Walking the Wall

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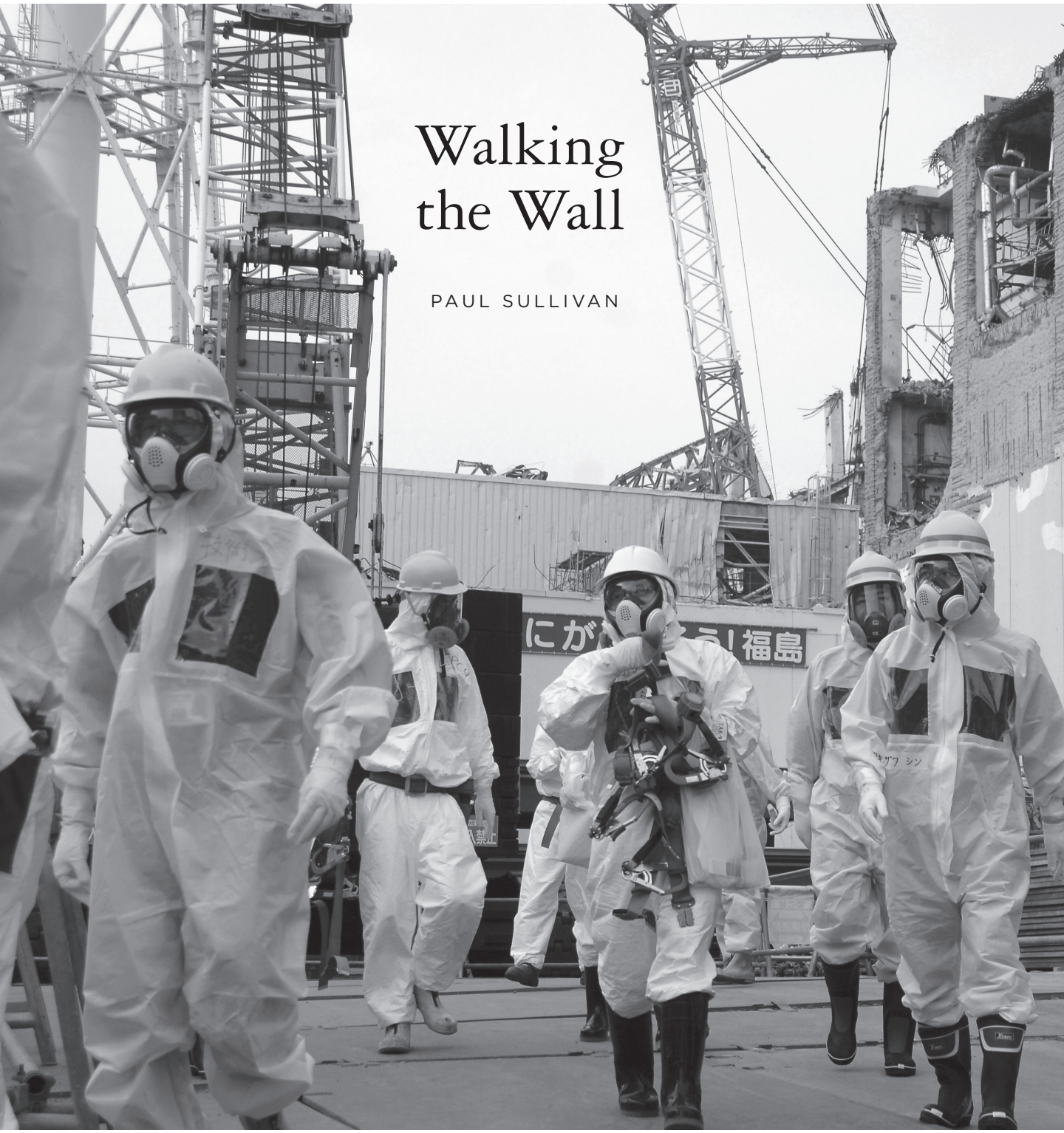

TOKYO—The concrete and steel tsunami wall at a nuclear plant south of Tokyo is nearly 50 feet high and stretches a mile long. It is only one of a host of other earthquake and tsunami refits—waterproofing some of the most vital areas of the plant, backing up cooling systems, and improving venting for the facility in the event of hydrogen build up. On March 11, 2011, known as 3/11 in Japan, in the aftermath of the nuclear disaster at Fukushima Daichi, thousands died in the earthquake and resulting tsunamis; countless others lost their lands and livelihoods. There were a number of casualties from stress, dislocation, and more, especially among the elderly. And worse yet, future health fallouts are still to be seen. It was unquestionably a social and cultural calamity for a country that has had so many in its past, yet always seems to recover and come back stronger than ever.

