"Nuclear Power and the Japanese Earthquake of 2011" by Steven Cohen, Alison Miller, Eve Solomon, and Alok Disa, The Earth Institute, Columbia University, July 2013

Introduction

A natural disaster on March 11, 2011 caused significant damage to the Fukushima Daiichi nuclear plant in Japan. This case study examines the facts of the Fukushima Daiichi accident and the history of the plant, Japan's dependence on nuclear power, Japanese regulation of the nuclear industry, and the political challenges associated with nuclear power. The case ends with a discussion of the policy issue of nuclear power plant closing and the consideration of reopening them under new terms.

The Facts of the Accident: Chronology of Event

The earthquake struck Japan's northeast coast at 2:46 p.m. on March 11, 2011. With a magnitude of 9.0 on the Richter scale, it was one of the strongest earthquakes ever recorded. The quake struck off the Coast of Honshu Island, in an area with 11 operating nuclear power reactors, including three operating reactors at Fukushima Daiichi, four at Fukushima Daini, three at Onogawa and one at Tokai. Three reactors at Fukushima Daiichi were undergoing routine maintenance and were not operating at the time of the earthquake.

When the earthquake struck, safety systems started and all 11 reactors were tripped by automatic shutdown systems that caused nuclear fission processes to halt. These systems terminate the fission process by placing control rods, composed of materials that block neutrons, into the reactor cores. However, fuel rods must still be kept cool even after the fission process stops, because byproducts of the nuclear reaction continue to produce heat for years. Safety mechanisms ensure that the control rods are cooled by continuously flowing water powered by electric-powered pumps. If water stops flowing, the water can evaporate, leaving fuel rods exposed and threatening a nuclear meltdown. The earthquake destroyed the connection between the reactors at Fukushima Daiichi and the national power grid, but in the immediate aftermath of the quake, backup diesel generators were able to power the pumps.[1]

At approximately 3:46 p.m., one hour after the earthquake occurred, a tsunami struck Fukushima. The tsunami was 46 ft. high and breeched the 19 ft. seawall that was meant to protect the Fukushima plant. The backup diesel generators did not survive the tsunami, and only batteries remained to power the cooling systems. The batteries lasted eight hours. Eight of the 11 reactors in the vicinity successfully went into "cold shutdown" mode and continued to circulate water, thanks to the use of portable diesel generators. Yet, as David Biello, writing for Yale Environment 360 notes, "it is unclear why more generators weren't put into service to cool the reactors."[2] According to a report in the New York Times, an anonymous nuclear executive

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[1] Biello, David. "Anatomy of a nuclear crisis: A chronology of Fukishima." Yale Environment 360, March 21 2011.

[2] Ibid.

said that in the immediate aftermath of the earthquake, “Fukushima plant officials focused their attention on a storage pool for spent nuclear fuel at the No. 2 reactor at Daiichi...The damage prompted the plant’s management to divert much of the attention and pumping capacity to that pool, the executive added. The shutdown of the other reactors then proceeded badly, and problems began to cascade."[3]

By 6:00 p.m., the water level in reactor No. 1 was falling, and the fuel in that reactor was eventually exposed. Around 7:00 pm, Prime Minister Naoto Kan declares a “state of nuclear emergency,” while reassuring the public that the proper procedures were being followed and that no radioactive leaks had been detected. One official stated, “It's possible that radioactive material in the reactor vessel could leak outside but the amount is expected to be small and the wind blowing towards the sea will be considerable."[4] However, after the uranium fuel in the No. 1 reactor became fully exposed, and damage to the central core began, the government ordered an evacuation notice for those living with a 3- kilometer radius of Fukushima I Power Plant.[5]

Early the next morning, the plant’s operator, Tokyo Electric Power Company (TEPCO), observed that pressure was rising inside reactor No. 1, doubling the normal operating pressure. This provided evidence that not enough water was reaching the core, causing steam to build up. By dawn, pressure was rising at another disconnected power plant, Fukushima Daini, but backup systems worked properly at that site. At this juncture, Tokyo Electric Power Company personnel decided to begin venting reactor No. 1 to alleviate some of the pressure and prevent the bursting of the vessel that houses the nuclear core. This move meant that radioactive gases would be shifted from the inner chamber to the wider building. As a result, the government expanded the evacuation to 20,000 residents with 3-km radius of Fukushima II and 10-km of Fukushima I.[6]

Pump failures, however, meant that the fuel rods could not be cooled. As a result, the casing of these rods swelled and cracked, releasing radioactive particles to the building. More urgently, the high temperatures in the core caused oxygen to be stripped from the surrounding steam, leaving hydrogen gas to spread throughout the facility. Hydrogen gas is extremely explosive at high enough concentrations, and thus the venting led to an explosion that blew off the roof of the building housing the reactor, injuring 4 workers. While the explosion was not thought to cause damage to the main reactor, the Japanese government further extended the evacuation zone, now covering a population of approximately 100,000 residents, and began distributing iodine pills to stave off radiation poisoning. Pumping of seawater began in a “desperate bid” to cool the reactor, with the use of fire trucks and hoses.[7]

By the following day, radiation levels within Fukushima Daiichi power plant exceeded government- designated safe limits. In the following days, the fuel in reactor No. 3 and reactor No. 2 would also become exposed, resulting in leakage of nuclear waste from these reactors and

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[3] Broad, William J., and Tabuchi, Hiroko. “In stricken fuel-cooling pools, a danger for the longer term.” The New York Times, 14 March 2011.

[4] Evans, Martin. “Japan nuclear crisis: Timeline of official statements.” The Telegraph, 15 March 2011. Accessed 8 August.

[5] Biello, 2011.

[6] Ibid.

[7] Ibid.

threatening a partial meltdown.[8] The operation to vent and then refill the reactors with seawater and boric acid to halt the progress of the nuclear reactions was expanded to these reactors. Another hydrogen explosion ripped through reactor No. 3 building, injuring 7 workers and 4 soldiers. The cooling system of No. 2 reactor completely failed, and to prevent another hydrogen explosion workers cut a hole in the building. At this time, Tokyo Electric Power Company believed the spent fuel rod storage pool at reactor No. 4 was overheating, threatening a criticality accident – or an increase in radioactivity transmitted to the surrounding areas. Radioactivity was detected up to the dangerous level of 1 Sievert/hour, at which point Japanese Prime Minister Kan urged those within 30 km of unit 4 to remain indoors. Within a few days, the government banned shipment of certain agricultural products from areas surrounding the nuclear incident. [9]

Initially, the Japan Atomic Energy Agency rated the incident as a Level 4 on the International Nuclear and Radiological Event Scale, implying an "accident with local consequences,"[10] while France's ASN maintained that the event should be rated Level 5 or Level 6, implying wider consequences or even "a serious accident."[11] To compare, Three Mile Island was a Level 5 and Chernobyl was a Level 7, or a "major accident."

