline is 1990, whereas Japan´s is only 2013. Similarly, Europe´s renewable energy targets are for total energy consumption, whereas Japan´s are only for electricity generation.

Nonetheless, Japan´s new targets represent an ambitious revamping of its previous commitments, a revamping that is also driven by changes in its domestic politics. The Suga administration has proven to be significantly more ambitious compared with the Abe administration´s passivity in setting GHG and renewable energy targets. This in part appears to reflect Suga´s personal views, which are less renewable-energy sceptical and less pro-nuclear than those of Abe were. It also appears to reflect a de facto alliance of two influential members of Suga´s cabinet, namely Environment Minister Koizumi Shinjirō and Administrative Reform Minister Kōno Tarō. These two ministers, especially Kōno, are popular politicians who have been seen as leading candidates to succeed Suga. Like Suga, they both represent electoral districts in Kanagawa prefecture south of Tokyo, and Kōno in particular is reputed to be close to Suga. Koizumi, son of popular former prime minister Koizumi Junichirō (who has become very opposed to nuclear power since the Fukushima Daiichi accident), is also seen as a rising star in the party. Koizumi and Kōno together successfully lobbied Suga to override objections from METI to setting a GHG reduction target for 2030 as high as 46% (METI had been arguing for a maximum of 35%) and have also succeeded in demoting the position of nuclear power and coal in Japan´s energy policy.[16] These targets, including the higher targets for renewable energy, have endured into the new Kishida adminstration despite the departure of Koizumi and Kōno from the cabinet the inclusion of some politicians in that administration who are known for being pro-nuclear.[17]

Institutionalisation of an EU-Japan Partnership on Renewable Energy

Sustained exchanges of energy and technology experts between Japan and Europe began in 1987 and have continued since. Fast forward twenty years to 2007 and the level of cooperation, especially regarding renewable energy, began to grow significantly. That year saw the inauguration of an EU-Japan Energy Dialogue. March 2009 saw the launch of the EU-Japan Joint Strategic Workshop on Energy Research and Technological Development, which included a focus on PV solar and electricity storage. In the wake of 3-11, and Japanese Prime Minister Kan Naoto's move toward eliminating Japan´s reliance on nuclear power, the May 2011 EU-Japan summit re-energised renewable energy cooperation as a key area for the two sides. In June 2012 the 4th EU-Japan Energy Dialogue was raised to the ministerial level for the first time. During this dialogue the ministers discussed joint research and development of PV solar and electricity storage technology. They also stressed the need to improve exchanges on the European experience of liberalising electricity markets and the development of smart grids, a focus that in part reflected Japan´s intention then to begin retail electricity market liberalization and grid reform.[18]

EU-Japan Synergies in Renewables

The most important thing Europe has learned from Japan in terms of renewable energy is PV solar technology itself, which Japan pioneered in developing during the 1970s and 1980s with its 'Sunshine' research project. In the 1990s, about a decade ahead of Germany and other European countries, Japan then pioneered the commercialisation of PV solar. It even offered subsidies for roof-top solar panels on homes and small businesses. However, this subsidy programme ended in 2005, and a year later Matsushita lost its position as the world's leading PV solar manufacturer to a German company. Soon afterwards Chinese companies became dominant globally, and now account for more than 60% of

15 Relatedly, Japanese banks are moving to end their funding of coal-fired plants overseas. Reuters, "Japan's SMFG to halt all new financing of coal-fired power plants," 12 May 2021. https://www.reuters.com/business/sustainable-business/japans-smfg-halt-all-new-financing-coal-fired-power-plants-2021-05-12/ Accessed 11 August 2021.

16 Kyodo, "Japan softens commitment to nuclear power in draft growth strategy," *Japan Times*, 3 June 2021. https://www.japantimes.co.jp/news/2021/06/03/national/nuclear-power-commitment/; Masatoshi Toda, Shinya Takagi and Daisuke Hirabayashi, "Suga overruled dissenters on higher emissions reduction Target," *The Asahi Shimbun*, 23 April 2021. http://www.asahi.com/ajw/articles/14336201 Accessed 28 April 2021; Richard Katz, "Japan´s Looming Climate Showdown," *Foreign Affairs*, 21 April 2021. https://www.foreignaffairs.com/articles/japan/2021-04-21/japans-looming-climate-showdown Accessed 21 April 2021.

