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Enhancing Energy Resilience: Challenging Tasks for Japan's Energy Policy

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Introduction

Three years after the 3-11 earthquake in Japan, the cabinet approved the new Basic Energy Plan (BEP) this spring. The new BEP, a product of lengthy and heated discussions among policy planners, academics, and business leaders, calls nuclear energy "an important base-load power supply source" for the future of Japan's energy supply, and provides fundamental policy direction for other energy sources such as coal, oil, natural gas, electricity, and renewable energy. The new BEP will serve as the framework for developing and implementing specific policies for each energy source.

In light of these developments, this paper reviews Japan's policy challenges from the viewpoint of enhancing resilience. The main theme is that Japan must enhance its energy supply system's resilience against supply shocks. The use of the term "resilience" has become common since the 3-11 earthquake. However, resilience has been discussed mainly in the context of "hard" disciplines, such as civil engineering and disaster prevention, and less so in the context of securing energy supply systems, other than in just a few studies.[2] Because the risk of supply disruption cannot be reduced to zero, strengthening prompt recovery capabilities should have more significance in Japan's energy policies. The objective of this paper is to apply resilience to energy security policy and to consider future policy directions. Section 1 considers the concept of resilience in the energy supply system. Section 2 discusses why Japan needs to enhance its resilience in its energy supply. Section 3 provides specific policy measures to upgrade impact

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[2] Such exceptions are Council on Competitiveness-Nippon, *Rejiriento Economi no Soushutsu* [Creation of Resilient Economy], March 2013; Ministry of Economy, Trade, and Industry, *Kakkoku no Energy Kankei Kigyou Kikann no Doukou wo Fumaeta Sekiyu Kanrenn Sangyou no Bunseki* [Analysis of Petroleum Industry based on the other countries' energy industry and organizations' activities], March 2013.

mitigation and achieve a more resilient energy supply structure. Section 4 identifies potential items of bilateral energy cooperation between Japan and the United States.

Resilience in Energy Supply

Resilience as a term was used originally in mathematics to describe the ability to return to a stable condition. The term then became used to describe the quality of material in the field of civil engineering. Resilience in civil engineering indicates to what extent a certain material can be bent by external physical force, how quickly the material recovers its original condition, and how much force finally breaks the material. These three properties are respectively referred to as resistance, elasticity, and robustness.[3] Resilience measures the longer-term sustainability of a certain material beyond simple physical robustness.

Resilience is used in psychological studies as well. A resilient person has mental toughness against external pressures as well as a high ability to adapt to hardship, particularly poverty.[4] Resistance against external hardship and the capability to turn given adverse conditions into more positive and acceptable ones are the most important features of resilience in psychological studies. In this sense, psychological resilience focuses more on flexibility than simple toughness in evaluating a person's mental characteristics.

Social sciences, such as economics and management studies, also deal with resilience. In macroeconomics, a country's resilience is defined by its capability to return to an economic growth track after an external (and often unavoidable) shock. Just as in psychology, adaptability to macroeconomic adversity is a key determinant of resilience.[5]

Similarly, a firm with the capacity to adapt to an adverse change in its management environment and to devise and implement a new business model to overcome this hardship is regarded as a highly resilient firm in the field of management studies.[6] Managerial resilience features not only a simple adaptability but also a capacity to create innovation and turn a crisis into a business opportunity.[7]

Although its definition and implications vary, several characteristics of resiliency are common across disciplines.[8] First, resilience in all the aforementioned disciplines assumes the presence of

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[3] Per Bodin and Bo L. B. Wiman, "Resilience and other stability concepts in ecology," *ESS Bulletin* 2, no. 2 (2004): 33–34; C.S. Holling, "Engineering Resilience versus Ecological Resilience," in *Foundations of Ecological Resilience*, ed. Peter Schulze (Washington, DC: National Academies Press, 1996), 32–33; Patrick Martin-Breen and J. Marty Anderies, " Resilience: A Literature Review," Rockefeller Foundation, September 2011, http://www.rockefellerfoundation.org/media/download/a63827c7-f22d-495c-a2ab-99447a8809ba.

[4] Tuppett M. Yates, Byron Egeland, and Alan Sroufe, "Rethinking Resilience: A Developmental Process Perspective," in *Resilience and Vulnerability*, ed. Suniya S. Luthar (Cambridge: Cambridge University Press, 2003), 249–50; Michael Rutter, "Implications of Resilience Concepts for Scientific Understanding," *Annals of New York Academy of Sciences*, 1094 (2006), 1–2.

[5] Romain Duval, Jørgen Elmeskov, and Lukas Vogel, "Structural Policies and Economic Resilience to Shocks," Working Paper No. 567, OECD (2007), 2–3.

[6] Gary Hamel and Liisa Valikangas, "The Quest for Resilience," *Harvard Business Review*, September 2003, 3.

[7] Ibid.

[8] The Rockefeller Foundation summarizes common aspects among usage of the term resilience as follows: "Like all

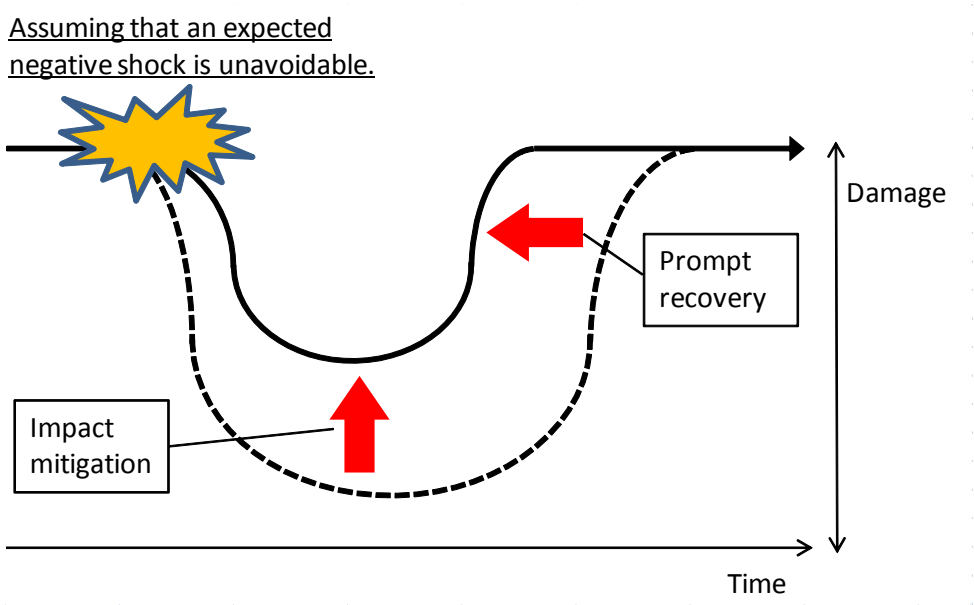
an adverse external pressure (physical, psychological, economic, or managerial) that is often unexpected and unavoidable but nevertheless must be overcome. Thus, resilience is not a passive concept that addresses only how to avoid risk; it is a proactive concept that also explores how to face risk and how to respond to unavoidable negative events.