It is important to keep in mind the role of party politics in the response to this crisis. For over 50 years, the Liberal Democratic Party ruled Japan. Prime Minister Kan's party, the Democratic Party was relatively new to power and was deeply suspicious of Japan's powerful nuclear industry, and had traditionally favored the interests of those opposed to the nuclear industry's activities. Furthermore, Kan bypassed the established disaster response system, which he felt was controlled by forces hostile to his rule, instead relying on a circle of trusted advisors to provide information. This partially explains why his government only learned of the existence of Speedi, or the System for Environmental Emergency Dose Information, a full five days into the crisis. This knowledge could have prevented many of the evacuated citizens from heading straight towards the radioactive plume.[12]

Prime Minister Kan's suspicions of Tokyo Electric Power Company may have had a negative impact on the company's response during the weekend following the tsunami, as the company was caught between satisfying the Prime Minister and abiding by International Atomic Energy Agency guidelines that local personnel should respond to disasters. The Tokyo Electric Power Company was also slow to release information to the government or to the public in the aftermath of the quake, as they moved to "play down the risks at the plant." The New York Times reported that, not fully grasping the gravity of the situation, "the Kan government essentially left the handling of the nuclear crisis in the crucial first three days to TEPCO, focusing instead on relief efforts for the hundreds of thousands left homeless..."[13] Only after learning of the Tokyo Electric Power Company's intention to withdraw from the plant did Kan visit the

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[8] Grimston, Malcolm. "Fukushima: What happened - and what needs to be done." BBC. 10 April 2011.

[9] Ibid.

[10] Maeda, Risa. "Japan rates quake less serious than Three Mile Island, Chernobyl." Reuters, 12 March 2011.

[11] "French nuclear agency rates Japan accident 5 or 6." Reuters UK. 14 March 2011.

[12] Onishii, Norimitsu and Flackler, Martin. "In nuclear crisis, crippling mistrust." The New York Times, June 12.

[13] Ibid.

company's executives and take control of the situation by assigning one of his most trusted advisors to coordinate with the company.

A month after the earthquake, nuclear officials changed its severity rating to Level 7, the same as the Chernobyl disaster, though highlighting the differences in characteristics of the crises. By May, Prime Minister Kan announced that Japan would abandon plans to build new nuclear reactors, saying his country needed to "start from scratch" to create a new energy policy.[14] Kan left power in September after the political debacle that followed the crisis.

As of August 2013, contaminated water was still leaking into the ocean at a rate of 300 metric tons daily.[15] According to reports in August, Tepco had avoided disclosing "spiking levels of radioactive elements in groundwater near the sea – in some cases hundreds of times higher than the legal limit."[16] Prime Minister Abe pledged government assistance to addressing the problem: "Prime Minister Shinzo Abe told a nuclear-disaster task force Wednesday that he had asked the plant operator, Japanese regulators and the minister in charge of overseeing the site's cleanup to ramp up measures to figure out where the contaminated water was coming from and stop it from spreading."[17] However, the Nuclear Regulation Authority proposed raising the rating of the seriousness of the leak to a level 3: serious incident, and urged Tepco to take precautionary measures. They also said that plant workers overlooked signs of the leak, and that these safety measures were not taken as seriously as they ought to. Tepco also revealed in August that the leak indeed might be leaking into the ocean.[18] It is becoming ever more clear that cleaning up the radioactive water after the failure is more difficult and complex than anticipated, and can significantly impact the cleanup – and could itself become a new disaster.

History of Fukushima Daiichi Nuclear Power Plant

Fukushima Daiichi, also known as Fukushima I Nuclear Power Plant, began operation in 1971. The facilities are located in the towns of Okuma and Futaba, in Fukushima Prefecture, along Japan's northeastern coast. It is Japan's oldest nuclear plant and was the first nuclear power plant to be completely built and operated by the Tokyo Electric Power Company, one of ten regional electric companies in Japan. The facility houses six boiling water reactors – an older nuclear technology – while two more were in the planning phase prior to the nuclear incident this March.[19] These units were set to begin construction in 2012, but following the accident at the facility, the Tokyo Electric Power Company formally abandoned these plans. Prior to the disaster, the reactors at Fukushima Daiichi produced nearly 10% of Japan's total nuclear power output, placing it among the 15 biggest nuclear power stations in the world.[20]

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14 "Earthquake, Tsunami and Nuclear Crisis" The New York Times. 9 August 2011.

15 Iwata and Dvorak, "Abe Pledges to Help Tepco with Water Leaks" August 2013.

16 Ibid.

17 Ibid.

18 Associated Press. "Fukushima Plant Has 300-Ton Water Leak." 20 August 2012.

19 "Nuclear Power in Japan." World Nuclear Association. 2011.

20 Ibid.

The original plans for the plant had it located on a bluff 35 meters above sea level, to make it safer from tsunamis. However, the company determined that no tsunami over 3.1 meters would hit the plant, and shaved the bluff 25 meters, to 10 meters above sea level, thereby reducing the cost of the plant's operations. We now know that these determinations were based on falsified and incomplete reports on the part of TEPCO.[21] As part of its application to start operations, the Tokyo Electric Power Company cited a 1966 report stating the region was "an area of low-seismicity, even compared with all the other areas of the country," and the government gave the company the go-ahead to begin construction.[22] Following recommendations from the Japan Society of Civil Engineers, Tokyo Electric decided to shore up the facility to have it withstand tsunamis up to 5.7 meters. Additionally, Tetsuo Ito, head of Kinki University's Atomic Energy Research Institute, has said the close proximity of the 6 reactors, while designed initially to increase efficiency, now seems like "a bad idea."[23]

By 1979, all six units had come online. Prior to the accident in March, the plant's worst safety incident occurred in 1978, when fuel rods fell into reactor, causing an uncontrolled chain reaction that briefly caused a nuclear reaction. Tokyo Electric claimed that the incident was quickly brought under control.[24] The plant was also involved in the Tokyo Electric Power Company's data falsification scandal of 2002, when it emerged that compressed air was "improperly injected into the containment vessel" during an inspection in 1991 and 1992. When this information came to light, Japanese regulators ordered the company to shut down the plants at Fukushima Daiichi for inspections.[25] Ten days before the earthquake struck Japan's northeast coast, the Tokyo Electric Power Company submitted a report to Japan's nuclear regulators admitting that the company failed to inspect 33 pieces of equipment and that its internal inspectors faked records during their inspections. The regulator had ordered the company to examine the thoroughness of the company's inspections, and it was found that the company did not inspect the functionality of aspects related to the safety cooling mechanisms.[26]

There were numerous warnings issued by various agencies about the design of Fukushima Daiichi nuclear power plant. In 2008, the International Atomic Energy Agency warned Japan that its safety guidelines were outdated, and that the country's reactors would only be able to withstand an earthquake of magnitude of 7.0 or less, potentially facing a "serious problem" in the face of a larger earthquake. The government responded by constructing an emergency response center at Fukushima Daiichi's facilities, but did not change the design basis of its earthquake regulations.[27] According to a report by Yale Environment 360, the core containment system used in Fukushima Daiichi could be prone to radioactive leaking, a conclusion supported by reports of the U.S. Atomic Energy Commission dating back to 1972.[28] Yet Japanese regulators

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21 Fecht, Sarah. "1 Year Later: A Fukushima Nuclear Disaster Timeline." Scientific American. 8 March 2012.

