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ABSTRACT

The March 11, 2011 tragedy at the Fukushima Daiichi power station in Japan immediately etched its place in history as arguably the most noteworthy of the three nuclear energy disasters to date. This Article surveys the response to Fukushima both in Japan and worldwide. It observes that rather than stopping what many thought was a burgeoning "nuclear renaissance," the global policy reaction post-Fukushima was more varied. Using the examples of Germany, the United States, and China, the Article examines the three general approaches to nuclear energy that nations have followed since Fukushima: abandonment, status quo, and expansion. The Article then uses these different responses to highlight core tensions in energy policy, namely, between markets and planning, between resilience and path dependence, and in values. The Article concludes by summarizing Fukushima's likely impact on nuclear power going forward, noting the inherent complexity in energy and energy law and policy systems.

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I. INTRODUCTION

"That place is finished. It's only fit for ghosts."[1] That is how one former resident of Japan's Fukushima Prefecture now describes the area that, on March 11, 2011, suffered the triple devastation of a 9.0 earthquake, its ensuing tsunami, and, then, a triple meltdown of the Fukushima Daiichi nuclear power station.[2] Indeed, the meltdown at Fukushima undeniably changed the place—so much so that, in an effort to assure the public of the government's rehabilitation efforts, national politicians in Japan, including the Prime Minister, have taken to television, drinking water from the site and eating peaches grown in the region, to advertise the area's safety.[3]

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1. Hannah Beech, *The World's Most Dangerous Room*, TIME (Aug. 21, 2014), http://time.com/worlds-most-dangerous-room/ [http://perma.cc/QMV6-KYK2] (archived Sept. 6, 2015).

2. For more details on the disaster itself, see, for example, INST. FOR NUCLEAR POWER OPERATIONS, SPECIAL REPORT ON THE NUCLEAR ACCIDENT AT THE FUKUSHIMA DAIICHI NUCLEAR POWER STATION (Nov. 2011), http://www.nei.org/corporatesite/media/filefolder/11_005_Special_Report_on_Fukushima_Daiichi_MASTER_11_08_11_1.pdf [http://perma.cc/R4U9-9TMK] (archived Sept. 6, 2015); FUKUSHIMA NUCLEAR ACCIDENT INDEP. INVESTIGATION COMM'N, THE OFFICIAL REPORT OF THE FUKUSHIMA NUCLEAR ACCIDENT INDEPENDENT INVESTIGATION COMMISSION, THE NATIONAL DIET OF JAPAN (2012) [hereinafter INVESTIGATION REPORT], https://www.nirs.org/fukushima/naiic_report.pdf [https://perma.cc/N4DH-27Q2] (archived Sept. 6, 2015); THE SASAKAWA PEACE FOUND., THE FUKUSHIMA NUCLEAR ACCIDENT AND CRISIS MANAGEMENT: LESSONS FOR JAPAN-U.S. ALLIANCE COOPERATION (Sept. 2012), http://www.spf.org/jpus/img/investigation/book_fukushima.pdf [http://perma.cc/4TRU-X95X] (archived Sept. 6, 2014); WORLD NUCLEAR ASS'N, *Fukushima Accident* (Sept. 6, 2015, 6:17 PM), http://www.world-nuclear.org/info/safety-and-security/safety-of-plants/fukushima-accident/ [http://perma.cc/B2M9-3Q5J] (archived Sept. 6, 2015).

3. *Id.*; Robert Mackey & Ravi Somaiya, *Japanese Official Drinks Water from Fukushima Reactor Buildings*, N.Y. TIMES (Nov. 1, 2011), http://thelede.blogs.nytimes.com/2011/11/01/japanese-official-drinks-water-from-fukushima-reactor-buildings/ [http://perma.cc/5LQ6-6H9V] (archived Sept. 6, 2015).

The fateful events of March 11 began simply enough. A massive earthquake in the middle of the Pacific Ocean unleashed an equally enormous tsunami that quickly reached Japan's coastline.[4] The earthquake itself automatically disabled Fukushima Daiichi's reactors, just as they were designed to do. But when the tsunami's waves struck, they engulfed the facility's backup diesel generators, which had been located in the basement and on the ground floor.[5] Then all havoc ensued. Unable to restore power to the facility—and thus to keep coolant water flowing—plant operators worked bravely but in vain to stop what quickly became unavoidable: a meltdown of three of the facility's reactors and a fire in Building 4, which housed spent fuel rods.[6] Much in contrast to the disaster's beginnings, its aftermath was, and continues to be, vastly complex. Japan established exclusion zones around the facility, evacuated scores of residents, stopped producing electricity using nuclear technology nationwide (until only recently), and eventually began cleaning up the site, a process that is expected to take decades.[7] As one worker put it at the time, "[i]f we're in hell now all we can do is to crawl up towards heaven."[8]

Of course, the disaster unleashed on Fukushima—an area that before the devastation was described as "picture-postcard,"[9] "a placid landscape of fishing villages, rice paddies and dairy farms,"[10] "a place with the 'feel of Maine: organic farms, pine forests, coastal towns where the air is spiked with sea salt'"[11]—is not limited to Japan alone. In the weeks and months after the meltdowns, calls that the disaster would unalterably shift the way energy is produced on this planet were not uncommon. As 2011 began, many eyed nuclear power

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4. *See supra* note 2.

5. Howard Chua-Eoan, *How to Stop a Nuclear Meltdown*, TIME (Mar. 12, 2011), http://www.time.com/time/world/article/0,8599,2058615,00.html [http://perma.cc/K9A2-E5K3] (archived Oct. 16, 2015); Evan Osnos, *The Fallout: Seven Months Later: Japan's Nuclear Predicament*, NEW YORKER, Oct. 17, 2011, at 46, http://www.newyorker.com/magazine/2011/10/17/the-fallout [http://perma.cc/EUD7-Q4NH] (archived Oct. 16, 2015).

6. O.M., *Piecing Together Fukushima*, ECONOMIST (May 5, 2011, 8:53 AM), http://www.economist.com/blogs/babbage/2011/05/japans_nuclear_disaster [http://perma.cc/Y2MM-XK2P] (archived Oct. 16, 2015).

7. *See infra* Part II.

8. *Letters from Fukushima: Tepco Worker Emails*, WALL ST. J. (Mar. 28, 2011, 8:21 PM), http://tinyurl.com/5skvh2l [http://perma.cc/E4FR-U3A6] (archived Oct. 16, 2015) (internal quotation marks omitted).

9. David McNeill, *Fukushima No. 1's Scary Shadow: Bucolic Farm Belt Now No-Go Zone of Radioactivity*, JAPAN TIMES, Mar. 31, 2011, http://www.japantimes.co.jp/text/nn20110331f1.html [http://perma.cc/LV2T-HU5X] (archived Sept. 13, 2015).

10. Beech, *supra* note 1.

11. Lincoln L. Davies, *Beyond Fukushima: Disasters, Nuclear Energy, and Energy Law*, 2011 B.Y.U. L. REV. 1937, 1946 (quoting Evan Osnos, *The Fallout: Letter from Fukushima: Seven Months Later: Japan's Nuclear Predicament*, NEW YORKER, Oct. 17, 2011, at 46, 55).

as a key tool to mitigate climate change, with some saying its importance for this purpose would lead to a "nuclear renaissance."[12] By March 11, however, all that changed. As the scope of destruction at Fukushima Daiichi became clear, many more said the tragedy would be the death knell for the nuclear industry.[13]

This Article surveys the impact that the disaster in Japan has had on nuclear power and energy policy across the globe—Fukushima's "shadow." The core point is that while common sense might predict that a disaster as devastating as Fukushima would fundamentally alter the global energy landscape, in fact the opposite is true. Rather than halting the growth of nuclear power, the paths that nations have chosen diverge. Post-Fukushima, a few nations decided to abandon nuclear energy, but many others have stayed the course, and some are expanding their investments in this resource. Thus, from an energy policy perspective, the story of Fukushima's aftermath is more complex and nuanced than might be expected.

As such, Fukushima's aftermath also provides insight into global energy policy. Specifically, the disaster at Fukushima—and countries' reactions to it—exposes three key tensions that undergird energy policy worldwide: those between markets and planning, between path dependence and resilience, and in energy values. These tensions in energy policy, in turn, highlight why energy decision making is so difficult. Energy systems form the basis of modern life, from economic security to industrial expansion. At the same time, modifying how energy is produced, transported, and used is a key target for constituents interested in protecting the basic ecological systems on which life relies. There are thus strong reasons for governments to intervene in how energy markets function, depending on what aim—or aims—they want to promote. Yet, the sheer massiveness of the energy system makes planning and change difficult. As a result, those

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12. *E.g.*, John F. Ahearne, *Prospects for Nuclear Energy*, 33 ENERGY ECON. 572, 573 (2011); Alexander Glaser, *After Fukushima: Preparing for a More Uncertain Future of Nuclear Power*, 24 ELECTRICITY J. 27, 27 (July 2011); Shinzo Saito, *Role of Nuclear Energy to a Future Society of Shortage of Energy Resources and Global Warming*, 398 J. NUCLEAR MATERIALS 1, 6 (2010).

13. Following the meltdowns, for instance, Christopher Flavin, President of Worldwatch, proclaimed that "the Fukushima disaster is an historic—if not fatal—setback" for the nuclear industry. *The End of Nuclear*, WORLDWATCH INSTITUTE, http://www.worldwatch.org/end-nuclear, (last visited Sept. 6, 2015) [http://perma.cc/WDR5-GZD8] (archived Sept. 6, 2015). This was a common sentiment, as the media and other observers suggested that the nuclear industry might well wilt given the risk that the Fukushima disaster made so clear. *See, e.g.*, Eben Harrell, *Fukushima: The End of the Nuclear Renaissance?*, TIME (Sept. 4, 2011), http://science.time.com/2011/03/14/fukushima-the-end-of-the-nuclear-renaissance/ [http://perma.cc/BX8G-LCR7] (archived Sept. 6, 2015); Per Lekander et. al., *Can Nuclear Power Survive Fukushima?*, UBS (Apr. 4, 2011), http://suomenkuvalehti.fi/wp-content/uploads/sk/files/pdf-liitteet/118095_QSeries-Nuclear%20Power.pdf [http://perma.cc/EX78-BYNJ] (archived Sept. 6, 2015).

who want to foment change may try to seize on a disaster like Fukushima as a key opportunity, but the fact that even great disasters do not always yield hard turns in energy policy should not be surprising. The energy system is incredibly complex, and so too are the legal and policy systems that govern it, as often must be the case. When one system's complexity increases, the complexity of those around it typically must as well in order to interface.[14] The variety in global responses to Fukushima is yet one more manifestation of this.

This Article proceeds in five parts. Part II describes the response in Japan to the Fukushima disaster since March 11, 2011. Focusing on the examples of Germany, the United States, and China, Part III summarizes three categories of global reaction that followed in nuclear policy: abandonment, status quo, and expansion. Part IV then uses the lens of Fukushima to briefly explore the three core tensions in energy policy. Part V concludes.

II. THE CLOUD: THE FUKUSHIMA DISASTER AND ITS AFTERMATH IN JAPAN

Time will tell, but odds are good that the triple meltdown at Fukushima Daiichi may eventually assume the place of the most significant nuclear energy disaster in history, eclipsing even Chernobyl. This is because, quite simply, the disaster is not yet over. "[T]he nightmare continues."[15]

In the four years since the tsunami struck, the scope of the havoc that Fukushima's failure unleashed on Japan has not diminished. Rather, as more study is done, and as efforts to clean up the region continue, the full impact of the disaster has continued to be revealed. In many ways, then, the cleanup efforts are much like a slow-motion autopsy—the full scope of the disaster's effects are discovered only iteratively, over a long period of time.

Thankfully, scientists believe that the meltdowns will not have any lasting health effects for the populace at large, with no known "deaths or cases of radiation sickness from the nuclear accident,"[16] even as 20,000 died from the tsunami itself.[17] A 2013 UN report thus

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14. *E.g.*, JOSEPH A. TAINTER, THE COLLAPSE OF COMPLEX SOCIETIES 119 (1988).

15. Kazuaki Nagata, *Fukushima No. 1's Never Ending Battle with Radioactive Water*, JAPAN TIMES, Mar. 11, 2015, http://www.japantimes.co.jp/news/2015/03/11/national/fukushima-1s-never-ending-battle-radioactive-water/#.VSl0OqZYgRY [http://perma.cc/6XLW-BBJW] (archived Sept. 13, 2015).

16. WORLD NUCLEAR ASS'N, *supra* note 2.

17. Hirok Tabuchi, *An Anniversary of 'Heartbreaking Grief' in Japan*, N.Y. TIMES (Mar. 11, 2012), http://www.nytimes.com/2012/03/12/world/asia/a-year-later-

concluded, "[r]adiation exposure following the nuclear accident at Fukushima Daiichi did not cause any immediate health effects" and is "unlikely" to result in "any health effects in the future among the general public and the vast majority of workers."[18] Other experts agree. A "sweeping" $958 million public health survey being conducted by Fukushima Medical University determined that almost all evacuees from the disaster received very low radiation doses—maxing out at 25 millisieverts (mSv), "well below the 100-mSv exposure that has been linked to an increased risk of cancer."[19] Likewise, the World Health Organization has observed that "no observable increases in cancer above natural variation in baseline rates are anticipated" from Fukushima.[20]

That is the good news. The other side of the story is that Fukushima Daiichi's detrimental effects are both far-reaching and severe. The meltdowns forced an estimated 150,000 people to evacuate their homes to avoid radiation, and today nearly 120,000 remain displaced because of the disaster.[21] The government has

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effects-of-japans-disaster-are-still-unfolding.html?_r=0 [http://perma.cc/942G-YNPQ] (archived Sept. 6, 2015).

18. Press Release, Information Service, No Immediate Health Risks from Fukushima Nuclear Accident Says UN Expert Science Panel, U.N. Press Release UNIS/INF/475 (May 31, 2013), *available at* http://www.unis.unvienna.org/unis/en/pressrels/2013/unisinf475.html [http://perma.cc/3YWX-PUTL] (archived Sept. 6, 2015).

19. Geoff Brumfiel & Ichiko Fuyuno, *Japan's Nuclear Crisis: Fukushima's Legacy of Fear*, NATURE (Mar. 7, 2012), http://www.nature.com/news/japan-s-nuclear-crisis-fukushima-s-legacy-of-fear-1.10183 [http://perma.cc/C56X-EFM2] (archived Sept. 6, 2015); Geoff Brumfiel, *Fukushima: Fallout of Fear*, NATURE (Jan. 16, 2013), http://www.nature.com/news/fukushima-fallout-of-fear-1.12194 [http://perma.cc/WR6C-8BA9] (archived Sept. 6, 2015). The survey seeks to monitor the health of 2 million people from the Fukushima region for 30 years.

20. WORLD HEALTH ORG., HEALTH RISK ASSESSMENT FROM THE NUCLEAR ACCIDENT AFTER THE 2011 GREAT EAST JAPAN EARTHQUAKE AND TSUNAMI BASED ON A PRELIMINARY DOSE ESTIMATION (2013), *available at* http://apps.who.int/iris/bitstream/10665/78218/1/9789241505130_eng.pdf [http://perma.cc/553J-QLP2] (archived Sept. 6, 2015).