17 The Mainichi, "Japan Ok´s plan to push clean energy, nuclear to cut carbon," 22 October 2022. https://mainichi.jp/english/articles/20211022/p2g/00m/0sc/057000c. Accessed 3 November 20202.

18 Wilhelm Vosse, 'Renewable Energy Strategies Leading to Closer Europe-Japan Cooperation after 3/11,' *Asian International Studies Review*, vol. 19, no. 2 (December 2018), pp. 61-85, at pp. 67-70.

global PV production, and they recently drove Matsushita (Panasonic) entirely out of the market.[19]

Probably the most important thing Japan has learned from Europe is the feed-in tariff (FIT) for promoting renewable energy, which was pioneered by Germany. Japan's 2011 FIT law closely resembles Germany's. The FIT sets high purchase prices for a fixed period for energy produced from renewable sources to encourage new investment by private companies, but gradually reduces these purchase prices for new investments over the course of one or two decades until the higher price disappears, at which point privately generated renewable energy should be price competitive with other forms of renewable energy.

The German-style FIT has been spectacularly successful in Japan with respect to PV solar, although not so with respect to wind or other renewables such as geothermal. From 2012, when the FIT was implemented in Japan, to 2019 approximately 63 GW of installed PV solar capacity has been added in Japan, giving the country the third largest capacity after China and the US. For comparison, the generating capacity of a nuclear reactor is approximately 1 GW, although when a nuclear reactor is in service it can produce this amount 24 hours a day while PV solar can only generate during daylight hours (with lower generation on cloudy days). Its rapid expansion of solar power has brought Japan face to face with second-stage renewable energy challenges as it moves from being a niche form of energy to replacing fossil and nuclear electricity generation: how to integrate large-scale intermittent power in electricity grids, a challenge that some European front-runners, like Denmark with its high reliance on wind power, and increasingly Germany, have already been facing.

EU-Japan Cooperation Moving Forward

The EU-Japan Strategic Partnership Agreement that was concluded in 2018 addresses energy cooperation between the two partners in its Article 26. It mandates cooperation "in the area of energy, including energy security, global energy trade and investment, the functioning of global energy markets, energy efficiency and energy-related technologies." Article 17 also mandates exchanges of views and best practices on industrial policies for "energy efficiency." The two partners were far more specific in the 'Partnership on Sustainable Connectivity and Quality Infrastructure Between Japan and the EU' that they concluded in September 2019. In Point 8, the two partners pledged to "continue their cooperation in areas such as hydrogen and fuel cells, electricity market regulation … and support sustainable energy connectivity" building on the existing Japan-EU energy dialogue. They intend to discuss sustainable energy infrastructure investment with a view to "strengthening … energy innovation in order to facilitate the transformation to low-carbon energy systems." This statement encapsulates important aspects of the agenda for EU-Japan cooperation on promoting renewable energy domestically as well as in third countries: expanding the capacity of grids to absorb more renewable energy, improving electricity markets and their regulation, and realising a hydrogen economy. This also builds on a long history of cooperation.

What Japan can most gain from Europe is help in reforming its electricity grid, learning that is already taking place. In 2015 Japan established a new national regulatory body to regulate the grid entitled Organisation for Cross-regional Coordination of Transmission Operators (OCCTO). OCCTO is modelled on Nordic grid regulators. Similarly, in April 2016 Japan liberalised its retail electricity market, allowing households and small businesses to select their electricity generator, and potentially prefer renewable energy producers. Again, Japan's retail liberalisation largely follows Nordic models.

Despite these innovations, Japan's national grid remains Balkanised, with limited inter-regional connections between grids owned by regional electric power companies (EPCOs), and it is further hampered by two power standards (60 vs. 50 Hertz) in western and eastern Japan. These characteristics hinder the further integration of renewable energy in the grid and have caused Kyushu EPCO to curtail the amount of electricity it accepts from PV solar generators. Norway's experience of integrating separate regional grids in the 1980s may be useful

19 Kenji Asano, "Early Promoter of Solar Photovoltaics: Forty Years of Development of Policy and Technology in Japan," in Espen Moe and Paul Midford, eds., *The Political Economy of Renewable Energy and Energy Security* (New York: Palgrave Macmillan, 2014), pp. 157-174; Natsumi Kawasaki, "Eclipsed by Chinese rivals, Panasonic quits solar cells and panels," *Nikkei Asia*, 31 January 2021. https://asia.nikkei.com/Business/Electronics/Eclipsed-by-Chinese-rivals-Panasonic-quits-solar-cells-and-panels Accessed 11 August 2021.