Second, and relatedly, resilience focuses on mitigating crisis impacts and adapting to negative events rather than risk mitigation. If an adverse situation can be anticipated, preparing for it and strengthening the ability to manage risks is certainly important. However, because negative shocks often happen unexpectedly, ensuring dynamic flexibility and adaptability is also an essential element of resilience.

Third, the time needed to recover is also critical in measuring resilience. In civil engineering or economics, the time needed to return to an original state determines the quality of material and the economic competitiveness of a country, respectively.

Thus, assuming that unavoidable negative events will happen, enhancing resistance to external shocks, mitigating impacts caused by such events, and improving the capacity to recover in a prompt manner are the three essential elements of resilience. Figure 1 depicts these aspects conceptually.

Figure 1: Graphical Representation of Resilience



Source: Akira Morita, "*Shimin Shakai no Anzen Hoshou*" [Security of Civil Society], November 2012, http://salix.at.webry.info/201211/article_1.html (modified by author).

words in circulation for so long, there are variations in its usage. But across the academic disciplines and indeed in common parlance there is a universal meaning of the term that includes the ability to respond to or bounce back from stress and shocks in a healthy and functional way." Rockefeller Foundation, *Embracing Change: Building Social, Economic, and Environmental Resilience* (New York: Rockefeller Foundation, June 2012), 2.

Resilience in an energy supply system, hereafter referred to as energy resilience, also employs these three aspects. Adverse events could include unexpected supply disruptions from oil and gas exporting countries, logistical problems in maritime transport of energy resources, severe accidents in the power generation sector, or excessive fluctuation of energy prices. Given these issues, Japan needs to strengthen its ability to mitigate impacts (risk management) and recover promptly (crisis management) to ensure a stable energy supply.

Japan's traditional energy security policy has placed a great emphasis on impact mitigation in addressing energy resilience. The foundation of present Japanese energy security policy was formed in the 1970s, when Japan experienced two oil crises. The largest challenge for energy security policymakers at that time was making Japan more immune to external disruptions to oil supply and accompanying price fluctuations. In order to achieve this goal, Japan worked intensively to reduce its dependence on oil, particularly in the power generation sector. Japan began to pursue nuclear energy, liquefied natural gas (LNG), and coal-fired power plants. As a result of efforts over the last several decades, the share of oil-fired power generation dropped sharply from 73.2 percent in 1973 to just 8.5 percent in 2012.

Japan has also made significant strides in energy conservation. Japan's energy intensity (energy consumption required to generate a unit of economic growth) has improved from 0.165 tons oil equivalent per one thousand dollars GDP in 1973 to 0.096 tons oil equivalent per one thousand dollars GDP in 2012, now among the lowest in the world. Japan has also built significant oil stockpiles retained by both the government and private companies. Total stockpiles exceed a 180-day equivalent of Japan's domestic oil sales. In this sense, Japan's efforts have successfully made the country's defenses against energy supply risk more robust.

These policies, however, are all impact mitigation measures implemented before a certain supply risk event happens. Possible responses once a risk to supply has occurred are less well developed. This lack of emphasis on crisis management has led to the idea that a serious crisis can be avoided as long as sufficient impact mitigation measures are undertaken. This so-called "safety myth" is often cited as one of the root causes of the accident at the Fukushima Daiichi Nuclear Power Plant. This myth arose from various factors, but the imbalance of emphasis on risk prevention versus emergency response is one important factor.[9] Of course, this does not mean impact mitigation measures are not important. As explained in Section 3, they continue to be a major part of efforts to enhance energy resilience and need to be reinvigorated. Even so, given the changing environment in international energy markets as well as the experience from the 3-11 earthquake,

[9] Safety myth issues have been pointed out as one of root causes of the Fukushima Daiichi nuclear power plant accident. See *Investigation Committee on the Accident at the Fukushima Nuclear Power Stations Final Report*, July 2012, 527–28; Rebuild Japan Initiative Forum, *Fukushima Genpatsu Jiko Dokuritsu Kensho Iinkai Chousa Kenshou Houkokusho* [Research Report by Independent Investigation Commission of Fukushima Nuclaer Power Plant Accident] (Discover 21, March 2012), 323–34. Such a myth was also needed to assure local residents near nuclear power plants.

Japan's energy security policy should focus more on emergency response as a way to enhance reliance.

Why Resilience Is Relevant to Japan's Current Energy Supply

Resilience is increasingly relevant to and significant for today's Japanese energy policy for several reasons. First, there are growing geopolitical uncertainties in the international energy supply. Japan depends on imports for most of its fossil fuel supply. In particular, its sources for oil supply are concentrated in the Middle East.[10] Political turmoil and civil unrest triggered by a series of civil movements beginning in 2011 (the so-called Arab Spring) have continued in several countries, such as Syria and Libya. Although there are signs of improvement in the relationship between the P5+1 and Iran since the November 2013 Geneva Agreement, ties are still strained. If no significant progress is made before the expiration of the agreement in July 2014, the United States and European Union might impose additional sanctions and political tensions could deteriorate further. Geopolitical uncertainties surrounding the Middle East continue to mount, so Japan must increasingly guard against an unexpected supply shock originating from the region.

Second, the demand side of the international energy market brings another risk to Japan's external supply. Energy demand growth from emerging countries will continue to heighten the risk of tightening market balances and price hikes. The Institute of Energy Economics, Japan (IEEJ) predicts that Asian energy demand will grow by 1.8 times from 2011 to 2040. The annual average growth rate will be 2.5 percent, far exceeding the world average at 1.6 percent.[11] Another aspect that should not be ignored is Asia's increasing import dependency. IEEJ predicts that by 2040, 80 percent of Asia's oil supply will come from imports. Emerging countries that require more energy imports may become more assertive in their foreign policies. Regardless of the extent to which energy demand from and imports to these countries actually grow, perceived supply insecurity could increase. Needless to say, political tensions in the South China Sea and East China Sea in the last few years are caused in part by regional powers' quest for energy resources and the desire to guarantee stable navigation routes for oil and gas.