21. INVESTIGATION REPORT, *supra* note 2; *see also* Jiji, *More Fukushima Evacuees are Deciding to Stay Away for Good*, JAPAN TIMES, Mar. 4, 2015, http://www.japantimes.co.jp/news/2015/03/04/national/more-fukushima-evacuees-are-deciding-to-stay-away-for-good/#.VfXfrbEo7IU [http://perma.cc/336Z-3TCY] (archived Sept. 13, 2015); Beech, *supra* note 1 ("Fukushima Daiichi nuclear power plant—ground zero of the worst atomic meltdown since Chernobyl."); Julie Makinen, *After 4 Years, Fukushima Cleanup Remains Daunting, Vast*, L.A. TIMES (Mar. 11, 2015), http://www.latimes.com/world/asia/la-fg-fukushima-nuclear-cleanup-20150311-story.html [http://perma.cc/NM24-5QSN] (archived Sept. 6, 2015) (stating that 20,000 citizens of Minamisoma remain evacuated); Rick Noack, *3 Ways the Fukushima Nuclear Disaster is Still Having an Impact Today*, WASH. POST (Mar. 12, 2015), https://www.washingtonpost.com/news/worldviews/wp/2015/03/12/3-ways-the-fukushima-nuclear-disaster-is-still-having-an-impact-today/ [https://perma.cc/PB9B-247S] (archived Sept. 6, 2015) (stating that the catastrophe caused 300,000 people to have to evacuate); Megan Rowling, *Japan Makes a Start on Sharing Lessons From Nuclear Crisis*, REUTERS (Mar. 26, 2015), http://www.reuters.com/article/2015/03/27/us-japan-disaster-

drawn a twenty-kilometer (12.4 mile) exclusion zone around the power station and continues to limit entry to areas farther outside that.[22] Many of these evacuees "now subsist in prefab units" that are "more evocative of a third-world disaster zone than the world's third largest economy."[23] The evacuation has both split families and caused measurable mental anguish for the displaced.[24] According to one assessment, roughly 15 percent of evacuated adults "showed signs of extreme stress, five times the normal rate, and one in five showed signs of mental trauma—a rate similar to that of the first responders to the attacks of September 11, 2001 in the United States."[25] Meanwhile, evacuated children "showed stress levels about double the Japanese average," a result perhaps hardly surprising given that nuclear refugees in Japan continue to receive regular thyroid examinations and health checks, and some have decided to wear dosimeters on a daily basis.[26]

The disaster also has imposed significant economic impacts. The additional fuel costs that Japan now pays because it, until recently, shut down its entire nuclear fleet are estimated at $28.82 billion per year, while residential electricity prices have increased almost 20 percent and industrial rates 30 percent.[27] The net effect is that in

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nuclear-idUSKBN0MN03M20150327 [http://perma.cc/B644-EWEY] (archived Sept. 6, 2015) ("Of the 160,000 people who left their homes after the nuclear accident, around 120,000 are still classified as evacuees.").

22. *Fukushima Accident*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/info/Safety-and-Security/Safety-of-Plants/Fukushima-Accident/ (last visited Oct. 2015).

23. BEECH, *supra* note 1

24. *See id.* ("Stress, both physical and mental, has led to a rise in suicides."); *see also* Martin Fackler, *Forced to Flee Radiation, Fearful Japanese Villagers Are Reluctant to Return*, N.Y. TIMES (Apr. 27, 2014), http://www.nytimes.com/2014/04/28/world/asia/forced-to-flee-radiation-fearful-japanese-villagers-are-reluctant-to-return.html [http://perma.cc/SL2V-NKCC] (archived Sept. 6, 2015) (indicating that many evacuees are forced to live in barracks-like housing); Abigail Haworth, *After Fukushima: Families on the Edge of Meltdown*, GUARDIAN (Feb. 23, 2013), http://www.theguardian.com/environment/2013/feb/24/divorce-after-fukushima-nuclear-disaster [http://perma.cc/YJ63-PMX5] (archived Sept. 6, 2015) ("Marital discord has become so widespread that the phenomenon of couples breaking up has a name: *genpatsu rikon* or 'atomic divorce.'"); Justin McCurry, *Fukushima Nuclear Disaster: Three Years On 120,000 Evacuees Remain Uprooted*, GUARDIAN (Sept. 10, 2014), http://www.theguardian.com/world/2014/sep/10/fukushima-nuclear-disaster-japan-three-years-families-uprooted [http://perma.cc/JP8R-KMMH] (archived Sept. 6, 2015) (stating that close-knit families are forced to live separately and are in "nuclear limbo").

25. Brumfiel, *supra* note 19.

26. *Id.*; *see also* WORLD HEALTH ORG., *supra* note 20 (indicating that dosimeters were made available to all workers); Justin McCurry, *Fukushima's Children at Centre of Debate Over Rates of Thyroid Cancer*, GUARDIAN (Mar. 9, 2014), http://www.theguardian.com/world/2014/mar/09/fukushima-children-debate-thyroid-cancer-japan-disaster-nuclear-radiation [http://perma.cc/AA5J-T34P] (archived Sept. 6, 2015) (stating that fears of radiation negatively impact children's health).

27. Agence France-Presse, *Why is Nuclear Power Important for Japan?*, INDUSTRY WEEK (Aug. 13, 2015), http://www.industryweek.com/energy/why-nuclear-power-important-japan; *Japan Continues to Count Cost of Idle Reactors*, WORLD

fiscal year 2013, Japan depended on imported fossil fuels for 88 percent of its electricity production, as opposed to only 62 percent in the year before Fukushima.[28]

The cost of cleanup is even greater. The Japanese government has embarked on an ambitious effort to remediate radiation contamination in the areas outside the Daiichi plant—a task that neither "Herculean" nor "Sisyphean" adequately describes. Throughout the region, radiated leaves, straw, dirt, and other detritus now pile up in giant double-lined plastic bags as big as hot tubs waiting for collection and disposal. Altogether, decontamination is proceeding in 105 cities, towns, and villages and already has cost more than $15 billion, amassing 5.5 million bar-coded bags of radioactive waste totaling 157,420 tons.[29] The government aims to have the 12,000 workers performing this task complete it by 2017 and has promised to store the waste outside Fukushima.[30] So far, however, no such site has been located, and the interim plan is to put what is expected to be sixteen to twenty-two million bags of waste in a 6.2-square-mile specialized landfill—five times the size of Central Park—not far from the Daiichi plant.[31]

Japan also faces expenses beyond the immediate costs of cleanup. Fishing off the coast of Fukushima Prefecture remains suspended,[32] and other agricultural products from the region continue to be received skeptically, despite careful testing by the Japanese government.[33] Localities that host nuclear power plants are

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NUCLEAR NEWS (June 17, 2014), http://www.world-nuclear-news.org/np-japan-continues-to-count-cost-of-idled-reactors-1706144.html [http://perma.cc/8SPX-B96P] (archived Sept. 6, 2015).

28. *Id.*

29. *See* Makinen, *supra* note 21; Yomiyuri Shimbun, *Radioactive Waste Left in Limbo; Local Authorities Avoid Filing Paperwork For 3,600 Tons*, JAPAN NEWS (Apr. 3, 2015), http://the-japan-news.com/news/article/0002031113; *Prime Minister Vows New 5-Year Fukushima Recovery Plan*, GREENWIRE (Mar. 10, 2015), http://www.eenews.net/greenwire/2015/03/10/stories/1060014755 [http://perma.cc/NL4Z-QW5C] (archived Sept. 6, 2015) ("Japan has spent more than $15 billion on a project to lower radiation in towns near the plant.").

30. Makinen, *supra* note 21.

31. *Id.*

32. Julie Makinen, *4 Years After Fukushima, Japan Considers Restarting Nuclear Facilities*, L.A. TIMES (Mar. 30, 2015), http://www.latimes.com/world/asia/la-fg-japan-nuclear-20150330-story.html#page=1 [http://perma.cc/SD5E-LS3D] (archived Sept. 6, 2015). Limited trial fishing (involving limited offshore fishing and inspections of certain species before sell) resumed in August 2012. *See* JAPAN MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES, RESULTS OF THE MONITORING ON RADIOACTIVITY LEVEL IN FISHERIES PRODUCTS (last updated Jul. 31, 2015), http://www.jfa.maff.go.jp/e/inspection/ [http://perma.cc/M6JN-7CLK] (archived Sept. 6, 2015).

33. *See, e.g.*, *After Meltdown, Consumer Won't Drink Sake From Fukushima*, GREENWIRE (Jan. 15, 2015), http://www.eenews.net/greenwire/2015/01/15/stories/1060011729 [http://perma.cc/3F2P-ZL6F] (archived Sept. 6, 2015) (stating that consumers are concerned that radiation-tainted air made it into rice fields and water supplies); *Fukushima Rice Passes Radiation Tests*, GREENWIRE (Jan. 5, 2015),

losing substantial tax revenue because almost none of these facilities are running.[34] And the government has announced a $6.8 billion plan to build 440 seawalls—a so-called "Great Wall of Japan"—to protect nuclear facilities from vulnerabilities in the future.[35] Decommissioning the Daiichi plant itself is supposed to cost $8.5 billion, though the Tokyo Electric Power Company ("TEPCO") has said it will need another $8.7 billion over the next decade to cover "unanticipated" costs.[36] What's more, a recent audit estimated that TEPCO wasted more than a third of the $1.6 billion it spent on cleanup following the meltdowns.[37]

On the Daiichi site, decontamination and decommissioning are expected to take thirty to forty years to complete.[38] Nearly 7,000 workers storm the property each day to do the work,[39] and their biggest battle is the continually growing stock of radiated water. Because Daiichi sits next to the ocean, rain and groundwater flowing downhill to the sea constantly flood the damaged reactor buildings, producing 300 tons—or 80,000 gallons—of radiated water each day.[40] To deal with this wastewater, TEPCO is "endlessly" building giant storage tanks—one every two-and-a-half days—to contain the contamination.[41] This expansive farm of tanks, some of which have

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http://www.eenews.net/greenwire/stories/1060011086/search?keyword=Fukushima+Rice+Passes+Radiation+Tests [http://perma.cc/N5DR-KM7K] (archived Sept. 6, 2015) (noting that all rice grown in the area of the Fukushima Daiichi nuclear plant passed government radiation testing); Reiji Yoshida, *Radiation Checks Clear Most Food Items*, JAPAN TIMES (Mar. 7, 2014), http://www.japantimes.co.jp/news/2014/03/07/national/radiation-checks-clear-most-food-items/#.VSmRuqZYgRY [http://perma.cc/53Z9-MCZW] (archived Sept. 13, 2015).

34. *See* Martin Fackler & Norimitsu Onishi, *In Japan, a Culture That Promotes Nuclear Dependency*, N.Y. TIMES (May 30, 2011), http://www.nytimes.com/2011/05/31/world/asia/31japan.html [http://perma.cc/V7EB-UWMG] (archived Sept. 6, 2015) (stating that the No. 3 reactor promised "$690 million in property tax revenues spread over more than 15 years" once it became operational in 2012).

35. Nick Cunningham, *The $6.8 Billion Great Wall of Japan: Fukushima Cleanup Takes on Epic Proportion*, TIME (Mar. 24, 2015), http://time.com/3757069/japan-fukushima-cleanup/ [http://perma.cc/9856-2EZK] (archived Sept. 6, 2015).

36. Makinen, *supra* note 32.

37. Mari Yamaguchi, *Japan Audit: Millions of Dollars Wasted in Fukushima Cleanup*, AP: THEBIGSTORY (Mar. 24, 2015, 10:33 AM), http://bigstory.ap.org/article/75dd3b31041949b7bbd4de14a2d5b287/japan-audit-millions-dollars-wasted-fukushima-cleanup [http://perma.cc/YM8X-R6RZ] (archived Sept. 27, 2015).

38. *See* Cunningham, *supra* note 35 (indicating that it could take up to forty years to complete the work).

39. Makinen, *supra* note 32.

40. Nagata, *supra* note 15; *see also* Julie Makinen, *Inspectors Urge Japan to Dump Water From Fukushima Plant Into Ocean*, L.A. TIMES (Feb. 17, 2015), http://www.latimes.com/world/asia/la-fg-iaea-japan-water-fukushima-plant-20150217-story.html [http://perma.cc/JYB6-U399] (archived Sept. 6, 2015). By comparison, workers at Three Mile Island had just over 2 million gallons of *total* wastewater to deal with.

41. Beech, *supra* note 1; Nagata, *supra* note 15.

leaked, now numbers over 1,300, with more than 800,000 tons of water inside.[42] Moreover, the techniques being used to address problems on the site is the stuff of science fiction. To slow the buildup of contaminated water, TEPCO plans to surround the reactor buildings with a one-and-a-half-kilometer-long frozen wall of soil, which itself will have a barrier of forty-one wells, or "subdrain pits," to siphon off incoming groundwater.[43] And while it has been able to remove fuel rods from one of the four damaged reactor buildings on site,[44] TEPCO also plans to use a shape-changing robot to help see inside the other three.[45] Edwin Lyman, a nuclear expert with the Union of Concerned Scientists, thus deadpanned that the decommissioning process "has been a lot more complex than anyone imagined."[46]

Indeed, the cloud of Fukushima's effects spread widely through Japan. Before March 11, nuclear power comprised roughly one-third of the nation's electricity production. Today, all of the country's reactors but two remain offline, as many undergo upgrades to comply with stricter safety standards and others are decommissioned.[47] The effect on the nation's energy system is deep. Japan has begun burning

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42. *Path to Restoration: Contaminated Water Plagues Fukushima Decommissioning*, JAPAN NEWS, Mar. 7, 2015; *see also* Makinen, *supra* note 32; Nagata, *supra* note 15.

43. Nagata, *supra* note 15; *see also Fukushima Operator Struggles to Build Ice Wall to Contain Radioactive Water*, GUARDIAN (June 17, 2014), http://www.theguardian.com/ environment/2014/jun/17/fukushima-ice-wall-radioactive-water [http://perma.cc/6QCR-KRLA] (archived Sept. 6, 2015) (detailing the complicated process that is building a frozen wall of soil); Cunningham, *supra* note 35 ("TEPCO plans on building an intricate array of coolant pipes underneath the reactors, freezing the soil into a hardened ice wall that will block the flow of water."). The subdrain pits are expected to halve the volume of water entering the buildings, to 150 tons per day. Yomiuri Shimbun, *Release of Treated Water into Sea a Step Toward Fukushima Decommissioning*, JAPAN TIMES (Aug. 13, 2015, 7:28 PM), http://the-japan-news.com/news/article/0002353495.

44. Martin Fackler, *Fuel Rods Are Removed From Damaged Fukushima Reactor Building*, N.Y. TIMES (Dec. 20, 2014), http://www.nytimes.com/2014/12/21/world/asia/fuel-rods-are-removed-from-japans-damaged-fukushima-reactor.html [http://perma.cc/DX72-4SUP] (archived Sept. 6, 2015).

45. *Looking Inside Fukushima Daiichi Unit 1*, WORLD NUCLEAR NEWS (Feb. 10, 2015), http://www.world-nuclear-news.org/RS-Looking-inside-Fukushima-Daiichi-unit-1-1002154.html [http://perma.cc/T9GE-LQSC] (archived Sept. 6, 2015).