The tsunami wall represents one attempt by the Japanese to hold back the power of nature lurking beneath and near its lands. It is but one example of Japan's attempts to get back some of the energy and economic self-reliance that it lost that day.

It is also a $1.5 billion investment by the power company that hopes to lessen the potentially existential threat of a permanent shut down of its nuclear facilities—an attempt to prove to the government and to the people of Japan that nuclear power is indeed safe. Post-Fukushima, this is no easy sell.

Nuclear power accounted for some 30 percent of all electricity generation and 13 percent of all energy production in Japan in the year prior to 3/11. All nuclear power was shut down after the disaster of 3/11. Some nuclear plants were immediately shut down; others were gradually shut down over the next few months. By January 2012, the nuclear industry was a tiny proportion of all energy in Japan. There was even a time in 2012 when they were all shut down. A couple of nuclear generators were reopened later that year, but all nuclear generators were eventually closed by September 2013.

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The closure of these plants paved the way for Japan to become an even bigger player in the energy commodities market.

INSECURITY

Japan's measure of domestic self-reliance in energy is now about 4 percent. It was 17 percent prior to 3/11 and the eventual shutdown of the entire Japanese nuclear industry. That measure of self-reliance is the lowest of any member of the Organization for Economic Cooperation and Development (OECD). It is the world's second largest fossil fuel importer. It is the largest importer of liquefied natural gas (LNG), with 37 percent of the market of internationally traded LNG. It is also the world's second largest importer of coal and the third largest importer of oil. In short, it imports about 99 percent of its fossil fuels.

ONE OF THE BIGGEST PROBLEMS CONFRONTING THE JAPANESE NUCLEAR PROGRAM IS WHERE TO STORE SPENT FUEL THAT IS NOT PROCESSED.

For some years after the oil shock of 1973, Japan was able to reduce its dependency on Middle East oil from its high of 92 percent in 1967 to 66 percent in 1988. Now it imports over 83 percent of its oil from the Middle East, and mostly from countries inside the Straits of Hormuz, including Iran, Saudi Arabia, and the UAE. Another source of Japanese oil is Russia, accounting for about 4 percent of imports, which has been supplying increasing amounts from its port at Kozmino since the East Siberian Pacific Ocean Oil Pipeline (ESPO) was completed at the end of 2009. Japan gets about 61 percent of its coal from Australia. It receives about 31 percent of its coal from Indonesia. The rest of its coal comes from Canada, Russia, the United States, China, and a few other smaller suppliers. It gets about 30 percent of its LNG from the Middle East—nearly a third from Oman, Qatar, and the UAE. Australia is a source of 18 percent of its LNG. Russia supplies 10 percent, and this may be growing given Russia's investments in new LNG facilities in Vladivostok. Malaysia supplies about 17 percent. Nigeria, a potentially very unstable state, supplies about 5 percent. Indonesia and Brunei supply 7 percent each. And in late May, the first shipment of LNG from a $19 billion Exxon Mobil development left Papua New Guinea destined for Tokyo Electric Power—a project that's expected to yield more than 9 trillion cubic feet of gas over 30 years.

Japan has diversified its sources of fossil fuels. However, some of these sources are potentially unstable or unreliable. Furthermore, all these energy sources arrive in Japan by sea—ports that need to be working up to speed, especially after earthquakes and tsunamis.

