Sources to *Nuclear is not the Solution: The Folly of Atomic Power in the Age of Climate Change*

Updated: 30 July 2024

Introduction

1. The World Nuclear Association, for example, proposes building thousands of nuclear reactors, which would together be capable of generating a million megawatts of electricity, by 2050.[1]

2. Thus, what is actually being advocated might be termed *faux* nuclear plants, existing only in the imagination of some, not in the real world.[2]

3. Ten days after the groundbreaking for first US nuclear plant, Strauss told his audience that given the great promise of nuclear technology, it would not be "too much to expect that our children will enjoy in their homes electrical energy too cheap to meter."[3]

4. Let me offer one example from a company called Hyperion Power Generation offering a small nuclear power plant design that was actively covered in the media between 2007 and 2012.[4]

5. In March 2010, the founder of this company, John Deal, told the *Albuquerque Journal*, "We started this company to clean water in Africa … Our emphasis is helping people not die from not having clean water … If you've got energy, you can have all the clean water you want."[5]

---

[1] WNA, "The Harmony Programme," World Nuclear Association, March 12, 2019, https://www.world-nuclear.org/our-association/what-we-do/the-harmony-programme.aspx.

[2] I am drawing on Admiral Rickover's description of academic reactors. See Kennedy Maize, "Hyman Rickover on Nuclear Designs," *POWER Magazine*, March 16, 2017, https://www.powermag.com/blog/hyman-rickover-on-nuclear-designs/.

[3] Richard Pfaul, *No Sacrifice Too Great: The Life of Lewis L. Strauss* (Charlottesville: University Press of Virginia, 1984), 187 There is some debate over whether Strauss was referring to nuclear fission or fusion when he spoke those words. But, if it did refer to nuclear fusion, the prognosis proved even more wishful. .

[4] In 2012, all founders of the company quit Hyperion and started a new company. Kevin Robinson-Avila, "Hyperion Founders Launch IX Power LLC," *Albuquerque Business First*, February 15, 2012, https://www.bizjournals.com/albuquerque/news/2012/02/15/hyperion-founders-launch-ix-power-llc.html.Hyperion eventually morphed into a company called Gen4 energy, which seems to have folded up around 2015 or so.

[5] Phil Parker, "Reactors Sized for Shipping," *Albuquerque Journal*, March 22, 2010, https://www.abqjournal.com/biz/222110577453biz03-22-10.htm.

6. It is the weakness of the nuclear industry that forces it to seek alliances with other constituencies.[6]

7. Nuclear energy advocates often argue against conflating nuclear energy with nuclear weapons[7], but the connection is visible for all those who want to look.

8. In 1946, when discussing a proposal for the international control of nuclear weapons, Robert Oppenheimer, the head of the program that produced the first atomic bombs, which destroyed Hiroshima and Nagasaki, expressed it thus: "We know very well what we would do if we signed such a convention: we would not make atomic weapons, at least not to start with, but we would build enormous plants, and we would design these plants in such a way that they could be converted with the maximum ease and the minimum time delay to the production of atomic weapons."[8]

9. This "greatest of destructive forces," Eisenhower prophesized, "can be developed into a great boon, for the benefit of all mankind," can be put to "universal, efficient and economic usage" and whose "special purpose would be to provide abundant electrical energy in the power-starved areas of the world."[9]

10. The consequences and burdens of such an expansion will fall primarily on communities that are distant from the centers of power, and economically and politically too marginal to figure in the calculations of decision makers.[10]

11. Radioactive cesium released by the disaster was found in sheep in England, which remained contaminated for decades; restrictions on eating these sheep were lifted in all areas only in 2012.[11]

12. In the United States, home to the most nuclear plants globally, the financial firm Lazard estimated in October 2021, before the war on Ukraine created supply chain–related uncertainties, that power from a new nuclear plant costs over four times the

---

[6] This idea has been explored in a different context by Steven Flank. See S. M Flank, "Reconstructing Rockets: The Politics of Developing Military Technology in Brazil, India and Israel" (Massachusetts Institute of Technology, 1993).

[7] For example, Ted Nordhaus, "Time to Stop Confusing Nuclear Weapons with Nuclear Power," *The Hill*, May 14, 2017, https://thehill.com/blogs/pundits-blog/energy-environment/333329-time-to-stop-confusing-nuclear-weapons-with-nuclear.

[8] Morton Grodzins and Eugene Rabinowitch, *The Atomic Age: Scientists in National and World Affairs. Articles from the Bulletin of the Atomic Scientists 1945-1962* (Basic Books, 1963), 55.

[9] Dwight Eisenhower, "'Atoms for Peace' Speech," *Atomic Heritage Foundation* (blog), December 8, 1953, https://ahf.nuclearmuseum.org/ahf/key-documents/eisenhowers-atoms-peace-speech/.

[10] Jinyoung Park and Benjamin K. Sovacool, "The Contested Politics of the Asian Atom: Peripheralisation and Nuclear Power in South Korea and Japan," *Environmental Politics* 27, no. 4 (July 4, 2018): 686–711, https://doi.org/10.1080/09644016.2018.1439436.

[11] BBC, "Chernobyl Sheep Controls Lifted in Wales and Cumbria," *British Broadcasting Corporation*, March 22, 2012, https://www.bbc.com/news/uk-wales-17472698.

corresponding costs of power from wind turbines and utility-scale solar plants respectively.[12]

13. The public also will have to pay the long-term expenses associated with dealing with the multiple forms of radioactive waste and the subsidies aimed at inducing private companies to invest in nuclear power.[13]

14. As Noam Chomsky explained in an interview about the financial crash of 2008, "What you have is a system of socialization of cost and risk and privatization of profit. And that's not just in the financial system. It is the whole advanced economy."[14]

15. I am following the great African American writer James Baldwin, who argued on the pages of the *New York Times* in 1962 that we must try to "utilize the particular in order to reveal something much larger and heavier than any particular can be."[15]

Chapter 1: Undesirable: Risks to the Environment and People's Health from Nuclear Energy

1. *Ira had just undergone a second operation. She told me that her mother had the same type of cancer, and that recently "the doctors found a 'knot' (vuzol) in my little sister's thyroid as well." Ira, like the other girls, marked the progression of her disease by counting the number of "knots" forming in her throat, chest, and neck. "The doctors tell me how many I have at a given time," Ira said, as if she was engaged in a ritualistic form of anticipation.* Adriana Petryna, 2003[16]

2. *Electricity is but the fleeting byproduct from atomic reactors. The actual product is forever deadly radioactive waste.* Kevin Kamps, 2016[17]

3. Rather than cremating her beloved dog Matsuko, Mizue Kanno chose to bury her pet intact, under a cherry tree in her garden in the town of Namie in Fukushima prefecture.[18]

---

[12] Lazard, "Lazard's Levelized Cost of Energy-Version 15.0" (New York: Lazard, October 2021), https://www.lazard.com/perspective/levelized-cost-of-energy-levelized-cost-of-storage-and-levelized-cost-of-hydrogen/.
[13] Doug Koplow, "Energy Subsidies: Global Estimates, Causes of Variance, and Gaps for the Nuclear Fuel Cycle," in *Learning from Fukushima*, ed. Peter Van Ness and Mel Gurtov (Canberra, Australia: ANU Press, 2017), 63–99.
[14] Simone Bruno, "The Financial Crisis of 2008: Noam Chomsky Interviewed," *ZNet*, October 13, 2008, https://chomsky.info/20081013/.
[15] James Baldwin, "As Much Truth as One Can Bear," *New York Times*, 1962.
[16] Adriana Petryna, *Life Exposed: Biological Citizens after Chernobyl*, 2013 edition (Princeton, N.J.: Princeton University Press, 2003), 79.
[17] Kevin Kamps, "After Flint, Don't Let Them Nuke the Great Lakes next!," *Counterpunch*, January 26, 2016, http://www.counterpunch.org/2016/01/26/after-flint-dont-let-them-nuke-the-great-lakes-next/.
[18] "Lives of Fukushima - 12 testimonies from Fukushima nuclear disaster," accessed October 11, 2022, https://fukushimatestimony.jp/en/.

4. Kanno, her son, and their dog stayed at home till March 15, four days later.[19]

5. When they reached Koriyama, another town within Fukushima prefecture, they were screened for radiation exposure. Kanno's levels were very high.[20]

6. One study published in the journal *Epidemiology* found an approximately thirty-fold increase in the number of thyroid cancer cases among children and adolescents.[21]

7. Over 300 residents of Fukushima prefecture have been diagnosed with thyroid cancer.[22]

8. For the remainder of their days, a paper in the journal *Thyroid* tells us, they will have to ingest thyroid hormones and will experience a poorer quality of life, with possible problems like insomnia and fatigue.[23]

9. In January 2022, six of these thyroid cancer patients, all between six and sixteen years of age at the time of the accident, filed a suit against Tokyo Electric Power Company (TEPCO) seeking a total of ¥616 million (about $5.4 million) in compensation.[24]

10. The case is complicated because Fukushima prefecture and the Japanese government deny any connection between the cancers and the accident.[25]

---

[19] Motoyuki Maeda, "Men in Protective Clothing," What's up Japan?, *Men in Protective Clothing This Is Translated from a Series of Articles Originally Published in Asahi Newspaper in Japan, Titled "Prometheus' Trap - the First Series: Men in Protective Clothing" By...* (blog), October 3, 2011, https://hopsii.tumblr.com/fukushima.

[20] According to Mizue Kanno, "When they held the Geiger counter against my jacket and hair, the needle shot right up to a hundred thousand cpm". Counts per minute is a measure of the radiation. This can be compared with the level of 13,000 cpm, the threshold level used by Fukushima prefecture's 'Exposure emergency medical response manual' to recommend thyroid screening and iodine tablets to lower the risk of thyroid cancer. See "Lives of Fukushima - 12 testimonies from Fukushima nuclear disaster."

[21] Toshihide Tsuda et al., "Thyroid Cancer Detection by Ultrasound Among Residents Ages 18 Years and Younger in Fukushima, Japan: 2011 to 2014," *Epidemiology* 27, no. 3 (May 2016): 320, https://doi.org/10.1097/EDE.0000000000000385.

[22] Toshiko Kato, Kosaku Yamada, and Tadashi Hongyo, "Area Dose–Response and Radiation Origin of Childhood Thyroid Cancer in Fukushima Based on Thyroid Dose in UNSCEAR 2020/2021: High 131I Exposure Comparable to Chernobyl," *Cancers* 15, no. 18 (September 15, 2023): 4583, https://doi.org/10.3390/cancers15184583; Ido Ken'ichi, "Urging Support for the 311 Children's Thyroid Cancer Trial," *Citizens' Nuclear Information Center* (blog), April 4, 2022, https://cnic.jp/english/?p=5973.

[23] Susanne Singer et al., "Quality of Life in Patients with Thyroid Cancer Compared with the General Population," *Thyroid* 22, no. 2 (February 2012): 117–24, https://doi.org/10.1089/thy.2011.0139.

[24] "6 People to Sue TEPCO over Thyroid Cancer after Fukushima Nuclear Disaster," *Mainichi Daily News*, January 21, 2022, https://mainichi.jp/english/articles/20220121/p2a/00m/0na/018000c.

[25] Thisanka Siripala, "Fukushima Disaster's Impact on Health Will Be Challenged in Court," *The Diplomat*, February 17, 2022, https://thediplomat.com/2022/02/fukushima-disasters-impact-on-health-will-be-challenged-in-court/; "Eight More Fukushima Kids Found with Thyroid Cancer; Disaster Link Denied," *Japan Times*, February 7, 2014, https://nuclear-news.net/2014/02/07/eight-more-fukushima-kids-found-with-thyroid-cancer-disaster-link-still-denied/; See also Majia Holmer Nadesan, "Nuclear Governmentality: Governing Nuclear Security and Radiation Risk in Post-Fukushima Japan," *Security Dialogue* 50, no. 6 (December 1, 2019): 512–30, https://doi.org/10.1177/0967010619868442.