Third, the experience of the 3-11 earthquake and the Fukushima Daiichi accident has reinforced the importance for Japan of preparing for an unexpected and even unimaginable event. Due to its geography, Japan is susceptible to various natural disasters such as typhoons, volcanic eruptions, heavy rain or snow, tsunamis, and earthquakes. In addition to natural disasters, new risks to energy supply systems, such as cyberattacks and pandemics, are also emerging. This changing environment has increased the vulnerability of Japan's energy supply. Potential supply disruption scenarios have therefore expanded significantly and it is more difficult to predict what scenarios might occur and to prepare for them adequately. This reality calls for Japan to develop more

[10] Dependence on Middle East crude oil as a percentage of total imports was 85.1 percent in 2011 and 83.2 percent in 2012, according to Keizai Sangyou Shou [Ministry of Economy, Trade, and Industry], *Shigen Enerugi-Tokei* [Resource and Energy Statistics].
[11] Institute of Energy Economics, Japan, *Asia / World Energy Outlook 2013*, October 2013.

thorough and comprehensive emergency response measures in addition to its efforts to anticipate likely scenarios and to develop ways to mitigate the risks attendant in those scenarios. In other words, the emergency recovery aspect of energy supply resilience needs to be strengthened.

Policy Items to Enhance Energy Resilience

Japan can enhance its energy resilience by upgrading impact mitigation measures as well as strengthening prompt recovery measures. Policy initiatives to achieve these goals are summarized in Figure 2.

Figure 2: Policy Items to Enhance Energy Resilience

Impact mitigation	Utilizing safe nuclear power plants Diversifying supply sources Diversifying energy pricing references Optimizing thermal power generation sources Taking pragmatic action on climate change
Prompt recovery	Guarding free and open energy market transactions Guaranteeing free and open international maritime order Developing prompt and adaptive government decisionmaking Implementing nationwide and interagency exercises Mobilizing stockpile

Source: Author.

Utilizing Safe Nuclear Power Plants

One of the primary elements in enhancing Japan's energy resilience is, as discussed above, upgrading impact mitigation measures. The first and most important task in this regard is to verify the operational safety of Japan's nuclear power plants. Although 50 nuclear units currently exist in Japan, as of February 2014 all units are not operational as the Nuclear Regulatory Authority (NRA) conducts its approval process.[12] Due to the loss of nuclear power generation, an additional 3.6 trillion yen was spent to increase purchases of alternative power generation fuels such as LNG and oil. This means, with a Japanese population of approximately 120 million, an average four-person household has to pay an *additional* $1,200 per year for fuel imports. Such a large import consumer burden is certainly damaging Japan's economic viability and worsening its vulnerability to external supply shocks and energy price hikes.

[12] The Fukushima accident raised severe criticism of the Japanese regulatory framework where essentially the same ministry (Ministry of Economy, Trade, and Industry) oversees safety oversight as well as promotes nuclear energy development. A new independent regulatory body, the Nuclear Regulatory Authority (NRA), was set up in September 2012, and the authority published a new safety standard in July 2013 to reflect the experience of the Fukushima accident. As of February 2014, 16 nuclear units are applying to restart operations, but NRA approval has been delayed.

Resuming nuclear power generation is never an easy task. Even though power companies could obtain approval from the NRA for several units to operate, the real hurdle is to obtain public acceptance of and confidence in nuclear safety. Public trust toward safety (*Anshin*, in Japanese) is quite different from objectively and scientifically confirmed safety (*Anzen*, in Japanese).[13] In order to recover the public's trust in nuclear energy, a strong, independent, and capable regulatory authority is necessary. Appropriate regulation and oversight of nuclear power plant operations are needed to show the public that the operations of nuclear power plants are controlled sufficiently. The NRA is expected to become such a reliable institution.

Besides the establishment of a proper regulatory body, changing perceptions of risk control are needed as a soft measure. In the past, the government and power companies have both tried to ensure that no risk of any accident at plants exists in order to obtain consent from local communities to install nuclear power. Indeed, such efforts contributed to the development of one of the strictest safety standards for nuclear power plants in the world. Simultaneously, however, the efforts helped to create a "safety myth" about nuclear power plants. In reality, it is not feasible to eliminate all risks in nuclear operations, even with the most rigorous and strict risk control and mitigation measures. Yet, even the existence of a minimal risk was not acceptable to the public, causing the government and power industry to demonstrate a situation of "zero-risk." This myth of complete and absolute safety gradually came to be perceived as a reality. Perpetuation of this myth led to the institutionalization of static and rigid nuclear safety measures.[14]

Risk of an accident at nuclear power plants can be reduced to zero only if all nuclear power plants are abandoned. Yet this will create another risk, growing vulnerability to external energy supply shocks or energy price fluctuations. Any discussion related to risk must not forget that there is always a tradeoff among different risks.[15] Increasing energy costs will further hurt the Japanese economy and thus affect the economic welfare and employment of the Japanese public. Ceasing all nuclear power generation also creates a serious security risk from the viewpoint of accumulating nuclear spent fuel in Japan. To address these issues properly, the dichotomous discussion of whether risk is zero or not needs to be replaced with a more objective discussion based on a probabilistic approach that accounts for tradeoffs. For example, the probability of a severe nuclear accident would be compared with the probability of severe economic impacts arising from a zero-nuclear option. Initiating this conversation may take a long time, but it is necessary for Japan's energy security and resilience.

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[13] The difference of these two concepts (*Anshin* and *Anzen*) has been a major research topic among the Japanese social psychologists even before the Fukushima accident. See Kazuya Nakayachi, *Anzen, demo Anshin dekinai: Shinrai wo meguru Shinri Gaku* [Being safe, but not being felt safe, psychology of trust], Chikuma Shobo, 2008, 12–15.

[14] Rebuild Japan Initiative Forum, *Fukushima Genpatsu Jiko Dokuritsu Kensho Iinkai Chousa Kenshou Houkokusho* [Research Report by Independent Investigation Commission of Fukushima Nuclear Power Plant Accident] (Discover 21, March 2012), 323–34.

[15] Junko Nakanishi and Hiroko Kono, *Risuku to Mukiau* [Facing risks], Chuo Koronsha, 2012, 6–12. Toichi Tsutomu, *Shale Kakumei to Nihon no Enerugi* [Shale Revolution and Japan's Energy], Nihion Denki Kyokai Shimbunbu, October 2013, 192.

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Diversifying Supply Sources

Another important measure to mitigate the impacts of energy supply disruptions is diversification. Diversification of oil supply has been a long-standing goal for Japan's energy security policy. Geographical diversification of oil supply has to become a reality not only because oil still makes up the largest energy source for Japan but also because Japan's major supply sources are concentrated in the Middle East.[16] Japan continues to import Middle Eastern crude oil because it is economical; Japan can secure a lot of cargo by utilizing a very large crude carrier (VLCC). In fact, except for several extreme situations such as the Gulf War in 1991, oil flows from the Middle East have been quite stable and reliable.