As for nuclear fuel, Japan has no domestic uranium reserves. About a third of its uranium imports come from Australia; the rest comes from Canada, Kazakhstan, and other smaller sources. It can enrich the imported uranium in Japan, but often relies on others, particularly France and Britain, for enrichment and reprocessing services even though it has a major, yet sometimes problematic (and now closed) reprocessing facility at Rakkasho in the north of Honshu Island. Tens of billions of dollars have been spent to develop reprocessing in Japan, only to see the reprocessing plants shut down.

One of the biggest problems confronting the Japanese nuclear program, faced also by many other nuclear programs worldwide, is where to store spent fuel that is not reprocessed. So far in Japan it has been mostly stored at the domestic nuclear plants in spent fuel pools and dry cask storage. These storage areas have been filling up fast. One insider suggested not dealing with the nuclear waste issue in the industry was like "building a house without a toilet." A considerable amount of spent nuclear fuel still sits in dry casks and spent fuel pools in the damaged Fukushima plants. Decommissioning nuclear plants requires dealing with the spent fuel on the site of the plants.

The solution to this nuclear waste problem has taken a back seat to making sure that the nuclear plants that are being stress-tested and evaluated for potential restarts are fulfilling the regulations for safety and security imposed by the new Nuclear Regulatory Authority (NRA) of Japan, now under the Ministry of Environment, which replaced the Nuclear and Industrial Safety Authority (NISA), once under the Ministry of Economy, Trade, and Industry (METI). This transfer of regulatory power is important.

METI is responsible for the development of the nuclear industry. It has acted as a proponent of the industry. Under the same roof was NISA, which was responsible for regulating the nuclear industry. So at the same time METI was pushing down on the accelerator for nuclear energy development, it was also putting on the brakes. Soon after 3/11, this all too cozy relationship between the nuclear industry and its regulators came under considerable scrutiny. It was subsequently decided that the Ministry of Environment—a strong proponent of renewable energy—would be the new regulator.

WARINESS OR WANT

Japan's nuclear industry development was boosted by sending subsidies to the localities where the plants would be built. In some places, some of the largest tax sources are the nuclear plants and their companies. There are also significant tax revenues from nuclear waste storage sites, but other economic drivers for some prefectures who were sought as sites for nuclear plants included government subsidies, jobs, and industrial plants that make use of such massive sources of energy nearby. These economic reasons are also driving some of the public desire to restart the closed plants.

Though polls show an increasing wariness towards nuclear power, with most Japanese anxious to phase it out, the party that is best-known for supporting such plants, Prime Minister Shinzo Abe's Liberal Democratic Party (LDP), was re-elected, while the opposition parties that were against the restart of the nuclear plants lost miserably in many areas.

The nuclear industry, the large electricity generation companies, METI, the former NISA, the LDP, and some pro-nuclear academics and energy experts were all part of what some of those opposed to nuclear power in Japan call "The Nuclear Village." This is seen as a cozy group that feeds off each other's studies to develop the nuclear industry, and now to restart as many nuclear plants as possible. Others see this group as the economic and energy champions of the nation.

All electricity for Japan is made in Japan. There are no interconnections with other countries. It is an island nation geographically, but also energy-wise. It is amazing that a country with so few indigenous energy resources could become a world economic powerhouse just a few decades after the immense destruction of World War II.

Japan had mostly hydropower and coal to rely on for electricity production in the early postwar period. In the late 1950s and early 1960s, Japan began to use increasing quantities of oil. By the time of the oil shocks of 1973, oil was by far the most important energy source in Japan, accounting for 75 percent of its energy. After the oil shocks, Japan started to look more toward natural gas and nuclear power. The country diversified its sources of energy over the next decades. These great energy transitions happened during some of the fastest economic developments in Japan's history.

Coal, which generated nearly three-quarters of all primary energy in Japan in the 1950s, remained a steady source of energy even as natural gas and nuclear replaced oil. Coal is a big part of the energy psyche of Japan. It is seen as a backbone fuel for electric power, especially in times of great stress, even if it is now all imported.

At a well-managed, high-tech clean coal facility near Yokohama, the managers are clear that coal is a cheaper fuel than LNG. However, they are also clear that coal produces more carbon dioxide than LNG when used in generating plants. While this plant brought down the carbon output considerably, it was still not competitive with LNG in this respect. The LNG-coal tradeoffs are important for Japan these days as it tries to navigate its way to enhanced energy, security, economic stability, and national security in difficult times and still hold to their 3E principals for energy policy: energy security, environmental sustainability, and energy efficiency.