11. Their officials typically attribute the increased number of thyroid cancers to "over diagnosis." [26]

12. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) has come to a similar conclusion.[27]

13. As Dillwyn Williams, a leading researcher on thyroid carcinogenesis, explained in a 2002 article in *Nature Reviews Cancer*, the spike in thyroid tumors formed "the largest number of cancers of one type, caused by a single event on one date, ever recorded."[28]

14. Between 1991 and 2015, the total number of registered thyroid cancers in Belarus, Ukraine, and the four most contaminated oblasts in Russia was 19,233, according to an UNSCEAR report from 2018.[29]

15. Studies have found excess numbers of cancers of other kinds, heart disease, congenital malformations, and so on in the region around Chernobyl.[30]

16. So, later in the chapter, I briefly document how the nuclear industry employs strategies reminiscent of the tobacco industry's efforts to delink smoking and cancer documented by historians Naomi Oreskes and Erik Conway in their *Merchants of Doubt*.[31]

17. Or the fossil fuel industry's efforts to deny the reality of climate change outlined by authors like Geoff Dembicki (*The Petroleum Papers*).[32]

---

[26] Kota Katanoda, Ken-Ichi Kamo, and Shoichiro Tsugane, "Quantification of the Increase in Thyroid Cancer Prevalence in Fukushima after the Nuclear Disaster in 2011—a Potential Overdiagnosis?," *Japanese Journal of Clinical Oncology* 46, no. 3 (March 2016): 284–86, https://doi.org/10.1093/jjco/hyv191; Kenji Shibuya, Stuart Gilmour, and Akira Oshima, "Time to Reconsider Thyroid Cancer Screening in Fukushima," *The Lancet* 383, no. 9932 (May 31, 2014): 1883–84, https://doi.org/10.1016/S0140-6736(14)60909-0.

[27] "UN Experts Find 'no Harmful Effects' from Fukushima," *DW.COM*, March 9, 2021, https://www.dw.com/en/un-experts-find-no-harmful-effects-from-fukushima-nuclear-disaster/a-56820805; "Frequently Asked Questions and Answers," UNSCEAR 2020/2021 Fukushima Report, 2021, https://www.unscear.org/unscear/en/areas-of-work/fukushima-report-faq//www.unscear.org/unscear/en/areas-of-work/fukushima-report-faq.

[28] Dillwyn Williams, "Cancer after Nuclear Fallout: Lessons from the Chernobyl Accident," *Nature Reviews Cancer* 2 (2002): 543.

[29] UNSCEAR, *Evaluation of Data on Thyroid Cancer in Regions Affected by the Chernobyl Accident* (New York: United Nations Scientific Committee on the Effects of Atomic Radiation, United Nations, 2018), 9, https://www.unscear.org/docs/publications/2017/Chernobyl_WP_2017.pdf.

[30] See for example Anton V. Korsakov et al., "De Novo Congenital Malformation Frequencies in Children from the Bryansk Region Following the Chernobyl Disaster (2000–2017)," *Heliyon* 6, no. 8 (August 1, 2020): e04616, https://doi.org/10.1016/j.heliyon.2020.e04616; V K Ivanov, "Late Cancer and Noncancer Risks among Chernobyl Emergency Workers of Russia," *Health Physics* 93, no. 5 (2007): 470–79; Roy E. Shore et al., "Recent Epidemiologic Studies and the Linear No-Threshold Model For Radiation Protection-Considerations Regarding NCRP Commentary 27," *Health Physics* 116, no. 2 (2019): 235–46, https://doi.org/10.1097/HP.0000000000001015.

[31] Naomi Oreskes and Erik M. Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* (New York: Bloomsbury Press, 2011).

[32] Geoff Dembicki, *The Petroleum Papers: Inside the Far-Right Conspiracy to Cover Up Climate Change* (Vancouver: Greystone Books, 2022).

18. Rob Socolow, a physicist and a colleague of mine at Princeton University at the time of the Fukushima accident, described this unfamiliar phenomenon as "the fire that you can't put out."[33]

19. As Oreskes and Conway explain in *Merchants of Doubt*, the tobacco industry used the uncertainty inherent in all scientific endeavors to undermine what the science had uncovered.[34]

20. The strategy is best captured in a phrase from a 1969 memo from British American Tobacco: "doubt is our product."[35]

21. As John explained in a September 2021 presentation to the US National Academies of Sciences, Engineering, and Medicine, both nuclear power plants and aircraft need to "do active work in order to remain safe."[36]

22. In 2010, for example, President Barack Obama announced that to deal with climate change "we're going to have to build a new generation of safe, clean nuclear power plants" alongside opening up new offshore areas for oil and gas development and investing in "clean coal technologies." [37]

23. Nuclear proponents want to quantify accident possibilities because they expect this exercise will result in very small probabilities and lead policymakers to ignore this contingency in their planning.[38]

24. NuScale goes on to calculate that if a reactor is struck by a hurricane, the likelihood of a subsequent release of radioactivity is less than one in a trillion (6.6×10^{-14} for the scientifically inclined).[39]

25. In a 2016 paper in the journal *Science & Global Security*, Suvrat Raju——whose research on string theory won him the Nishina Award, given to outstanding Asian physicists—has demonstrated rigorously that the existing empirical record of nuclear accidents means that one can simply rule out such extraordinarily small estimates.[40]

---

[33] Robert Socolow, "Reflections on Fukushima: A Time to Mourn, to Learn, and to Teach," *Bulletin of the Atomic Scientists Online*, March 21, 2011, https://thebulletin.org/2011/03/reflections-on-fukushima-a-time-to-mourn-to-learn-and-to-teach/#post-heading.

[34] Oreskes and Conway, *Merchants of Doubt*, 34.

[35] "Smoking and Health Proposal" (British American Tobacco, 1969), https://www.industrydocuments.ucsf.edu/tobacco/docs/#id=psdw0147.

[36] John Downer, "What Can Be Learned from Other Industries" (The National Academies of Sciences, Engineering, and Medicine, Online, September 2021), https://nap.nationalacademies.org/resource/26606/interactive/.

[37] *Investing in Clean, Safe Nuclear Energy*, 2010, https://www.youtube.com/watch?v=YAsHEjbQKjA; Kate Sheppard, "Obama's Risky Nuclear Renaissance," *The Guardian*, February 17, 2010, https://www.theguardian.com/commentisfree/cifamerica/2010/feb/16/barack-obama-nuclear-power.

[38] John Downer, "Disowning Fukushima: Managing the Credibility of Nuclear Reliability Assessment in the Wake of Disaster," *Regulation & Governance* 8, no. 3 (2014): 289, https://doi.org/10.1111/rego.12029.

[39] NRC, "Probabilistic Risk Assessment and Severe Accident Evaluation" (Washington, D. C.: Nuclear Regulatory Commission, 2019), https://www.nrc.gov/docs/ML1907/ML19073A071.pdf.

[40] Suvrat Raju, "Estimating the Frequency of Nuclear Accidents," *Science & Global Security* 24, no. 1 (2016): 38.

26. How operators might act is "intrinsically hard to analyze," as an elite group of safety experts explained in their 1978 Risk Assessment Review Group Report to the US Nuclear Regulatory Commission.[41]

27. "The three-dimensional world doesn't faithfully obey manuals," in the pithy phrase from the historian Gabrielle Hecht.[42]

28. The failure "was beyond our imagination," a Tokyo Electric Power Company official confessed.[43]

29. After years of focusing on the world of organizations, Perrow turned his attention to nuclear safety when he was requested, as a social scientist, to offer some input into a study of the reactor meltdown at the Three Mile Island nuclear plant in 1979.[44]

30. And as the 1978 Risk Assessment Review Group Report to the US Nuclear Regulatory Commission pointed out, it is conceptually impossible to list all possible pathways to accidents.[45]

31. This possibility is best understood through an example first pointed out by the political scientist Scott Sagan in his book *The Limits of Safety*: the case of the 1966 accident that ruined the Fermi fast breeder reactor in the United States.[46]

32. The accident started with two pieces of zirconium breaking off from what was called the "core catcher" at the base of the reactor.[47]

33. Bereft of any means to conduct away the heat produced by fission reactions, those fuel rods melted and contaminated the reactor with radioactive materials.[48]

34. In his book *Rational Accidents*, John Downer draws on a voluminous literature on safety, specifically aircraft safety, to elaborate on the ways in which redundant systems can fail.[49]

---

[41] H. W Lewis et al., "Risk Assessment Review Group Report to the U. S. Nuclear Regulatory Commission," NUREG/CR-0400 (Washington, D. C.: Nuclear Regulatory Commission, 1978), 31.
[42] Gabrielle Hecht, "Does Chernobyl Still Matter?," *Public Books*, November 22, 2019, https://www.publicbooks.org/does-chernobyl-still-matter/.
[43] M. V. Ramana and Ashwin Kumar, "Nuclear Safety Lessons from Japan's Summer Earthquake," *Bulletin of the Atomic Scientists Online*, December 5, 2007, https://thebulletin.org/2007/12/nuclear-safety-lessons-from-japans-summer-earthquake/.
[44] Charles Perrow, *Normal Accidents: Living with High-Risk Technologies*, Rev. ed. (Princeton, NJ: Princeton University Press, 1999), vii.
[45] Lewis et al., "Risk Assessment Review Group Report to the U. S. Nuclear Regulatory Commission."
[46] Scott Sagan, *The Limits of Safety: Organizations, Accidents and Nuclear Weapons* (Princeton: Princeton University Press, 1993), 160.
[47] Atomic Power Development Associates, Inc., "Report on the Fuel Melting Incident in the Enrico Fermi Atomic Power Plant on October 5, 1966" (Power Reactor Development Company, January 1, 1968), https://doi.org/10.2172/4766757.
[48] John G. Fuller, *We Almost Lost Detroit* (New York: Reader's Digest Press, 1975).
[49] John Downer, *Rational Accidents: Reckoning with Catastrophic Technologies* (Cambridge MA: MIT Press, 2024), https://mitpress.mit.edu/9780262546997/rational-accidents/.

35. Analysts have come up with at least three scenarios that could plausibly end with radioactive materials escaping into the atmosphere from some facility at the Zaporizhzhia complex and contaminating the surrounding region.[50]

36. The second scenario involves one of the spent fuel pools—structures filled with water where the irradiated nuclear fuel rods are stored for cooling—being damaged, causing the water to leak out and the fuel rods to burn.[51]

37. As Michael Sailer from the ÖkoInstitut in Germany, who was chair of the country's Reactor Safety Commission from 2002 to 2006, pointed out in the 2022 edition of the World Nuclear Industry Status Report (see chapter 2), a nuclear plant needs "a stable environment" to operate safely, including "permanently functioning cooling," which is required even when the reactor is "shut down."[52]

38. Further, in the event of an accident, some of these external conditions—for example, floods or wildfires—would make accessing the site harder, challenging potential responses to the accident.[53]

39. My former colleague Ali Ahmad showed that in the last decade (2010–2019), the frequency of climate-related nuclear plant outages was already nearly eight times higher than it was in the 1990s.[54]

40. The commission set up by the National Diet, for example, concluded that the "accident was the result of collusion between the government, the regulators and TEPCO, and the lack of governance by said parties" and went on to express its belief that "the root causes were the organizational and regulatory systems."[55]

41. The Rebuild Japan Initiative Foundation report found it remarkable that "even in the technologically advanced country of Japan, the government and the plant operator, Tokyo

---

[50] Matt Field and Susan D'Agostino, "What Experts Say an Attack on a Ukrainian Nuclear Power Plant Could Do," *Bulletin of the Atomic Scientists*, March 5, 2022, https://thebulletin.org/2022/03/what-experts-say-an-attack-on-a-ukrainian-nuclear-power-plant-could-do/.