22 Yoshidi, Reiji and Fukada, Takahiro."Fukushima plant site originally was a hill safe from tsunami." The Japan Times. 12 July 2011.

23 Shirouzu, Norihiko and Smith, Rebecca. 2011. "Plant's design, safety record are under scrutiny." The Wall Street Journal, 16 March 2011.

24 Ibid.

25 International Energy Agency."Energy policies of IEA countries: Japan – 2003 review." 2003.

26 "Operator of Fukushima nuke plant admitted faking repair records." Herald Sun. 20 March 2011.

27 "IAEA warned Japan over nuclear quake risk: WikiLeaks." 2011. Indian Express, 17 March. 2011.

28 Biello, 2011.

granted the Tokyo Electric Power Company a 10-year license extension for Fukushima Daiichi Unit 1 in February 2011.[29]

In 2011, following the disaster, the plant was only accessible by government authorities. The plant remains closed as of this writing, considered "idle". In February 2013, Prime Minister Shinzo Abe announced that due to improved safety regulations, the idled plants would be reopened later in 2013.[30] The plants would have to pass the guidelines, which would be monitored by a new watchdog agency, Nuclear Regulation Authority.

Japan's Reliance on Nuclear Power

To many commentators, the central puzzle in the wake of Japan's nuclear crisis was how a country with a long history of severe earthquakes, and the only country to experience a nuclear attack, would be so vulnerable to a nuclear disaster. To understand this, one must consider the history of Japan's reliance on nuclear power. Japan built its first commercial nuclear power reactor in 1966. Nuclear energy has been a "national strategic priority" for the Japanese government since 1973 and its reliance on nuclear power has increased steadily since then.[31] As of 2011, 30% of Japan's electricity came from nuclear power, making it the largest source of power generated domestically, and the third largest type of power consumed in the country (including domestically generated power and imported power sources). Prior to the Fukushima disaster, there were plans to substantially increase nuclear capacity, with a target to generate half the country's electricity from nuclear power by 2030.

Today, Japan is considered a world leader in nuclear technology, and a major exporter of nuclear technology. However, Japan's reliance on nuclear power did not happen overnight. Understanding their nuclear dependence calls for a look at Japan's history in the postwar period. The New York Times explains, "the push for nuclear power underpinned postwar Japan's focus on economic growth and its dream of greater energy independence."[32] Following the war's devastation, Japanese leaders focused their efforts internally, actively pursuing a policy of industrial-based economic growth. Securing an adequate supply of energy became a critical issue as the country started to rebuild. In fact, this issue was so important that it became a backbone of the Japanese notion of "comprehensive security" – energy and economic concerns were considered essential elements of national security policy in addition to traditional military issues.[33] Energy policy has long been a critical issue for the Japanese state, which issued its first long-term energy policy in 1967, a full decade before the United States Department of Energy was created during the Carter administration.[34]

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[29] World Nuclear Association, 2011

[30] Fackler and Tabuchi. "Japan to Begin Restarting Idled Nuclear Plants, Leader Says" 2013.

[31] Ibid.

[32] Onishi, Norimitsu."'Safety Myth' Left Japan Ripe for Nuclear Crisis." The New York Times, 24 June 2011.

[33] Katzenstein, Peter J. and Nobuo Okawara. "Japan's National Security: Structures, Norms, and Policies." International Security 17.4 (1993) 84.

[34] Fukasaku, Yukiko. "Energy and Environment Policy Integration: The Case of Energy Conservation Policies and Technologies in Japan." Energy Policy. 23.12. (1995) 1064.

Underlying Japan's shift towards nuclear is the simple fact that Japan is resource poor, especially when it comes to fossil fuels or uranium. The country produces less than 2% of its oil and gas needs domestically.[35] Additionally, while Japan does have some modest coal resources, and despite explicit policies in the late 1940s aimed at increasing the supply and promoting the use of domestic coal, mining for Japanese coal proved to be more expensive than importing fossil fuels.[36] Furthermore, Japan lacks any domestic uranium deposits, exposing even its nuclear industry to the hazards of international vulnerability. Finding ways to mitigate its energy vulnerability has been a cornerstone of Japan's foreign and domestic policy for decades. Despite this focused effort, Japan's economy – the third largest in the world– remains highly dependent on imports to fuel its growth. According to the Energy Information Agency of the United States Department of Energy, 84% of Japan's total primary energy supply is imported – making Japan the world's third largest consumer of imported oil after the United States and China, and the largest importer of liquefied natural gas and coal.[37] Japan's postwar reconstruction was an economic miracle, but it was based on imported resources.

Minimizing the effects of resource vulnerability is perhaps the main consideration of Japan's energy policy, and at least partially explains why its leaders have consistently shown a preference for developing nuclear power. "Indeed the idea of Japan as a small and isolated island nation, easily held hostage in a hostile international environment, still retains a very powerful hold over Japanese thinking." Japan's "extreme dependence on foreign sources of energy and other raw materials" underscores the notion of a dangerous international environment that resonates with most Japanese citizens.[38] In Japan, energy security and economic security go hand-in-hand.

It is against this backdrop that nuclear power emerged as a very attractive energy option. Since the end of World War II, Japanese policymakers have opted for technological solutions to facilitate energy independence.[39] The need for a large-scale and primarily domestic solution was made more apparent after the oil shocks of the 1970s, and nuclear power was seen as the best bet. Thus, policymakers took steps to lower reliance on fossil fuels, using nuclear energy as the main leverage point. The goal has been to soften the consequences of such energy vulnerability, thus Japanese energy policy has included measures such as energy efficiency, new resource development, and diplomacy, alongside a committed policy that encourages nuclear power as part of an overall diversification strategy to reduce the country's dependence on foreign oil.[40] Some risks would have to be endured; the risks of nuclear safety were deemed as being less severe than an energy policy without a nuclear option, in which Japan would be nearly completely dependent on international imports.

However, economic security considerations, while significant, do not fully explain Japan's dependence on nuclear power. Nuclear power also forms an important element of the country's environmental policy, particularly with respect to reduced carbon emissions. "Japan's debate

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35 Takase, Kae and Tatsujiro Suzuki. "The Japanese energy sector: Current situation, and future paths." Energy Policy (2010).