THE GREAT NUCLEAR SHUTDOWN

Japan invested hundreds of billions of dollars in its nuclear industry. Then, as tragedies struck, and the public turned further away from nuclear power, it all was shut down. This has been a massive energy and financial shock to the country—potentially even worse than the 1973 oil shocks.

As nuclear power was shut down in Japan, it needed to import more LNG, coal, and oil. Japan was already the largest importer of LNG in the world so its sharply increased demand put pressure on LNG prices worldwide. It has been importing the most expensive LNG in the world, at about $16-$18 per MMBTU, which is about 1,000 cubic feet of natural gas in its gaseous state, not in its liquefied state. In Europe, natural gas has been hovering around $10-$12 per MMBTU. Gas prices in the United States dipped to under $3 for awhile and have hovered mostly between $3 and $4, with some spikes now and then due to weather and pipeline capacity issues.

Japan has had to import a lot more coal after 3/11. Fortunately, coal prices have been in decline during this difficult time. Japan has had to also increase its imports of oil to run some marginally important electricity generation plants, but that foreign exchange shock has been less than the shock of having to sharply increase imports of LNG. As a result of the huge increases in energy imports, Japan was thrown into its first series of trade deficits since 1980 because of its increasing demand for fossil fuels needed to run electricity generating plants and replace lost nuclear capacity.

The loss of nuclear power in Japan was not just an energy shock. It was a foreign exchange and economic shock.Japan's overall economy took a big hit as brownouts and rolling blackouts took hold. Some major companies, including exporters like Toyota, were forced to cut back on production. GDP took a hit. This was especially evident in the regions of Fukushima,

ACTION STEPS

Japan needs to:

- Come to some effective consensus on making its electricity system more resilient and even anti-fragile in the future.
  - Unbundle the 10 major regional electricity near monopolies
  - Increase transmission capacity across and within electric regions
  - Increase transmission capacity across its 50 Hz/60 Hz electricity wall
  - Develop proper transmission operators, open access transmission networks, futures and spot markets for electricity
  - Open competition across and within electricity regions
- Move beyond its very low energy self-sufficiency level toward the development of more indigenous energy resources: geothermal, solar, wind, tidal, and the potential game changer of methane hydrates found off its shoreline.
- Develop innovations like *setsuden* (energy savings) programs and deal less with entrenched political and economic power groups like "The Nuclear Village."
- Prepare (beyond building tsunami walls and water proof doors) for the next, inevitable, disasters. Political, economic, technological, and other structures need as much refitting and reforming as the doors and walls of nuclear power plants or ports.

—Paul Sullivan

Iwate, and Miyagi, where the earthquakes and tsunamis had their biggest impact. Though the disaster hit these regions the hardest, it reverberated across the nation.

The Great East Japan Earthquake of 3/11 was a massive 9.0 on the Richter scale. Some 19,000 people died. Thousands were physically injured, tens of thousands more were emotionally scarred for life. Direct measurable economic losses are estimated in the $300 billion to $400 billion range, including cleanup costs of the areas damaged by the tsunami and nuclear disaster. The emotional and cultural losses are impossible to quantify, especially given the relatively private nature of Japanese society, where outward signs of resilience are seen as positive traits. Undoubtedly though, 3/11 was a personal, national, and international event that could reverberate for many years to come—and not just in Japan, but across the entire spectrum of the global energy industry.

SYSTEMS WITHIN SYSTEMS

In order to understand the gravity of earthquakes and tsunamis in Japan, it is important to understand that energy systems are actually systems nested within other systems. Massive and complex trading, transport, and information systems are needed to get the coal, gas, oil, and nuclear fuel to the generating plants. Major earthquakes can damage the ports where these vital fuels are imported. Fortunately for Japan, most of its ports remained intact and workable after 3/11. Some faced dam-

age. Most were rapidly repaired. A serious issue here is what happens when the expected big earthquakes hit Tokyo, Yokohama, Isogo, and many other areas along Japan's coastline where large amounts of these fuels are imported.