[51] This possibility was first explored in detail in Alvarez R. et al., "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States," *Science and Global Security* 11, no. 1 (2003): 1–51; See also Frank N. von Hippel and Michael Schoeppner, "Reducing the Danger from Fires in Spent Fuel Pools," *Science & Global Security* 24, no. 3 (September 1, 2016): 141–73, https://doi.org/10.1080/08929882.2016.1235382; and Thomas G. A. S. Spence and Ali Ahmad, "Risks to Persian Gulf Cities from Spent Fuel Fires at the Barakah and Bushehr Nuclear Power Plants," *Science & Global Security* 29, no. 2 (May 4, 2021): 67–89, https://doi.org/10.1080/08929882.2021.1951000.

[52] Schneider and Froggatt, "The World Nuclear Industry Status Report 2022," 253.

[53] Natalie Kopytko, "Uncertain Seas, Uncertain Future for Nuclear Power," *Bulletin of the Atomic Scientists* 71, no. 2 (January 1, 2015): 29–38, https://doi.org/10.1177/0096340215571905; Natalie Kopytko and John Perkins, "Climate Change, Nuclear Power, and the Adaptation–Mitigation Dilemma," *Energy Policy* 39, no. 1 (January 2011): 318–33, https://doi.org/10.1016/j.enpol.2010.09.046.

[54] Ali Ahmad, "Increase in Frequency of Nuclear Power Outages Due to Changing Climate," *Nature Energy* 6, no. 7 (July 2021): 755–62, https://doi.org/10.1038/s41560-021-00849-y.

[55] Fukushima Nuclear Accident Independent Investigation Commission, "The Official Report of the Fukushima Nuclear Accident Independent Investigation Commission" (Tokyo: The National Diet of Japan, 2012).

Electric Power Company (TEPCO), were astonishingly unprepared, at almost all levels, for the complex nuclear disaster that started with an earthquake and a tsunami."[56]

42. The most important cause for the failure to prepare was a "belief in the 'absolute safety' of nuclear power," a "myth" propagated by "interest groups seeking to gain broad acceptance for nuclear power."[57]

43. The primary mission of organizations operating hazardous technologies, they explained, is typically "something other than safety, such as producing and selling products … In addition, it is often the case that the non-safety goals are best achieved in ways that are not consistent with designing or operating for lowest risk."[58]

44. Of course, as someone who dismissed public concerns following Fukushima with "In that case, let's not bring gas canisters to our homes, let's not install natural gas, let's not stream crude oil through our country,"[59] Erdoğan was not particularly concerned about safety.

45. The result, as Paul Krugman explained in a June 2013 article in the *New York Review of Books*, was that "papers and economists who told the elite what it wanted to hear were celebrated, despite plenty of evidence that they were wrong; critics were ignored, no matter how often they got it right."[60]

46. In a 2010 article in the *British Journal of Sociology*, John Downer called such regulators "a twenty-first century clergy" whose conclusions are typically accepted "at face value with minimal reflection or circumspection." [61]

47. One of the problems identified by the independent investigation commission set up by Japan's Diet was the loss of "the necessary independence and transparency in the relationship between the operators and the regulatory authorities of the nuclear industry of Japan," which it clarified was "best described as 'regulatory capture'—a situation that is inconsistent with a safety culture."[62]

---

[56] Y. Funabashi and K. Kitazawa, "Fukushima in Review: A Complex Disaster, a Disastrous Response," *Bulletin of the Atomic Scientists* 68, no. 2 (2012): 11.
[57] Funabashi and Kitazawa, 13–14.
[58] Nancy Leveson et al., "Moving Beyond Normal Accidents and High Reliability Organizations: A Systems Approach to Safety in Complex Systems," *Organization Studies* 30, no. 2–3 (February 1, 2009): 239, https://doi.org/10.1177/0170840608101478.
[59] Associated Press, "EU to Apply Stress Tests on Its Nuclear Plants," *Deseret News*, March 15, 2011, https://www.deseret.com/2011/3/15/20179340/eu-to-apply-stress-tests-on-its-nuclear-plants#european-commissioner-for-energy-guenther-oettinger-addresses-the-media-after-a-hastily-convened-meeting-of-energy-ministers-nuclear-regulators-and-industry-officials-in-brussels-tuesday-march-15-2011-the-european-union-on-tuesday-considers-stress-tests-t.
[60] Paul Krugman, "How the Case for Austerity Has Crumbled," *The New York Review of Books*, June 6, 2013, http://www.nybooks.com/articles/archives/2013/jun/06/how-case-austerity-has-crumbled/.
[61] John Downer, "Trust and Technology: The Social Foundations of Aviation Regulation," *The British Journal of Sociology* 61, no. 1 (2010): 84, https://doi.org/10.1111/j.1468-4446.2009.01303.x.
[62] Fukushima Nuclear Accident Independent Investigation Commission, "The Official Report of the Fukushima Nuclear Accident Independent Investigation Commission."

48. Writing in the *New York Times*, my former colleague and mentor at Princeton University Frank von Hippel chastised the US Nuclear Regulatory Commission (NRC) as a "textbook example" of regulatory capture. [63]

49. The Canadian journalist Matthew McClearn has exposed in the pages of the *Globe and Mail* how the country's nuclear safety commission overlooked dubious data in renewing a nuclear plant's license and allowed the companies it is regulating to continue operating reactors even though components are deteriorating faster than expected. [64]

50. The NEI's 2017 End of Year Report proudly announced that it had "worked with the House Appropriations Committee to again reduce the NRC's budget … by an additional $85 million," going on to explain that this represented a decline of at least "$139 million (close to $800,000 per reactor)" since the 2014 fiscal year. [65]

51. Described as "the most important legislator for all things nuclear" by the former director of Sandia National Laboratories, which designs the non-fissile material components of the US nuclear arsenal, Domenici describes in his 2004 book *A Brighter Tomorrow* how he threatened Shirley Ann Jackson, the NRC's first African American chair, with cutting the "agency's budget by a third" and forcing the NRC to lighten regulations on the nuclear industry.[66]

52. The senator was richly rewarded for his efforts, receiving hundreds of thousands of dollars in campaign contributions, including from "at least three dozen firms on the membership roster of the Nuclear Energy Institute," according to *NBC News*. [67]

53. His memoir, *Confessions of Rogue Nuclear Regulator*, describes "the bulldozer mentality of the American nuclear power industry and the majority in Congress who supported it."[68]

54. When ASN head Pierre-Franck Chevet told journalists that problems at a reactor under construction were "serious, even very serious," retired executives called his action an "abuse of power" and accused him of going against the national interest.[69]

---

[63] Frank Von Hippel, "It Could Happen Here," *The New York Times*, March 23, 2011.

[64] Matthew McClearn, "Nuclear Reactor Pressure Tubes Are Deteriorating Faster than Expected. Critics Warn Regulators Are 'Breaking Their Own Rules,'" *The Globe and Mail*, January 5, 2023, https://www.theglobeandmail.com/canada/article-canada-nuclear-power-plants-candu-tubes/; Matthew McClearn, "Canada's Nuclear Regulator Overlooked Dubious Data When Renewing Pickering Plant's Licence, Documents Show," *The Globe and Mail*, March 23, 2021.

[65] Daniel Tait, "NEI 2017 End of Year Report" (Energy and Policy Institute, 2018), https://www.documentcloud.org/documents/5975633-DocumentsReport-2019-04-03-12-36-16-3.html#document/p168/a496216.

[66] Pete V. Domenici, *A Brighter Tomorrow: Fulfilling the Promise of Nuclear Energy* (Lanham, MD: Rowman & Littlefield Publishers, 2004), 75.

[67] Mike Stuckey, "Sen. Pete Domenici: Nuclear Renaissance Man," *NBC News*, January 22, 2007, https://www.nbcnews.com/id/wbna15922365.

[68] Gregory Jaczko, *Confessions of a Rogue Nuclear Regulator* (New York: Simon & Schuster, 2019), 137.

[69] Michel Rose, "French Nuclear Watchdog Upsets Industry with Straight Talk," *Reuters UK*, June 22, 2015, https://uk.finance.yahoo.com/news/french-nuclear-watchdog-upsets-industry-143303148.html.

55. This was particularly galling to Chevet, a career civil servant whose motivation to work on nuclear safety dated back to the 1986 Chernobyl accident, which sparked a desire to avoid a similar catastrophe in France.[70]

56. The situation reminds one of John Steinbeck's characterization of banks in *The Grapes of Wrath*: "The bank is something more than men, I tell you. It's the monster. Men made it, but they can't control it."[71]

57. During one of the side events at the 26th Conference of Parties to the Climate Convention in 2021, the director general of the International Atomic Energy Agency, Rafael Grossi, announced: "No one died from radiation at Fukushima."[72]

58. This is confirmed in reports by international bodies such as the United Nations Scientific Committee on the Effects of Atomic Radiation.[73]

59. For example, based on a "comprehensive review of the biology data," the 2006 report of the US National Research Council's Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation (or BEIR committee, for "biological effects of ionizing radiation") concluded, "The risk would continue in a linear fashion at lower doses without a threshold and that the smallest dose has the potential to cause a small increase in risk to humans."[74]

60. After reviewing twenty-nine papers that examined "total solid cancer, leukemia, breast cancer, and thyroid cancer, as well as heritable effects and a few nonmalignant conditions," a group of leading epidemiologists concluded in a 2019 article in *Health Physics* that "the preponderance of recent epidemiologic data on solid cancer is supportive of the continued use of the linear no-threshold model for the purposes of radiation protection."[75]

61. According to the 2020-2021 UNSCEAR report, the collective effective radiation dose to the population of Japan from the Fukushima reactor meltdowns over just the first ten years after the accident is 32,000 person-sieverts. [76]

---

[70] Ludovic Dupin, "Au Chevet de la sûreté nucléaire," *L'Usine Nouvelle*, March 7, 2013, https://www.usinenouvelle.com/article/au-chevet-de-la-surete-nucleaire.N192725.

[71] John Steinbeck, *The Grapes of Wrath* (London: Penguin, 2006), 33.

[72] Sofia Lotto Persio, "'No One Died From Radiation At Fukushima': IAEA Boss Statement Met With Laughter At COP26," *Forbes* (blog), November 4, 2021, https://www.forbes.com/sites/sofialottopersio/2021/11/04/no-one-died-from-radiation-at-fukushima-iaea-boss-statement-met-with-laughter-at-cop26/.

[73] UNSCEAR, "Levels and Effects of Radiation Exposure Due to the Accident at the Fukushima Daiichi Nuclear Power Station: Implications of Information Published since the UNSCEAR 2013 Report" (New York: United Nations Scientific Committee on the Effects of Atomic Radiation, 2022), //www.unscear.org/unscear/en/publications/2020_2021_2.html.

[74] National Research Council, *Health Risks from Exposure to Low Levels of Ionizing Radiation : BEIR VII, Phase 2* (Washington, D.C.: National Academies Press, 2006), 7, http://www.loc.gov/catdir/toc/ecip066/2006000279.html.

[75] Shore et al., "Recent Epidemiologic Studies and the Linear No-Threshold Model For Radiation Protection-Considerations Regarding NCRP Commentary 27," 235.

[76] UNSCEAR, "Levels and Effects of Radiation Exposure Due to the Accident at the Fukushima Daiichi Nuclear Power Station: Implications of Information Published since the UNSCEAR 2013 Report," 169.