Two favorable developments may aid in Japan's efforts to achieve geographical diversification. The first is the potential for crude oil exports from the United States. Thanks to the shale revolution, U.S. net oil imports in 2012 dropped by almost 40 percent from their 2005 peak.[17] Crude oil supply in the United States has shifted from scarcity to abundance. The recent large discount of the U.S. benchmark crude oil price against the European benchmark shows this changing market reality.[18] Backed by such a rapid growth of production and the oil supply glut in the American Midwest, there is a vocal movement among U.S. lawmakers and policymakers, and in the U.S. oil industry, to review the existing export restrictions.[19] In addition to the import of crude oil produced from shale reservoirs, import of Alaskan oil is also a possibility. Japan imported Alaskan North Slope crude oil until the 1990s. The crude oil's quality is similar to the Middle Eastern crude oil that Japanese refiners are accustomed to processing. Alaska's geographic proximity to Japan further increases the attractiveness of this option. While it takes approximately 18 days to transport crude oil from the Gulf of Mexico to Japan, it takes only 12 days to go from Alaska to Japan. Existing export infrastructure in Alaska will also be a big cost saver and advantage if the state restarts exports of its crude oil to Asia. If U.S. export restrictions are lifted, imports of Alaskan crude oil may be a more likely and realistic scenario for Japan than imports of shale oil.

Another favorable movement for diversifying Japan's crude oil supply is Russia's increasing interest in developing Siberian oil resources. Due to a stagnant economy, the maturing oil demand

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[16] Japan's dependence on Middle Eastern LNG imports (29.1 percent of total imports in 2012) is far smaller than its dependence on the region's oil (83.2 percent in 2012), but the share has been increasing steadily due to growth in demand caused by the shutdown of nuclear power plant.

[17] According to the U.S. Energy Information Administration (EIA), the net import volume of the United States in 2012 was 7.6 million b/d while its net import volume was 12.5 million b/d in 2005. EIA website: http://www.eia.gov/.

[18] The U.S. benchmark crude price (West Texas Intermediate) had typically been higher than the European benchmark (Brent) by $1/barrel. But since 2011, the U.S. benchmark has been lower than the European by almost $10/barrel.

[19] Senator Lisa Murkowski (R-AK), ranking member of the Senate Committee on Energy and Natural Resources, publicly claimed in January 2014 that the existing restriction is anarchic and should be ended. ("The Future of Energy Trade: A Conversation with Senator Lisa Murkowski," Brookings Institution, January 7, 2014.) In December 2013, Energy Secretary Ernest Moniz said that the United States needs to review the restriction established when oil supply was scarce. ("Energy Secretary Calls Oil Export Ban Dated," *New York Times*, December 13, 2013.) Some have suggested that the restriction of crude oil exports in the Unites States may violate the rules of the World Trade Organization (WTO). ("Oil Supply Surge Brings Calls to Ease U.S. Export Ban," Bloomberg, December 17, 2013.)

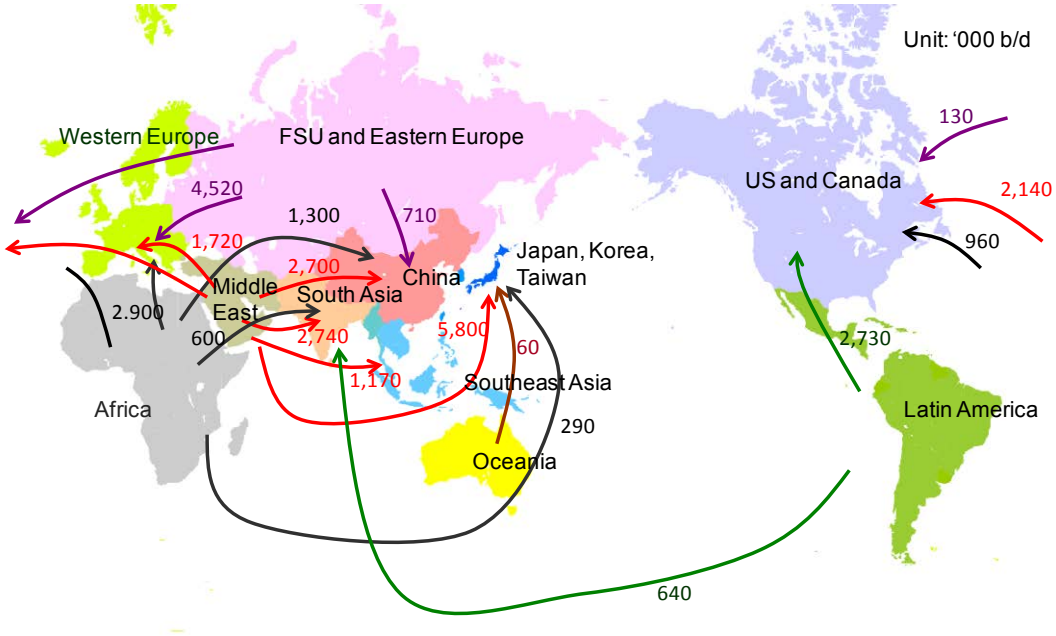
in Europe, Russia's need to find another supply source to make up the depleting existing oil fields in Western Siberia, Russia has become more interested in developing its resources in the East.[20] Russia is already an established crude oil exporter in Asian markets, supplying more than one million barrels per day. The country has built pipelines toward its Pacific coast and it is expected that more western crude oil will be directed eastward through this expanded capacity. Japan can take advantage of this increasing Russian crude oil supply to Asian markets.

Changing oil market balances will lead to a more diversified crude oil supply for Asia. IEEJ has developed a scenario for possible changes in crude oil supply flows in 2030 compared to today, as shown in Figures 3a and 3b. In 2030, oil demand in developed economies will shrink while import demand in emerging economies will grow. In this scenario, the center of gravity of the international crude oil market will shift decisively to Asia. African crude oil suppliers will export more crude oil to Asian markets because the demand of their traditional customer, the United States, will decline with the growth of domestic production. This means that Asian economies will have more geographically dispersed options from which to choose their crude oil supply sources. This outcome will contribute to impact mitigation of potential supply disruptions. At the same time, it should be mindful that the Middle East will continue to be the lowest-cost oil producer in the world and its competitiveness in Asian markets will remain dominant. Additional crude oil from non-Middle Eastern sources may ease the thirst of Asian crude oil demand growth, but will not overtake the position of the Middle East.