for Japan's efforts to more closely integrate regional grids. Japan can also learn from European experiences and policies linking national grids, including the use of undersea interconnections, such as the 711 km (1.4 GW capacity) seabed cable being built between Norway and the UK. Japan can also benefit from regional European electricity markets covering several countries such as Nord Pool Spot, which is the leading power market in Europe for day-ahead and intraday electricity sales. Linking regional grids and building interconnectors between Japan and neighbours such as Korea, Russia, the island of Taiwan, and perhaps China enhances supply security and facilitates expanded use of renewable energy, reducing the need for curtailment.

One other concept that Japan might perhaps learn from Europe is the so-called 'green battery' championed by Norway. This uses conventional hydropower (rather than pump-hydro) for electricity storage. In this way conventional hydropower can be used as a reserve power source to back-up variable wind and solar power. When the sun sets on German solar or the winds die down in Denmark and the UK, Norwegian hydro can compensate by ramping up production and sending electricity via undersea connectors to these countries.[20] The only significant drawback is that hydropower is occasionally less available in drier years.

A key area where the EU and Japan can learn from each other is in developing and promoting smart grids, including smart meters. Smart grids help promote renewable energy by allowing demand management, as fluctuations in renewable energy production can be mitigated by correspondingly varying demand by using price signals. Smart grids also make it easier for homeowners to sell electricity produced by roof-top solar and for electricity market liberalisation to be implemented by tracking power purchases in real time. The electricity targets in Japan's 2018 Basic Energy Plan include an unusually large percentage of base-load power (especially nuclear and fossil fuel generation), reflecting an inflexible grid in need of modernising.

Japan can learn from, and contribute to, the European Electricity Grid Initiative (EEGI), a European research, development and demonstration programme. On the other hand, Europe can learn from Japanese smart grid technology: in recent years up to 45% of smart grid patents have been granted in Japan. Europe can also learn from Japan's advances in reducing transmission losses on high voltage lines by using superconducting materials. At the same time, both the EU and Japan should consider ways to cooperate to maintain their competitive positions in smart meters vis-à-vis Chinese companies, which have been gaining market share.[21]

Hydrogen. The most important area where the EU can learn from Japan moving forward is the hydrogen economy. In March 2014 Japan became the first country to announce a national hydrogen strategy, its 'Road Map for Hydrogen and Fuel Cells,' which set the goal of establishing a hydrogen society by 2050. Japan has a long history going back to 1974 of promoting hydrogen as a clean energy carrier (producing energy from hydrogen only produces water as a by-product) and storage medium for electricity.[22] Surplus solar and wind electricity can power electrolysis to produce environmentally friendly 'green hydrogen'[23] from water, hydrogen that can then be used to produce electricity in fuel cells or by burning it like natural gas.

Japan's commercialisation of hydrogen began in earnest in 1999 with the establishment of the Fuel Cell Commercialisation Conference of Japan (FCCJ) composed of 112 firms. Two important commercial applications that Japan has pioneered since then are ENE-FARMs and fuel-cell-powered electric vehicles. ENE-FARMs are a fuel co-generation system that produces electricity through a chemical reaction between oxygen and hydrogen extracted from natural gas. Japan was the first to develop and market ENE-FARMs, and had installed 200,000 units by 2017, including many home systems that also function as water heaters. ENE-FARMS have very low, but not zero, CO2 emissions. Japan is also the first country to mass market hydrogen fuel cell automobiles, starting with the Toyota Mirai in 2014. Honda has also produced limited numbers of

20 Anne Therese Gullberg, 'The Political Feasibility of Norway as the "Green Battery" of Europe.' *Energy Policy* 57 (2013), pp. 615-623. For a skeptical view, see Espen Moe, Susanne Therese Hansen,and Eirik Hovland Kjær, "Why Norway as a Green Battery for Europe Is Still to Happen and Probably will Not," in Paul Midford and Espen Moe, eds., *New Challenges and Solutions for Renewable Energy: Japan, East Asia and Northern Europe* (Cham: Palgrave Macmillan, 2021), pp. 281-318.