62. When combined with the BEIR committee's cancer mortality estimates, this dose estimate will lead to roughly 34,000 deaths. [77]

63. These disproportionate impacts have long been discounted by those in power, as Cynthia Folkers explained in a 2021 paper in the *Journal of the History of Biology*. [78]

64. Epidemiological studies have uncovered evidence linking increased levels of cardiovascular and cerebrovascular diseases and instances of congenital malformations to radiation exposure.[79]

65. In her 2019 book *Manual for Survival: A Chernobyl Guide to the Future*, historian Kate Brown has elaborated how some of these agencies and scientific administrators used an "arsenal of tactics" in the aftermath of Chernobyl to make unwanted health reports "go away," using a playbook that included classifying data, limiting questions, stonewalling investigations, blocking funding for research, sponsoring rival studies, relating dangers to "natural" risks, and drawing up study protocols designed to find nothing but catastrophic effects. [80]

66. Perhaps the most publicized version of this comparison came from the well-known climate scientist James Hansen and his collaborator Pushker Kharecha, who estimated in a 2013 paper in *Environmental Science and Technology* that the use of nuclear power around the world "has prevented an average of 1.84 million air pollution–related deaths" and "could additionally prevent an average of 420,000–7.04 million deaths … by midcentury."[81]

67. Had the process continued, the exposed spent fuel would have caught fire, leading to the release of much larger amounts of radioactive materials than were actually released by the accident. [82]

68. Subsequently, in his book recounting his experience of leading Japan at the time of the Fukushima disaster, Kan wrote that the possibility "sent a chill down [his] spine."[83]

---

[77] UNSCEAR, *Sources and Effects of Ionizing Radiation: UNSCEAR 1993 Report to the General Assembly, with Scientific Annexes* (New York: United Nations Scientific Committee on the Effects of Atomic Radiation, United Nations, 1993), 23; M. V. Ramana, "Twenty Years after Chernobyl: Debates and Lessons," *Economic and Political Weekly* XLI, no. 18 (2006): 1743–47.

[78] Cynthia Folkers, "Disproportionate Impacts of Radiation Exposure on Women, Children, and Pregnancy: Taking Back Our Narrative," *Journal of the History of Biology* 54, no. 1 (April 1, 2021): 31–66, https://doi.org/10.1007/s10739-021-09630-z.

[79] Korsakov et al., "De Novo Congenital Malformation Frequencies in Children from the Bryansk Region Following the Chernobyl Disaster (2000–2017)."

[80] Kate Brown, *Manual for Survival: A Chernobyl Guide to the Future* (New York: W.W. Norton & Company, 2019), 256–57.

[81] Pushker A. Kharecha and James E. Hansen, "Prevented Mortality and Greenhouse Gas Emissions from Historical and Projected Nuclear Power," *Environmental Science & Technology* 47, no. 9 (May 7, 2013): 4889–95, https://doi.org/10.1021/es3051197.

[82] von Hippel and Schoeppner, "Reducing the Danger from Fires in Spent Fuel Pools"; Frank Von Hippel, Masafumi Takubo, and Jungmin Kang, *Plutonium: How Nuclear Power's Dream Fuel Became a Nightmare* (Singapore: Springer, 2019).

[83] Naoto Kan, *My Nuclear Nightmare: Leading Japan through the Fukushima Disaster to a Nuclear-Free Future*, trans. Jeffrey S. Irish (Ithaca, NY: Cornell University Press, 2017), 9.

69. Fortunately, evacuation proved unnecessary due to a "fortuitous" occurrence no one could have predicted: water leaked into the spent fuel pool from the reactor well, allowing the evaporating water to be replaced.[84]

70. As Peter Bradford, a former member of the US Nuclear Regulatory Commission, once wrote in an email to me: "the fact that 99% of drunk drivers get home safely doesn't prove that the activity is 'clean, safe and reliable.'"[85]

71. Estimates of how many people were evacuated varies from 146,520 residents (according to the Fukushima Nuclear Accident Independent Investigation Commission),[86] to 164,865 people (as of May 2012, according to the Citizens Nuclear Information Center).[87]

72. These unrealistic plans, Clarke explains, are written and adopted primarily to inspire public confidence in the operating organizations.[88]

73. Farmers who moved back to the area, anthropologist Maxime Polleri found during his field work, were forced to learn how "to live with contamination," including by carrying radiation monitoring devices. [89]

74. Thomas Bass, a journalism professor who visited the laboratory, wondered, "Is this what our future looks like? A day-care centre full of radiation maps and equipment for monitoring our contaminated Earth?"[90]

75. This is what happened to Russian soldiers who occupied this area and dug trenches in 2022.[91]

76. An even larger area, over 10,000 square kilometers initially, was contaminated with somewhat lower levels of cesium-137.

77. At both Chernobyl and Fukushima, scientists have observed a variety of impacts on the flora and fauna. [92]

---

[84] Committee on Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Plants, *Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Plants: Phase 2* (Washington, D.C.: National Academies Press, 2016), http://www.nap.edu/catalog/21874; Richard Stone, "Near Miss at Fukushima Is a Warning for U.S.," *Science*, May 27, 2016.

[85] Peter A. Bradford, "Personal Email," September 23, 2012.

[86] Fukushima Nuclear Accident Independent Investigation Commission, "The Official Report of the Fukushima Nuclear Accident Independent Investigation Commission," 38.

[87] CNIC, "Evacuation Orders Lifted for Iitate, Kawamata, Namie, Tomioka," *Citizens' Nuclear Information Center* (blog), June 2, 2017, http://www.cnic.jp/english/?p=3855.

[88] Lee Clarke, *Mission Improbable: Using Fantasy Documents to Tame Disaster* (Chicago: University of Chicago Press, 1999).

[89] Maxime Polleri, "Life in Fukushima Is a Glimpse into Our Contaminated Future," *Aeon*, December 15, 2022, https://aeon.co/essays/life-in-fukushima-is-a-glimpse-into-our-contaminated-future.

[90] Bass, "Made in Japan," 18.

[91] Bill Chappell, "'Russian Mutants Lost This Round,' Ukraine Says after Troops Leave Chernobyl," *NPR*, April 1, 2022, sec. Ukraine invasion — explained, https://www.npr.org/2022/04/01/1090270567/chernobyl-russia-radiation.

[92] Timothy A. Mousseau, "The Biology of Chernobyl," *Annual Review of Ecology, Evolution, and Systematics* 52, no. 1 (2021): 87–109, https://doi.org/10.1146/annurev-ecolsys-110218-024827; Timothy A. Mousseau and Anders Pape Møller, "Plants in the Light of Ionizing Radiation: What Have We Learned From Chernobyl, Fukushima, and Other 'Hot' Places?," *Frontiers in Plant Science* 11 (2020), https://www.frontiersin.org/articles/10.3389/fpls.2020.00552.

78. Mousseau explained that relative to what standard models of bird populations would have predicted, there was approximately only one-third as many birds and only half as many species present in high-contamination areas. [93]

79. One reason for the depletion is that many species of birds suffer from declines in sperm counts, sometimes to the point of vanishing; even the available sperms were less viable and had lower swimming velocities compared with birds from areas away from Chernobyl.[94]

80. One of the more moving sections of *Chernobyl Prayer*, the history of the disaster penned by Svetlana Alexievich, Nobel Prize winner in literature, dealt with the sorry plight of pets, especially dogs, that were left behind as people were evacuated.[95]

81. According to the Japan Center for Economic Research's estimate from 2019, the final costs of cleanup may exceed ¥80 trillion (around $750 billion at 2019 exchange rates).[96]

82. In a February 2023 interview with CNBC, he dismissed waste as "not a huge problem," because it can be put into deep boreholes underground "where it stays geologically for hundreds of millions of years."[97]

83. Their studies are the basis for assertions like the World Nuclear Association's "Safe methods for the final disposal of high-level radioactive waste are technically proven."[98]

84. As my UBC colleague Allison Macfarlane, former chair of the US Nuclear Regulatory Commission, once explained, no "site will … contain nuclear waste indefinitely."[99]

85. As Rod Ewing, a professor of geological sciences at Stanford University, explained, "We will never see whether we were correct or not," and we have no means of obtaining feedback. [100]

86. In 2001, the Committee on Disposition of High-Level Radioactive Waste Through Geological Isolation, Board on Radioactive Waste Management, convened by the US National Research Council, recognized the persistence of "surprises" and had to admit that "there always will be uncertainties about the long-term performance of the repository system."[101]

---

[93] Mousseau, "The Biology of Chernobyl," 99.
[94] Mousseau, 96.
[95] Svetlana Alexievich, *Chernobyl Prayer: Voices from Chernobyl* (Penguin UK, 2016).
[96] JCAER, "Accident Cleanup Costs Rising to 35-80 Trillion Yen in 40 Years," Japan Center for Economic Research, July 3, 2019, https://www.jcer.or.jp/english/accident-cleanup-costs-rising-to-35-80-trillion-yen-in-40-years.
[97] Catherine Clifford, "Bill Gates: Nuclear Waste Is Not a Reason to Avoid Nuclear Energy," *CNBC*, February 10, 2023, https://www.cnbc.com/2023/02/10/bill-gates-nuclear-waste-is-not-a-reason-avoid-nuclear-energy.html.
[98] WNA, "Radioactive Waste Management," World Nuclear Association, January 2022, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-waste-management.aspx.
[99] Allison Macfarlane, "Is It Possible To Solve The Nuclear Waste Problem? Innovations Case Discussion: Siting of Eurajoki Nuclear Waste Facility," *Innovations: Technology, Governance, Globalization* 1, no. 4 (2006): 84, https://doi.org/10.1162/itgg.2006.1.4.83.
[100] Nicole Feldman, "The Steep Costs of Nuclear Waste in the U.S.," *Stanford Earth*, July 3, 2018, https://earth.stanford.edu/news/steep-costs-nuclear-waste-us.
[101] Committee on Disposition of High-Level Radioactive Waste Through Geological Isolation, Board on Radioactive Waste Management, National Research Council, *Disposition of High-Level Waste and Spent Nuclear*

87. Conditions at the repository can change considerably over the eons.[102]

88. There is also uncertainty about how microbes might impact the repository over these long periods of time.[103]

89. Despite quixotic research funded by the US Department of Energy and other nuclear organizations, one simply cannot reliably communicate the dangers of buried radioactive waste to people living many millennia in the future.[104]

90. Planners built this repository inside a salt dome, ignoring warnings about flooding raised by local NGOs.[105]

91. The explosion occurred because of a decision to use "kitty litter made out of wheat instead of clay," an error that happened amid organizational pressures on workers to accelerate their performance, creating stress and increased workload.[106]

92. Even the Department of Energy concluded that organizations involved in managing the facility had allowed safety culture "to deteriorate within pockets of the organization."[107]

93. Reinforcing the argument about why it is impossible to be confident about safety, three scholars from Stanford University explained why the accident showed "how difficult it is to predict potential failures of such a disposal system over millennia" in an article in the journal *Nature*.[108]

94. Scholars Gordon MacKerron and Frans Berkhout coined the catchy term "DADA"—short for "decide, announce, defend, and abandon"—to describe how the process has unfolded in many countries: a decision is made by technical personnel with little or no input from affected communities, followed by a public announcement, followed by a

---

Fuel: The Continuing Societal and Technical Challenges (Washington, DC: National Academy Press, 2001), 3, http://www.nap.edu/catalog/10119.html.

[102] Allison Macfarlane and Rodney C. Ewing, *Uncertainty Underground : Yucca Mountain and the Nation's High-Level Nuclear Waste* (Cambridge, Mass.: MIT Press, 2006), 394.