46. Makinen, *supra* note 32.

47. *See* Kentaro Hamada, *Japan Utilities Set to Scrap Five Aging Nuclear Reactors*, REUTERS (Mar. 17, 2015, 5:38 AM), http://www.reuters.com/article/2015/03/17/us-japan-nuclear-decommission-idUSKBN0MD0WX20150317 [http://perma.cc/WED3-Q2VD] (archived Sept. 27, 2015) (reporting that all of Japan's reactors were taken offline after the Fukushima disaster and as many as two-thirds may never return to service). Despite public opposition, Japan restarted its first nuclear reactor since the Fukushima accident in August 2015. Paul Armstrong, *Japan Restarts First Nuclear Reactor Since Fukushima Disaster*, CNN (Aug. 12, 2015, 9:52 PM), http://www.cnn.com/2015/08/11/asia/japan-nuclear-reactor/ [http://perma.cc/9XSF-UZGR] (archived Oct. 16, 2015).

record amounts of coal to make up for the gap left by the loss of nuclear power, increasing electricity production from this source by 6 percent.[48] Greenhouse gas emissions likewise are up 1.6 percent.[49] Nonetheless, the nation has also made substantial energy gains, with LEDs comprising 30 percent of all light bulbs sold since 2012 and a new goal in place to make all new public buildings and homes net-zero energy by 2030.[50]

Meanwhile, nuclear energy policy in Japan continues to yo-yo. The year before the disaster, the government had announced it would build fourteen new reactors, increasing the resource's share of electricity production from 30 to 50 percent by 2030.[51] After the meltdowns, then-Prime Minister Naoto Kan declared that Japan would abandon nuclear power, only to later clarify that his statement was a personal preference and not an official position.[52]

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48. *Japan Plans to Restart some Nuclear Plants in 2015 After Fukushima Shutdown*, U.S. ENERGY INFORMATION ADMINISTRATION (Feb. 11, 2015), http://www.eia.gov/todayinenergy/detail.cfm?id=19951 [http://perma.cc/7LYQ-V678] (archived Oct. 16, 2015); *Japan*, U.S. ENERGY INFORMATION ADMINISTRATION, http://www.eia.gov/countries/cab.cfm?fips=ja [http://perma.cc/G7RS-A7FC] (archived Oct. 23, 2015); *International Energy Statistics*, U.S. ENERGY INFORMATION ADMINISTRATION, http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=3&pid=26&aid=2 [http://perma.cc/3CWM-ZQUU] (archived Oct. 23, 2015); *see also With Nuclear Offline, Japan Turns to Coal*, CLIMATEWIRE, Mar. 16, 2015.

49. Aaron Sheldrick & Osamu Tsukimori, *As Japan Burns More Fuel, Climate Policies under Pressure*, REUTERS (Dec. 11, 2014), http://www.reuters.com/article/2014/12/12/climatechange-japan-idUSL3N0TL1U220141212 [http://perma.cc/NPC4-ZY3R] (archived Sept. 14, 2015).

50. *Nuclear Shutdown Sparks Energy Efficiency Gains*, GREENWIRE, Feb. 26, 2015.

51. Peter Drysdale, *Japan's Energy Options After Fukushima*, EAST ASIA FORUM (Sept. 5, 2011), http://www.eastasiaforum.org/2011/09/05/japans-energy-options-after-fukushima/ [http://perma.cc/MKP2-NFUB] (archived Sept. 14, 2015); Peter Fairley, *Japan Faces Post-Fukushima Power Struggle*, IEEE SPECTRUM (July 28, 2011), http://spectrum.ieee.org/green-tech/solar/japan-faces-postfukushima-power-struggle [http://perma.cc/9PSA-765U] (archived Sept. 14, 2015); *see also Bright Ideas Needed: Japan's Power Monopolies Raise Costs and Stifle Innovation*, ECONOMIST (Sept. 17, 2011); Suvendrini Kakuchi, *Energy-Saving 'Setsuden' Campaign Sweeps Japan After Fukushima*, GUARDIAN (Aug. 22, 2011), http://www.theguardian.com/environment/2011/aug/22/energy-saving-setsuden-japan-fukushima [http://perma.cc/S9CZ-2LMQ] (archived Sept. 14, 2015); Yoree Koh, *Summer's Over: 'Setsuden' Summer, That Is*, WALL ST. J. (Sept. 13, 2011), http://blogs.wsj.com/japanrealtime/2011/09/13/summers-over-setsuden-summer-that-is/ [http://perma.cc/N8L6-T222] (archived Sept. 14, 2015).

52. Drysdale, *supra* note 51; *Fukushima to Scrap Nuclear Plants: Prefecture Vows to Shift from Atomic to Renewable Energy*, JAPAN TIMES (July 16, 2011), http://www.japantimes.co.jp/text/nn20110716a4.html [http://perma.cc/FF2Z-5LQV] (archived Sept. 14, 2015); *Kan's Nuclear Phase-Out Plan Draws Anger over Lack of Details, Talks*, ASAHI SHIMBUN (July 14, 2011), http://ajw.asahi.com/article/0311disaster/fukushima/AJ201107144468 [http://perma.cc/N59H-8AM7] (archived Sept. 14, 2015); *Kan Says Call to End Nuclear Power Was Only a Personal View*, ASAHI SHIMBUN (July 15, 2011), http://ajw.asahi.com/article/0311disaster/fukushima/AJ201107154682 [http://perma.cc/FJ6P-MFL2] (archived Sept. 14, 2015); *see also* David Biello, *The Nuclear*

Subsequently, Kan's successor, Yoshihiko Noda, announced a compromise path: Japan would not build new facilities but would continue to use existing nuclear plants.[53] Since, the new government of Prime Minister Shinzo Abe has said that nuclear power will need to make up about 20 percent of electricity production long-term, and steps are being taken to restart some of the nation's nearly fifty idled reactors.[54] All this has taken place against a broader social backdrop that, just after the disasters, showed as many as 74 percent of Japanese citizens supporting a nuclear phaseout and 84 percent opposing the construction of new plants.[55] Even officials engaged in nuclear power production agree that Fukushima has changed the energy landscape. "We have to honestly and deeply reflect on the accident," TEPCO's managing executive officer, Takafumi Anegawa has said.[56] Akira Ono, Fukushima Daiichi's plant superintendent, concurs: "Because of the accident, nuclear energy is an issue that should be discussed again in our country."[57]

III. THE SHADOW: GLOBAL REACTIONS TO FUKUSHIMA

One would expect that the reverberations of any disaster as cataclysmic as Fukushima would be far-reaching. Particularly for an

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Odyssey of Naoto Kan, Japan's Prime Minister During Fukushima, SCI. AM., Oct. 16, 2013, http://www.scientificamerican.com/article/nuclear-power-odyssey-of-naoto-kan-former-japan-prime-minister-during-fukushima/ [http://perma.cc/8Q7C-THN6] (archived Sept. 27. 2015).

53. Hiroko Tabuchi, *Japan Leader to Keep Nuclear Phase-Out*, N.Y. TIMES (Sept. 2, 2011), http://www.nytimes.com/2011/09/03/world/asia/03japan.html [http://perma.cc/AZM4-AJY5] (archived Sept. 14, 2015) ("To build new reactors is unrealistic, and we will decommission reactors at the end of their life spans . . . . But it is also impossible to immediately reduce our dependence to zero.").

54. *Ruling Party Wants to Increase Nuclear Share of Energy Mix*, GREENWIRE, Apr. 3, 2015; *Nuclear Takes a Step Forward in Japan as Reactor Clears Regulatory Hurdle*, CLIMATEWIRE, Mar. 19, 2015; *see also* Martin Fackler, *Three Years After Fukushima, Japan Approves a Nuclear Plant*, N.Y. TIMES, Sept. 10, 2014, http://www.nytimes.com/2014/09/11/world/asia/japanese-nuclear-plant-declared-safe-to-operate-for-first-time-since-fukushima-daiichi-disaster.html [http://perma.cc/985E-B5YT] (archived on Sept. 27. 2015); Martin Fackler, *Warily Leading Japan's Nuclear Reawakening*, N.Y. TIMES, Mar. 20, 2014, http://www.nytimes.com/2014/03/21/world/asia/warily-leading-japans-nuclear-reawakening.html [http://perma.cc/CRR9-VCU3] (archived on Sept. 27. 2015). For more on the course of nuclear policy in Japan post-Fukushima, *see* T.N. Srinivasan & T.S. Gopi Rethinaraj, *Fukushima and Thereafter: Reassessment of Risks of Nuclear Power*, 52 ENERGY POL'Y 726, 732 (2013); Yang-Hyun Koo et al., *Radioactivity Release from the Fukushima Accident and its Consequences: A Review*, 74 PROGRESS IN NUCLEAR ENERGY 61 (2014).

55. *Opposition to Nuclear Energy Grows: Global Poll*, GLOBESCAN (Nov. 25, 2011) [hereinafter *BBC 2011*], http://www.globescan.com/images/images/pressreleases/bbc2011_nuclear_energy/bbc2011_energy.pdf [http://perma.cc/7TRL-E42F] (archived Sept. 14, 2015); Drysdale, *supra* note 51.

56. Beech, *supra* note 1.

57. *Id.*

industry like nuclear power, which long has been situated in an uneasy place,[58] common sense might predict that the triple meltdown at Fukushima would put the brakes on nuclear power. Thus, it came as no surprise that, in the disaster's immediate aftermath, many commentators fervently declared Fukushima Daiichi a "death knell" for the nuclear industry.[59]

There was something to these predictions. Public approval of nuclear power certainly declined worldwide after the disaster. For instance, a *BBC*-commissioned survey conducted in November 2011 of nearly 25,000 people in twenty-three countries found public opinion increasingly skeptical about nuclear energy: only 39 percent agreed that their country should continue using existing reactors (without building new ones), and 30 percent wanted to shut everything down immediately.[60] Likewise, an April 2011 *Reuters* survey revealed that 62 percent of respondents in twenty-four countries opposed nuclear power, and that more than a quarter of those individuals had changed their previously held attitudes as a result of Fukushima.[61]

Fukushima's shadow, moreover, was not limited to public opinion. The disaster also impacted nuclear plant operations. Following the Fukushima Daiichi meltdowns, worldwide production of nuclear power declined significantly,[62] as some plants closed

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58. *See generally* AMORY LOVINS, SOFT ENERGY PATHS: TOWARD A DURABLE PEACE (1977).

59. After the accident, Christopher Flavin, President of Worldwatch, proclaimed that "the Fukushima disaster is an historic–if not fatal–setback." *See* WORLDWATCH INSTITUTE, *supra* note 13; *see also* Victor Nian & S.K. Chou, *The State of Nuclear Power Two Years After Fukushima – The ASEAN Perspective*, 136 Applied Energy 838, 840 (2014); Per Lekander et al., *supra* note 13; Matthew L. Wald, *Nuclear Power's Death Somewhat Exaggerated*, N.Y. TIMES, Apr. 10, 2012, http://www.nytimes.com/2012/04/11/business/energy-environment/nuclear-powers-death-somewhat-exaggerated.html [http://perma.cc/32MK-79UL] (archived Sept. 27. 2015); *Nuclear Scholars Initiative: A Collection of Papers from the 2013 Nuclear Scholars Initiative*, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES 18 (Jan. 2014), http://csis.org/files/publication/140109_Weiner_NuclearScholarsInitiative2013_WEB.pdf [http://perma.cc/4VLE-H2TE] (archived Sept. 14, 2015).

60. *BBC 2011*, *supra* note 55. In particular, from 2005 to 2011, the proportion of people opposed to building new nuclear power reactors increased from 73 to 90 percent in Germany, 66 to 83 percent in France, 61 to 83 percent in Russia, and 76 to 84 percent in Japan. *Id.* Only the United States and the United Kingdom bucked this trend, with support remaining unchanged at 40 percent in the United States, and rising from 33 to 37 percent in the United Kingdom. *Id.*

61. *Ipsos Global @dvisory: Sharp World Wide Drop in Support for Nuclear Energy as 26% of New Opponents Say Fukushima Drove Their Decision*, IPSOS (June 20, 2011), http://www.ipsos-na.com/news-polls/pressrelease.aspx?id=5265 [http://perma.cc/52S5-26AL] (archived Sept. 14, 2015).

62. *International Energy Statistics*, U.S. ENERGY INFORMATION ADMINISTRATION, [hereinafter *Energy Statistics*] http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=2&pid=27&aid=12&cid=&syid=2004&eyid=2008&unit=BKWH (last visited Jan. 5, 2014) [http://perma.cc/K2CB-TUZR] (archived Sept. 27, 2015); *see also* Mycle Schneider et al., *World Nuclear Industry Status Report 2014*, THE WORLD

permanently, and numerous others suspended operations or construction.[63] Prior to the accident, 442 nuclear reactors in thirty countries produced 14 percent of the world's electricity, whereas in 2012, 427 reactors worldwide produced only 11 percent of electricity globally.[64] By 2013, 434 reactors in thirty countries[65] produced 10.8 percent of electricity.[66]

While the initial response to Fukushima was very much what common sense might have predicted, the disaster's longer-term implications have proven to be more nuanced. Fukushima Daiichi may have shocked the global nuclear industry initially, but just four years out, Fukushima seems to have left only a modest, if lasting, mark on the global energy landscape. The nuclear industry has weathered the storm and, today, appears quite stable in some countries and growing in others.[67] Indeed, as of April 2015, thirty countries worldwide are operating 438 nuclear reactors—only four fewer than were in operation before Fukushima.[68] Further, while some countries, like Germany, have moved sharply away from nuclear energy post-Fukushima, the heavy media attention those countries have received obscures the fuller picture.

Nations' reactions to the Fukushima disaster are not monolithic, but rather, diverse. In broad strokes, they can be grouped into three categories: countries that (1) abdicated nuclear energy, or are now moving swiftly away from it; (2) roughly kept their status quo; and (3) are expanding their use of nuclear energy despite Fukushima. That the nuclear narrative post-Fukushima is following these three paths—rather than a singular one away from nuclear use—underscores that while disasters can have important, lasting effects, the shape and scope of those effects, including how they manifest in

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NUCLEAR INDUSTRY STATUS REPORT (Aug. 18, 2014), http://www.worldnuclearreport.org/WNISR2014.html [http://perma.cc/2EMS-5KGF] (archived Sept. 14, 2015).

63. *See infra* sections A–C.

64. Ivana Kottasova, *Interactive: How Fukushima changed world's attitudes to nuclear power*, CNN (Mar. 12, 2014), http://edition.cnn.com/2014/03/12/business/nuclear-power-after-fukushima/#index. [http://perma.cc/4RWR-XWJG] (archived Sept. 27, 2015). This drop was a result of the retirement of fifteen reactors from service, including eight in Germany and four in Japan as a result of Fukushima, and two in the United Kingdom and one in Canada, which had reached the end of their operational lifetimes. The idling of all forty-eight of Japan's operational reactors is not accounted for in this number. *Energy Statistics*, *supra* note 62.

65. *Nuclear Power Reactors in the World*, INTERNATIONAL ATOMIC ENERGY AGENCY 6 (2014), *available at* http://www-pub.iaea.org/MTCD/publications/PDF/rds-2-34_web.pdf [http://perma.cc/RLQ7-QR7N] (archived Sept. 14, 2015).

66. Mycle Schneider et al., *supra* note 62; Mycle Schneider et al., THE WORLD NUCLEAR INDUSTRY STATUS REPORT 2015, July 2015, http://www.worldnuclearreport.org/-2015-.html [http://perma.cc/N8TM-5QPD] (archived Oct. 16, 2015).

67. *See infra* Parts III.B–C.