36 Fukasaku, 1995. 1064.

37 Energy Information Association. "Country Analysis Briefs: Japan." Department of Energy, 11 March 2011.

38 Katzentein and Okawara, 98-99.

39 Ibid. 106.

40 IEA. 23.

closely mirrors those worldwide, as governments highlight nuclear power as an easier way to cut carbon emissions than boosting wind and solar power."[41] Before the 2011 nuclear accident in Japan, President Obama advocated a new generation of nuclear power in the United States, while Japanese leaders touted nuclear power as the main vehicle to achieve a 75% reduction of carbon emissions from 1990 levels by 2020.[42]

Historically, Japanese energy policy developed alongside environmental policy dating back to the Basic Law for Environmental Pollution Control enacted in 1967 introducing environmental quality standards for emissions and ambient air quality. It was during this period that public awareness of environmental issues spiked: "During the two decades of high economic growth after the war, environmental concerns were overshadowed by economic priorities. The result was a severe deterioration of the environment by industrial pollution which caused serious health hazards, such as the well-known Minamata disease."[43] Following this heightened interest, the government collaborated with industry to promote integration of environmental considerations into energy policy. Yukiko Fukasaku writes, "Among the OECD countries, Japan has achieved one of the lowest energy intensities and has been successful in reducing emissions of key air pollutants and CO^2 associated with energy use while maintaining a relatively high rate of economic growth, indicating that in Japan energy and environment policies have been able to address each other effectively."[44]

In 2002, Japan ratified the Kyoto Protocol and issued new global warming guidelines that closely mirrored previous environmental regulations, emphasizing technological solutions and economy-wide efforts to enhance energy efficiency, along with a cooperative role by industry in energy policy.[45] In terms of energy supply, "the plan is based on three main elements: the addition of new nuclear capacity, the accelerated introduction of new and renewable energy sources and a subsidy to encourage fuel-switching from coal to gas-based generation."[46] According to Uchiyama's analysis of potential carbon mitigation in Japan's power sector, nuclear power plants release much less carbon than fossil fuel plants, with nuclear-related carbon emissions occurring indirectly from construction, operation and maintenance of nuclear plants.[47]

Based on these considerations, the role of nuclear power with respect to greenhouse gas (GHG) mitigation was expanded. The Ministry for Economy, Industry and Trade (METI) issued "Japan's Nuclear Energy National Plan," which called for a continuation of its target to meet 30%-40% of electricity generation from nuclear fuel, beyond the year 2030, along with goals to improve the existing nuclear technology.[48] Subsequently, in 2008, then-Prime Minister Fukuda announced

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41 Adams, Jonathan. "Earthquake prone Japan sees green in new nuclear plants." Christian Science Monitor, March 1 2010.

42 Kurczy, Stephen. "Why earthquake-prone Japan relies on nuclear power." Christian Science Monitor, March 14 2011.

43 Fukasaku, 1995. 1064.

44 Ibid., 1063.

45 IEA, 37.

46 Ibid., 40.

47 Uchiyama, Yohji. "Present Efforts of Saving Energy and Future Energy Demand/Supply in Japan." Energy Conservation and Management. (2002): 43. 1128.

48 Takase and Suzuki, 2010.

the "Fukuda Vision" of energy and environmental policy, calling for an expansion of the GHG emissions reductions into the medium and long-term, and greater emphasis on "zero emissions electricity," which includes mainly nuclear power and large hydroelectric plants.[49] However, Japan's electricity market had recently been liberalized, potentially threatening the cost-competitiveness of nuclear power. Based on this threat and in order to shore up the future viability of nuclear power, the government issued new policies to reduce the financial risk to utilities to build new plants or develop new, more productive nuclear technology.

Japan's reliance on nuclear power is a complex issue. It is due to this complexity that the International Energy Agency, noting that there is no perfect energy option for a country like Japan, recommended that energy "measures be analyzed on the basis of their contribution to the environment, the economy and energy security."[50]

The Regulation of Nuclear Power in Japan

In the aftermath of the Fukushima disaster, some commentators have written that Japan's authorities were caught off guard by the nuclear disaster. In order to understand the effectiveness of nuclear power regulation in Japan, we must ask the question: did the inadequate response in the immediate aftermath of the disaster stem from deficiencies in the legal framework regulating nuclear power? In other words, had the proper regulatory structure been in place, would the damage have reached the same proportions?

Regulation of the industry was more or less contemporaneous with the start of Japan's nuclear power program. Less than 10 years after the end of World War II, Japan began a nuclear research program. In 1955, one year after the research program started, the government introduced the Atomic Energy Basic Law, the bedrock of Japan's nuclear regulatory regime. This law enshrined three principles as the foundation for any subsequent nuclear program: democratic methods, independent management, and transparency. In 1956, the Atomic Energy Commission (AEC) was created, which officially began promoting nuclear power development and utilization as a component of the government's energy policy.[51] The AEC is a statutory body that is authorized to "plan, discuss and decide on" the nation's nuclear policy and development program. The AEC develops Long-Term Plans that are renewed every 5 years.[52]

Under the Atomic Energy Basic Law, several bodies were created to govern various aspects of the nuclear industry. The Nuclear & Industrial Safety Agency (NISA), housed in METI, is responsible for nuclear safety, licensing as well as the design of nuclear plants, and regulating the production and transmission of nuclear power. The Nuclear & Industrial Safety Agency is the main body in charge of conducting safety inspections. This agency also incorporated the duties of the Science & Technology Agency for the safety of test and research reactors and nuclear fuel facilities.[53] However, in addition to safety-related oversight, duties related to the promotion of

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[49] Ibid.

[50] IEA, 44.

[51] World Nuclear Association, 2011.

[52] IEA, p. 108.

[53] World Nuclear Association, 2011.

nuclear policy also reside within METI, with the Agency of Natural Resources and Energy (ANRE)'s Electricity and Gas Utility Department.[54] This Natural Resource and Energy organization is also involved in helping Japanese companies win contracts overseas.[55] In line with the Nuclear Safety Convention, which states that safety oversight should be separate from the promotion of the nuclear power industry, the Nuclear & Industrial Safety Agency reports directly to the METI minister and not to the head of ANRE.[56] However, The New York Times notes that officials often moved between departments of nuclear oversight and nuclear promotion, blurring the distinctions within METI[57].