[103] Artur Meleshyn, "Microbial Processes Relevant for the Long-Term Performance of High-Level Radioactive Waste Repositories in Clays," *Geological Society, London, Special Publications* 400, no. 1 (January 1, 2014): 179–94, https://doi.org/10.1144/SP400.6; Brenda Little and Patricia Wagner, "An Overview of Microbiologically Influenced Corrosion of Metals and Alloys Used in the Storage of Nuclear Wastes," *Canadian Journal of Microbiology* 42, no. 4 (April 1, 1996): 367–74, https://doi.org/10.1139/m96-052.

[104] *Containment*, 2015, http://www.containmentmovie.com/.

[105] Beate Kallenbach-Herbert, "Germany," in *Managing Spent Fuel from Nuclear Power Reactors: Experience and Lessons from Around the World*, ed. Harold Feiveson et al. (Princeton: International Panel on Fissile Materials, 2011), 48, http://www.fissilematerials.org/blog/2011/09/managing_spent_fuel_from_.html.

[106] Vincent Ialenti, "Waste Makes Haste: How a Campaign to Speed up Nuclear Waste Shipments Shut down the WIPP Long-Term Repository," *Bulletin of the Atomic Scientists* 74, no. 4 (July 4, 2018): 263, https://doi.org/10.1080/00963402.2018.1486616.

[107] DoE, "Accident Investigation Report, Phase 2: Radiological Release Event at the Waste Isolation Pilot Plant, February 14, 2014" (Washington, D. C.: U.S. Department of Energy Office of Environmental Management, April 2015), ES-17.

[108] Cameron L. Tracy, Megan K. Dustin, and Rodney C. Ewing, "Reassess New Mexico's Nuclear-Waste Repository," *Nature* 529, no. 7585 (January 14, 2016): 150.

defense of the decision against criticism of different kinds, and ultimately an abandonment of the idea in the face of public protest.[109]

95. Substantial majorities of people consider nuclear waste with dread and disapprove of plans to dispose of radioactive wastes near them or, often, far away.[110]

96. Plans to store nuclear waste in an area create such a negative image that it leads people to shun or avoid that area, a phenomenon termed "stigma."[111]

97. As a resident of Ignace, one of the areas considered for Canada's nuclear waste repository, explained: "No matter how safe the project is purported to be … the very idea of Ignace as a nuclear waste 'dump' will sully its name."[112]

98. The public's sentiments are often dismissed by nuclear proponents as ignorance.[113]

99. Radioactive contamination from reprocessing plants in the United Kingdom and France has been detected as far away as Norway.[114]

100. In fact, globally, more plutonium has been produced through "civilian" reprocessing than in facilities marked as being military, as the International Panel on Fissile Materials has documented in its annual reports.[115]

101. Arsenic, for example, is a known carcinogen and gives rise to a host of other health problems involving organs like the kidney and the skin.[116]

102. As scholar Valerie Kuletz points out in her book *The Tainted Desert*, the "Navajo people in the surrounding area were unable safely to use their single source of water, nor could they sell or eat the livestock that drank from this water."[117]

---

[109] Gordon Mackerron and Frans Berkhout, "Learning to Listen: Institutional Change and Legitimation in UK Radioactive Waste Policy," *Journal of Risk Research* 12 (October 2009): 989–1008, https://doi.org/10.1080/13669870903126085.

[110] James Flynn and Paul Slovic, "Yucca Mountain: A Crisis for Policy: Prospects for America' s High-Level Nuclear Waste Program," *Annual Review of Energy and the Environment* 20 (1995): 83–118.

[111] Paul Slovic, James Flynn, and Robin Gregory, "Stigma Happens: Social Problems in the Siting of Nuclear Waste Facilities," *Risk Analysis* 14, no. 5 (1994): 773–77; Robin Gregory, James Flynn, and Paul Slovic, "Technological Stigma," *American Scientist* 83, no. 3 (1995): 220–23.

[112] Joe Castaldo, "Environment: Nuclear Options," *CanadianBusiness.Com*, April 11, 2011, http://www.canadianbusiness.com/article/20366--environment-nuclear-options.

[113] See, for example, Per F. Peterson, "Spent Nuclear Fuel Is Not the Problem," *Proceedings of the IEEE* 105, no. 3 (2017): 411–14, https://doi.org/10.1109/JPROC.2017.2661498.

[114] NRPA, "Discharges of Radioactive Waste from the British Reprocessing Plant near Sellafield" (Nowegian Radiation Protection Authority, 2002).

[115] IPFM, "Global Fissile Material Report 2022" (Princeton: International Panel on Fissile Materials, 2022), https://fissilematerials.org/publications/2022/07/global_fissile_material_r.html.

[116] I. Palma-Lara et al., "Arsenic Exposure: A Public Health Problem Leading to Several Cancers," *Regulatory Toxicology and Pharmacology* 110 (February 1, 2020): 104539, https://doi.org/10.1016/j.yrtph.2019.104539; Khaja Shameem Mohammed Abdul et al., "Arsenic and Human Health Effects: A Review," *Environmental Toxicology and Pharmacology* 40, no. 3 (November 1, 2015): 828–46, https://doi.org/10.1016/j.etap.2015.09.016; Paul B. Tchounwou, Anita K. Patlolla, and Jose A. Centeno, "Carcinogenic and Systemic Health Effects Associated with Arsenic Exposure—A Critical Review," *Toxicologic Pathology* 31, no. 6 (October 1, 2003): 575–88, https://doi.org/10.1080/01926230390242007.

[117] Valerie Kuletz, *The Tainted Desert: Environmental Ruin in the American West* (New York: Routledge, 1998), 26–27.

103. Even without accidents, the Navajo people have suffered incalculable health consequences as a result of uranium mining.[118]

104. Proposed uranium mining projects, too, tend to be in areas with large Indigenous populations—for example, in Meghalaya in India or in the area around the Grand Canyon in the United States.[119]

105. Naturally, these communities have long resisted uranium mining and associated activities.[120]

106. The nuclear industry's plans for disposing of radioactive waste streams also disproportionately target areas largely populated by Indigenous peoples.[121]

107. The now-canceled Yucca Mountain repository was strongly resisted by the Western Shoshone people, on whose lands the site is located.[122]

---

[118] Doug Brugge, Timothy Benally, and Esther Yazzie-Lewis, eds., *The Navajo People and Uranium Mining* (Albuquerque: University of New Mexico Press, 2007); Doug Brugge and Rob Goble, "The History of Uranium Mining and the Navajo People," *American Journal of Public Health* 92, no. 9 (2002): 1410–19; L. M Shields et al., "Navajo Birth Outcomes in the Shiprock Uranium Mining Area," *Health Physics* 63, no. 5 (1992): 542–51; Cate Gilles, "No One Ever Told Us: Native Americans and the Great Uranium Experiment," in *Governing the Atom: The Politics of Risk*, ed. John Byrne and Steven M. Hoffman (New Brunswick: Transaction Publishers, 1996), 103–25; John Byrne, Leigh Glover, and Cecilia Martinez, *Environmental Justice: Discourses in International Political Economy*, Energy and Environmental Policy Series ; v. 8 (New Brunswick, N.J.: Transaction Pub., 2002).

[119] Ophelia Watahomigie-Corliss, "Uranium Mining Threatens Our Home, the Grand Canyon," *High Country News*, April 14, 2020, https://www.hcn.org/articles/indigenous-affairs-mining-uranium-mining-threatens-our-home-the-grand-canyon; Rajeev Bhattacharyya, "Uranium Exploration Stepped Up in India's Northeast," *The Diplomat*, November 8, 2022, https://thediplomat.com/2022/11/uranium-exploration-stepped-up-in-indias-northeast/.

[120] Iyko Day, "Nuclear Antipolitics and the Queer Art of Logistical Failure," in *Colonial Racial Capitalism*, ed. Susan Koshy et al. (Durham: Duke University Press, 2022), https://read-dukeupress-edu.eu1.proxy.openathens.net/books/book/3084/Colonial-Racial-Capitalism; Arn Keeling and John Sandlos, eds., *Mining and Communities in Northern Canada: History, Politics, and Memory*, Canadian History and Environment Series, no. 3 (Calgary, Alberta: University of Calgary Press, 2015); Peter van Wyck, *The Highway of the Atom* (Montreal: McGill-Queen's University Press, 2010); Gilles, "No One Ever Told Us: Native Americans and the Great Uranium Experiment"; Peter H. Eichstaedt, *If You Poison Us: Uranium and Native Americans*, vol. 1st (Santa Fe, N.M.: Red Crane Books, 1994); Lilian Jones Jarding, "Uranium Activities' Impacts on Lakota Territory," *Indigenous Policy Journal* 22, no. 2 (2011): 1–21; Prerna Gupta, "Reason and Risk: Challenging the Expert and Public Divide in the Risk Debates on Uranium Mining in India," in *Making the Unseen Visible: Science and the Contested Histories of Radiation Exposure*, ed. Jacob Darwin Hamblin and Linda M. Richards (Corvallis, USA: Oregon State University Press, In press).

[121] Grace Thorpe, "Our Homes Are Not Dumps: Creating Nuclear-Free Zones," *Natural Resources Journal* 36, no. 4 (1996): 955–63; Anna Stanley, "Representing the Knowledges of Aboriginal Peoples: The 'Management' of Diversity in Canada's Nuclear Fuel Waste," in *Nuclear Waste Management in Canada: Critical Issues, Critical Perspectives*, ed. Darrin Durant and Genevieve Johnson (Vancouver: UBC Press, 2009), 106–29; Jim Green, "Radioactive Waste and the Nuclear War on Australia's Aboriginal People," *The Ecologist*, July 1, 2016, http://www.theecologist.org/News/news_analysis/2987853/radioactive_waste_and_the_nuclear_war_on_australias_aboriginal_people.html; Anne Sisson Runyan, "Disposable Waste, Lands and Bodies under Canada's Gendered Nuclear Colonialism," *International Feminist Journal of Politics* 20, no. 1 (February 12, 2018): 24–38, https://doi.org/10.1080/14616742.2017.1419824.

[122] Jeniffer Solis, "Western Shoshone Step up Resistance to Yucca Project," *Nevada Current*, May 14, 2019, https://www.nevadacurrent.com/2019/05/14/western-shoshone-step-up-resistance-to-yucca-project/; Danielle Endres, "The Rhetoric of Nuclear Colonialism: Rhetorical Exclusion of American Indian Arguments in the Yucca Mountain Nuclear Waste Siting Decision," *Communication and Critical/Cultural Studies* 6, no. 1 (March 1, 2009): 39–60, https://doi.org/10.1080/14791420802632103.

108. In 2020, the Saugeen Ojibway Nation overwhelmingly rejected Ontario Power Generation's plan for a radioactive waste repository near Lake Huron.[123]

109. Forty years ago, scholars Ward Churchill and Winona LaDuke coined the term "radioactive colonialism," and highlighted that "American Indians" were selected by this process to be "the first twentieth century national sacrifice peoples."[124]

110. Since then, the term "nuclear colonialism"—meaning a "system of domination through which governments and corporations disproportionately target and devastate indigenous peoples and their lands to maintain the nuclear production process," according to Daniel Endres—has become more commonly used.[125]

111. France, for example, obtained exclusive access to Africa's uranium reserves as part of the decolonization arrangements it obtained in the 1950s and 1960s, as historian Gabrielle Hecht has documented in her book Being Nuclear: Africans and the *Global Uranium Trade*. [126]

112. In contrast, historian Jacob Hamblin points out, the United States not only refused to help Ghana but helped "crush" the "prospect of an ambitious peaceful nuclear program by an independent African nation not ruled by whites."[127]

113. As she pointed out on the show *Democracy Now*, he "does not live near an abandoned uranium mine. He doesn't live near a waste site."[128]

114. For those people who choose to move back to such lands, or those who never leave, living in this contaminated zone becomes a daily challenge.[129]

115. In November 2022, when Japan's prime minister, Fumio Kishida, announced yet another push to restart the country's nuclear reactors, Tsuyoshi Suda, an activist, told the

---

[123] Mitchell Beer, "Saugeen Nation Votes Against Nuclear Waste Site," *The Energy Mix* (blog), February 5, 2020, https://www.theenergymix.com/2020/02/05/saugeen-nation-sends-opg-back-to-square-one-voting-86-against-nuclear-waste-site/.