68. *Operational & Long-Term Shutdown Reactors*, INTERNATIONAL ATOMIC ENERGY AGENCY, http://www.iaea.org/PRIS/WorldStatistics/OperationalReactorsByCountry.aspx (last visited Apr. 8, 2015) [http://perma.cc/P986-975Y] (archived Sept. 27, 2015).

law and policy, are often much more country-specific and varied than might be anticipated.

In fact, looking beneath the surface, different countries' reactions to Fukushima Daiichi may comport well with what a careful contextual analysis might have predicted. Generally, countries that chose to abdicate nuclear energy post-Fukushima already harbored deep-seated opposition to it before the disaster.[69] On the other hand, those that kept the status quo, such as the United States, France, and the United Kingdom, rely quite heavily on the resource and have not been as politically conflicted about its use historically. Accordingly, they did not change their overall nuclear promotion policies but instead conducted safety and stress tests, and some safety upgrades,[70] while otherwise essentially continuing operations as before. Finally, a number of countries, including China, India, Russia, and South Korea, which are growing rapidly or are heavily reliant on energy imports, have expanded their use of nuclear power despite the Fukushima disaster.[71] Indeed, these countries have specifically noted the need to meet rising electricity demands, limit foreign and fossil fuel reliance, reduce pollution, and ensure a stable, affordable energy supply.[72] Thus, although the general response post-Fukushima was for countries to perform safety checks,[73] the similarity among countries' responses largely ends there.

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69. Masatsuga Hayashi & Larry Hughes, *The Fukushima Nuclear Accident and its Global Effect on Global Energy Security*, 59 ENERGY POL'Y 102, 106 (2012).

70. NUCLEAR ENERGY AGENCY, OECD, NUCLEAR ENERGY TODAY 3 (2012), *available at* http://www.oecd-nea.org/pub/nuclearenergytoday/6885-nuclear-energy-today.pdf [http://perma.cc/L9SX-Z79Q] (archived Sept. 14, 2015).

71. *See infra* Part III.C.

72. *See infra* Part III.C.

73. NUCLEAR ENERGY AGENCY, *supra* note 70. However, these safety tests were conducted at nuclear reactors in nearly all nuclear-producing countries. *See id.*; *Member Countries and Dates of Accession*, NUCLEAR ENERGY AGENCY, https://www.oecd-nea.org/nea/mcnea.html (last visited Jan. 20, 2015) [https://perma.cc/6LNX-TN2W] (archived Sept. 28, 2015); *Safety of Nuclear Power Reactors*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/info/Safety-and-Security/Safety-of-Plants/Safety-of-Nuclear-Power-Reactors/ (last visited Feb. 2015) [http://perma.cc/97QL-G9TG] (archived Sept. 28, 2015); *EU Member States*, ENSREG, http://www.ensreg.eu/EU-Stress-Tests/Country-Specific-Reports/EU-Member-States (last visited Apr. 9, 2015) [http://perma.cc/D53H-WERS] (archived Sept. 28, 2015); *Enhancing Nuclear Reactor Safety in Africa: The IAEA Conducts an Integrated Nuclear Safety Assessment of Research Reactors (INSARR) Mission in South Africa with EC Report*, IAEA.ORG (Nov. 8, 2013), https://www.iaea.org/technicalcooperation/Home/Highlights-Archive/Archive-2013/11082013-INSARR.html [https://perma.cc/4EFH-SY4Z] (archived Sept. 28, 2015); *Nuclear Power in China*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Power/ (last visited Mar. 31, 2015) [http://perma.cc/MFL6-9NJ8] (archived Sept. 28, 2015); Chris Cote et al., *Brazil's Nuclear Power Plans Three Years After Fukushima: A BrazilWorks Briefing Paper*, BRAZILWORKS (Apr. 2014), at 5, http://www.brazil-works.com/wp-content/uploads/2014/04/Brazil%E2%80%99s-Nuclear-Power-Plans-Three-Years-after-Fukushima.pdf [http://perma.cc/J8BN-9TSS] (archived Sept. 14, 2015).

The remainder of this Part explores the three key reactions that nations had to the Fukushima disaster in their nuclear policies: abandonment of nuclear energy; continued use with safety checks and other prophylactic measures, that is, effectively the status quo; and expansion of nuclear power. To highlight these three responses, the Part focuses on one exemplar country from each category: Germany for abandonment, the United States for the status quo, and China for expansion.

A. *Abandonment*

Fukushima pushed some countries to abandon nuclear power entirely, or to forego plans to use the technology. The countries that fit this category should not be surprising. Most already harbored deep-seated opposition to nuclear energy, with sizeable anti-nuclear lobbies,[74] or low public opinion of the technology, which plummeted further following the disaster.[75] Fukushima, then, became a talisman: for some countries, a convenient symbol to call for change; for others, a warning signal not to proceed. Consequently, three nuclear-producing countries—Germany, Switzerland, and Belgium—backed out of their nuclear programs entirely,[76] and others that had been considering building plants—including Italy, Bahrain, Kuwait, and Oman—abandoned their investigations.[77] Perhaps most notably, however, while these countries' choices received substantial attention, especially in the press,[78] the number of nations that chose this path is not particularly large.

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74. Hayashi & Hughes, *supra* note 69.

75. For further discussion of public opinion pre- and post-disaster, see *infra* notes 93–99 and accompanying text.

76. For specific discussion of all three countries' decisions, see *infra* notes 93–99 and accompanying text.

77. Ali Ahmad & M.V. Ramana, *Too Costly to Matter: Economics of Nuclear Power for Saudi Arabia*, 69 ENERGY 682, 682 (2014).

78. *See, e.g.*, *Belgium Plans to Phase Out Nuclear Power*, BBC (Oct. 31, 2011), http://www.bbc.com/news/world-europe-15521865 [http://perma.cc/C7PD-YJX4] (archived Sept. 14, 2015); Juergen Baetz, *Merkel Reverses Nuclear Energy Plan*, WASH. TIMES (May 30, 2011), http://www.washingtontimes.com/news/2011/may/30/merkel-reverses-nuclear-energy-plan/?page=all [http://perma.cc/HWG2-ELJE] (archived Sept. 28, 2015); Stephen Evans, *Nuclear Phase-Out Can Make Germany Trailblazer – Merkel*, BBC (May 31, 2011), http://www.bbc.com/news/world-europe-13597627 [http://perma.cc/AW7T-BZN7] (archived Sept. 28, 2015); Stephen Faris, *Italy Says No to Nuclear Power – and to Berlusconi*, TIME (June 14, 2011), http://content.time.com/time/world/article/0,8599,2077622,00.html [http://perma.cc/L7YK-92KF] (archived Sept. 28, 2015); James Kanter, *Switzerland Decides on Nuclear Phase-Out*, N.Y. TIMES (May 25, 2011), http://www.nytimes.com/2011/05/26/business/global/26nuclear.html [http://perma.cc/27NL-NT5V] (archived Sept. 28, 2015); Duncan Kennedy, *Italy Nuclear: Berlusconi Accepts Referendum Blow*, BBC (June 14, 2011), http://www.bbc.com/news/world-europe-13741105 [http://perma.cc/4XEA-UAZV] (archived Sept. 14, 2015).

Of these countries, Germany's announcement that it would abandon nuclear power by 2022 perhaps received the most attention.[79] In the wake of Fukushima, Germany's already deep public opposition to nuclear power grew even stronger,[80] and the government wasted no time in responding. Immediately after the tsunami, Germany's federal parliament, joined by state governments (Länder), requested a safety review of the nuclear power plants in Germany.[81] Germany's Ministry for the Environment, Nature Conservation and Nuclear Safety heeded that call, asking the Reactor Safety Commission (RSK) to perform a "comprehensive safety review for preparing a political and regulatory decision."[82]

The RSK carried out its safety review in two months, beginning March 15, 2011. Its emphasis was on the possibility of Fukushima-related natural hazards at German reactors, though it also examined other risks, such as aircraft crashes, as its aim was to assess all hazards beyond those previously considered.[83] Ultimately, RSK concluded that German plants featured more safeguards than those at Fukushima Daiichi.[84]

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79. *Germany to Shut All Nuke Plants: Merkel*, CHINA DAILY (May 31, 2011), http://www.chinadaily.com.cn/world/2011-05/31/content_12612106.htm [http://perma.cc/R75X-GNS6] (archived Sept. 28, 2015); Osha Gray Davidson, *Nuclear Advocate Merkel Flips: Says Germany to Quit Nukes by 2022*, FORBES (May 30, 2011), http://www.forbes.com/sites/oshadavidson/2011/05/30/nuclear-advocate-merkel-flips-says-germany-to-quit-nukes-by-2022/ [http://perma.cc/49F5-YRX9] (archived Sept. 28, 2015); Osha Gray Davidson, *So Far So Good for Germany's Nuclear Phase-Out, Despite Dire Predictions*, INSIDE CLIMATE NEWS (Nov. 16, 2012) [hereinafter Davidson, *So Far So Good*], http://insideclimatenews.org/news/20121115/germany-energiewende-nuclear-energy-fukushima-chernobyl-merkel-renewables [http://perma.cc/5KA8-6JHQ] (archived Sept. 28, 2015); Helen Pidd, *Germany to Shut All Nuclear Reactors*, GUARDIAN (May 30, 2011), http://www.theguardian.com/world/2011/may/30/germany-to-shut-nuclear-reactors [http://perma.cc/TS3M-NTPQ] (archived Sept. 28, 2015).

80. Opposition to building reactors in Germany was 73 percent in 2005 and 90 percent in 2011. *See* Ioannis N. Kessides, *The Future of the Nuclear Industry Reconsidered: Risks, Uncertainties, and Continued Promise*, 48 ENERGY POL'Y 185, 187 (2012); *BBC 2011*, *supra* note 55.

81. FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION AND NUCLEAR SAFETY, EUROPEAN NUCLEAR SAFETY REGULATIONS GROUP, EU STRESSTEST: NATIONAL REPORT OF GERMANY 5 (Sept. 15, 2011) [hereinafter EU STRESSTEST], http://www.oecd-nea.org/nsd/fukushima/documents/GERMANY-Progress_Report_Germany_15.09.11_13Uhr.pdf [http://perma.cc/5Q5R-VQJE] (archived Sept. 28, 2015); FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION AND NUCLEAR SAFETY, GERMAN ACTION PLAN FOR THE IMPLEMENTATION OF MEASURES AFTER THE FUKUSHIMA DAI-ICHI REACTOR ACCIDENT (Dec. 31, 2012) [hereinafter GERMAN NATIONAL REPORT].

82. EU STRESSTEST, *supra* note 81, at 5–6.

83. The German nuclear power plant operators also carried out their own assessments immediately after the accident. Their initial studies found no indication of any deficiencies in design, although they identified potential further safeguard improvements. *Id.* at 6.

84. *Developments in Germany Following the nuclear disaster in Japan*, FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION, BUILDING AND NUCLEAR SAFETY (last updated Oct. 3, 2014),) [hereinafter *Germany Developments*],

During this review, Germany appointed the "Ethics Commission for a Safe Energy Supply" to find public consensus on future energy supply. [85] The Commission concluded that, although the risks associated with nuclear energy had not changed, the way these risks are perceived had because of Fukushima. [86] As a result, the Commission called for decreasing the country's reliance on nuclear energy and for abandoning its use within a decade.[87]

Germany then quickly did an about-face on nuclear energy. After having safely used the technology for over fifty years,[88] and having decided only the year prior to extend the lives of all seventeen of the country's nuclear power facilities,[89] the government announced that it would abandon the resource by 2022.[90] German Chancellor Angela Merkel delivered the message: "We learned from Fukushima that we have to deal differently with risks," and "[w]e believe we as a country can be a trailblazer for a new age of renewable energy sources."[91]

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http://www.bmub.bund.de/en/topics/nuclear-safety-radiological-protection/nuclear-safety/response-to-fukushima/overview/ [http://perma.cc/X6UQ-67KB] (archived Sept. 28, 2015).

85. Judy Dempsey & Jack Ewing, *Germany, in Reversal, Will Close Nuclear Plants by 2022*, N.Y. TIMES (May 30 2011), http://www.nytimes.com/2011/05/31/world/europe/31germany.html?_r=0 [http://perma.cc/4RZP-3F9J] (archived Sept. 28, 2015); *Germany Developments*, *supra* note 84; GERMAN NATIONAL REPORT, *supra* note 81, at 7.

86. *Germany Developments*, *supra* note 84.

87. *Id.*; FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION AND NUCLEAR SAFETY, CONVENTION ON NUCLEAR SAFETY: REPORT BY THE GOVERNMENT OF THE FEDERAL REPUBLIC OF GERMANY FOR THE SIXTH REVIEW MEETING IN MARCH/APRIL 2014 13 (June 26, 2013) [hereinafter GERMANY 2014 REPORT], *available at* http://www.bmub.bund.de/fileadmin/Daten_BMU/Pools/Broschueren/bericht_uebereinkommen_nukl_sicherheit__en_bf.pdf [http://perma.cc/467D-BVBX] (archived Sept. 6, 2015).

88. *See Nuclear Power in Germany*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Germany/ (last visited Sept. 6, 2015) [http://perma.cc/X7FU-4SXS] (archived Sept. 6, 2015) (detailing the history of nuclear power in Germany); *see also* GERMANY 2014 REPORT, *supra* note 87, at 14.

89. Larry Greenemeier, *Should Japan's Reactor Crisis Kill the Nuclear Renaissance?* SCIENTIFIC AM. (Mar. 17, 2011), http://www.scientificamerican.com/article/japan-nuclear-renaissance/ [http://perma.cc/W89C-GMMT] (archived Sept. 6, 2015). In 2010, Merkel explained that nuclear power was "desirable as a bridging technology" to renewables. *Slowing the Phase-Out: Merkel Wants to Extend Nuclear Power Plant Lifespans*, SPIEGEL (Aug. 30, 2010), http://www.spiegel.de/international/germany/slowing-the-phase-out-merkel-wants-to-extend-nuclear-power-plant-lifespans-a-714580.html [http://perma.cc/TG4C-T7SK] (archived Sept. 6, 2015); *see also* Kate Connolly, *Germany Agrees to Extend Life of Nuclear Power Stations*, GUARDIAN (Sept. 6, 2010), http://www.theguardian.com/world/2010/sep/06/germany-extend-nuclear-power-stations [http://perma.cc/AP4L-GV6U] (archived Sept. 6, 2015); Andrea Wong & Lucy Meakin, *E.ON, RWE Shares Surge on Merkel's Nuclear Lifeline*, BLOOMBERG (Sept. 6, 2010), http://www.bloomberg.com/news/articles/2010-09-05/merkel-coalition-proposes-12-year-nuclear-reactor-extension-for-germany [http://perma.cc/3K77-G9J5] (archived Sept. 6, 2015).