Moreover, in addition to The Nuclear & Industrial Safety Agency and the Atomic Energy Commission, the Nuclear Safety Commission (NSC), set up under the Atomic Energy Basic Law, is a senior government body responsible for nuclear sector policy formation specific to safety issues. While The Nuclear & Industrial Safety Agency is the primary regulatory agency regarding nuclear safety, the Nuclear Safety Commission, housed separately within the Cabinet office, monitors the administrative procedures of The Nuclear & Industrial Safety Agency – redundancies designed to ensure the integrity of the "double- check system." The regulatory and oversight system was reviewed favorably as recently as 2005, at a meeting of the Convention on Nuclear Safety.[58]

In 2002, the Tokyo Electric Power Company data falsification scandal led to major regulatory change to strengthen the integrity of the regulatory process. The regulatory work of the Nuclear & Industrial Safety Agency was supplemented with inspections by an independent organization, the Japan Nuclear Energy Safety Organization (JNES). The Japan Nuclear Safety Organization strengthens the implementation of safety regulations by replacing voluntary self-assessments by plant operators with mandatory inspections backed by harsher penalties.[59] Around the same time as these reforms, the nuclear industry shored up its own internal safety procedures. Power companies, along with other firms involved in the business of nuclear power, established the Nuclear Safety Network (NSnet), which was conceived to "enhance the safety culture" of the nuclear industry through knowledge sharing and the incorporation of industry-wide peer reviews.[60]

The aspect of Japan's regulatory structure that has drawn the most attention right after the Fukushima disaster is its seismic regulations. Because of the country's history of seismic activity, Japan's legal framework places great emphasis on the siting, design and construction of nuclear plants. Individual components are tested through a complex regulatory mechanism. Further, the Regulatory Guide for Reviewing Seismic Design of Nuclear Power Facilities was updated in 2006 to increase, by a factor of 1.5, the minimum requirement of seismic activity that a nuclear plant

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54 IEA, p. 109.

55 Shirouzu, Norihiko and Tudor, Alison. "Crisis Revives Doubts on Regulation." The Wall Street Journal, March 15 2011.

56 IEA, p. 109.

57 Onishi, Norimitsu and Belson, Ken. "Culture of Complicity Tied to Stricken Nuclear Plant." The New York Times. April 26 2011.

58 Nuclear and Industrial Safety Agency. NISA. "Summary of Safety Regulation in Japan." NISA. May 24 2011.

59 IEA, p. 107.

60 World Nuclear Association, 2011. p. 21.

must be able to withstand.[61] Still, the likely frequency or magnitude of earthquakes varies by region. Following the Kobe earthquake of 1995 – which had a magnitude of 7.2 – the NSC concluded that, under guidelines then on the books, nuclear plants could survive an earthquake up to a magnitude of 7.75, with facilities maintaining their safety functions even after an earthquake hits. The last upgrade of the seismic design criteria at Fukushima happened in 2008, and the recent earthquake did not exceed the Tokyo Electric Power Company's figures.[62] Whether the guidelines were sufficient to prevent disaster remains to be seen and critics have claimed that nuclear companies circumvented these seismic regulations anyway.[63] Further criticism focused on additional details such as the tsunami seawall height and the location of backup generators at ground-level as safety mistakes that a country familiar with seismic regulations should not have missed.

Despite the existence of this large web of regulation, some observers continued to doubt the integrity of Japan's nuclear safety protocols. A major concern of these critics is whether the public can be sure that their interests are served given the deep connections between Japan's political parties, regulators and utility and nuclear companies. A recent report documenting financial donations to Japan's Liberal Democratic Party highlight these concerns, as the nuclear industry was revealed as playing an extremely large role in the party's finances.[64] A June 2011 article in The Wall Street Journal, in which a former inspector criticized what he considered lax safety-management practices, along with a systematic effort to downplay criticisms within the regulatory bodies, reinforces these concerns.[65] We also now know about TEPCO ignoring many historical indicators about the potential size and scale of tsunami waves- another gap in safety regulations.[66]

Moreover, claims of regulatory or industry capture abound as data shows official after official taking jobs at the Tokyo Electric Power Company and other utilities after leaving positions at regulatory agencies.[67] Critics argue that officials failed to adequately police and regulate the companies at which they would later seek employment. "At TEPCO, from 1959 to 2010, four former top-ranking ministry officials successively served as vice presidents at the company. When one retired from TEPCO, his junior from the ministry took over what is known as the ministry's 'reserved seat' of vice president at the company."[68] Additionally, critics point to inadequate technical training by regulatory officials and note that the Nuclear & Industrial Safety Agency, lacking its own engineering experts, needed industry experts from nuclear power-related companies, to create the regulations, leading to less stringent standards.[69]

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61 World Nuclear Association, "Nuclear Power Plants and Earthquakes."

62 Ibid.

63 Onishi, Norimitsu and Martin Fackler. "Japanese Officials Ignored or Concealed Dangers." The New York Times. 16 May 2011.

64 "Utilities, LCD long held cozy ties in Japan." *Japan Times*. 2011, July 29.

65 Hayashi, Yuka. "Former inspector complains of regulators' practices." The Wall Street Journal, 15 June 2011.

66 Kitamura, M. and Shiraki, M. "Tepco Ignored Warnings About Tsunami Risk, Ex-Lawmaker Says." Bloomberg. 18 March, 2011.

67 Onishi and Belson. 2011.

68 Ibid.

69 Ibid.

Was industry capture as widespread as critics claim and was it a contributing factor leading up to the Fukushima Daiichi disaster? A regulatory structure that favors the industry it was set up to oversee cannot adequately guard against abuse and accidents. After detailed and long term investigations the actual role of industry capture in the Fukushima disaster has been that collusion and failed regulatory structure were the main reasons for the disaster, as opposed to the earthquake. Studies show that the crisis could have been prevented through the use of proper regulatory structure.[70] Japan's nuclear regulatory capture is derived from its regulatory structure. There are three nuclear organizations- Japan Atomic Energy Commission (AEC), Nuclear Safety Commission (NSC), and Nuclear and Industrial Safety Agency (NISA). The general administration is done by NISA, which is a division of the Ministry of Economy, Trade and Industry (METI), which is also responsible for promoting the nuclear industry. NISA, METI and the nuclear power industry share common interests in promoting nuclear energy as a carbon-free energy source, which would lower Japan's reliance on foreign fuels. This promoter-regulator conflict makes Japan unique since countries like the United States split these functions long ago. NISA seeks profits from nuclear power but is also responsible for safety inspections. This crisis could potentially lead to Japan splitting these functions.[71]

To rectify this issue of conflict of interest, the Japanese government established the Nuclear Regulation Authority (NRA). Housed in the cabinet, the NRA is charged with establishing and maintaining nuclear safety. The NRA, unlike the NISA, is housed under the Ministry of Environment, instead of the Ministry of Economy, Trade and Industry. The Chairman of the NRA is Shunichi Tanaka and his mandate is to improve safety when (or if) Japan resumes nuclear capacity. The newly proposed regulation is split into three parts: 1) Design Basis Safety Standards, 2) Severe Accident Measures; and 3)Safety Standards Relative to Earthquakes and Tsunamis.

<u>Part I Design-Basis Safety Standards</u>

- Structures, systems and components (SSCs) of critical importance for plant safety must meet strict requirements taking into account common technical standards, rules and guidelines. In particular, safety standards for design basis (DB) should be re-established, taking into careful consideration the lessons of Fukushima, the latest state-of-the-art knowledge and experience on nuclear safety at the national and international level including the safety standards developed and issued by the IAEA.
- Safety measures against natural phenomena (e.g., tornados, forest fires) and external man-made hazards (e.g., an aircraft crash), the reliability of off-site power supply, ultimate heat sink and the functions of SSCs, as well as fire protection measures on site should be strengthened.