[124] Winona LaDuke and Ward Churchill, "Native America: The Political Economy of Radioactive Colonialism," *The Journal of Ethnic Studies* 13, no. 3 (Fall 1985): 107–32.

[125] Endres, "The Rhetoric of Nuclear Colonialism," 39; see also Kuletz, *The Tainted Desert*; Runyan, "Disposable Waste, Lands and Bodies under Canada's Gendered Nuclear Colonialism"; Kendra Chamberlain, "Nuclear Colonialism: Indigenous Opposition Grows against Proposal for Nation's Largest Nuclear Storage Facility in NM," *The NM Political Report*, November 14, 2019, https://nmpoliticalreport.com/2019/11/14/nuclear-colonialism-indigenous-opposition-grows-against-proposal-for-nations-largest-nuclear-storage-facility-in-nm/.

[126] Gabrielle Hecht, *Being Nuclear: Africans and the Global Uranium Trade* (Cambridge MA: MIT Press, 2012).

[127] Jacob Darwin Hamblin, *The Wretched Atom: America's Global Gamble with Peaceful Nuclear Technology* (New York: Oxford University Press, 2021), 121.

[128] Leona Morgan, "With First Native Interior Secretary, Deb Haaland, Hope Grows U.S. Will Confront Toxic Uranium Legacy," *Democracy Now!*, March 17, 2021, https://www.democracynow.org/2021/3/17/deb_haaland_interior_secretary.

[129] The anthropologist Ryo Morimoto has used the metaphor of shape shifting to capture the changing radiation environment for those who continue to live in the vicinity of Fukushima. See Ryo Morimoto, *Nuclear Ghost: Atomic Livelihoods in Fukushima's Gray Zone* (Berkeley, CA: University of California Press, 2023).

Guardian: "For Japan to keep putting its faith in nuclear power plants is like a form of self-destruction."[130]

116. At that time, the Australian Nuclear Free Alliance sent a solidarity statement addressed to the people of India that pointed out the obvious: "On a good day Australian uranium becomes radioactive waste. On a bad day it becomes fallout [from an accident]."[131]

Chapter 2: Infeasible: The Financial and Temporal Costs of Nuclear Energy

1. *It is difficult to fault optimism; it is equally difficult to accept fantasy.* Nikhil Desai, 1984[132]

2. *We've had our share of useless presidents, but at least in the past they knew when to listen and when to back down…But Macron, he's on another planet.* Michel Doneddu, Pensioner, at a March 2023 protest in Paris. [133]

3. France's official government Twitter account posted a photo of the president standing against the backdrop of a giant steam turbine, addressing seated executives and workers in masks.[134]

4. Although the speech included many proposals, and Macron advocated for "a plural strategy … to develop both renewable and nuclear energies," media outlets around the world overwhelmingly focused on a program of building nuclear power plants, which, the president promised, would "lead to the commissioning of 25 gigawatts of new nuclear capacity by 2050." [135]

5. But Reuters chose to title its article "Announcing New Reactors, Macron Bets on Nuclear Power in Carbon-Neutral Push," whereas the *Guardian* announced, "France to Build up to 14 New Nuclear Reactors by 2050, Says Macron." [136]

---

[130] Justin McCurry, "'A Form of Self-Destruction': Japan Weighs up Plan to Expand Nuclear Power," *The Guardian*, November 30, 2022, https://www.theguardian.com/world/2022/nov/30/a-form-of-self-destruction-japan-weighs-up-plan-to-expand-nuclear-power.

[131] Australian Nuclear Free Alliance, "Solidarity Statement from the Australian Nuclear Free Alliance to the People of India," South Asia Citizens Web, October 12, 2012, http://www.sacw.net/article2920.html.

[132] Nikhil Desai, "Atoms for Peace, Atoms for War, Atoms for Profit" (Ottawa: Energy Research Group, International Development Research Centre, November 1984), 12.

[133] Benjamin Dodman, "'Democracy at Stake': French Protesters Vent Fury at Macron over Pension Push," *France 24*, March 23, 2023, sec. france, https://www.france24.com/en/france/20230323-democracy-at-stake-french-protesters-vent-fury-at-macron-over-pension-push.

[134] Emmanuel Macron, "Développons massivement les énergies renouvelables. https://t.co/RsMlE0ieNB," Tweet, @EmmanuelMacron, February 10, 2022, https://twitter.com/EmmanuelMacron/status/1491828695761305600.

[135] WNN, "Macron Sets out Plan for French Nuclear Renaissance," *World Nuclear News*, February 11, 2022, https://www.world-nuclear-news.org/Articles/Macron-announces-French-nuclear-renaissance.

[136] Reuters, "Announcing New Reactors, Macron Bets on Nuclear Power in Carbon-Neutral Push," *France 24*, February 10, 2022, sec. europe, https://www.france24.com/en/europe/20220210-announcing-new-reactors-macron-puts-nuclear-power-at-heart-of-carbon-neutral-push; Angelique Chrisafis, "France to Build up to 14 New Nuclear

6. And the *New York Times* account carried the headline "France Announces a Vast Expansion of Nuclear Power."[137]

7. One had to dig deeper into these articles to see that even Macron, despite his clear fascination with nuclear power, had to admit that France needed "to massively develop renewable energies because it is the only way to meet our immediate electricity needs, since it takes 15 years to build a nuclear reactor." [138]

8. The UK's Boris Johnson, for example, used the occasion of his very first address to the House of Commons as prime minister to announce, "It is time for a nuclear renaissance, and I believe passionately that nuclear must be part of our energy mix," and express his conviction that nuclear energy will help the UK meet its carbon-emission reduction targets.[139]

9. Political officials from the next rung have also sung the praises of nuclear energy. In Canada, for example, Minister of Natural Resources Seamus O'Regan pronounced that there was "no path to net-zero without nuclear power." [140]

10. And down south, Jennifer Granholm, secretary of the US Department of Energy, stepped up to say pretty much the same thing at a meeting of the American Nuclear Society. [141]

11. In a follow up message, Mycle also added, "These are strange days. But life in La-La-Land is not new for the French nuclear establishment." [142]

12. And Mycle added that when the situation in 2020 was compared with that in 2007, overall capacity was slightly below, and there were around fifteen fewer reactors operating. [143]

Reactors by 2050, Says Macron," *The Guardian*, February 10, 2022, sec. World news, https://www.theguardian.com/world/2022/feb/10/france-to-build-up-to-14-new-nuclear-reactors-by-2050-says-macron.

[137] Liz Alderman, "France Announces a Vast Expansion of Nuclear Power," *New York Times*, February 11, 2022.

[138] Alderman.

[139] WNN, "UK's New Premier Promises Boost for Nuclear Power," *World Nuclear News*, July 26, 2019, https://world-nuclear-news.org/Articles/UKs-new-premier-promises-boost-for-nuclear-power.

[140] Chris Hall, "There's No Path to Net-Zero without Nuclear Power, Says O'Regan," *CBC Radio*, September 19, 2020, https://www.cbc.ca/radio/thehouse/chris-hall-there-s-no-path-to-net-zero-without-nuclear-power-says-o-regan-1.5730197.

[141] WNN, "USA Needs Nuclear to Achieve Net Zero, Says Granholm," *World Nuclear News*, June 17, 2021, https://www.world-nuclear-news.org/Articles/USA-needs-nuclear-to-achieve-net-zero-says-Granhol.

[142] Mycle Schneider, "Personal Email," February 12, 2022.

[143] Schneider.

13. As Mycle explained in an interview to Amy Goodman of *Democracy Now* in April 2011, "You've got to look at the film. Don't look at the photograph. Look at the film in order to understand what's happening." [144]

14. In 2022, that fraction had come down to just over 9 percent of worldwide electricity.[145]

15. In contrast, modern renewables—namely, solar, wind, geothermal, and biomass-based energy—have grown in importance, from around 1 percent in 1997 to over 14 percent in 2022.[146]

16. Globally, the number of nuclear plants connected to the grid annually peaked in 1984 and 1985; during each of those years, thirty-three nuclear reactors became operational. [147]

17. EDF announced in 2019 that it had poured 9,000 cubic meters of concrete, reinforced by 5,000 tons of steel, into a large hole in the ground that it had excavated previously. [148]

18. By the time the two reactors are ready, at least 200,000 tons of steel will have been used on that site. [149]

19. Others have claimed that the project might require up to a million tons of steel.[150]

20. In 2021, for example, the BBC Two TV channel broadcast a documentary called *Building Britain's Biggest Nuclear Power Station* that measured the project "in swimming pools and football pitches"; extolled "a tunnelling machine so enormous it requires a police cavalcade"; praised the "largest continuous cement pour in the UK"; and informed viewers "that Hinkley's canteens consume 316 tons of baked beans a year." [151]

---

[144] "'The Connection Between Energy Use And Political Power Is Essential': Right Livelihood Laureate Mycle Schneider," *Democracy Now!*, April 14, 2011, http://www.democracynow.org/blog/2011/4/14/the_connection_between_energy_use_and_political_power_is_essential_right_livelihood_laureate_mycle_schneider.

[145] My calculations based on data in Energy Institute, "Statistical Review of World Energy 2023."

[146] This does not include hydropower from large dams, which are not usually included in listings of renewables because of their significant environmental impacts.

[147] Mycle Schneider and Antony Froggatt, "The World Nuclear Industry Status Report 2021" (Paris: Mycle Schneider Consulting, September 2021), 47, https://www.worldnuclearreport.org/.

[148] Reed Landberg, "Biggest Concrete Pour in U.K. History Completed at Nuclear Plant Site," *Bloomberg News*, June 27, 2019, https://www.bloomberg.com/news/articles/2019-06-27/hinkley-point-biggest-concrete-pour-in-u-k-history-completed.

[149] Rob Smith, "UK Steel Snubbed for Hinkley Point C," *Process Engineering*, January 20, 2016, http://processengineering.co.uk/article/2022130/uk-steel-snubbed-for-hinkley-point.

[150] Maytaal Angel, "Hinkley Point a Boost to UK Steel, but Not a Game Changer," *Reuters*, September 23, 2016, https://www.reuters.com/article/us-britain-nuclear-steel-idUSKCN11S1I6.

[151] Barbara Speed, "Building Britain's Biggest Nuclear Power Station Was a Boys-and-Their-Toys View of a Divisive Build," *Inews.Co.Uk*, June 2, 2021, https://inews.co.uk/culture/building-britains-biggest-nuclear-power-station-bbc2-review-a-boys-and-their-toys-view-of-a-divisive-build-1031036.