90. GERMANY 2014 REPORT, *supra* note 87, at 16.

91. Evans, *supra* note 78.

This announcement was not a standalone policy decision. Rather, Merkel's disavowal of nuclear power came as part of a broader pronouncement of a new German energy policy for the twenty-first century—its *Energiewende*, or "energy turnaround." [92] The *Energiewende* was a declaration of energy revolution in Germany. In addition to announcing the plan to permanently close all of Germany's nuclear plants by 2022,[93] the *Energiewende* policy aims to reduce CO_2 emissions by 40 percent and to double Germany's electricity production from renewables to 35 percent.[94]

To accomplish the *Energiewende*'s objectives for nuclear power, the government thus quickly amended its Atomic Energy Act, setting in motion plans to permanently shut down Germany's eight oldest reactors in August 2011.[95] The amendments also approved plans to phase out Germany's other nine reactors by 2022.[96]

Though Germany might have been inclined in this direction anyway, the government seized on Fukushima as an impetus for change. As Jürgen Becker, Germany's deputy environment minister at the time, said, "Japan has shown that even if there is a miniscule occurrence, the residual risk is too high to justify the continuation of

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92. *Energy Transition: The German Energiewende*, ENERGIEWENDE GERMANY, http://energytransition.de/ (last visited Sept. 6, 2015) [http://perma.cc/6UNL-ACPS] (archived Sept. 6, 2015); GERMAN NATIONAL REPORT, *supra* note 81; Kottasova, *supra* note 64; Lars Ditmar & Georg Erdmann, *Generation in Germany Under Decarbonisation: The German "Energiewende"* 2 (Nov. 2013), *available at* http://www.iea.org/media/training/bangkoknov13/session_4b_germany_generation.pdf. [http://perma.cc/A2X9-2DKA] (archived Sept. 6, 2015); *UPDATE 3-Germany to Shut Down Pre-1980 Nuclear Plants*, REUTERS (March 15, 2011), http://www.reuters.com/article/2011/03/15/germany-nuclear-idUSLDE72E17620110315 [http://perma.cc/5N39-F6Q2] (archived Sept. 6, 2015).

93. Davidson, *So Far So Good*, *supra* note 79. These plants include Germany's seven oldest reactors, which were initially taken off the grid pending safety inspections after Fukushima, and an eighth that has been offline for years as a result of technical problems. Baetz, *supra* note 78; *Germany to Shut All Nuke Plants: Merkel*, *supra* note 79.

94. Baetz, *supra* note 78.

95. Seven of these had already been switched offline in March, and one was offline prior to the accident for refueling. Davidson, *So Far So Good*, *supra* note 79; *General information: Nuclear Safety and Nuclear Security*, FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION, BUILDING AND NUCLEAR SAFETY, http://www.bmub.bund.de/en/topics/nuclear-safety-radiological-protection/nuclear-safety/general-information/ (last visited Sept. 6, 2015) [http://perma.cc/6HA7-S5LF] (archived Sept. 6, 2015); *Questions and Answers on the Situation in Japan and the Possible Impact on Germany*, FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION, BUILDING AND NUCLEAR SAFETY, http://www.bmub.bund.de/en/topics/nuclear-safety-radiological-protection/nuclear-safety/response-to-fukushima/questions-and-answers/ (last visited Sept. 6, 2015) [http://perma.cc/8WMR-VUFX] (archived Sept. 6, 2015).

96. Kottasova, *supra* note 64; Schneider et al., *supra* note 66.

nuclear power."[97] Chancellor Merkel put it even more starkly, emphasizing that "the country must 'not let go the chance' to end its dependence on nuclear power."[98]

Like Germany, a number of other countries abandoned or decided to forego the use of nuclear energy post-Fukushima. Switzerland, which has five nuclear reactors producing 40 percent of the country's electricity, decided to abandon the technology by 2034.[99] Unlike Germany, however, Switzerland had planned, prior to Fukushima, to replace its aging reactors and in fact had three construction applications under consideration.[100] In some ways, then, Switzerland's reversal of nuclear policy post-Fukushima was even sharper than Germany's.[101] The people of Italy also turned down a government plan to construct new plants after Fukushima,[102] a decision that came as part of a referendum to reject a proposal to re-launch nuclear power after it had been banned in 1987.[103] Finally, Belgium, which had already decided in 2003 to abandon its nuclear plants beginning in 2015 and ending in 2025,[104] confirmed its closure policy in the wake of Fukushima.

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97. MYCLE SCHNEIDER ET AL., THE WORLD NUCLEAR INDUSTRY STATUS REPORT, 2010–2011: NUCLEAR POWER IN A POST-FUKUSHIMA WORLD: 25 YEARS AFTER THE CHERNOBYL ACCIDENT" 45–46 (April 2011), *available at* http://www.worldwatch.org/system/files/WorldNuclearIndustryStatusReport2011_%20FINAL.pdf [http://perma.cc/B8TU-RTMG] (archived Sept. 6, 2015). The German government has reaffirmed this plan. *See* Press Release No. 039/14 | Berlin, March 10, 2014; Press Release, On the Occasion of the Third Anniversary of the Fukushima Nuclear Disaster Fed'l Env't Minister Barbara Hendrick States:, FED. MINISTRY FOR THE ENV'T, NATURE CONSERVATION, BLDG. & NUCLEAR SAFETY (Mar. 10, 2014) [hereinafter *Hendrick Statement*], http://www.bmub.bund.de/en/press/press-releases/detailansicht-en/artikel/zum-3-jahrestag-der-atomkatastrophe-von-fukushima-erklaert-bundesumweltministerin-barbara-hendricks/?tx_ttnews%5BbackPid%5D=255&cHash=9e12682d07aa30fb0b922c6238ff5545 [http://perma.cc/VC49-884B] (archived Sept. 6, 2015).

98. Dempsey & Ewing, *supra* note 85; *see also Hendrick Statement*, *supra* note 97 ("[T]he events in Fukushima once again reminded us of the risks associated with the use of nuclear energy, and that the so-called residual risk is real and not just a theoretical risk. The sad and terrifying events in Fukushima have made it clear that the quickest possible phase-out of nuclear energy and consistent advancement of our energy system transformation are the way forward.") (statement of Federal Environment Minister Barbara Hendricks in 2014).

99. Koo et al., *surpa* note 54, at 68.

100. Michael Siegrist, et. al, *Why have some people changed their attitudes toward nuclear power after the accident in Fukushima*, 69 ENERGY POL'Y 356, 358 (2014).

101. *See id.*; Kanter, *supra* note 78.

102. Hayashi & Hughes, *supra* note 69, at 106.

103. SCHNEIDER ET AL., *supra* note 97, at 46; *see also* Giada Zampano & Nathania Zevi, *Italians Vote to Abandon Nuclear Energy*, WALL ST. J. (June 14, 2011), http://online.wsj.com/articles/SB10001424052702303714704576383452729642270 (subscription required) [http://perma.cc/A6DA-3BD8] (archived Sept. 6, 2015).

104. *Nuclear Power in Belgium*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Belgium/ (last visited Sept. 6, 2015) [http://perma.cc/LM2J-UQA8] (archived Sept. 6, 2015).

Altogether, then, these four countries—along with four others that announced decisions post-Fukushima not to pursue prior plans to introduce nuclear energy to their borders—established one of the three key paths nations have followed in altering their energy policies in the wake of this disaster.[105] Notably, however, this path is a decided minority position. By far, more countries are either maintaining or expanding their nuclear programs.

B. *Status Quo*

In contrast to nations that backed away from nuclear power, many others chose to continue to rely heavily on the technology post-Fukushima, even as they took measures to ensure that the events in Japan would not be repeated in their jurisdictions.

Specifically, the United States, France, Sweden, and the Czech Republic all have maintained their existing policies of promoting nuclear power. In doing so, they cited a bevy of reasons, including the importance of nuclear power to overall electricity supplies, the need to address climate change, keeping prices down, and fostering domestic industry.[106] As former French President Nicolas Sarkozy said shortly after the disaster, "[t]here is no alternative to nuclear energy today,"[107] and a moratorium on new nuclear plants is a "choice of the past, of the Middle Ages."[108]

Likewise, other countries, though not as strident in their defense of nuclear power, nevertheless have effectively stayed the course since Fukushima. These jurisdictions, including Bulgaria, Canada, Finland, and the Netherlands,[109] all indicated that they would reexamine their use of nuclear power in Fukushima's wake but have not made any significant changes since. Rather, across the board, the countries in this status quo category have been careful to bolster

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105. *See* Ahmad & Ramana, *supra* note 77 (Bahrain, Kuwait, and Oman abandoned plans to introduce nuclear energy after the Fukushima accident).

106. Yuhji Matsuo et al., *A global energy outlook to 2035 with strategic considerations for Asia and Middle East energy supply and demand interdependencies*, ENERGY STRATEGY REVIEWS 79, 87 (2013).

107. Kim Willsher, *Nicolas Sarkozy makes* €1bn *commitment to Nuclear Power*, GUARDIAN (June 27, 2011), http://www.theguardian.com/world/2011/jun/27/nicolas-sarkozy-france-nuclear-power [http://perma.cc/T3X4-UWLN] (archived Sept. 6, 2015).

108. Ann MacLachlan, *France's Sarkozy Denounces Nuclear Phase-Out Calls as "Medieval"*, PLATTS (May 3, 2011, 11:10 AM), http://www.platts.com/latest-news/electric-power/paris/frances-sarkozy-denounces-nuclear-phase-out-calls-8841312 [http://perma.cc/V2XW-D3CE] (archived Sept. 29, 2015).

109. *See Actions Taken by Regulatory Bodies and International Organisations Following the Fukushima Daiichi Nuclear Accident*, NUCLEAR ENERGY AGENCY (last visited Sept. 6, 2015) [hereinafter *NEA Regulatory Actions*], http://www.oecd-nea.org/nsd/fukushima/ [http://perma.cc/9WST-JDKM] (archived Sept. 6, 2015).

safety measures, but otherwise have not significantly altered their policies on nuclear energy.[110]

The United States is a leading example. The United States generates nearly one-third of the world's nuclear power, with ninety-nine reactors producing roughly one-fifth the nation's electricity.[111] Today, five more reactors are under construction,[112] and public support for the technology is on the rise. Although public support for nuclear power dipped by twenty-one percentage points in the United States following Fukushima,[113] by March 2012, nuclear energy's approval rating was on the rebound—up four points and essentially identical to the rating measured just before the accident in early March 2011.[114] Indeed, today, at least one poll shows support for nuclear energy in the United States at 63 percent, or one point higher than in 2010.[115]

Given the nation's heavy reliance on nuclear energy, and the relatively high approval rating for it in the United States, it is perhaps unsurprising that the U.S. policy reaction to Fukushima was basically incremental. The Nuclear Regulatory Commission (NRC) ordered safety reviews of the country's then-104 reactors,[116] delayed

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110. Koo et al., *supra* note 54, at 68. Altogether, stress tests and safety checks were performed in Belgium, Bulgaria, Canada, the Czech Republic, Finland, France, Germany, Hungary, India, Japan, South Korea, Lithuania, the Netherlands, Romania, the Russian Federation, Slovakia, Slovenia, Spain, South Africa, Sweden, Switzerland, the United Arab Emirates, the United Kingdom, and the United States. *See NEA Regulatory Actions*, *supra* note 109; Nuclear Energy Agency, THE FUKUSHIMA DAIICHI NUCLEAR POWER PLANT ACCIDENT: OECD/NEA NUCLEAR SAFETY RESPONSE AND LESSONS LEARNT 2 (2013), *available at* http://www.oecd-nea.org/pub/2013/7161-fukushima2013.pdf. [http://perma.cc/TT4H-BPSU] (archived Sept. 6 2015); 2 Nuclear Energy Agency, NUCLEAR ENERGY TODAY 3 (2012).

111. *How Many Nuclear Power Plants Are in the United States, and Where Are They Located?*, *Frequently Asked Questions*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/tools/faqs/faq.cfm?id=207&t=21 (last visited Sept. 6, 2015) [http://perma.cc/QYZ2-8FPU] (archived Sept. 6, 2015); *Nuclear Power in the USA*, WORLD NUCLEAR ASSOC., http://www.world-nuclear.org/info/Country-Profiles/Countries-T-Z/USA--Nuclear-Power/ (last visited Sept. 6, 2015) [http://perma.cc/85PW-BW8Z] (archived Sept. 6, 2015).

112. *Nuclear Power in the USA*, *supra* note 111; Matt Smith, *The 'Nuclear Renaissance:' What Went Wrong?*, CNN (Nov. 6, 2013, 7:18 AM), http://www.cnn.com/2013/11/06/us/atomic-economics/ [http://perma.cc/C4JA-B6VE] (last visited Sept. 6, 2015).

113. The decrease was to 53 percent, compared to 74 percent in the prior year. Kessides, *supra* note 80, at 187.

114. Frank Newport, *Americans Still Favor Nuclear Power a Year After Fukushima*, GALLUP (March 26, 2012) http://www.gallup.com/poll/153452/americans-favor-nuclear-power-year-fukushima.aspx [http://perma.cc/298Y-CL2J] (archived Sept. 6, 2015).

115. *Poll: Americans See Nuclear Energy as Key to Limit Carbon Emissions*, NUCLEAR ENERGY INSTITUTE (Oct. 28, 2014), http://www.nei.org/News-Media/Media-Room/News-Releases/Poll-Americans-See-Nuclear-Energy-as-Key-to-Limit [http://perma.cc/US3L-D52J] (archived Sept. 6, 2015).

116. Hayashi & Hughes, *supra* note 69, at 104.

discussion of plans to restart reactors at one site,[117] and, eventually, adopted additional safety requirements nationwide in an effort to avoid a Fukushima-like event.[118]

Some of these changes came quickly. In March 2011, while the Fukushima disaster was still unfolding, the NRC ordered nuclear operators to install enhanced equipment for monitoring water levels in spent fuel pools, obtain additional emergency equipment, and improve or install emergency venting systems to relieve pressure in the event of a serious accident in facilities with a design similar to the Fukushima facility.[119]

The next month, the NRC ordered plant inspectors to assess facilities' readiness to implement more aggressive management guidelines for severe accidents. [120] These inspections took a particularly hard look at procedures to compensate for conditions like those that occurred at Fukushima, including extensive onsite damage, loss of power, seismic and flooding issues, and procedures for dealing with damaged reactors.[121]

As part of its longer-term strategy, the NRC also established a task force to review the Fukushima disaster and determine what lessons U.S. reactors could learn from it.[122] The task force engaged in a wide-ranging, systematic, and methodological review of the NRC's regulations and procedures in order to make policy recommendations for the NRC in light of the Fukushima accident.[123] The task force then issued recommendations on how to enhance reactor safety[124] and mitigate risks from accidents resulting from natural phenomena.[125]

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117. Greenemeier, *supra* note 89.

118. Backgrounder, *NRC Response to Lessons Learned from Fukushima*, U.S. NUCLEAR REGULATORY COMM'N (Feb. 9, 2015), http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/japan-events.html [http://perma.cc/4FYB-LUWZ] (archived Sept. 6, 2015).

119. *Id.*

120. U.S. Nuclear Regulatory Comm'n, NRC INSPECTION MANUAL: AVAILABILITY AND READINESS INSPECTION OF SEVERE ACCIDENT MANAGEMENT GUIDELINES (April 29, 2011), http://pbadupws.nrc.gov/docs/ML1111/ML11115A053.pdf [http://perma.cc/R66A-KU62] (archived Sept. 6, 2015).

121. *See id.*

122. *What Are the Lessons Learned From Fukushima?*, U.S. NUCLEAR REGULATORY COMM'N (April 17, 2015) [hereinafter *Lessons Learned*], http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard/priorities.html [http://perma.cc/P37H-PA74] (archived Sept. 6, 2015).