21 Smart grids also have significance for 5G cellular networks, as the most advanced models communicate over these networks.

22 Robert Uriu, "Betting on Hydrogen: Japan´s Green Industrial Policy for Hydrogen and Fuel Cells," in Paul Midford and Espen Moe, eds., *New Challenges and Solutions for Renewable Energy: Japan, East Asia and Northern Europe* (Cham: Palgrave Macmillan, 2021), pp. 154-155.

23 'Brown hydrogen' refers to hydrogen produced from fossil fuels such as coal. 'Blue hydrogen' is a synonym for green hydrogen.

the fuel cell version of the Honda Clarity.[24]

The Japanese government is also supporting large-scale fuel cells for powering apartment buildings, hospitals and even cities. The Olympic Village for the 2020 Tokyo Olympics (being held in July 2021) will be powered by electricity produced by fuel cells that use green hydrogen produced from renewable energy in Fukushima Prefecture. To this end, in March 2020 the world´s largest green hydrogen plant that only uses renewable energy (mostly solar power) to produce hydrogen opened in Fukushima prefecture, close to the site of the Fukushima Daiichi nuclear power plant accident. This plant is powered by 20 MW worth of solar panels and produces 100 kg of hydrogen an hour.[25] Former Tokyo Governor Masuzoe Yoichi well summarised Japan's hydrogen economy aspirations: "The 1964 Tokyo Olympics left the Shinkansen high-speed train system as a legacy. The upcoming Olympics will leave a hydrogen society as its legacy."[26]

Hydrogen is one promising solution to the problem of how to reduce curtailment and maximise the use of variable solar and wind power. Excess solar and wind power can be stored as hydrogen and turned back into electricity at night or when the wind dies down. The renewable-energy-powered Fukushima hydrogen plant is thus an important milestone in Japan's 2014 Hydrogen Roadmap. The roadmap sets the goal of storing 250-300 TWh of surplus electricity as hydrogen in the 2020s, building full-scale hydrogen plants by 2030, and storing 500 TWh of excess renewable energy as hydrogen by 2050 (Japan's current total electricity demand is a little over 1000 TWh). The roadmap sets the goal of achieving a self-sustaining hydrogen economy that no longer needs subsidies by 2050.

So far there has been relatively little cooperation between the EU and Japan on the hydrogen economy. The EU-Japan energy dialogues have spent little time discussing hydrogen. The September 2018 'Partnership on Sustainable Connectivity' is one of the first significant bilateral documents to stress hydrogen and fuel cells. This lack of EU-Japan cooperation to date is surprising given that there has been an annual Sino-Japanese hydrogen seminar. There is real trade potential here as well. For example, 'stranded wind power' in northern Scandinavia that cannot be easily connected to grids further south can be used to produce green hydrogen that can then be exported to Japan via the Arctic, as Norwegian natural gas is currently. Norway already exports green hydrogen produced from hydro-electric dams to Japan.

Conclusions

As this paper demonstrates, the EU and Japan have built a decades-long framework for mutual exchange and learning regarding renewable energy, which is at the heart of efforts to reduce GHG emissions and combat human-induced climate change. Both partners now face similar 'second-stage' challenges in expanding variable solar and wind power from niche sources of power into sources that can replace fossil and nuclear fuel power sources. They both need to fundamentally restructure their electricity grids, turning them from exclusively supply-focused to adding an equal demand-focused element through demand management made possible by deploying smart grids. The two sides can learn from each other's smart grid initiatives and Japan can learn from Europe's inter-regional grid integration and electricity markets. Europe, on the other hand, can learn much from Japan's far-sighted 2014 Hydrogen Economy Roadmap. Finally, the EU and Japan can cooperate through their 'Partnership on Sustainable Connectivity' to help third countries, especially developing countries, deal with stage-one (e.g. FIT formulation) and stage-two challenges (e.g. grid restructuring, electricity market liberalisation, deploying storage assets and the hydrogen economy) to facilitate transitioning from fossil and nuclear fuelled power to renewable energy. EU-India solar energy cooperation could be a potential model on which the EU and Japan could base their cooperation in third countries.

Finally, this paper makes five policy recommendations. First, establish an annual EU-Japan hydrogen dialogue. There is a multilateral Hydrogen Ministerial Dialogue, and a nascent trilateral dialogue with the US, but currently no EU-Japan bilateral dialogue. Given that future cooperation with the US cannot be assumed, and that the EU and Japan are the two leading economies most

24 *Ibid.*, pp. 155-162.