LNG vessels, coal barges, and oil tankers sit at and near each port. A giant earthquake could be devastating to some of the most important LNG, coal, and oil import facilities. Many ports in the most potentially seismic areas must urgently be made more resilient to the future shocks that scientists are convinced will come. It is best to plan and invest now, rather than wait for the inevitable. If Japan had performed the resiliency drills, built high tsunami walls, and set up the many other security, safety, and fail safe devices prior to 3/11, then instead of a nuclear catastrophe, the tsunami waves might just have bounced off, shutting down the plants temporarily—rather than indefinitely. The deaths, injuries, and loss of livelihood and property from the earthquakes and tsunamis would have happened, but the energy shock would have not.

Many fossil fuel generating stations near the earthquake area were damaged. Some were repaired in astonishingly quick order. Others, such as some coal plants in and near Fukushima took much longer, such as the Haramachi plant. Many of the large electricity generating companies had fossil fuel plants in mothballs. These were restarted quickly to make up for some of the losses due to the nuclear shutdowns.

Large investments are in the works to increase fossil fuel generating capacity in the event most, if not all, nuclear plants stay offline permanently. The Japanese government has relaxed some environmental regulations to give incentives for more coal plant capacity to be built. It is also encouraging the further development of clean coal technologies. Coal is a lot cheaper than LNG for each megawatt hour produced in Japan, but it produces a lot more carbon dioxide for each megawatt hour. It is very curious indeed, and an interesting hedging strategy, that many of the very companies investing billions in greater nuclear safety and security are also the companies investing in fossil fuel electricity plants that can replace them.

TRADING POWER

Electricity involves generation, transmission, and distribution. Along with several generating plants, multiple transmission lines were damaged. These are generally more easily repaired than generating stations, particularly of the nuclear generating variety. Some transformer stations, substations, and other parts of the system were badly damaged in the areas hardest hit. It took considerable time to get many of these repaired and in working order. Others were not repaired given that they were in the no-go nuclear radiation zone near Fukushima Daiichi.

The country is split into two electricity zones, 50 Hz and 60 Hz, each having a different frequency for its alternating current. This is an historical quirk going back to the 19th century when the then Tokyo Electric Light Company chose German generators with 50 Hz electrical frequency, and Osaka Electric Lamp Company chose American generators with 60 Hz frequency. These two systems coexisted, side by side through two world wars and the transformation of Japan into a world economic powerhouse.

Electricity cannot move from one frequency zone to another without going through giant frequency converters to change the alternating current (AC) of one frequency to the AC of another frequency.

To do this, the AC has to first be converted to a high voltage direct current (DC), then back to the higher or lower AC frequency depending on which direction the electricity is flowing.

The total generating capacity of the 50 Hz zone, where Tokyo Electric Power (TEPCO), Tohoku Power and Hokkaido power are found, has the potential of around 74 gigawatts, a gigawatt being the equivalent of 10,000,000 hundred watt light bulbs all glowing at once. The 60 Hz side of the country, where Chubu, Hokuriku, Kansai, Shikoku, Chugoku, and Kyushu power companies can be found, has the potential of about 88 gigawatts of electrical capacity. If there were no limits to moving electricity from the 60 Hz to the 50 Hz sides of the island, then the economic effects of 3/11 would have been significantly less.

However, the frequency converter stations that allow electricity to go from the 50 Hz part of the island to the 60 Hz part of the island and vice-versa can only move about 1.2 gigawatts in potential capacity. In other words, with the massive losses in electricity generating capacity after 3/11, the 60 Hz side of Japan could not transmit enough electricity to help out the 50 Hz side of the country, where Tokyo and other industrial cities are found. TEPCO, the biggest electricity company in Japan, lost the most generating capacity. All of its nuclear plants were shut down rather rapidly. Fukushima units 1 and 4 were written off completely, mothballed for eternity, as they were the infamous sites of the explosions and meltdowns. The company faced a 2.7 gigawatt capacity loss from these two plants alone—and very rapidly.