123. U.S. Nuclear Regulatory Comm'n, RECOMMENDATIONS FOR ENHANCING REACTOR SAFETY IN THE 21ST CENTURY: THE NEAR-TERM TASK FORCE REVIEW OF INSIGHTS FROM THE FUKUSHIMA DAI-ICHI ACCIDENT vii (July 12, 2011) [hereinafter NRC RECOMMENDATIONS], http://pbadupws.nrc.gov/docs/ML1118/ML111861807.pdf [http://perma.cc/5LTJ-UPGF] (archived Sept. 6, 2015).

124. *Lessons Learned*, *supra* note 122.

125. *Id.*

The task force published its recommendations in July 2011, concluding that the NRC's existing "regulatory approach has served the Commission and the public well,"[126] and "that a sequence of events like the Fukushima accident is unlikely to occur in the United States."[127] The task force thus determined that continued operation of nuclear reactors in the United States does not "pose an imminent risk to public health and safety."[128] The task force did, however, issue a number of recommendations for clarifying the NRC's regulatory framework and for better ensuring safety onsite at reactors.[129] These included evaluations and upgrades of earthquake-, flooding-, and fire-related design features; updates to facility emergency plans; and stronger regulatory oversight of safety performance.[130] The NRC adopted these recommendations in November 2011.[131]

Of course, the United States' experience post-Fukushima is emblematic of countries in this category not because of its use of a task force or the specific safety measures, but rather, because of the general arc the nation's policy reaction. Much like the United States, other countries that have basically maintained the status quo post-Fukushima examined safety measures, implemented incremental changes specifically responding to the type of conditions present at Fukushima Daiichi, and saw a rebound in public support for this technology—all without measurably shifting course in their reliance on nuclear power.[132]

Thus, France, which leads the world in the share of electricity produced by nuclear energy, generating 74 percent of its electricity from fifty-eight nuclear reactors,[133] performed safety checks of all operating reactors, but also reaffirmed its commitment to nuclear power after Fukushima, going so far as to dedicate additional funds

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126. NRC RECOMMENDATIONS, *supra* note 123, at 18.

127. *Id.* at vii.

128. *Id.* at vii.

129. *Id.* at viii–ix.

130. *Id.* at viii–ix; *see also Lessons Learned*, *supra* note 122 (outlining a three-tiered prioritization plan to increase safety of nuclear reactors).

131. *Japan Lessons Learned Division*, U.S. NRC, http://www.nrc.gov/reactors/operating/ops-experience/japan/japan-lessons-learned.html (last updated Sept. 9, 2014) [http://perma.cc/9JPS-H3X8] (archived Sept. 5, 2015); *see also Plant-Specific Japan Lessons-Learned Activities*, U.S. NRC, http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard/japan-plants.html (last updated June 18, 2013) [http://perma.cc/P8SL-326Q] (archived Sept. 5, 2015) (listing all operating nuclear power plants that have adopted NRC recommendations following the Fukushima incident).

132. *See* Koo et al., *supra* note 54, at 68 (comparing nuclear policy of the United States with countries who have abandoned nuclear energy in wake of Fukushima).

133. *See* Kottasova, *supra* note 64; Willsher, *supra* note 107.

to its development.[134] Similarly, the United Kingdom performed extensive safety checks but basically saw public sentiment for reactors remain steady after Fukushima,[135] with 38 percent of those polled believing the benefits of nuclear outweighed the risks in 2010, and 41 percent believing the same in 2011.[136] In fact, since Fukushima, the United Kingdom gave the go-ahead for work to begin on its first new nuclear reactor in 20 years.[137] Altogether, then, the majority of countries have responded to Fukushima not by making a sharp change in direction, but rather, by making minor reactor and regulatory upgrades while effectively maintaining their existing policy favoring the technology.

C. *Expansion*

A third category of countries has expanded, or is considering expanding, their use of nuclear power technology since the Fukushima disaster. Most notably, these include China, India, Russia, and South Korea, each of which has also maintained relatively positive attitudes toward the technology.[138] Indeed, one study of Fukushima's impact on global attitudes about nuclear energy found that China had the highest level of acceptance before the accident at 83 percent, followed by Bulgaria, South Korea, Bangladesh, and Russia (at 68, 65, 64, and 63 percent, respectively).[139] It should not be particularly surprising, then, that there is overlap in the lists of jurisdictions that heavily favored nuclear power pre-disaster and those that have chosen to expand their use of the technology after the meltdowns.

Of course, these countries were not unaffected by Fukushima. The accident caused some nations to pause, others to slow down, and many to reconsider their plans. China temporarily suspended approval of nuclear projects, including those under development after

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134. Willsher, *supra* note 107, at 1; *see also* MYCLE SCHNEIDER ET AL., *supra* note 97, at 45 (citing the French Prime Minister's request for safety audit of all nuclear power plants).

135. *BBC 2011*, *supra* note 55, at 1.

136. Matt McGrath, *UK Nuclear Support 'Rises After Fukushima'*, BBC 3 (Sept. 9, 2011), http://www.bbc.com/news/science-environment-14847875 [http://perma.cc/6NML-K6WS] (archived Sept. 5, 2015).

137. *See* Jessica Aldred & Natalie Starkey, *Nuclear Power in the UK – a history*, GUARDIAN 11 (Oct. 21, 2013), http://www.theguardian.com/environment/2013/oct/21/nuclear-power-in-the-uk-a-history [http://perma.cc/ECK3-UR9G] (archived Sept. 5, 2015) (summarizing the history of nuclear power in the UK).

138. *See* WIN-GALLUP, JAPAN EARTHQUAKE AND ITS IMPACT ON VIEWS ABOUT NUCLEAR ENERGY 8 (2011), http://www.gallup.com.pk/wp-content/uploads/2015/02/Volume-3-_Japan-Survey.pdf [http://perma.cc/RS52-9A6H] (archived Sept. 5, 2015) (showing data of attitudes of various countries toward nuclear power before and after Fukushima).

139. *Id.*

Fukushima,[140] in order to undertake safety reviews.[141] Similarly, India temporarily postponed approval of four projects after the accident and conducted safety reviews of its existing plants under construction and in operation.[142] It also announced that it would set up a Nuclear Safety Regulatory Authority.[143] Russia commissioned a review of its future nuclear power sector after Fukushima,[144] and Vietnam declared its intention to use the lessons learned from the accident in building its nuclear power program.[145]

Nevertheless, many of these countries have added new reactors since the Fukushima disaster, including China, Kazakhstan, South Korea, Pakistan, and Russia.[146] Others are maintaining plans to build up their programs, such as in Malaysia and Indonesia,[147] the United Arab Emirates,[148] and Brazil.[149] In fact, as of July 2015, sixty-seven reactors were under construction globally, with twenty-four in China, six in India, nine in Russia, three in the United Arab Emirates, one in Brazil, and four in South Korea.[150] In other words, nearly two-thirds of the reactors under construction are located in China, India, and Russia, with one-third in China alone—arguably making it the most prominent exemplar of countries in this category of expanding nuclear use post-Fukushima.[151]

Indeed, China has the most ambitious nuclear power plan in the world[152] and, as of 2013, had already overtaken Germany to become

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140. MYCLE SCHNEIDER ET AL., *supra* note 97, at 18.

141. Keith B. Richburg, *China Suspends All New Nuclear Plants, Orders Safety Reviews; U.S. Plans Unchanged*, WASH. POST 1 (March 16, 2011), http://www.washingtonpost.com/world/china-suspends-all-new-nuclear-plants-orders-safety-review/2011/03/16/ABZHUld_story.html [http://perma.cc/MD4X-DPNA] (archived Sept. 5, 2015); *Nuclear Power in China*, *supra* note 73; MYCLE SCHNEIDER ET AL., *supra* note 97, at 18.

142. Hayashi & Hughes, *supra* note 69, at 109; *see also* RAJYA SABHA, GOV'T OF INDIA DEP'T OF ATOMIC ENERGY EXPERIENCE FROM FUKUSHIMA DISASTER (Nov. 24, 2011), *available at* http://dae.nic.in/writereaddata/rsus317_241111.pdf [http://perma.cc/R6SM-6W8D] (archived Sept. 6, 2015).

143. SABHA, *supra* note 142; MYCLE SCHNEIDER ET AL., *supra* note 97, at 42.

144. SCHNEIDER ET AL., *supra* note 97, at 47.

145. *Id.* at 44.

146. Nian & Chou, *supra* note 59, at 839.

147. *See* SCHNEIDER ET AL., *supra* note 97, at 42–43 (citing Malaysia's plans to continue with nuclear plant program despite increasing opposition).

148. *Id.* at 44.

149. *Id.* at 47.

150. *Nuclear Units Under Construction Worldwide*, NUCLEAR ENERGY INST., http://www.nei.org/Knowledge-Center/Nuclear-Statistics/World-Statistics/Nuclear-Units-Under-Construction-Worldwide (last updated July 2015) [http://perma.cc/4RT7-RLJ9] (archived Sept. 6, 2015).

151. *Id.*

152. *See* Stephen Chen, *China Plans to be World Leader in Nuclear Power by 2020*, SOUTH CHINA MORNING POST, (Sept. 14, 2014, 6:34 AM), http://www.scmp.com/news/china/article/1591984/china-plans-be-world-leader-nuclear-power-2020?page=all [https://perma.cc/AK5L-SH74?type=image] (archived Sept. 6, 2015); *see also* Yongxiang

the world's fifth largest nuclear energy producer.[153] The Fukushima disaster transpired in the midst of a revolution in China's energy system: in 2011, China became the world's largest energy consumer,[154] accounting for 17 percent of world demand for energy, with consumption only expected to continue rising to 22 percent of world demand by 2035.[155] At the same time, the Chinese government is also attempting to dramatically reduce air pollution, cut reliance on fossil fuels, prevent power shortages,[156] and reduce reliance on imported energy sources.[157] Add to this the nation's pledge to reduce greenhouse gas emissions by 45 percent by 2020,[158] and it is immediately clear that China's energy system is truly one in flux.[159]

China's reaction to Fukushima reflected the broader context of the nation's energy landscape. Immediately after the disaster, on March 16, 2011, China announced that it would temporarily suspend its nuclear plant approval process while it conducted comprehensive safety checks of all nuclear projects, drafted a new nuclear safety plan, and adjusted the medium- and long-term nuclear development plan.[160] An inspection group composed of the National Energy Administration (NEA), the National Nuclear Safety Administration, and the China Earthquake Administration completed this process for operating plants in three months, and for facilities under construction by October 2011.[161] The inspection results found that while China's

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Wang et al., *Media Coverage and Government Policy of Nuclear Power in the People's Republic of China*, 77 PROGRESS IN NUCLEAR ENERGY 214, 214 (2014) (stating that China has twenty eight nuclear power units under construction); *International Energy Statistics*, *supra* note 62 (showing growth trend).

153 Schneider, *supra* note 62, at 14.

154. *China*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/beta/international/analysis.cfm?iso=CHN (last updated May 14, 2015) [http://perma.cc/XSM2-DVTA] (archived Sept. 6, 2015).

155. Clifford Krauss, *In Global Forecast, China Looms Large as Energy User and Maker of Green Power*, N.Y. TIMES (Nov. 9, 2010), http://www.nytimes.com/2010/11/10/business/global/10oil.html (subscription required) [http://perma.cc/FPM7-T3SH] (archived Sept. 6, 2015).

156. *See Nuclear Power in China*, *supra* note 73.

157. Brian Spegele, *China Mulls New Steps on Nuclear Energy*, WALL ST. J., http://online.wsj.com/articles/SB10001424052702303506404577444173316508002 (last updated June 4, 2012, 10:30 AM) (subscription required) [http://perma.cc/9U2N-7365] (archived Sept. 6, 2015).

158. *See Nuclear Power in China*, *supra* note 73; *see also* Kottasova, *supra* note 64.

159. *See generally* Elspeth Thomson, *Introduction to Special Issue: Energy Issues in China's 12th Five Year Plan and Beyond*, 73 ENERGY POL'Y 1 (2014); Joel B. Eisen, *The New Energy Geopolitics?: China, Renewable Energy, and the "Greentech Race"*, 86 CHICAGO-KENT L. REV. 9 (2011).

160. Y.C. Xu, *The Struggle for Safe Nuclear Expansion in China*, 73 ENERGY POL'Y 21, 21, 26 (2014).

161. *Nuclear Power in China*, *supra* note 73; *see* Du Juan, *Nuclear Power to Become 'Foundation' of Country's Electrical System*, CHINA DAILY, http://www.chinadaily.com.cn/cndy/2011-12/07/content_14223281.htm (last updated Dec. 7, 2011) [http://perma.cc/H2CS-NDG3] (archived Sept. 6, 2015); *see also Country*

plants met domestic and International Atomic Energy Agency (IAEA) safety standards, some facilities lacked necessary accident prevention and mitigation plans.[162] As a result, the State Council approved in principle a new nuclear safety plan that required appropriate safety improvements at all civilian nuclear facilities by 2015, thereby affirming that China would continue to put safety and quality first and would fully incorporate the IAEA safety standards into its own safety standards.[163] In an attempt to improve the transparency of nuclear regulation, the government then formally solicited public comments on this nuclear safety plan.[164] Soon after, to further enhance nuclear safety at Chinese plants, the NEA promulgated technical specifications to be used in general renovations of plants under operation and construction, which were issued in June 2012 in the "General Technical Specifications for Nuclear Power Plant Renovation After the Fukushima Accident (For Trial Implementation)."[165]

Despite these new specifications, China's nuclear program did not resume until October 2012, when China's State Council debriefed reports on the safety inspections, officially approved the "Twelfth Five Year Plan and 2020 Vision for Nuclear Safety and Radioactive Pollution Prevention, 2011-2020 Planning for Nuclear Power Safety, and the amended the 2011-2020 Mid-long Term Development Planning for Nuclear Power."[166] These plans called for improved safety standards for nuclear expansion, including construction at a controlled pace, limited approval of nuclear projects in coastal regions to those that pass safety and environmental reviews, and no approval of any projects in inland provinces from 2011–2015.[167] As a result, inland projects at three locations—Taohuajiang, Xianning, and Pengze—that had been expected to start construction before 2015 were rescheduled.[168] Moreover, since approvals recommenced, China

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Nuclear Power Profiles: China, IAEA (2014), https://cnpp.iaea.org/countryprofiles/China/China.htm [https://perma.cc/GCM2-PQFU] (archived Sept. 6, 2015).

162. Hui Zhang & Shangui Zhao, *China Moves Cautiously Ahead on Nuclear Energy*, BULL.OF THE ATOMIC SCIENTISTS (Apr. 22, 2013), at 2, http://thebulletin.org/china-moves-cautiously-ahead-nuclear-energy [http://perma.cc/8XX3-DHFH] (archived Sept. 6, 2015); *see also Country Nuclear Power Profiles: China*, *supra* note 161 (outlining China's nuclear safety measures post-Fukushima).

163. *See* Zhang & Zhao, *supra* 162, at 2 (examining China's Medium- and Long-term Nuclear Power Development Plan); *see also Nuclear Power in China*, *supra* note 73.

164. *Nuclear Power in China*, *supra* note 73.

165. *Id.*

166. *Country Nuclear Power Profiles: China*, *supra* note 161; *see also* Xu, *supra* note 160, at 26.

167. Xu, *supra* note 160, at 23–26; Zhang & Zhao, *supra* note 162.

168. *China Resumes New Reactor Approvals*, WORLD NUCLEAR NEWS (Mar. 10, 2015), http://www.world-nuclear-news.org/NN-China-resumes-new-reactor-approvals-1003155.html [https://perma.cc/Q7Q8-ARFQ?type=source] (archived Sept. 5, 2015).

has only approved three new reactors as of April 2015,[169] confirming their controlled pace and limited approval of projects. However, China continues to push forward, completing reactors that had already been approved before Fukushima.