Pursuing further diversification of LNG supply is also an important task for Japan to undertake. Although its sources of LNG are currently more geographically varied in comparison to its oil supply (Figure 4), it is expected that Japan's supply sources will concentrate around a more limited number of suppliers in the future, such as Qatar and Australia. As the domestic demand of traditional suppliers like Indonesia and Malaysia increases, their export volumes will diminish. Increasing LNG imports from North America will also be a great opportunity for Japan's diversification. Six projects have already obtained export permission from the U.S. Department of Energy.[21] LNG projects along the coast surrounding the Gulf of Mexico, Alaskan LNG and Canadian LNG will potentially be important sources of diversification for Japan. Emerging supply sources in the Eastern Mediterranean and in Eastern Africa are also candidates for future diversification.

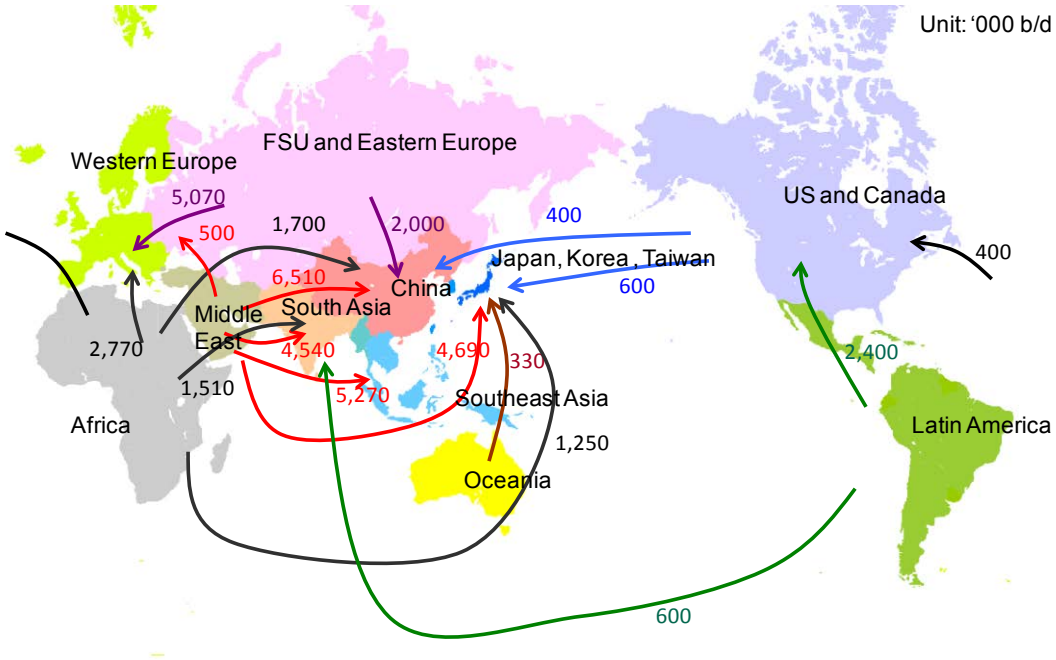
[20] For further details, see Shoichi Itoh, *Russia Looks East: Energy Markets and Geopolitics of Northeast Asia* (Washington, DC: CSIS, July 2011), https://csis.org/files/publication/110721_Itoh_RussiaLooksEast_Web.pdf.
[21] The projects that have obtained permission are Sabine Pass (May 20, 2011), Freeport (May 17, 2013), Lake Charles (August 7, 2013), Cove Point (September 11, 2013), Freeport Expansion (November 15, 2013), and Cameron (February 11, 2014).

Figure 3a: Crude Oil Trade Flows, 2012



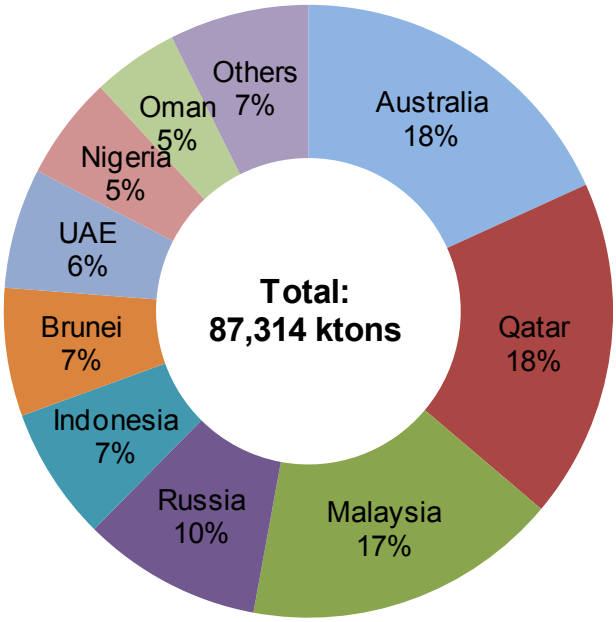
Source: Institute of Energy Economics, Japan.

Figure 3b: Crude Oil Trade Flows, 2030



Source: Institute of Energy Economics, Japan.

Figure 4: LNG Import Sources of Japan, 2012



Source: Trade Statistics of Japan.

Diversifying Energy Pricing References

In addition to supply sources, it is important to diversify energy pricing references as well. In Japan, because most LNG supply prices are linked to the price of crude oil, more than 70 percent of Japan's energy supply is linked to a single energy price.[22] Linking natural gas prices to oil prices makes the Japanese economy more susceptible to volatile international oil markets. Traditionally, the Japanese LNG price has been linked to the average import price of crude oil in Japan because LNG was initially introduced as an alternative to oil in the power generation sector. Forty years later, however, LNG no longer competes with oil in the power sector. Thus, linking LNG prices to oil prices has lost its historical justification. The existing pricing formula needs to be changed to more closely reflect the demand and supply balance of natural gas markets in order to enhance Japan's resilience when faced with oil price fluctuations.