25 New Energy and Industrial Technology Development Organization (NEDO), "The world's largest-class hydrogen production, Fukushima Hydrogen Energy Research Field (FH2R) now is completed at Namie town in Fukushima," 7 March 2020. https://www.nedo.go.jp/english/news/AA5en_100422.html Accessed 7 May 2021.

26 Cyrus Daugherty, "Hydrogen Is the Energy of the Future for Japan." *International Association for Hydrogen Energy* 8 (3) (2016), p. 1.

consistently committed to combating climate change, a trilateral dialogue is no replacement for bilateral dialogue. Concrete areas the EU and Japan should focus on include promoting the use of hydrogen fuel cells to power automobiles, trucks, trains and ships. This would be a bidirectional exchange as in some areas, such as fuel-cell-powered trains and ships, Europe is ahead of Japan.

Second, the EU should formulate its own hydrogen strategy. There are already voices in some European states, notably Norway, calling for national hydrogen strategies. The EU-Japan Hydrogen Dialogue could aid the EU in formulating its own hydrogen strategy.

Third, establish an EU-Japan annual seminar on hydrogen technology and commercial applications. On a smaller scale, there has already been a Japan-Norway hydrogen seminar, and there has been a regular Sino-Japan hydrogen seminar.

Fourth, establish an EU-Japan dialogue on sustainable energy connectivity to focus on promoting infrastructure that helps third countries replace fossil and nuclear-fuel-based energy production with renewables. These infrastructure areas include distributed electricity production off-grid and small local grids, with a focus on storage. On a larger scale, they include smart-grid development, extensive grid development across wider areas, inter-regional grid connections and electricity market liberalisation, including the development of spot and day-ahead markets and the promotion of electricity storage, especially in hydrogen. Concrete examples of cooperation regarding hydrogen could include promoting ENE-FARMs in developing countries, promoting fuel-cell-powered trains and ships, establishing hydrogen production facilities that use excess wind and solar power, and using fuel cells for electricity storage and for supply security in the case of natural disasters. Enhancing disaster preparedness and resilience through distributed power generation would thus be another objective of this connectivity initiative.

Another area for cooperation would be helping Japan with its announced target of establishing 10,000 hydrogen filling stations worldwide for fuel cell vehicles within 10 years. This initiative can build on the mass infrastructure investment plan announced at the 2021 Cornwall G-7 summit that is meant to compete with China´s Belt and Road Initiative (BRI).

Finally, while the EU and Japan should seek to expand existing cooperation with China and the United States, the EU and Japan must build a long-term special relationship for promoting cooperation in promoting renewable energy and GHG emissions reduction (and in many other fields), a special relationship that is not dependent on either the US or China but that can survive and even thrive if China and/or the US should abandon cooperation or even renege on their pledges. The US, as discussed earlier, has oscillated between cooperating and actively undermining global cooperation to reduce global GHG emissions. China, on the other hand, has been more consistent in supporting efforts to combat climate change, but to date its targets, including that of peaking its GHG emissions by the late 2020s, are distinguished by their lack of ambition. The EU and Japan therefore cannot count on China, or perhaps particularly the US, to commit in the long term to GHG emissions reduction and renewable energy promotion policies. The EU and Japan through their partnership must prepare for potential unreliability of one or both of these two superpowers.

In the case of China, the two partners should be vigilant over its sustained efforts to not only lead in advancing renewable energy technologies, such as photo-voltaic solar panels, electric vehicles and large lithium-ion batteries, but to dominate these industries for commercial and even strategic gain. The EU and Japan need to deepen industrial and commercial cooperation in these areas to maintain their industrial and technological independence. They also need to ensure diversified supply chains for renewable energy technologies. This even extends to hydrogen, where Japan is the current leader and Europe is also a strong player, but where China is investing large resources and rapidly improving its position.

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Published by
European University Institute (EUI)
Via dei Roccettini 9, I-50014
San Domenico di Fiesole (FI)
Italy

Co-funded by the
Erasmus+ Programme
of the European Union

doi:10.2870/83313
ISBN:978-92-9466-108-1
ISSN:2467-4540
QM-AX-21-052-EN-N