Ultimately, then, besides moderating its pace for approving new reactors, China's overall plans have not changed significantly since Fukushima. Prior to the accident, China's aim was to add 70–80 gigawatts (GWe) of nuclear power by 2020; however, in October 2012, that plan was modified to 60 GWe by 2020.[170] Then, in 2014, the NEA announced it was "aiming for world leadership in nuclear technology, with detailed plans to come in April 2015."[171] Before the accident, China was operating thirteen nuclear reactors, with thirty under construction.[172] As of October 2015, China had twenty-eight nuclear power reactors in operation and twenty-four under construction, with plans to increase that number significantly by 2020.[173]

China's experience post-Fukushima is emblematic of the approach that other countries in this category have followed. India, like China, temporarily postponed its approval process to undertake safety reviews of its existing plants. [174] However, it resumed approvals in June 2012[175] and has since begun construction on seven reactors.[176] Similarly, Russia reviewed the safety of its nuclear plants after the accident,[177] but maintains its intent to double its current nuclear capacity by 2020. [178] Saudi Arabia also reiterated its commitment to the acquisition and expansion of nuclear power after the accident,[179] and put forward a plan to build sixteen new nuclear

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169. *Id.*; Brian Spegele, *China Sends Nuclear-Industry Message with New Reactor Approval*, WALL ST. J. (Apr. 16, 2015, 7:25 PM), http://blogs.wsj.com/chinarealtime/2015/04/16/china-sends-nuclear-industry-message-with-new-reactor-approval/ [http://perma.cc/9D5L-KALZ] (archived Oct. 16, 2015).

170. *Nuclear Power in China*, *supra* note 73.

171. *Id.*

172. Matsuo et al., *supra* note 106, at 87.

173. INT'L ATOMIC ENERGY AGENCY [IAEA], *China, People's Republic of*, IAEA PRIS, http://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=CN (last updated Oct.. 6, 2015) [http://perma.cc/JM57-QRB6] (archived Oct. 16, 2015); Kottasova, *supra* note 64.

174. Hayashi & Hughes, *supra* note 69, at 109.

175. *Id. See generally* DEPARTMENT OF ATOMIC ENERGY, GOVERNMENT OF INDIA, *Experience from Fukushima Disaster* (Nov. 24, 2011), *available at* http://dae.nic.in/writereaddata/rsus317_241111.pdf (last visited Sept. 5, 2015) [https://perma.cc/UD35-EDXT] (archived Sept. 5, 2015).

176. Matsuo et al., *supra* note 106, at 87.

177. *See* SCHNEIDER ET AL., *supra* note 97, at 47 (noting the request "that the energy ministry, nuclear agency and environment ministry carry out an analysis of the current condition of the atomic sector and an analysis of the plans for future development").

178. Hayashi & Hughes, *supra* note 69, at 109.

179. Ahmad & Ramana, *supra* note 77, at 682.

reactors by 2030.[180] Other countries have expressed their interest in building nuclear power plants despite Fukushima and intend to do so despite public opposition.[181] Malaysia and Indonesia, for instance, have indicated that they will proceed with their plans to build out nuclear power facilities in their jurisdictions,[182] and the United Arab Emirates dismissed concerns about the safety of nuclear power plants and broke ground for the initial work at a proposed nuclear site in Braka. [183] Thus, when the approach of these jurisdictions is considered together with that of those who have chosen to maintain their existing plants, it becomes quite clear: Fukushima may have cast a shadow, clouding the future of nuclear power in some nations, but in many others, the technology forges ahead nonetheless.

IV. SOME LIGHT: FUKUSHIMA AS A LENS INTO GLOBAL ENERGY POLICY

One might think that the shadow of Fukushima would transform the nuclear industry, and energy policy with it. Instead, as the diverse approaches nations have chosen shows, while Fukushima's impact has been global, it appears not to have inalterably reshaped the nuclear industry, much less nuclear energy policy. The standard response in the short term was to pause, assess, and implement additional safety measures; one would expect nothing less. But in the long term, most countries have been largely unmoved, continuing to pursue policies of nuclear utilization or expansion.[184] Only a few nations, such as Germany, Italy, and Switzerland, turned hard against nuclear power, and even for that group, one might say they were predisposed to do so.[185] Fukushima's shadow, then, while certainly broad, appears to be just that—a penumbra, definitely felt but only moderately influential and perhaps only in passing.

Nevertheless, countries' varying responses to Fukushima offer important insight into the global energy system and the policies that support it. If a tragedy of the scope and amplitude of Fukushima cannot fundamentally alter the way the world approaches energy, that says much about how countries address energy decision making. Indeed, that nations varied so widely in their responses to Fukushima itself exposes the very complexity of the energy system, as well as the energy law and policy systems that govern it.

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180. Matsuo et al., *supra* note 106, at 87.

181. *See* SCHNEIDER ET AL., *supra* note 97, at 41–48.

182. *Id.* at 42–43.

183. *Id.* at 45.

184. *See generally* Matsuo et al., *supra* note 106, at 87; *Actions Taken by Regulatory Bodies and International Organisations Following the Fukushima Daiichi Nuclear Accident*, *supra* note 109.

185. *See supra* Part III.A.

Complexity theory,[186] and particularly the idea of panarchy,[187] would suggest that nations would follow no single path in the wake of a disaster like Fukushima, precisely because so many values and interests are at stake. That, of course, is exactly what happened. Different nations took different paths, based on their own predilections, unique cultures, and assessments of energy tradeoffs.

Fukushima, however, is useful not just for spotlighting the complexity of the energy, and energy law and policy, systems. Even more concretely, the complexity of nations' responses to Fukushima exposes three core tensions within energy policy worldwide. Specifically, in designing their energy policies, countries are inevitably forced to choose between markets and planning. Many countries favor allowing markets to dictate the pace and type of their energy development, with the idea that free markets reach more economically efficient outcomes. But to the extent a country favors any particular direction for its energy system, it inevitably will want to use policy to shape how those markets function. This recognition that markets may not achieve desired energy policies leads to two other difficulties. Energy systems are massive, so they quickly become path dependent, in part because they demand such heavy capital investment. Thus, when government objectives change, or technologies advance, quickly changing the shape of a nation's energy system can be difficult. Likewise, because energy is so fundamental to how modern nations function, energy policies inevitably promote

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186. For more on complexity theory generally, see, for example, NEIL F. JOHNSON, TWO'S COMPANY, THREE IS COMPLEXITY (2007); MELANIE MITCHELL, COMPLEXITY: A GUIDED TOUR (2009); JOHN H. MILLER & SCOTT E. PAGE, COMPLEX ADAPTIVE SYSTEMS: AN INTRODUCTION TO COMPUTATIONAL MODELS OF SOCIAL LIFE (2007).

187. As J.B. Ruhl has put it:

> Resilience theory does not posit that a system as complex as law is entirely either a vase or a saucer; rather, it is more a set of landscapes over which we find engineering and ecological resilience strategies mixing in different blends to form topographies of various contours depending on where in the system we look. Some resilience theorists refer to this multiscalar complex of topographies as a "panarchy."

J.B. Ruhl, *General Design Principles for Resilience and Adaptive Capacity in Legal Systems: With Applications to Climate Change Adaptation*, 89 N.C. L. REV. 1373, 1383 (2011). Clearly, different nations' approaches to nuclear power post-Fukushima exhibit precisely this kind of "different blends" of engineering and policy strategies depending on the context. For more on panarchy more generally, however, see, for example, C.S. Holling et al., *Sustainability and Panarchies*, *in* PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 63-102 (Lance H. Gunderson & C.S. Holling eds., 2002), and Ahjond S. Garmestani et al., *Panarchy, Adaptive Management and Governance: Policy Options for Building Resilience*, 87 NEB. L. REV. 1036 (2009).

multiple, often conflicting values.[188] These might include industrialization, economic growth, social support, equity, and environmental protection. How any given policy works out—or fails to work out—the tension in these values can heavily influence the composition of the nation's energy system.

The reactions countries had to the Fukushima disaster highlight each of these tensions in global energy policy. Each policy tension, moreover, deserves far more extensive treatment in its own right than can be provided here. Nonetheless, to help begin that work, the remainder of this Article briefly explores these tensions through the lens of Fukushima. It then briefly examines the implications of the tensions in the nuclear energy context.

A. *Markets vs. Planning*

A fundamental tension in energy policy is whether government allows energy outcomes to be determined by markets or dictates those outcomes via directives and planning.[189] This tension is pervasive. In the United States, for instance, a market approach has long applied to oil sales, but that was not always the case.[190] The story of U.S. natural gas likewise is dominated by the twists and turns needed to reach, and to react to, wellhead deregulation.[191] And U.S. electricity policy remains riven by this tension, with markets dominating wholesale sales but states divided messily between those pursuing retail choice and those not.[192] Law and policy thus grapple ceaselessly with how to shape markets, and how to ensure they perform properly.[193]

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188. *See, e.g.*, Andrew Long, *Complexity in Global Energy-Environment Governance*, 15 MINN. J.L. SCI. & TECH. 1055 (2014); Hari M. Osofsky, *Complex Value Choices at the Environment-Energy Interface*, 3 MICH. J. ENVTL. & ADMIN. L. 261 (2014). For an excellent summary, see Robin Kundis Craig, *Learning to Think About Complex Environmental Systems in Environmental and Natural Resource Law and Legal Scholarship: A Twenty-Year Retrospective*, 24 FORDHAM ENVTL. L. REV. 1 (2013).

189. Bernard S. Black & Richard J. Pierce, Jr., *The Choice Between Markets and Central Planning in Regulating the U.S. Electricity Industry*, 93 COLUM. L. REV. 1339, 1341 (1993).

190. *See* FRED BOSSELMAN ET AL., ENERGY, ECONOMICS AND THE ENVIRONMENT: CASES AND MATERIALS 18–22 (2d ed. 2005) (discussing the United States' history of regulation in the energy industry).

191. LINCOLN L. DAVIES ET AL., ENERGY LAW AND POLICY 629–51 (2014).

192. *See id.* at 397–435.

193. David B. Spence, *Can Law Manage Competitive Energy Markets?*, 93 CORNELL L. REV. 765, 776 (2008); *see also* Emily Hammond & David B. Spence, *The Regulatory Contract in the Marketplace*, 68 VAND. L. REV. (forthcoming), http://ssrn.com/abstract=2584619 [http://perma.cc/MDZ5-9UMK] (archived Sept. 5, 2015) (examining how the United States' piecemeal regulatory approach, which includes "both increasing reliance on markets and competition in public utility regulation, and stricter environmental regulation of energy production facilities," has led to numerous dysfunctions).

Nuclear power exhibits the same tension, some would say in spades. The resource would not have been available for civilian purposes but for massive U.S. government research and development funding,[194] followed by policies aimed at promoting it, including limited liability provisions such as the Price-Anderson Act.[195] Still, when the industry backed off the rapid expansion of its early years, it assigned much blame to unpredictable, iterative government safety regulation, which drove up costs.[196] Thus, as in other areas of energy policy, the push-pull tension of markets and central planning emerged in nuclear energy just as it pervaded other energy sectors.

Fukushima, without question, highlighted the tension. Countries like China and India that chose to continue promoting nuclear power serve as reminders that, whether it is in the name of energy security or supply abundance or something else, governments often pick winners.[197] At the same time, nations like Germany that announced their abdication of atomic power in the name of safety and environmental protection likewise showed that governments are not hesitant to put a policy thumb on the market scale—if in a much different direction than China or India—when it comes to energy.[198] Indeed, in bidding farewell to nuclear power, the German *Energiewende* and its dominant tool of the *Erneuerbare-Energien-Gesetz* (EEG, or Renewable Energy Sources Act) use a kind of market-based regulation to encourage incumbent companies and especially new entrants to produce electricity from the government's new winner of renewable resources.[199]

Such decisions also demonstrate the deep interconnectedness of our energy systems. Germany may turn to renewables to replace its nuclear power, but renewables bring their own demands, including substantial transmission upgrades, intensive legal and policy attention, and, perhaps, capacity markets.[200] Thus, the tradeoff of one energy source for another cannot be described as simply choosing one kind of "cleaner" or "safer" technology over another. Rather, any movement in one direction necessarily compels other shifts and evolutions in the broader energy system. Even from an environmental perspective, and particularly with respect to climate effects, any

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194. *See* Pac. Gas & Elec. Co. v. State Energy Res. Conservation & Dev. Comm'n, 461 U.S. 190, 194 (1983).

195. *See* 42 U.S.C. §§ 2039, 2210.

196. *See* Richard Goldsmith, *Regulatory Reform and the Revival of Nuclear Power*, 20 HOFSTRA L. REV. 159, 182–83 (1991).

197. *See supra* Part III.C.

198. *See supra* Part III.A.

199. *Id.*

200. *See generally* Lincoln L. Davies & Kirsten Allen, *Feed-In Tariffs in Turmoil*, 116 W. VA. L. REV. 937 (2014) (examining the dilemmas presented by feed-in tariffs in Germany, Spain, and South Korea).

decision to abandon nuclear power carries heavy consequences with it.[201]

Fukushima, then, shines a bright light on the hard questions that the markets-versus-planning tension raises. When should governments intervene in energy decision making? How should they intervene? How should governments assess energy tradeoffs? How should different kinds of risks be weighed? Under what conditions should governments be willing to regulate retroactively,[202] especially since retroactivity can both undermine efficacy and increase compliance cost?[203] In nuclear power as well as in energy generally, these dilemmas are not just prevalent, but deep.

B. *Path Dependence vs. Resilience*

Cataclysm for electrical engineers is the lights going off. Why? The very goal of the system is reliability—power as needed, when needed, all the time. The aim is not electricity's alone. A persistent objective of energy policy is security: making sure enough supply is available whenever needed.[204] Governments go to great lengths to achieve this aim, and those efforts in turn create a second important tension in energy policy also highlighted by Fukushima: limiting path dependence while also ensuring system resilience.

It is in vogue today to question whether disruptive innovation will foment an electric utility "death spiral."[205] This tension, of course, has long been a part of energy law and policy, dating back at least to the U.S. Supreme Court's decision in *Market Street Railway Co. v. Railroad Comm'n of California*[206] and persisting to this day.

One side of the tension is the risk of path dependence. Energy law and policy have often been criticized as preferencing large,

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201. *See* Stephen J. Dubner, *What Happens Next as the World Turns Away From Nuclear Power? A Freakonomics Quorum*, FREAKONOMICS (June 21, 2011, 11:31 AM), http://freakonomics.com/2011/06/21/what-happens-next-as-the-world-turns-away-from-nuclear-power-a-freakonomics-quorum/ [https://perma.cc/G2Y8-BH6A] (archived Sept. 6, 2015).

202. Emily Hammond, *Nuclear Power, Risk and Retroactivity*, 48 VAND. J. TRANSNAT'L L. 1059 (2015).

203. On values important to energy investors and energy transformation, see generally, for example, Felix Mormann, *Enhancing the Investor Appeal of Renewable Energy*, 42 ENVTL. L. 681 (2012); Felix Mormann, *Requirements for a Renewables Revolution*, 38 ECOLOGY L.Q. 901 (2011).