Optimizing Thermal Power Generation Sources

Optimizing thermal power generation sources is equally important. Although renewable energy installation has proceeded quite rapidly in Japan, its share of total electricity generated is still negligible at 0.7 percent as of 2012.[23] It is therefore not realistic to assume renewable energy will be a majority share of Japan's energy supply in the short term. Thermal power generation must

[22] The share is the sum of oil and natural gas over the total primary energy supply in fiscal year 2012. Energy Data and Modeling Center, Institute of Energy Economics, Japan.
[23] *Denki Jigyou Binran: Heisei 25 nendo-ban* [Bulletin on power industry 2013 edition], (Nihon Denki Kyoukai, November 2012). The figure excludes hydropower generation, which is 7.6 percent of total electricity generated in 2012.

therefore play a substantial role. One energy policy specialist in Japan has argued that policy discussions of the electricity mix are weighted toward the debate over the utilization of nuclear energy and promotion of renewable energy sources. Little attention has been paid to thermal power generation, despite its supplying more than 90 percent of Japan's electricity needs.[24]

How to optimize the power generation mix needs to be discussed more comprehensively. LNG is undoubtedly a preferred fuel for power generation due to its lower carbon emissions and high heat efficiency if used in advanced technologies such as More Advanced Combined Cycle (MACC). Yet LNG cannot be stored in large quantities like crude oil because it evaporates easily. Maintaining a certain share of coal- and oil-fired power generation in this regard is worth considering as a means of ensuring the resiliency of the power supply. The benefits of coal, namely its relatively low price compared with oil and gas and the political stability of its major suppliers, cannot be ignored even though its higher carbon content should be taken into account.

Oil, on the other hand, is a very flexible energy source, as it has a well-developed international market. In fact, oil-fired power generation has always played an important role when power demand surges in the summer time or if power supply capacity drops significantly, such as during the 3-11 earthquake. The market for oil for power generation is quite liquid and it is relatively easy to secure a required amount in a short period of time. This is a big difference from the LNG market, which is dominated by long-term contracts and is thus less flexible. Oil can also be stockpiled at a much lower cost than LNG and is less carbon intensive than coal. Although it is often ignored in energy policy discussions, the benefits of maintaining a certain share of oil in the power mix (from 5 percent to 10 percent) enhances high resilience and adaptability of the power supply system in case of emergency.

Taking Pragmatic Action on Climate Change

Finally, mitigation of potential damage caused by climate change is also an important item for Japan's energy policy. After the expiration of Kyoto Protocol, the international community has failed to build an effective international framework to control greenhouse gas (GHGs) emissions. Slowdown in the economies of the world, particularly in Europe, has lowered attention to climate change issues. Emissions of GHGs, however, have continued to rise, and the risk of serious impacts caused by climate change has also increased. Japan, as a major emitter of GHGs, should take the initiative to revive efforts to formulate and implement an international framework to respond to climate change, a very important task that will affect the welfare of future generations. The experiences of the Kyoto Protocol and successive negotiations in Conferences of the Parties (COP) meetings suggests that a "top-down" approach, or a process that identifies a global reduction target and then allocates numerical reduction targets to each country, will not obtain broader support, especially from emerging countries. The development of a more effective and realistic framework that emerging countries can ascend to more easily is needed. Such a framework should take a

[24] Kikkawa Takeo, *Nihon-no Enerugi Mondai* [Japan's energy problem], (NTT Shuppan, November 2013), 9.

"bottom-up" approach where each country determines and commits to a carbon emissions reduction target that is not legally binding, and institutes a regular review process for following through on those pledges. This framework may sound too loose, but it is an important step to forging a global consensus to reduce carbon emissions. Japan could contribute to reducing global carbon emissions through transfer of technologies to developing economies. For instance, a bilateral carbon credit framework will further facilitate such technology transfer.

Guarding Free and Open Energy Market Transactions

Improving emergency response measures is another crucial pillar of enhancing resilience. Though Japan has traditionally paid less attention to this aspect, the most important precondition to a prompt recovery in the case of an unexpected supply disruption is a properly functioning international market. For a country like Japan that depends on imports for most of its energy supply, a free and open international market is necessary for its survival; barriers and restrictions to the free flow of energy supply should be minimized. We can expect Japan to continue to emphasize the virtue of free and open international markets in various forums. The subject should always be on the agenda at international organizations like the International Energy Agency, and other multinational frameworks such as the Asia-Pacific Economic Cooperation (APEC), Association of Southeast Asian Nations+3 (ASEAN+3), G-8, and G-20. Multilateral trade frameworks such as the Trans-Pacific Partnership (TPP) should also include provisions for free trade in the international energy market.

Recent examples in which free and open markets contributed to prompt recovery from oil supply disruption include those caused by Hurricanes Katrina and Rita in August and September 2005. After hitting the southern part of the United States, these hurricanes seriously damaged both oil producing facilities and refineries. The oil supply was restricted in both the northern and southern United States as hurricanes damaged power supplies required to operate oil pipelines connecting refining centers along the coast of the Gulf of Mexico and the northern United States. Domestic gasoline futures rose sharply before the hurricanes but despite the extent of the damage the price soon fell back to pre-hurricane levels of around $2.00 per gallon in just 10 days.[25] The U.S. government's swift decision to release its Strategic Petroleum Reserves, as well as the collective release of oil stockpiles by International Energy Agency member countries, undoubtedly helped to ease concerns about a supply shortage in the market. Yet the most decisive force was price signaling. Loss of oil production and refining capacity raised domestic energy prices significantly and the high price relative to international levels attracted product imports from all over the world.[26] No other system rivals free-market mechanisms for allocating limited resources optimally. To this end, guarding the current international liquid oil and coal market as well as improving

[25] EIA website: http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm.
[26] U.S. gasoline imports from August 2005 to December 2005 increased by 28 percent from 138 million barrels to 177 million barrels. EIA website: http://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_epobg_im0_mbbl_m.htm.

liquidity in international LNG markets is the highest priority for Japan's emergency response system.[27]

Guaranteeing Free and Open International Maritime Order

Free and open maritime order based on the international rule of law is a fundamental premise of market utilization in the case of an emergency. Japan has to work to ensure such an environment is in place in case of unexpected supply risks.[28] Since geopolitical tensions along the sea lines of communication (SLOCs) from the Strait of Hormuz to the South China Sea and East China Sea have been heightened, preserving maritime order has become far more important than in the past. Japan's past energy security discussions have not focused on these maritime security issues. Given the increasing geopolitical tensions over the SLOCs, however, guarding a free and open maritime order has to be regarded as a primary policy goal for energy resilience efforts.

Solidifying the alliance with the United States is a cornerstone of ensuring a free and open maritime order, as is security cooperation with like-minded countries such as Korea, Australia, and India. Above all, cooperation with ASEAN countries will become a priority for Japan because they are located along SLOCs and Japan shares common interests with these countries. Most ASEAN countries are energy importers. Cooperation with ASEAN countries could include technical assistance for coast guard services and sharing of navigation safety information. Japan could also encourage ASEAN to solidify their actions to ensure a maritime order based on international rule of law.

The relationship with China is critically important for Japan's security and economic prosperity, and thus Japan should continue dialogue with China to encourage China to view a free and open maritime order as beneficial. Since China's recent naval activities are to some extent driven by the need to secure their energy supply, Japan is ready to cooperate with China to ease its energy security concerns. Japan can do so by sharing its expertise on stockpiling developments and operations, its experiences recovering from natural disasters, and its expertise with energy conservation to alleviate concerns regarding unexpected energy supply disruptions.