<u>Part II Severe Accident Countermeasures</u>

- A strict application of Defense-in-Depth with the layer 4th or more will henceforth become a mandatory regulatory requirement including severe accident management (SAM) that has hitherto stayed on discretionary judgment of licensees.
- Licensees shall be bound by regulation to take countermeasures against:
    - Severe core damage under multiple failures;

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[70] Maeda, R. and Sieg, L. "Japan's atomic disaster due to 'collusion:' panel report. Reuters. 5 July 2012.

[71] Grossman, Karl. "'Nuclear 'Regulatory Capture'- A Global Pattern." Huffington Post. 13 July 2012.

    - Containment vessel failure;
    - Severe fuel damage in spent fuel storage pools; and
    - Severe fuel damage in a reactor during shutdown.
- Licensees shall also take measures:
    - To improve the safety margin of equipment for DB requirement against natural phenomena and external man-made hazards;
    - To establish procedures to cool reactors, containment vessels and spent fuel storage pools and to minimize the release of radioactive materials following large scale natural hazards or acts of terrorism;
    - To construct specific safety facilities (SSFs) designed for the case of terrorism actions (such as an intentional aircraft crash), in order to suppress the release of radioactive materials due to containment damage;
    - To prepare systems to suppress the release of radioactive materials outside the site in the case of containment failures; and
    - To prepare an evaluation of the effectiveness of countermeasures against severe accidents.

Regulations are functional requirements in nature. Accordingly, the followings are examples. Equivalent or better measures are acceptable.

- For heat removal and depressurization of a containment vessel in the event of severe core damage: “filtered containment vessel venting system”.
- For injecting coolant into the bottom of a containment vessel in the event of severe core damage in order to cool melted core: “permanent and portable equipment (e.g., pump trucks, pressure resistant hoses)” which shall be redundant, diversified, independent and dispersed over a wide area.
- For preventing a hydrogen explosion in a containment vessel: “hydrogen concentration control equipment” and “hydrogen and radioactive material
- concentration measurement equipment” to measure during severe core damage.
- For preventing criticality, shielding and cooling the fuel in spent fuel storage
- pools in the event of Beyond Design Basis Accident (B-DBA): “portable alternate
- cooling water injection equipment (e.g., cooling water injection line).
- For mitigating fuel damage and preventing criticality: “spray equipment”, which
- shall be prepared as portable spray equipment (e.g., spray headers, spray lines,
- pump trucks).
- For securing make-up water
- For mitigating fuel damage and preventing criticality: “spray equipment”, which shall be prepared as portable spray equipment (e.g., spray headers, spray lines, pump trucks).
- For securing make-up water and water sources: “multiple alternate freshwater sources (e.g., water storage tanks, dams, reservoirs)”, as well as sea water as a water source to provide sufficient water from the time when a B-DBA occurs until the time when the accident is managed.
- For securing DC power sources: onsite DC power source equipment able to provide electricity for 8 hours without load-shedding plus 16 hours with load-shedding.
- For requiring AC power sources: power generation vehicles and connecting facilities.
- For the control room: an “emergency control room” shall be installed in case operators cannot remain in the main control room.

Emergency Response Center: the center shall be prepared to command the site in the case of severe accident, and shall not lose their functions due to a design basis earthquake, and shall not be impacted by a design basis tsunami.

Procedures and Drills: Licensees shall develop, in advance, procedures, a personnel drill plan and a necessary system that allow an accurate and flexible handling of B-DBA .

Specific Safety Facilities (SSFs)

- SSFs are designed to suppress the unexpected release of large amounts of radioactive materials due to acts of terrorism (including aircraft crash).
- SSFs shall be located far enough away from reactor buildings to prevent simultaneous failures from terrorism actions (e.g., over 100 meters).
- SSFs shall be designed to withstand a design basis earthquake and a design basis tsunami (earthquake resistant structures, in watertight buildings and/or located on high ground).
- SSFs shall be installed with equipment to prevent containment vessel failure.

Part III Earthquakes and Tsunamis

- Although the "Regulatory Guidance for Reviewing Seismic Design of Nuclear Power Reactor Facilities" was revised in September, 2006, by the former Nuclear Safety Commission, further protective measures against earthquakes and tsunamis should be enhanced.
- In this regard, protective measures (e.g., sea walls against tsunamis, anti-inundation measures, no construction of Class S nuclear facilities on the exposure of active faults) should be prepared in line with a more stringent approach on earthquake, active faults and tsunami assessments.[72]

The Politics of Nuclear Power in Japan

Critics within Japan and around the world have criticized the government's performance in the immediate aftermath of the nuclear crisis. Norimitsu Onishi of The New York Times called into question the government's intentions in some of the actions they pursued while handling the crisis:

> With radiation levels too high for workers to approach the reactors, the Japanese authorities floundered. They sent police trucks mounted with water cannons — equipment designed to disperse rioters — to spray water into the reactor buildings. Military helicopters flew over the buildings, dropping water that was scattered off course by strong winds, in a "performance, a kind of circus" that was aimed more at reassuring an increasingly alarmed Japanese population and American government, said Kenichi Matsumoto, an aide to Prime Minister Naoto Kan.[73]

Furthermore, Onishi and others criticized Japan's overall level of preparedness for a nuclear catastrophe. Most troubling was how Japan – a country proud of its reputation as the world's

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[72] Nuclear Regulation Authority. "Overview: Draft New Safety Standards for Nuclear Power Stations, NRA, Japan: January 2013"

[73] Onishi, 2011.

leader in cutting-edge technology – systematically allowed a series of basic failures in the technology of its nuclear safety. He points to the nuclear industry's "overall reluctance to improve maintenance and invest in new technologies," which complicated and even compromised the immediate response to the disaster.[74]

Undeniably, the mistakes and miscalculations of specific individuals contributed to the inadequacy of Japan's official response to the crisis. It came out that TEPCO tried to abandon the plant after the disaster occurred, while they denied this strongly in their report.[75] But some attribute this surprising unpreparedness to a collective attitude towards nuclear power, an attitude that has been actively shaped since the advent of Japan's nuclear program. Even though nuclear power was deemed a national strategic priority, the government had to ensure national acceptance of such a fraught program, given the chilling memory of nuclear weapons. Immediately, nuclear policy gained the backing of major industrial players in Japan, including electric utilities and the construction industry. Much of Japan's post-war economic growth was attributable to these two sectors. Japan's major party during the post war era, the Liberal Democratic Party, has long favored the interests of the nuclear[76] and construction industries, adopting an electoral strategy that marginalizes environmentalist and anti-nuclear groups.[77] Given the party's influence over Japanese politics over much of the last half-century, the steady development of nuclear power is unsurprising.