21. As of February 2023, construction alone is estimated to cost almost £33 billion (roughly $40 billion).[152]

22. Indeed, it has increased in steps over the last decade: £16 billion in 2013, to £19.6 billion in 2017, to between £21.5 billion and £22.5 billion in 2019. [153]

23. Close on Hinkley Point's heels is the Vogtle project in the state of Georgia in the United States, with a total cost estimate of close to $35 billion. [154]

24. Like Hinkley Point, the plant's cost has risen in steps, from the $14 billion that was promised when construction was approved. [155]

25. Flamanville's distinction, though, is that this cost estimate is more than four times what was forecast when construction started.[156]

26. Further, as detailed in the 2020 Status Report, there are other costs, including for financing the project, which could add up to another €6.7 billion.[157]

27. Russia's Leningrad-2 plant went up from ₽133 billion to ₽244 billion.[158]

---

[152] Annabel Cossins-Smith, "Cost of EDF's Hinkley Point C Nuclear Project Rises to $40bn," *Power Technology*, February 21, 2023, https://www.power-technology.com/news/hinkley-point-c-project-costs-rise-again/.
[153] Sean Farrell, "Hinkley Point: Nuclear Power Plant Gamble Worries Economic Analysts," *The Guardian*, October 30, 2013, https://www.theguardian.com/environment/2013/oct/30/hinkley-point-nuclear-power-plant-uk-government-edf-underwrite; "Clarifications on Hinkley Point C Project," EDF France, July 3, 2017, https://www.edf.fr/en/the-edf-group/dedicated-sections/journalists/all-press-releases/clarifications-on-hinkley-point-c-project; "Update on Hinkley Point C Project," EDF, September 25, 2019, https://www.edfenergy.com/media-centre/news-releases/update-on-hinkley-point-c-project.
[154] "More Delays, Cost Overruns for Plant Vogtle, SEC Filing Shows," *FOX 5 Atlanta*, January 11, 2023, https://www.fox5atlanta.com/news/plant-vogtle-georgia-power-southern-company-nuclear-power-plant-delays.
[155] Steve Hargreaves, "First New Nuclear Reactors OK'd in over 30 Years," *CNNMoney*, February 9, 2012, http://money.cnn.com/2012/02/09/news/economy/nuclear_reactors/index.htm.
[156] Dominique Vidalon and Geert De Clercq, "EDF Warns Flamanville Weld Repairs to Cost 1.5 Billion Euros," *Reuters*, October 9, 2019, https://www.reuters.com/article/us-edf-flamanville-idUSKBN1WO0HF; Phil Chaffee, "Flamanville Doubles Original Cost Estimate, Targets 2016 Start-Up," *Nuclear Intelligence Weekly*, July 25, 2011.
[157] Mycle Schneider and Antony Froggatt, "The World Nuclear Industry Status Report 2020" (Paris: Mycle Schneider Consulting, September 2020), 147, https://www.worldnuclearreport.org/.
[158] Anatoli Diakov, "Status and Prospects for Russia's Fuel Cycle," *Science & Global Security* 21, no. 3 (2013): 171.

28. India's Koodankulam-1 and -2 reactors, imported from Russia, rose from ₹131.71 billion in 2010 to ₹224.62 billion by 2015,[159] and its prototype fast breeder reactor has gone up from ₹34.9 billion to, currently, ₹68.4 billion.[160]

29. Below I list a few examples from the 2021 Status Report of reactors that were started up between 2018 and 2020.[161]

30. These details might seem boring and repetitive, but they corroborate the persistent observation that nuclear power plants are seldom built on schedule or under budget.[162]

31. The remaining 175 took, on average, 64 percent more time than projected, and had final costs that exceeded the initial budget, again on average, by 117 percent.[163]

32. A recurrent problem is the underestimation of costs and construction times by project proponents, both when advocating for investment in these projects and during construction.[164]

33. Bent Flyvbjerg, who specializes in studying large projects of all kinds, explained in the pages of *Harvard Design Magazine* in 2005 that the ones that receive investment and approval are ones where the "proponents best succeed in designing— deliberately or not—a fantasy world of underestimated costs, overestimated revenues, overvalued local development effects, and underestimated environmental impacts." [165]

34. The net result of introducing competition into the electricity markets has been what George Orwell observed when he reviewed what would become a libertarian bible,

---

[159] MoSPI, "Project Implementation Status Report of Central Sector Projects Costing Rs. 150 Crore & above (April-June, 2010)" (New Delhi: Ministry of Statistics and Programme Implementation, 2010); MoSPI, "Project Implementation Status Report of Central Sector Projects Costing Rs. 150 Crore & above (January-March, 2015)" (New Delhi: Ministry of Statistics and Programme Implementation, 2015).

[160] MoSPI, "Project Implementation Status Report of Central Sector Projects Costing Rs. 150 Crore & above (January-March, 2021)" (New Delhi: Ministry of Statistics and Programme Implementation, 2021), http://www.cspm.gov.in/english/QrtrlyReport.htm.

[161] Schneider and Froggatt, "The World Nuclear Industry Status Report 2021," 55.

[162] Benjamin K. Sovacool, Alex Gilbert, and Daniel Nugent, "An International Comparative Assessment of Construction Cost Overruns for Electricity Infrastructure," *Energy Research & Social Science* 3 (September 2014): 152–60, https://doi.org/10.1016/j.erss.2014.07.016; M. V. Ramana, *The Power of Promise: Examining Nuclear Energy in India* (New Delhi: Penguin India, 2012); Nathan E Hultman and Jonathan G Koomey, "The Risk of Surprise in Energy Technology Costs," *Environmental Research Letters* 2 (2007): 1–6; Nathan E Hultman, Jonathan G Koomey, and Daniel M Kammen, "What History Can Teach Us about the Future Costs of U.S. Nuclear Power," *Environmental Science & Technology* 40, no. 7 (2007): 2088–94.

[163] Benjamin K. Sovacool, Alex Gilbert, and Daniel Nugent, "Risk, Innovation, Electricity Infrastructure and Construction Cost Overruns: Testing Six Hypotheses," *Energy* 74 (September 1, 2014): 909, https://doi.org/10.1016/j.energy.2014.07.070.

[164] C. C. Cantarelli et al., "Cost Overruns in Large-Scale Transportation Infrastructure Projects: Which Explanations Can Be Given?," in *2008 First International Conference on Infrastructure Systems and Services: Building Networks for a Brighter Future (INFRA)*, 2008, 1–6, https://doi.org/10.1109/INFRA.2008.5439650.

[165] Bent Flyvbjerg, "Design by Deception: The Politics of Megaproject Approval," *Harvard Design Magazine*, 2005, 50.

Friedrich Hayek's *The Road to Serfdom*: "The trouble with competitions is that somebody wins them." In the electricity sector, nuclear power lost the competition. [166]

35. In the United States, there were 104 nuclear reactors in operation at the end of 2010.[167]

36. A decade later, at the end of 2020, there were 94.[168]

37. The European utility company E.ON justified its decision to shut down two of its reactors in Sweden by emphasizing the absence of any "prospects of generating financial profitability either in the short or the long term." [169]

38. Should its benefits be adequately appreciated, electricity companies will pay a lot more for it. Or so goes the refrain.[170]

39. The 1967 annual report of Philip Morris, for example, proclaimed: "Unfortunately the positive benefits of smoking which are so widely acknowledged are largely ignored by many reports linking cigarettes and health, and little attention is paid to the scientific reports which are favorable to smoking." [171]

40. Operating reactors in this manner would also make revenue streams uncertain since how much nuclear power is generated will depend on the ebbs and flows of sunshine and the wind. [172]

41. Speaking at the 2021 World Nuclear Association's annual symposium—in other words, among nuclear proponents—an Exelon official explained the corporate giant's problem was that wind power "coming in from the Dakotas and elsewhere" can "depress the market prices, particularly in the evening whenever the wind is high and the load is low."[173]

---

[166] George Orwell, "Review of The Road to Serfdom and The Mirror of the Past," *The Observer*, April 9, 1944, https://maudestavern.com/2008/10/09/george-orwell-review/.
[167] IAEA, "Nuclear Power Reactors in the World: 2011 Edition" (Vienna: International Atomic Energy Agency, 2011).
[168] IAEA, "Nuclear Power Reactors in the World: 2021 Edition" (Vienna: International Atomic Energy Agency, 2021).
[169] WNN, "Sweden's Oskarshamn 1 and 2 Reactor Units to Close," *World Nuclear News*, October 14, 2015, http://www.world-nuclear-news.org/C-Swedens-Oskarshamn-1-and-2-reactor-units-to-close-14101501.html.
[170] See, for example, NEI, "Press Release: Failure to Value Nuclear Energy's Attributes KOs Fort Calhoun," *Nuclear Energy Institute*, June 16, 2016; more generally, see NEI, "Nuclear Energy 2014- 2015: Recognizing the Value" (Annual Briefing for the Financial Community, Nuclear Energy Institute, February 12, 2015), http://www.nei.org/Master-Document-Folder/Backgrounders/Presentations/Wall-Street-Briefing-2015-Slides.
[171] Jane Mayer, *Dark Money: The Hidden History of the Billionaires Behind the Rise of the Radical Right* (New York: Doubleday, 2016), 91.
[172] Steve Kidd, "Will Nuclear Power Continue to Stagnate Through 2030?," *Nuclear Intelligence Weekly*, September 4, 2015.
[173] Phil Chaffee, "Non-Power Applications In Focus," *Nuclear Intelligence Weekly*, September 10, 2021, 4–5.

42. It is this difficult economic context that leads nuclear plant owners to desperately seek new sources of revenue, for example, through the bizarre alliance with Bitcoin-mining firms.[174]

43. (Unless, like Ted Cruz, the former presidential hopeful from the Republican Party, one believes that Bitcoin will be the solution to strained electricity grids.)[175]

44. This comparison is not so straightforward. One of my local newspapers, the *Vancouver Sun*, told its readers a few years ago that "a rooftop array of 20 photovoltaic panels with a capacity of five kilowatts will cost around CAD 15,000 installed."[176]

45. The process that is commonly used to account for this variation in the time distribution of costs is called discounting, a practice developed in the mid-nineteenth century by a group of German foresters, and then subsequently rediscovered by the economist Irving Fisher in 1907.[177]

46. In its 2020 report, BEIS estimated that a large-scale solar project targeted to become operational in 2025 in the UK would produce electricity with a levelized cost of £44 per megawatt-hour.[178]

47. How this can be dealt with, and why this rhetorical castigation of renewables is misplaced, is discussed in more detail in the conclusion.[179]

48. Several academic studies bear out this piece of common sense, including one econometric analysis of data from thirty countries published in 2018 in *Renewable and*

---

[174] Shoshana Wodinsky, "Bitcoin Bros and Nuclear Bros Have Found Common Cause," *Gizmodo*, September 27, 2021, https://gizmodo.com/bitcoin-bros-and-nuclear-bros-have-found-common-cause-1847753537; Nate DiCamillo, "Bitcoin Mining Firm Compass Inks Deal With Nuclear Microreactor Company Oklo," *CoinDesk*, July 14, 2021, https://www.nasdaq.com/articles/bitcoin-mining-firm-compass-inks-deal-with-nuclear-microreactor-company-oklo-2021-07-14.

[175] Audrey Carleton, "Ted Cruz Says Bitcoin Mining Can Fix Texas' Crumbling Electric Grid," *Vice*, October 13, 2021, https://www.vice.com/en/article/jg8yj8/ted-cruz-says-bitcoin-mining-can-fix-texas-crumbling-electric-grid.

[176] Randy Shore, "Chasing the Solar Dream in B.C.: It Takes Cash and Commitment," *Vancouver Sun*, July 21, 2017, https://vancouversun.com/news/local-news/chasing-the-solar-dream-in-b-c-it-takes-cash-and-commitment. The article also informed us that installing something of that sort could save one CAD 750 per year in electricity bills. That was irrelevant to me since I live in a rented apartment in a tall building and people like me can't put up any solar panels.

[177] Gerald R. Faulhaber and William J. Baumol, "Economists as Innovators: Practical Products of Theoretical Research," *Journal of Economic Literature* 26, no. 2 (1988): 583–84.

[178] BEIS, "Electricity Generation Costs (2020)" (London: Department for Business, Energy and Industrial Strategy, August 24, 2020), 25, 27, https://www.gov.uk/government/publications/beis-electricity-generation-costs-2020 BEIS also estimated onshore and offshore wind power projects completed in 2025 to cost 46 and 57 pounds per megawatt hour.

[179] Lovins and Ramana, "Three Myths About Renewable Energy and the Grid, Debunked."