By May 2011, only 17 nuclear units were still operating in Japan, but en route to shutting down. These produced 15.5 gigawatts, or about 35 percent of the total electricity capacity of the nuclear industry. By the beginning of 2012, very little capacity was left in the nuclear system at all. When the nuclear plants were shut down completely, 43 gigawatts of electricity disappeared. This was 30 percent of all of the potential electricity supply in the country. Electricity also could not move freely between the 50 Hz and 60 Hz sides of Japan as these extreme energy events were happening.

Not only was it impossible to send enough of the electric power that was produced in the 60 Hz zone into the 50 Hz area, but there were also severe limitations on the transmission of electricity from one company's areas of service to another company's zone. For example, on the 50 Hz side of the island, as the fossil fuel stations run by Hokaido Power and Tohuko Power were restarted, there were limits to what they could send into the TEPCO areas that were hit the hardest by 3/11. Hokaido had 5.8 gigawatts of generating capacity, but its transmission lines could carry only 0.6 gigawatts to Tohoku or on to TEPCO. Tohoku transmissions lines could send only 2.4 gigawatts of capacity at most to TEPCO and vice-versa.

A NEED FOR A FULLY FUNCTIONING AND COMPETITIVE NATIONAL GRID WAS NEVER ENVISIONED OR ESTABLISHED.

Interconnections among the five electric companies in the 60 Hz zone are also much smaller than their capacities for generation. If there were any major emergencies in the 60 Hz area, only limited amounts of electricity could be moved between these companies.

So we have the combination of the country splitting into two electricity frequency zones, added to the lack of transmission capacity between the electricity producing regions of the major electric companies, restricting the vital transmission of electricity between them.

A single market with free flowing electricity set up properly to respond to economic, energy, and other shocks would have been best. However, there are 10 major electricity companies in Japan—six in the 60 Hz zone, three in the 50 Hz zone, and Okinawa separated from the rest. There is little electricity traded among them, which is quite odd for an advanced, industrial country. Each of these companies is a vertically integrated near-monopoly for its region.

PART OF THE REASON BEHIND JAPAN'S ECONOMIC STAGNATION AND DECLINING COMPETITIVENESS IN TRADE IS ITS ENERGY COSTS.

These companies were set up during the time of the post-World War II American occupation of Japan under the leadership of General Douglas McArthur. They were founded on the then widely accepted premise in the United States and Western Europe that electric utilities were natural monopolies that needed to be regulated. Their growth over the years was based on the simple understanding that there must be enough electricity for each of the regions they serve, not for all of Japan. There was not much thought put into the importance of full networked interconnections across their territories, electricity power pooling, and the establishment of a fully functioning national electrical system operator to control transmission across companies and areas when there might be surpluses or shortages among them. In short, a need for a fully functioning and competitive national grid was never envisioned or established. Essential to understanding this is the reality, then and now, that there is no real option for the storage of electricity. Network demand for electricity must equal network supply for electricity at all times. Otherwise there will be brownouts, blackouts, or overloads to the system.

One way to help balance an electricity system is to have functioning electricity trading systems. The Japanese Electric Power Exchange (JEPX) only moves about 3 percent of electricity in forward and spot markets. In most OECD countries, this would be about 20 to 40 percent or more. These 10 giant electric companies control 75 percent of the nation's capacity and 90 percent of the retail electricity market. Furthermore, for Japan, those few electricity producers who are not part of the big 10 companies have had to pay exorbitant fees to put their electricity on the companies' transmission lines. Electricity cannot move from one area to the other over long distances without being put into the transmission network of a specific company, and across their high-voltage AC lines.

Above all, Japan needs freer flows of cheaper electricity—a need that has been clarified by the sudden and catastrophic developments post 3/11. This includes the development of a proper pricing system and an open-access transmission network. Such a network will be important in the development of competition, which would allow a reduction in the price of electricity. Japan has the second highest electricity rates for households in the OECD. It also has extremely high electricity rates for industry and commercial enterprises—on

par with Germany. Japan is working on the reform of its electricity system. The 3/11 shocks and subsequent economic jolts may push it to a more rationalized electricity system that can respond to crises, both very large and even minute to minute, with a more flexible, single market, as well as a more competitive and interconnected electricity system.