Developing Prompt and Adaptive Government Decisionmaking

Prompt decisionmaking is required in emergencies. The allocation of limited resources such as food, medical supplies, and energy products requires a prioritization philosophy or guidelines. In the case of the 3-11 earthquake and tsunami, for instance, oil product supply to the quake-hit area was coordinated through close communication between the Agency of Natural Resource and

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[27] Many of the past oil supply disruptions besides Hurricanes Katrina and Rita were resolved essentially by the market function and price signal. See Eugene Gholz and Daryl G. Press, "Protecting 'The Prize': Oil and the U.S. National Interest," *Security Studies* 19 (2010): 453–85.

[28] The significance of and measures to ensure free and open maritime order for Japanese energy supply are discussed in detail in Rebuild Japan Initiative Foundation's Japan-US Strategic Vision Program, "'Shizuka na Yokushiryoku' wo Kouchiku Suru: Pawa Tagenka Jidai no 'Senryakuteki Kokueki'" [Building 'Quiet Deterrence': 'Strategic national interest' in the age of multiple powers], *Chuo-Koron* (January 2014), 146–56.

Energy and the oil industry. But this arrangement was not determined a priori; rather, it was established in a muddle-through process after the disaster. Supply arrangements were made on an ad hoc basis. In hindsight, due to interruptions in communication, there was not adequate information on supply requirements and distribution was not carried out in a well-organized manner. Predetermined processes to establish such supply coordination mechanisms, as well as to prioritize supply to one location or purpose over another for limited supply resources, will facilitate prompt recovery in case of emergency.

Furthermore, the introduction of adaptive and flexible regulatory arrangements may be important in order to facilitate a prompt recovery. During the 3-11 earthquake, several regulations became a barrier toward rapid recovery. In the case of the oil supply, donated oil products from China could not be discharged immediately because quality specifications for products were slightly different from those of Japan. Additionally, tanker trucks could not drive through long-distance tunnels for safety reasons and were unable to supply oil products to quake-hit areas. The fact that coastal tanker regulations require Japanese-flagged vessels to be used to transport cargo between Japanese ports may also prove a large obstacle when stockpiled oil is released to refineries. These regulations are of course meaningful for safety, environmental, and security purposes. In case of an emergency, however, they should be relaxed for a predetermined, short period of time to ensure prompt recovery. Identifying priority areas for temporary relaxation and determining a procedure to enact such relaxation requires attention.

Implementing Nationwide and Interagency Exercises

As a further step toward solidifying the government's capabilities, nationwide exercises should be undertaken. Such exercises should be conducted with all related organizations from the Cabinet Office to the Ministry of Economy, Trade, and Industry; the Ministry of Land, Infrastructure, and Transportation; the National Police Agency; the Fire and Disaster Management Agency; and the Ministry of Defense. Nationwide emergency response exercises in fact have been conducted for potential nuclear power plant accidents in accordance with the Disaster Countermeasures Basic Act and the Act on Special Measures Concerning Nuclear Emergency Preparedness. The scope of such an exercise could be expanded to include nonnuclear energy supply as well and various potential scenarios such as severe natural disasters or disruption of energy imports. Private companies that play an important role in the operation of vital public goods and services such as energy companies and public transportation companies could be invited to join the exercise. The proper functioning of the response system requires that Japan identify potential problems in decisionmaking, information collection, and analysis; communicate among ministries and agencies; demarcate the roles and the mission of government and industry; and conduct nationwide exercises.

Mobilizing Stockpiles

Stockpiling is a classic measure of energy security. As mentioned above, Japan holds more than 180

days consumption equivalent for crude oil stockpiles, which is among the largest of the Organization for Economic Cooperation and Development (OECD) countries. In order to enhance Japan's energy resilience, Japan could improve the "mobilization" of the current energy stockpile. In other words, crude oil stored in a stockpile would not just remain in a storage tank but would flow continuously while maintaining the total level of inventory. Enhancing mobility of stockpiling would facilitate prompt release when it is needed, and also, by rotating the stockpiled crude oil, the grade of crude oil could be replaced to meet changing grade preferences of domestic refiners. Japanese oil stockpiles, especially government stockpiles, have been static and seldom released so far; but it would be preferable to transform this static stockpile into one that is more mobile and dynamically utilized.

There are several policy developments in this regard. The Japanese government introduced a joint stockpiling arrangement with major Middle Eastern oil suppliers such as the United Arab Emirates in 2009 and Saudi Arabia in 2011. This is a framework that allows oil producers to use Japanese stockpiling facilities for storage, while in exchange Japan gains priority access in case of an emergency. By allowing oil-producing countries to use stockpiling facilities, stored oil continues to be sold and replenished and promotes a shift in stockpiled oil from staying oil to flowing oil. Another attempt to make Japanese stockpiling more dynamic is to expand oil product stockpiling for commercial purposes. This expansion was introduced in 2012 after the 2011 earthquake where 30 percent of domestic refining capacity was lost in the immediate aftermath. Because stockpiled oil products have to be replaced regularly, unlike crude oil stockpiling, to avoid quality degradation, this will also "mobilize" stockpiled oil in Japan.

A further step worth considering to promote this flowing stockpile would be regular test releases. These releases could be done as part of the government-wide emergency exercise discussed above. The procedure for such a release needs to be elaborated upon, and the current regulation requiring that Japanese-flagged tanker vessels transport crude oil between Japanese ports may require review. Due to Japan's dependence on oil supply imports, effective operation of stockpiles will be crucial to its emergency response planning efforts.

How to Balance Economic Competitiveness?

The actions mentioned above for enhancing energy resilience are not free. Some measures require additional expenditures while others demand infrastructure redundancy. In Japan, most energy supplies are undertaken and maintained by private companies and it is not realistic to have only these players undertake actions that enhance Japan's ability to recover from a crisis. Actions that private business cannot undertake should certainly be in the domain of the government.

It should be noted at the same time, however, that resilience enhancement is often paired with commercial benefit for private players. Given the potential for significant impact from an emergency, limited additional expenditures to enhance resilience should be regarded as an insurance premium that will reasonably reduce future uncertainties in business activities.

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Strengthening capabilities for impact mitigation and prompt recovery from damage incurred is also considered a matter of competitiveness for an economy or firm. Diversification is sometimes associated with logistical or quality risks if an unfamiliar energy cargo is acquired. But at the same time, if pursued properly it will give more leverage to the buyer against seller.