However, nuclear siting laws in Japan require that the authorities win over local populations wherever nuclear sites are proposed. Local governments have the authority to veto nuclear plant operations, making acceptance from local communities a matter of vital importance.[78] Even if national sentiment ebbs against the expansion of nuclear capacity, there is no guarantee that such a factor alone could mitigate the expansion of nuclear capacity, so long as localities are willing to continue housing the plants. In addition, there are many new financial issues that pose as a double-burden.[79] To soothe local opposition to nuclear plant siting, former Prime Minister Kakuei Tanaka created "a sophisticated system of subsidies" that funneled money from electricity consumers to communities with nuclear plants.[80] Plants were often built in remote areas that are typically economically depressed. Payouts directly to the citizens in these areas provide a valuable and much-needed source of income, which then become indispensable over time, in a sort of "structure of dependency." These funds – and, by extension, nuclear power itself - provide vital resources and support modern facilities that these cash-strapped communities come to depend on. Affected groups, like farmers and fisherman, are further placated with transfer payments that total up to $600,000 per person.[81] In this way, the

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74 Ibid.

75 Aoki, M and Rothwell, G. "A comparative institutional analysis of the Fukushima nuclear disaster: Lessons and policy implications." Energy Policy. 2013; 53: 240-7.

76 "Utilities, LDP long held cozy ties in Japan." 2011, July 29. Japan Times.

77 Cohen, Linda, McCubbins, Matthew and Rosenbluth, Frances. 1994. "The politics of nuclear power in Japan and the United States." p. 3.

78 IEA, 106.

7979 Aoki and Rothwell, 2013.

80 Fackler, Martin and Norimitsu Onishi. "In Japan, a Culture That Promotes Nuclear Dependency." The New York Times. 2011 30 May.

81 Ibid.

government used the revenue generated from nuclear plants as a lever to ensure and even deepen local support for the nuclear industry.

Beyond these subsidies, the nuclear industry, together with allies in the government, set out to convince the country of the merits and necessity of domestic nuclear energy. As a result, public opinion towards nuclear energy was crafted over the decades in a way that downplayed the possibility of nuclear accidents and emphasized only the safety of the technology. This so-called "nuclear village" cultivated a full-fledged public relations machine with hundreds of millions of dollars pouring in from the government and the utilities, promulgating a message that nuclear power was "absolutely safe." The Japan Atomic Energy Relations Organization was created for just this purpose, and receives 60 percent of its budget from plant operators and 40 percent from two ministries that oversee nuclear power. They created lavish public relations buildings that have become tourist attractions, operated a consistent advertising and educational campaign, and even fostered connections with the nation's educational department that revised national textbooks, all to propagate the message of nuclear safety. [82]

Until the events of 2011, the nuclear safety issue was a fringe issue in Japan's politics. Unlike in the United States and many other countries where nuclear safety is a major political issue, in Japan, major incidents such as Three Mile Island and Chernobyl barely registered in the public consciousness. The impact of these major international events has been negligible in shaping attitudes towards nuclear power, generating no major shifts in the debate surrounding the appropriateness of nuclear power or in the country's nuclear policy. Some public opposition did emerge, but the politics and mood favoring nuclear power did not change:

> Public officials were unrelenting in defending their knowledge of what was best for the nation. In addition, opinion polls throughout the 1980s and 1990s showed that: 1) a majority of Japanese found Japan's nuclear power plants "safe" or "somewhat safe" and 2) a large majority of those who supported development of nuclear power believed that nuclear power was the key to energy independence. These views allowed officials to discount protests as short-term, selfish economic anxiety. They effectively used financial rewards and compensation to dampen discontent. Little attention was given to the legitimacy of public concerns on safety.[83]

The drive to transform Japan into a "nuclear state" continued. Chernobyl only caused the nuclear establishment's public relations machine to ramp up its campaign to convince the public of the technology's absolute safety.[84] Even after a few small scale nuclear incidents within Japan, a 2005 poll conducted by the International Energy Agency found that 82 percent of Japanese still favored the maintenance or expansion of nuclear capacity.[85] Prior to the Fukushima disaster, 12 new nuclear plants were either planned or under construction – in addition to the 54 existing nuclear plants in the country.

The major consequence of this massive public relations effort was that it created an apathetic attitude regarding the quality of safety measures. As a result, while the public was lulled into a

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82 Onishi, 2011.

83 Kotler, Mindy L., and Hillman, Ian T. "Japanese Nuclear Energy Policy and Public Opinion. Japan Information Access Project. (2000). p 4.

84 Onishii, 2011.

85 Ramana, M.V. 2011. Nuclear power and the public. Bulletin of the Atomic Scientists, 67(4): p. 43.

false sense of security - "the operators and nuclear regulators, believing that accidents would never occur, steadfastly opposed the introduction of what they regarded as unnecessary technology."[86] The thinking within the inner circles of Japan's nuclear industry was that safety measures would actually inspire fear in the public and do more harm than good. This false sense of security has been dubbed the "safety myth" and goes a long way towards explaining why Japanese officials were unprepared for the events that unfolded in March 2011. Banri Kaeeda, head of METI, has stated: "In Japan, we have something called the 'safety myth.'...It's a fact that there was an unreasonable overconfidence in the technology of Japan's nuclear power generation...*The nuclear industry's thinking about safety had a poor foundation."[87]

However, there are indications that conditions that have long enabled the expansion of nuclear policy are starting to erode. The downward spiral began after the accident at a fuel facility in 1999, which led to the death of two workers. According to Mindy L. Kotler and Ian T. Hillman:

> "Trust in the government's nuclear energy policy, whether real or constructed, evaporated after the September 1999 Tokaimura criticality accident. Workers at a JCO fabrication plant, ignoring safety procedure, mixed several times the maximum safe amount of uranium in buckets, causing a nuclear chain reaction. Three workers suffered serious radiation poisoning (two died), and significant amounts of radiation were released into the environment for a brief period. Subsequent International Atomic Energy Agency and Japanese government reports focused on the human error and faulty procedures resulting in the accident, but the real question on the public's mind was why the government hadn't been able to prevent the incident.[88]

Furthermore, two data falsification scandals, especially the Tokyo Electric Power Company scandal of 2002, have undermined trust in the nuclear industry. Tokyo Electric Power Company admitted to falsifying plant safety tests, and it was later revealed that the company also suppressed plant inspection records indicating improper procedures at one of their Fukushima Daiichi units. Pointing to these and other incidents, the International Energy Agency argued in 2005 that "the most significant challenge" for the nuclear industry is to reestablish public support for nuclear power. While public opinion does not play as large a role in Japan as it does in Western democracies, it has a serious impact on the local political processes involving nuclear power.