Part of the reason behind Japan's economic stagnation and declining competitiveness in trade is its energy costs. Oil, LNG, and coal prices are determined by forces outside of Japan. However, Japan has considerable control over where its electricity network could be going—a control that until now it has failed to exercise, but may not be in a position to delay much longer.

RENEWABLE ENERGY?

Even with all the talk about how quickly Japan is developing solar and wind power, the nation has one of the smallest percentages of renewable energy of any OECD country. Cheap nuclear energy and the power of the big 10 producers helped block renewable energy in the past. Japan's electric feed-in tariff system (FIT) provides a guaranteed price to the producer of the renewable energy, be it a household or a company, which makes it quite profitable to produce renewable energy over the next 20 years or so. However, incorporating solar, wind, and other intermittent power systems into the overall electricity system needs cheaper transmission costs, a more connected energy system with greater capacity across prefectures and other regions. It will also require cross-frequency interconnections with higher capacities.

The base load, the old reliable of electricity, could be nuclear, coal, and LNG, but the intermittent sources may be used for peak periods of the day or whenever there are shortages in the overall or regional system. For that to happen, there needs to be a rational and efficient energy trading system at the wholesale and even

RADIATION DETECTOR

retail levels, and there needs to be a countrywide transmission operator (or a small number of coordinated regional transmission operators) to run that auction. These changes would help keep the transmission network working properly for all providers and suppliers. Without these changes, renewable energy could end up being only for local and sub-regional use, or even for use by companies and households as backup power. This is not a way to create energy change in a country.

Also essential is a role for the massive potential of geothermal power that needs to be unleashed by opening up Japan's national parks to these developments. Most geothermal resources are in the national parks. Geothermal is a great source of energy for Japan, and is surely more environmentally friendly than LNG, coal, and nuclear power. Developing geothermal energy would also increase the energy self-sufficiency of Japan from its anemic 4 percent without nuclear to a much higher number, possibly 8 or 10 percent. These small percentage changes could make a big difference for the country's energy security. Of course, the Japanese would have to work out the many emotionally and politically charged issues related to building power stations in national parks.

Development of renewable energy could also open Japan to the potential of not just one-way electricity systems, from the generator to homes and businesses, but two-way electric systems, with homes and businesses (even transport vehicles) exporting their electricity production into the system while generating companies do the same. However, this takes a lot of economic and technical coordination and agreement across these groups, freeing entrenched markets and long-standing concepts, as well as proper regulations to make it all happen. Still, Japan may not have much choice here, nor much longer to wait before moving forward on the project.

EFFICIENCY VS. CRISES

Japan achieved enormous efficiencies in terms of transportation, heating, cooling, and industrial production over the past few decades. In Japanese, saving energy even has its own word—*setsuden*, which made a huge difference during the energy crises after 3/11. The government mandated a 15 percent drop in energy demand for many larger energy users. Households had their own, mostly voluntary targets, even in zones that were not in crisis. The entire nation seemed to get on board. Lights were turned off in buildings and houses. More efficient lighting, cooling, and heating systems were installed by industries, storeowners, and homeowners. Air conditioners were either shut off or operated at a much higher temperature in homes and offices. Short sleeve shirts with loose collars became more acceptable in a business culture where button-down shirts and three-piece suits are the norm. The mild summer of 2011 also helped a bit. Elevators were used less often than before. Laundry was done less frequently. Some companies launched in-house electricity production and developed more backup power. Other companies exported electricity into the grid to help out, while also making some money.

Setsuden was a success. Electricity demand did fall—actually more than many expected. The blackouts and brownouts became less frequent, ending a lot faster than anticipated. But with a proper pricing system and a more rational and interconnected electricity network for the whole country, *setsuden* might never have been needed. There is always some excess capacity in a well-developed system that

can be used for peak and over-peak demand in a region. Future developments of two-way base-load-renewable energy systems could also make *setsuden* less austere, even during the most difficult times. Then there is the concept of *sho-ene*, or long-term energy efficiency. Japan could eke out even more efficiencies, which could help the nation whether future energy crises.