Any action toward greater resilience must not be static, of course. Actions have to be reviewed to determine whether costs associated with any action are justified through defended wealth or avoided expenditures. Striking the best balance will remain a central interest in resilience enhancement.

U.S.-Japan Energy Cooperation: Setting-up of Strategic Energy Dialogue

The U.S.-Japan alliance, needless to say, plays a crucial role in enhancing Japan's energy resilience. First of all, LNG exports from the United States will further solidify our bilateral relationships because, as already mentioned, it has significant effects on Japan's diversification of supply sources and energy prices. If all of the proposed LNG export projects that plan to export to Japan (Freeport, Cove Point, and Cameron) were realized, 17 million tons of LNG would be exported to Japan. The volume exceeds the export from Qatar to Japan in 2013 and ranks second only after Australia of total Japanese LNG imports in 2013. This level of exports will certainly have a material impact to Japan's diversification effort as well as Asia's LNG market balance.

Even though not all of these projects would start up as scheduled, U.S. LNG exports to Japan will have a symbolic meaning for the alliance. No doubt there is an economic motivation to export LNG to capture the rents caused by the natural price difference in the U.S. and Asian market. As the study commissioned by the Department of Energy reveals, LNG exports will bring net benefits to the U.S. economy on a macro basis.[29] The export of energy, however, always has a different political sensitivity as energy is a critical resource for all economies. The U.S. manufacturing and petrochemical industries repeatedly argue against the U.S. government's pro-export attitude.[30] There remains concern of potential price spikes in natural gas market as actually observed when the United States was hit by very cold weather in February 2014. U.S. willingness to export LNG to non-free trade agreement (FTA) countries like Japan, despite all these concerns and opposition within the United States, is interpreted as a sign of U.S. intention to assist with the restoration of the post-earthquake Japanese economy. Increased trade of a vital commodity such as LNG will naturally draw U.S. attention to free and safe maritime order to the Asia-Pacific basin. This will accelerate the U.S. rebalancing policy to Asia and will have a favorable effect on the U.S.-Japan alliance.

LNG export, though it has significant meaning for Japan and the United States, is only a part of

[29] NERA Economic Consulting, *Macroeconomic Impacts of LNG Exports from the United States* (Washington, DC: NERA Economic Consulting, December 2012), http://energy.gov/sites/prod/files/2013/04/f0/nera_lng_report.pdf.
[30] Companies such as Alcoa and Dow Chemical are opposing LNG exports because of concerns about the rise of natural gas prices due to increased exports. For details, see the website of America's Energy Advantage, an organization founded by these companies, at http://www.americasenergyadvantage.org/.

bilateral energy cooperation. Another equally important area for the bilateral cooperation is nuclear energy. Japan and the United States have developed cooperative partnerships in civil utilization of nuclear energy since the 1950s, and have deepened cooperation since the current Japan-U.S. Nuclear Power Cooperation Agreement went into effect in 1988. The earthquake in 2011 provided additional momentum to the bilateral nuclear energy cooperation. President Obama and then-prime minister Noda agreed to the U.S.-Japan Bilateral Commission on Civil Nuclear Cooperation in April 2012. The commission intends to "facilitate discussions on future nuclear energy cooperation; and advance shared interests in nuclear safety and security, nonproliferation, counterterrorism, decommissioning and decontamination, emergency preparedness and response, and research and development."[31] In February 2004, the two countries held a working group meeting to discuss the advancement and adoption of Probabilistic Risk Assessment methodology for nuclear power plants' operation.[32] The next step is, in accordance with the agreement of the bilateral commission, to expand the scope of cooperation to areas such as nuclear security and emergency response.

Nuclear energy, despite the severe accident at Fukushima, has gained further importance due to growing energy demand in the developing world, the increasing need to reduce global greenhouse gas emissions, and chronic geopolitical uncertainties in major oil and gas producing regions. Sharing its experience of long-term peaceful use of nuclear energy and lessons from the Fukushima Daiichi accident with all existing and future nuclear energy users is Japan's global responsibility. As leading countries in civil nuclear energy, the United States and Japan have to tighten their collaborative relations to ensure safe and peaceful expansion of nuclear energy in the world.

In light of the increasing importance of energy between the two countries, establishing a bilateral strategic energy dialogue is worth considering. Its primarily private companies both in Japan and the United States that undertake the energy market and business activities, and government intervention has to be minimized. Yet regulatory issues such as LNG exports or, in the long term, crude oil exports as well as nuclear security and safety issues cannot be discussed and promoted without serious commitments by both governments. Regular meetings at the minister level will accelerate the development of bilateral cooperation and solidify the U.S.-Japan alliance.

Conclusion

Figure 5 summarizes the preceding discussion. Resilience aims to make the Japanese energy supply system more adaptive and responsive to supply shocks.

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[31] Ministry of Foreign Affairs of Japan, "Summary results of the US-Japan bilateral committee first meeting on civilian nuclear cooperation," press release, July 24, 2012, http://www.mofa.go.jp/mofaj/press/release/24/7/0724_04.html.

[32] Ministry of Economy, Trade, and Industry of Japan, "'Probabilistic risk assessment US-Japan Round Table' improve safety of nuclear power," press release, February 14, 2014, http://www.meti.go.jp/press/2013/02/20140214003/20140214003.html.

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Figure 5: Elements of Japan's Traditional Energy Security and Energy Resilience

	Traditional energy security	Energy resilience
Primary policy goal	Risk prevention and impact mitigation.	Impact mitigation and emergency response.
Diversification	Significant efforts have been made but the supply of oil is still concentrated in the Middle East.	New supply potential has emerged and may ease Japan's high dependence on the Middle East.
Perceived energy supply disruption	Geopolitical events in energy-producing countries.	Whole supply chain including safe navigation to Japan.
Views about energy supply risk	Risk can be minimized (or completely removed in case of nuclear power plants) through rigorous mitigation measures.	Risk cannot be fully removed. Risk needs to be managed based on probabilistic approach considering risk tradeoffs.
Stockpiling operation	Static stockpile.	Mobilized stockpile.
Regulatory actions in case of emergency	Static.	Adaptive and flexible.

Source: Author.

Uncertainties in international energy markets have been increasing. The experience of the 3-11 earthquake has provided lessons for Japan. All these factors and lessons have to be reflected in Japan's energy security policy, and enhancing energy resilience is one of the directions that Japan should pursue. Some measures mentioned above may be relatively easy to undertake, while others may take a long time. Japan does not have the luxury to defer its efforts from greater energy resilience. Since the experience and memory of the earthquake is still fresh among the Japanese public and a new Basic Energy Plan has been published, now is the right time for the Japanese government and public to discuss and act to enhance resilience in Japan's energy supply.

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