Since the turn of the 21st century, this has created a relatively new condition in Japanese politics, a "political sensitivity" to nuclear power. Kotler and Hillman show, "the nuclear accidents have contributed greatly to shattering public confidence in government and corporate nuclear oversight." This shift reflects a broader reshuffling taking place in Japanese politics, which has historically been dominated by the influence of the central government but is gradually coming to reflect public opinion and local concerns in a more efficacious way.[89] Even before recent events, trust in central government began wearing away. Beyond nuclear power, trust in major institutions has declined as Japan has suffered what appears to be a period of long term economic decline. Popular movements demanding reform have become more commonplace in

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86 Onishii, 2011. [75] Ibid.,

87 Ibid.,

88 Mindy Kotler and Ian Hillman Hillman, "Japan Nuclear Energy Policy and Public Opinion" May 2000. p 22. [77] Kotler and Hillman, p 13.

89 Kotler and Hillman, p. 13.

Japanese politics. The nuclear crisis only deepens and solidifies this trend. There is a very clear "fork in the road" for nuclear energy in the world- Japan and Germany have gone one route, while the US and UK have taken the other, which bring about problems of public opinion and fear, environmental justice and ethical issues.[90] As The Economist wrote, "the meltdown at the Fukushima Daiichi power plant is forcing a reexamination of Japan's most influential institutions," including the power companies, academics, bureaucrats, and the media – potentially laying the groundwork for a post-nuclear Japan.[91]

The government has been supporting Tepco through this cleanup process, "with a ¥1 trillion ($10.30 billion) injection of capital, [but] it hasn't directly taken charge of or budgeted money for work being done to clean up, control or dismantle the reactors. Other money Tepco has received so far from the government to help with accident compensation and decontamination is in the form of loans that the utility is supposed to repay in the future. That has left the battered utility to handle a task that is expected to take up to 40 years and trillions of yen."[92] This complex power structure is underscored by a changing political regime.

The new Prime Minister, Shinzo Abe, takes the opposite approach of his predecessor. With a new watchdog agency in place, Abe plans to reinvigorate the nuclear industry in Japan. His hope centers around the fact that the economy is hurting in the two years since the disaster, with the Japanese needing to fill the displaced source of energy with much more expensive (and foreign) sources of oil and gas. "Leaders from the previous Democratic Party government had vowed to slowly phase out nuclear power by the 2030s in favor of cleaner alternatives like solar and wind power. But Mr. Abe, who took power after his Liberal Democratic Party won national elections in December on a platform of economic revitalization, said the phaseout would keep Japan from the cheap electricity it needs to compete economically."[93] With support weaning for nuclear in Japan, and the cleanup still underway, the balance of safety and economic security is crucial. The new regulations, "surprised many for their toughness, though skeptics worry that industry supporters in the government will manage to get around the regulations."[i] Strict though they may be, as of now none of the 19 reactors are expected to pass. As of August 2013, only 2 of Japan's 50 nuclear reactors were on, with plans to restart postponed to restart 16 of them by March 2015.[94]

Should Japan Continue Its Nuclear Program?

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90 Butler, C; Parkhill, KA; Pidgeon, NF. "Nuclear Power After Japan: The Social Dimensions. Environment. November-December 2011.

91 "A question of trust: Japan's nuclear crisis is eroding deference to authority." The Economist. 14 July 2011.

92 Iwata and Dvorak, "Abe Pledges to Help Tepco with Water Leaks" August 2013.

93 Fackler and Tabuchi. "Japan to Begin Restarting Idled Nuclear Plants, Leader Says" 2013.

94 Rueters. "Japan may restart nuclear reactors next summer: Highly radioactive water still seeping into ocean 2 years after disaster" 2013.

Following the nuclear crisis, the Tokyo Electric Power Company decided to decommission units 1-4 at Fukushima Daiichi, in addition to abandoning its plans to build two additional reactors. In July 2011, Prime Minister Kan stated that Japan should reduce and eventually eliminate its dependence on nuclear energy. Such a policy change would represent a radical shift, and given Kan's depressed approval ratings, it is unclear whether such a policy change would succeed. Now that a new administration is in power, the reverse course seems to be happening. The current state of limbo of the fate of the nuclear industry is not very secure for the Japan economy and citizens. Similarly, the health of the people still suffering two years later should not be ignored by rushing back into a nuclear-dependent society.

The nuclear industry has fared poorly in the debates following the crisis, and its reputation and status as a pillar of the Japanese economy may be threatened. But, with oil susceptible to supply shocks and price [78] fluctuations, there seem to be few ready alternatives to nuclear energy for Japan's policymakers. They had invested so much in nuclear energy, both for energy security and for climate policy, that other avenues remain underdeveloped. It is unclear how Japan could meet its energy demand without nuclear, at least in the short run. Replacements such as renewables are appealing, but not nearly at the scale necessary - only 5% of the country's energy comes from renewable sources of energy, for example. After the Fukushima disaster, Japan escaped heavy energy shortages because of the strict energy efficiency measures by citizens. Despite the success of these efficiency actions, this would not be a long term sustainable solution.[95]

Furthermore, many communities near existing or proposed nuclear plants remain dependent on the web of influence exuding from the nuclear industry and its government supporters. To be successful, lawmakers must craft a policy that enables these communities to not only withstand the shift away from nuclear, but to prosper from the change. Complicating matters further, the broad Japanese public is far more cautious in general about nuclear safety. In a 2011 poll of Japanese residents, 74 percent of respondents said they supported phasing out nuclear power with the goal of abandoning it entirely.[96] Local opposition may make it politically and economically impossible to continue the nuclear program, as the costs for developing new or re-opening old plants could become prohibitive.

In the wake of the 2011 crisis, and in the two years following, the political climate in Japan has turned against its leaders. Political leaders used to enjoy a great deal of deference in Japanese politics, but that is beginning to change. Widespread protests have emerged, criticizing not just the handling of the crisis by the nuclear industry, but the deep political ties that created a culture that downplayed or overlooked safety precautions. Gaining public acceptance and industry buy-in for an energy policy that requires a major government role will likely be difficult in the near to medium-term. After Kan's stepping down, Yoshihiko Noda has tried to stay away from nuclear power. However, Prime Minister Shinzo Abe has reignited attention on these idled nuclear plants with a desire for cheap electricity in order to compete internationally.[97] While health issues are still being dealt with from the disaster, the political issue is complex. Japanese society successfully turned to energy efficiency and reduction in demand to make up for

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95 Aoki and Rothwell, 2013.

96 Tabuchi, Hiroko. "Japan Premier Wants Shift Away From Nuclear Power." The New York Times. 13 July 2011.

97 Fackler, Martin. "Japan to Begin Restarting Idled Nuclear Plants, Leader Says." The New York Times. 28 February, 2013.

shortfalls in the immediate aftermath of the Fukushima crisis, but the country still requires a long-term solution to its energy needs.

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[i] Ibid.