204. INT'L ENERGY AGENCY, ENERGY POLICY HIGHLIGHTS 11 (2013), *available at* https://www.iea.org/publications/freepublications/publication/Energy_Policy_Highlights_2013.pdf [https://perma.cc/LQQ5-UEQU?type=source] (archived Sept. 6, 2015).

205. Peter Kelly-Detwiler, *Relentless and Disruptive Innovation Will Shortly Affect US Electric Utilities*, FORBES (Apr. 18, 2013, 11:15 AM), http://www.forbes.com/sites/peterdetwiler/2013/04/18/relentless-and-disruptive-innovation-will-shortly-affect-us-electric-utilities/ [https://perma.cc/9L7S-79ZE?type=source] (archived Sept. 6, 2015).

206. 324 U.S. 548 (1945).

incumbent, institutional actors.[207] In the United States, for example, the electricity system has historically favored large centralized power plants that deliver electricity over three large grid systems, rather than more localized, "distributed generation" systems. This preference, in turn, has entrenched institutions related to coal, natural gas, and nuclear energy. Thus, the prevalence of these institutions makes transforming the energy system quite hard to do. This "dominant" energy paradigm then doubles down on itself because a capital investment as large as a nuclear reactor is hard to walk away from, particularly when the plan was to recoup the investment over several decades. Amory Lovins thus famously referred to the "hard path" of energy, and nuclear power was his prototypical example.[208] Nuclear power, of course, is but one example. The problem is pervasive in energy systems generally, which historically have been very capital intensive. Thus, whether the objective is to reduce emissions that cause acid rain, to limit land consumption for renewables, or to move away from coal for climate change reasons,[209] the fact remains that in energy, as in life, abandoning massive sunk costs is no easy task.

The other side of this tension is resilience. For many reasons, scholars increasingly look to the idea of resilience, rather than sustainability, to talk about the staying power of systems.[210] Nuclear power, of course, has many sustainability benefits—most prominently, its limited greenhouse gas emissions as well as its much lighter impact on air quality than natural gas and especially coal.[211] One might note that nuclear power provides our energy system with a remarkable amount of resilience as well. No other conventional energy source has produced so much electricity with such a record of safety. Further, the manner in which it produces electricity is noteworthy, as no new plants were built in the United States for decades, but the fleet substantially increased its production anyway through upgrades and operational optimization.[212] If adaptability is a

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207. *See* Joseph P. Tomain, *The Dominant Model of United States Energy Policy*, 61 U. COLO. L. REV. 355, 375 (1990) ("[D]omestic energy policy favors large-scale, high-technology, capital-intensive, integrated, and centralized producers of energy from fossil fuels.").

208. Amory B. Lovins, *Energy Strategy: The Road Not Taken?*, 55 FOREIGN AFF. 65 (1976), https://www.foreignaffairs.com/articles/united-states/1976-10-01/energy-strategy-road-not-taken [https://perma.cc/MQH4-AYV7] (archived Sept. 6, 2015).

209. *See* Patrick Charles McGinley, *Climate Change and the War on Coal: Exploring the Dark Side*, 13 VT. J. ENVTL. L. 255 (2011) (analyzing the future of coal-based energy in relation to the current threat of climate change).

210. *See, e.g.*, Robin Kundis Craig & Melinda Harm Benson, *Replacing Sustainability*, 46 AKRON L. REV. 841, 844 (2013).

211. *See* Fred Bosselman, *The Ecological Advantages of Nuclear Power*, 15 N.Y.U. ENVTL. L.J. 1 (2007).

212. *Nuclear Power in the USA*, *supra* note 111.

hallmark of resilience, this trend alone argues that nuclear power, despite the massive size of its plants and the immense capital costs the technology demands, is indeed adaptable when needed.

Again, nations' reactions to the Fukushima disaster make this tension apparent. On one hand, nations that chose to keep the status quo, like France and the United States, might be criticized as making that decision out of reluctance to abandon longstanding investments: that is, the effect of sunk costs, or path dependence. On the other hand, nations that chose to build more nuclear plants, like China, India, and South Korea, may serve as a testament to the technology's reliability and durability: even in the wake of a tragedy, they trust that if their energy systems need to adapt further, they can. Certainly, nations that have shifted their bet from atomic energy to renewables, like Germany, believe that Lovins' soft path is the more resilient one in the long term—more agile, nimble, and adaptable. But the fact that any nation's policy must make this call, and that every nation was faced with reevaluating this question post-Fukushima, only underscores its centrality in global energy policy.

C. *Values vs. Values*

It is of course true that laws often have multiple objectives—criminal law, for instance, aims to both punish and deter—but perhaps no field is as laden with as many values as is energy law and policy.[213] This, then, is the third fundamental tension. Energy policies espouse many values, often many at once. Discerning which value is in question is difficult enough; measuring tradeoffs among competing values is far harder still.

Values in energy policy sometimes are plain. For example, Professor Tomain has identified several values of traditional U.S. energy policy: abundance of supply, reliability of supply, low price, and governance via competition and state-federal oversight.[214] Increasingly, environmental protection (or at least mitigation of environmental harms) also is a value of energy policy[215]—as are efficiency, equity, and, to some degree, democracy. Energy "independence" is often held out as a core value of U.S. energy policy,

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213. *See, e.g.*, Tomain, *supra* note 207, at 356–69.

214. *Id.*

215. *See, e.g.*, Amy J. Wildermuth, *Is Environmental Law a Barrier to Emerging Alternative Energy Sources?*, 46 IDAHO L. REV. 509, 510–11 (2010) (exploring the energy policy and environmental law divide); Amy J. Wildermuth, *The Next Step: The Integration of Energy Law and Environmental Law*, 31 UTAH ENVTL. L. REV. 369 (2011) (arguing that a failure to integrate environmental and energy law will cause both to suffer).

whatever "energy independence" means, if it means anything at all.[216]

One problem, however, is that sometimes it is not clear which value a given energy law or policy seeks to promote. A renewable portfolio standard, for instance, would seem to be all about greening the electricity supply, but jurisdictions often cite the idea of job creation in support of these laws' passage.[217] Another difficulty is that energy policy values can conflict. Part I of the Federal Power Act, which regulates hydroelectricity, specifically identifies recreation and ecological concerns as considerations in its licensing process, but its original core aim is obviously to augment power supplies.[218] Finally, it is often difficult to quantify or measure the value that is being promoted in any given energy policy—and, sometimes, different values that a policy advances are not seen, or are ignored. Congress might pass a law that can help shore up reliability in the electricity grid, but the way the law ultimately is implemented preferences traditional values about who governs over other aims,[219] perhaps in part because the value of reliability is invisible on a day-to-day basis.

As with the other tensions, Fukushima exposed the inherent clash of values in energy policy. In choosing whether to continue with nuclear energy production, different nations expressed different values in their energy policies. Arguably, Germany's choice was to preference risk reduction over everything (or to promote energy democracy through renewable resources), while the United States' was primarily to keep reactors safe and prices down, and China's can be chalked up to a desire to promote both energy access and economic expansion.[220] In each of these cases, multiple values are or could be at play.

That is the point. In terms of its end product, nuclear power does the same thing all other generation sources do. It produces electricity. "Electrons can't be colored," electrical engineers are fond of saying,

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216. *Cf.* Lincoln L. Davies, *Tracing U.S. Renewable Energy Policy*, 43 ENVTL. L. REP. NEWS & ANALYSIS 10320 (2013) (discussing the unlikelihood of attaining energy independence from foreign nations).

217. *See, e.g.*, Lincoln L. Davies, *State Renewable Portfolio Standards: Is There a "Race" and Is It "To the Top"?*, 3 SAN DIEGO J. CLIMATE & ENERGY L. 3 (2011–12); Joshua P. Fershee, *When Prayer Trumps Politics: The Politics and Demographics of Renewable Portfolio Standards*, 35 WM. & MARY ENVTL. L. & POL'Y REV. 53, 53 (2010).

218. *See* 16 U.S.C. § 803(a) (2012); *see also, e.g.*, Bear Lake Watch, Inc. v. FERC, 324 F.3d 1071, 1074 (9th Cir. 2003); Am. Rivers v. FERC, 201 F.3d 1186, 1201 (9th Cir. 1999).

219. Piedmont Envtl. Council v. FERC, 558 F.3d 304 (4th Cir. 2009); *see also* Kevin Decker, Comment, *Allocating Power: Toward a New Federalism Balance for Electricity Transmission Siting*, 66 ME. L. REV. 229 (2013). *But cf.* Jim Rossi, *The Trojan Horse of Electric Power Transmission Line Siting Authority*, 39 ENVTL. L. 1015 (2009).

220. On the question of China using energy policy to promote economic growth in the renewables context, see Eisen, *supra* note 159.

meaning that electricity cannot be traced once it is injected into the grid.[221] But the same thing is true from a consumption perspective. One kilowatt-hour of electricity from a nuclear plant is perfectly fungible with one kilowatt-hour from a coal-fired or photovoltaic plant; they all do the same amount of work. The problem is that a focus on energy systems' end products can obfuscate the other values the systems advance.[222] For example, nuclear power plants and coal-fired plants differ in both their actual externalities (e.g., air pollution or water consumption or waste storage and treatment) and in the short- and long-term risks they impose. To the extent that the same focus on end products rather than overall context occurs in policy, a similar distortion can manifest in how we think about energy. In choosing to democratize its energy system post-Fukushima, for instance, Germany may have foregone key values (such as baseload stability and no greenhouse gas emissions) that nuclear power can promote—just as Japan, until March 11, masked or ignored the technology's risk to human health and the environment for the sake of a stable, abundant, made-at-home electricity supply.

D. *Implications: Nuclear Energy Post-Fukushima*

The tensions of energy policy are not easily resolved, and arguably are not even resolvable. Energy is so critical to the very way in which modern society functions, it is inevitable that conflicts will arise over how it should be used, and over the ways in which policy seeks to promote and shape its use. For modern nations, particularly industrialized nations, energy is lifeblood. The energy policy that is used to ensure the availability, and delivery, of this resource, then, also is fundamental.

At the same time, the lifeblood of energy carries with it many risks. These risks are manifold, and are not just environmental but economic and social as well. The immediate loss of an energy source has the potential to cast just as many ripples throughout a nation's economy as might an energy disaster through the eco- and biological systems on which societies rely.

Fukushima demonstrated this in every way. The disaster's effects on Japan have been heavily economic and social as well as environmental. The tens of thousands who have been relocated from the prefecture may have avoided long-term radiation impacts from

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221. *See* Federal Power Comm'n v. Florida Power & Light Co., 404 U.S. 453 (1972); *see also* David Radcliffe, *From Altamont Pass to Mountain View: Getting More Renewable Energy on the Grid*, GOOGLE GREEN BLOG (Feb. 11, 2015), http://googlegreenblog.blogspot.com/2015/02/from-altamont-pass-to-mountain-view.html [http://perma.cc/3YWN-DZG9] (archived Sept. 6, 2015).

222. From a systems perspective, for instance, baseload nuclear power is much different from an intermittent, non-dispatchable residential solar array.

the meltdowns, but they feel the disaster's aftereffects on a daily basis.

Moreover, the shadow that Fukushima has cast on global energy policy is undeniably significant. This observation is plain for countries that chose to abandon nuclear power in Fukushima's wake, but it is equally clear, if less obvious, for those that decided to maintain or even expand use of nuclear energy following the disaster. Even those jurisdictions paused, reassessed, and recalibrated their policies to adjust to the Fukushima disaster. Fukushima, then, also made clear the global interconnectedness of energy systems and energy policy systems. The immediate environmental effects of the disaster radiated through the Japanese countryside, but the aftershocks of this one facility's demise spread across the globe.

Inevitably, every energy industry operates in a policy context that is inherently elastic, murky, and evolutionary. The very nature of energy policy, with its conflicting values and multiple tensions, makes this the case. When a government chooses to reshape a policy in one way, it by definition influences the overall shape and composition of the policy in other ways as well. That is, the energy system, and the energy law and policy systems that govern it, are intricately complex. They are, moreover, interlinked and interrelated. As complexity theory would suggest, a change in one part of one of these systems inevitably will influence the others—and how those changes play out should be expected to differ from one context to another.[223] Thus, for example, when technology changes, or new ones emerge, or the costs or risks of those already in use are made clear, policies likewise have to adapt. Policymakers are responsible for this uneasy task, a task that requires balancing multiple factors, interests, objectives, and values. Disasters only make the calculus more complex—both for the regulators and the regulated.

In Fukushima's shadow, the nuclear industry faces this reality directly. Perhaps the specific reaction of any given nation to this disaster could not be predicted, but the overall breadth of countries' reactions might, in retrospect, be hardly surprising. This is what complexity theory would predict. In systems as complex as energy and energy policy, panarchy—as manifested in the idea that responses will vary depending on their context, including space, time, and socio-political culture—reigns. [224] It certainly did post-Fukushima. Not one but three responsive paths emerged, and the details of how different nations followed those paths varied from one jurisdiction to the next.

Moreover, the global response to Fukushima also highlighted core tensions within energy policy more broadly and nuclear energy

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223. *See supra* notes 187–89 and accompanying text.
224. *See supra* note 188.

policy more specifically—tensions that cross borders and that are not bound by technology type. The fact that some countries chose to abdicate nuclear power, or stop exploring its possible use, reflects the need to use regulation to influence markets if an energy policy aims for a specific outcome or direction. It also may highlight the preference of many policymakers for market outcomes; nuclear power, indeed, often is criticized as possible only with heavy governmental support. Likewise, the fact that many nations chose to either continue to use, or even to expand, their nuclear energy use after a disaster as severe as Fukushima shows the heavy influence of path dependence on energy policy. Once a nation becomes reliant on any resource, switching is not simple. Finally, Fukushima exposed a wide variety of conflicting values embedded within energy policy, often at the same time, whether that is Germany's emphasis on energy democracy and participation, the United States' strong desire for cheap prices and reliable supplies, or China's exponential energy demands for industrial growth.

The nuclear energy industry, of course, arguably rests on shakier ground post-Fukushima than it did before the disaster. Gone are the days when commentators, policymakers, and others trumpeted the impending nuclear renaissance. At the same time, nuclear power appears on the rebound. Reactors are being added to the global fleet, it remains a key resource in some of the world's most influential nations, and the need for climate change mitigation continues to present a possible opportunity for the industry's growth. Overall, the policies adopted by nations in response to the Fukushima disaster also reflect these realities, even if a minority of nations has stricken nuclear energy from their electricity policy portfolios. As nuclear power approaches its sixth decade of use, then, it appears to have earned a reliable toehold in the global energy and energy policy systems—even in the aftermath of Fukushima Daiichi, or at least until another disaster of its magnitude occurs.

V. CONCLUSION

Disasters such as Fukushima cannot be overlooked, or underestimated. Undeniably, they call not just for humanitarian aid but also legal response, and legal structures that support restitution of damaged areas and the people in them. What the reaction to Fukushima shows, however, is that how legal and policy systems change in response to disasters cannot necessarily be expected to be uniform. Just as disasters are complex, so too are the legal, industrial, and policy systems that allow for them to occur in the first instance—and that respond once they take place. Such systems are more like living organisms than raw materials ready for external manipulation: they adapt and evolve, and seek to protect their own

interests. For systems as complex as energy and energy policy, which reflect many values and promote just as many goals, a single disaster certainly may have influence, but is unlikely to effect a global sea change by itself. Even where the shadow cast is wide and dark, light may come again, once the disaster finally ends.

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