DECISION TIME

Without nuclear power, Japan is the most energy insecure country in the OECD, even with its diversified sources of LNG, coal, oil, and uranium. It needs to make some decisions rather quickly about either restarting or mothballing and decommissioning some of its nuclear power plants. It is costing billions just to keep these plants in operable condition. It is costing billions more to develop safety and security upgrades that could return them to service. Japan is also investing massively in the development of more fossil fuel generation capacity.

Japan needs to come to some consensus on what to do about spent nuclear fuel, nuclear fuel reprocessing, and its plutonium reserves, and whether it wants to go forward with further development of new nuclear power plants. Changes in the balances of power directed at energy systems at the federal and prefect levels seem to be in order. Prior to 3/11, there was serious discussion of moving toward 50 percent nuclear energy in the coming decades, but that seems moot at the moment. "The Nuclear Village" has lost a lot of credibility and clout.

Meanwhile, Japan faces growing trade deficits and further economic stagnation. Energy, or the lack thereof, has much to do with both. Above all, the Japanese people need to find some consensus on nuclear power's role in its energy systems and in its society. Japan's considerable domestic energy sources of solar, wind, geothermal, and tidal sources could increase its energy self-sufficiency considerably. The *sogo-shosha*, the big trading companies, such as Mitsubishi, Mitsui, Marubeni, Itochu, Shojitz, and others will continue to play large roles in the import of LNG, coal, oil, and uranium, as well as being big investors in energy facilities and fields globally.

Public, industry, and other buy-ins are needed if Japan is to move toward rationalizing its electricity system, creating a fully functioning spot and forward market for electricity, better interconnections across electric company regions and across the different frequency regions, and an open-access transmission network. It would make a lot of sense to put substantial investments into greater linkages between the 50 Hz and 60 Hz areas of the country. It would also make sense to build greater interconnection capacity across the many large electricity company zones. Also essential is an unbundling of the vertical virtual monopolies in the country. Generation would need to be unbundled from transmission, which would need to be unbundled from distribution. Giving regional monopoly power to vertically integrated companies gives them huge leverage on pricing and control of the electricity flows. Unbundling and breaking up these companies, as has been done in many other countries, may be needed. Japanese leadership and the Japanese people will need to come to some consensus on what structure

THE FUTURE MAY APPEAR A BIT COMPLEX AND BLEAK RIGHT NOW, BUT DO NOT UNDERESTIMATE THE JAPANESE.

and performance they want from their electrical industry.

It is not enough to create a single Japanese system operator, if it cannot function properly in the face of vertically integrated virtual monopolies in each region. Improving the overall interconnectedness of generation, transmission, and distribution can be of great benefit to Japan. Lower electricity prices can make a huge difference in the overall competitiveness of the country. There will be another major earthquake. There will be dangerous tsunamis. There need not be another nuclear catastrophe or even similarly serious energy shocks from any such natural disasters if proper investments are made and if more diversified domestic and international energy sources are developed.

Japan is energy insecure. It relies mostly on the outside world for its energy and exists in a volatile seismic zone. It also has great potential for renewable energy that can be domestically produced, as well as the looming potential for frozen natural gas off its shores, but so far this seems like a far off dream cure for energy insecurity.

Japan could develop greater energy coalitions with other major energy importers. It could work with the United States to import shale gas in the form of LNG—provided Western Europe doesn't get first call on these reserves to ease politico-economic pressure from Russia. However, LNG exports from the United States will be developed by private companies so it may just go to the highest bidder, which would be Japan. The *sogo-shosha* have also invested in American LNG export facilities and shale gas fields. Japan could work with the United States to import its shale oil or shale oil refined products. Japan can further diversify its fossil fuel sources into East Africa and Latin America (especially Brazil), but it will still be at the whim of world markets—and especially its neighbor China.

The future may appear a bit complex and bleak right now, but do not underestimate the Japanese. These are a resilient, even an anti-fragile people, who have come back from disasters many times before. The greatest source of and reason for hope for Japan has been its people. The same could be said for its future. ●