Sustainable Energy Reviews,[180] and another paper from *Nature Energy* in 2020 that examined data from "123 countries over 25 years." [181]

49. Spending large sums on elegant solutions (especially those with side effects) that provide little relief will diminish what we can spend on more promising approaches. [182]

50. To be sure, there is the occasional reactor that does get built in half that time, but these are compensated by those that take twice that time, which is why the average works out to be 9.9 years. [183]

51. In May 2002, the Finnish parliament voted to build the country's fifth nuclear reactor; the following December, the power company Teollisuuden Voima decided to invest in an EPR unit. [184]

52. In the case of Hinkley Point C, the UK government's 2008 white paper that endorsed the idea of building nuclear plants to reduce emissions envisioned new reactors producing power by 2018. [185]

53. The white paper recommended choosing Hinkley Point as the location for the first nuclear plant because it already had the requisite environmental clearances.[186]

54. One of the few attempts at hypothetically laying out the geographical distribution of nuclear power in a scenario where it contributes significantly to climate mitigation was in an influential study published by the Massachusetts Institute of Technology in 2003.[187]

---

[180] Taeyoung Jin and Jinsoo Kim, "What Is Better for Mitigating Carbon Emissions – Renewable Energy or Nuclear Energy? A Panel Data Analysis," *Renewable and Sustainable Energy Reviews* 91 (August 1, 2018): 464, https://doi.org/10.1016/j.rser.2018.04.022.

[181] Benjamin K. Sovacool et al., "Differences in Carbon Emissions Reduction between Countries Pursuing Renewable Electricity versus Nuclear Power," *Nature Energy* 5, no. 11 (November 2020): 928, https://doi.org/10.1038/s41560-020-00696-3.

[182] Peter A. Bradford, "Honey, I Shrunk the Renaissance: Nuclear Revival, Climate Change, and Reality," *Electricity Policy*, October 11, 2010, https://www.electricitypolicy.com/index.php?option=com_content&view=article&id=2553:honey-i-shrunk-&catid=99:article&Itemid=710.

[183] For the technically inclined, the 9.9 years is a weighted mean of the construction time for all reactors that became operational between 2011 and 2020, and construction time is how long it took to go from when concrete was first poured at the base of the reactor and the reactor starts feeding electricity to the grid.

[184] Matti Kojo and Tapio Litmanen, eds., *The Renewal of Nuclear Power in Finland*, Energy, Climate and the Environment Series (Basingstoke, U.K. ; New York: Palgrave Macmillan, 2009), 3.

[185] Department for Business, Enterprise & Regulatory Reform, "Meeting the Energy Challenge: A White Paper on Nuclear Power" (London: Department for Business, Enterprise & Regulatory Reform, January 2008), 36, https://www.gov.uk/government/publications/meeting-the-energy-challenge-a-white-paper-on-nuclear-power.

[186] Department for Business, Enterprise & Regulatory Reform, 131.

[187] Ansolabehere et al., "The Future of Nuclear Power."

55. One national level seminar in 1974, for example, projected an installed nuclear capacity of 15 to 25 gigawatts by 2000; a 1976 IAEA report projected 6.4 to 20 gigawatts by 1992. [188]

56. In January 2006, for example, Indonesia's energy and mineral resources minister announced that the government would be calling for tenders for 4,000 megawatts of nuclear capacity, aiming for a completion date of 2016.[189]

57. Construction of its first experimental reactor started in 1964, with Kwame Nkrumah, the country's first president, inaugurating the project and singing praises of atomic energy.[190]

58. In the 1970s, the IAEA projected that Ghana would have 600 megawatts of installed nuclear power capacity by the end of the 1980s.[191]

59. That did not happen, but in 2007 another nuclear capacity target, this time of 400 megawatts by 2018, was approved by Ghana's government.[192]

60. China alone built solar power plants that can generate over 250 gigawatts (wind power plants, around 236 gigawatts) between 2011 and 2020.[193]

61. As Howard Zinn explained during a 2005 interview with *Democracy Now*: "If you don't know history it is as if you were born yesterday. And if you were born yesterday, anybody up there in a position of power can tell you anything, and you have no way of checking up on it."[194]

62. Nuclear power plants have always been enormously expensive, even during the era of Atoms for Peace, with its "too cheap to meter" rhetoric. [195]

---

[188] Daniel Poneman, *Nuclear Power in the Developing World* (London: Allen & Unwin, 1982); IAEA, "Nuclear Power Planning Study for Indonesia (Java Island)" (Vienna: International Atomic Energy Agency, 1976).
[189] Xinhua, "Indonesia's Nuke Plant Tender Set for 2007," *People's Daily Online*, June 29, 2006, http://en.people.cn/200606/29/eng20060629_278473.html.
[190] Kwame Nkrumah, "Speech Delivered by Osagyefo the President at the Laying of the Foundation Stone of Ghana's Atomic Reactor at Kwabenya," November 25, 1964, http://gaecgh.org/dr-kwame-nkrumah-s-ghana-atomic-reactor-foundation-stone-laying-speech/.
[191] James Lane, "The Impact of Oil Price Increases on the Market for Nuclear Power in Developing Countries," *IAEA Bulletin* 16, no. 1–2 (1974): 69.
[192] Isaac Ennison et al., "Determination of Suitable Sites for Nuclear Power Plants in Ghana:-The Issues Involved," *Environmental Research, Engineering and Management* 62, no. 4 (January 2, 2013), https://doi.org/10.5755/j01.erem.62.4.2655.
[193] IRENA, "Renewable Capacity Statistics 2021," March 2021, /publications/2021/March/Renewable-Capacity-Statistics-2021.
[194] "'To Be Neutral, To Be Passive In A Situation Is To Collaborate With Whatever Is Going On,'" *Democracy Now!*, April 27, 2005, http://www.democracynow.org/2005/4/27/howard_zinn_to_be_neutral_to.
[195] To be fair, what Lewis Strauss said was that atomic energy was to provide "our children… [with] electrical energy too cheap to meter", which meant that it was a forecast for nuclear economics in the 1970s rather than a statement about 1953.

63. As Lee Clarke documented in a 1985 paper in *Social Problems*, most US utilities were resistant to the idea of building atomic power plants and the federal government had to put a lot of pressure on them to persuade them to invest in these.[196]

64. In the United States, for the seventy-five nuclear plants whose construction started between 1966 and 1977, final costs and construction times exceeded initial projections by 207 percent and 94 percent respectively.[197]

65. Many of the projects were abandoned. In 2007, the US Congressional Research Service reported that "more than 120 reactor orders were ultimately canceled" within the United States.[198]

66. At a global level, France's Commissariat à l'énergie atomique et aux énergies alternatives (Alternative Energies and Atomic Energy Commission, or CEA) reported in 2002 that there were 253 "canceled orders" in thirty-one countries.[199]

67. In August 1983, the Washington Public Power Supply System was involved in the largest municipal bond default in US history when it could not repay what it had borrowed to construct two nuclear power plants.[200]

68. The following year, the US Office of Technology Assessment opined that nuclear power "is an option that no electric utility would seriously consider."[201]

69. In 2001, a team led by Vice President Dick Cheney released a report titled, in truly Orwellian fashion, "Reliable, Affordable, and Environmentally Sound Energy for America's Future" that recommended, among other things, supporting "the expansion of nuclear energy"; just in case one might be wondering whether Cheney had a secret desire to address climate change, the report also recommended the promotion of "enhanced oil and gas recovery from existing wells through new technology."[202]

---

[196] Lee Clarke, "The Origins of Nuclear Power: A Case of Institutional Conflict," *Social Problems* 32, no. 5 (1985): 474–87.
[197] "An Analysis of Nuclear Power Plant Construction Costs" (Washington, D.C: Energy Information Administration, Department of Energy, 1986), https://www.osti.gov/servlets/purl/6071600.
[198] Larry Parker and Mark Holt, "Nuclear Power: Outlook for New U.S. Reactors" (Washington, D. C.: Congressional Research Service, March 9, 2007), 3, https://sgp.fas.org/crs/misc/RL33442.pdf.
[199] Schneider and Froggatt, "The World Nuclear Industry Status Report 2021," 58.
[200] Charles P. Alexander, "Whoops! A $2 Billion Blunder: Washington Public Power Supply System," *Time*, August 8, 1983, http://content.time.com/time/magazine/article/0,9171,955183,00.html.
[201] OTA, "Nuclear Power in an Age of Uncertainty," OTA-E-216 (Washington, D. C: U.S. Congress, Office of Technology Assessment, 1984), 3.
[202] National Energy Policy Development Group, "Reliable, Affordable, and Environmentally Sound Energy for America's Future" (Washington, D. C.: U.S Government Printing Office, May 2001), 5–20, 5–21, https://www.nrc.gov/docs/ML0428/ML042800056.pdf.

70. The Department of Energy, for its part, announced "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010."[203]

71. Among the provisions of the act that specifically applied to newly built nuclear reactors were funding for research and development, loan guarantees and insurance against regulatory delays, and a production tax credit.[204]

72. As a 2008 Congressional Budget Office report explained, "Loan guarantees and insurance against delays reduce the financial risk of investing in advanced nuclear power plants by transferring risk to the public" and even went on to add a cautionary note: "Economic theory suggests that such incentives cause recipients to invest in excessively risky projects because they do not bear all the cost of a project's failure."[205]

73. Utility companies *did* invest in excessively risky projects. Altogether, they proposed building more than thirty reactors. [206]

74. Such estimates came from nuclear reactor vendors, the US Department of Energy, and prestigious universities like the University of Chicago and the Massachusetts Institute of Technology.[207]

75. When Westinghouse started promoting this design, it claimed that it would be built for about $4 billion (in 2020 dollars) within thirty-six months.[208]

---

[203] Tony McConnell and Louis Long, "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010" (Washington, D. C.: United States Department of Energy Office of Nuclear Energy, Science and Technology, October 31, 2001), https://www.energy.gov/sites/prod/files/ntdroadmapvolume1.pdf.
[204] CBO, "Nuclear Power's Role in Generating Electricity" (Washington, D. C.: United States Congressional Budget Office, 2008), 1, https://www.cbo.gov/publication/41685.
[205] CBO, 22.
[206] Mark Holt, "Nuclear Energy Policy" (Washington, D. C.: Congressional Research Service, October 15, 2014), 6–9.
[207] McConnell and Long, "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010"; UC, "The Economic Future of Nuclear Power" (Chicago, U.S.A.: University of Chicago, 2004); Ansolabehere et al., "The Future of Nuclear Power."
[208] McConnell and Long, "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010"; Marvin S. Fertel, "Statement of Marvin S Fertel, Senior Vice President, Nuclear Generation, and Chief Nuclear Officer, Nuclear Energy Institute" (Washington, D. C.: Committee on Energy and Natural Resources, United States Senate, One Hundred Ninth Congress, February 3, 2005), https://www.govinfo.gov/content/pkg/CHRG-109shrg20004/pdf/CHRG-109shrg20004.pdf; Nick Shulyak, "Westinghouse AP1000® Pwr: Meeting Customer Commitments and Market Needs" (10th International Conference: Nuclear Option in Countries with Small and Medium Electricity Grids, Zadar, Croatia, June 1, 2014), http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/46/136/46136339.pdf.

76. More efficient energy planning to reduce demand was one of the central ideas motivating the Seoul Metropolitan Government's "One Less Nuclear Power Plant" program that Mycle and nine other energy analysts advised.[209]

77. The free-market-supporting think tank Institute for Energy Research puts it bluntly, if unsurprisingly: "Regulatory burdens on nuclear plants are making them expensive." [210]

78. Steve Kidd, who worked for seventeen years with the lobbying organization World Nuclear Association, argued that nuclear advocates should concentrate on undoing what he termed the tangle of regulations.[211]

79. One more illustration to prove the point. In a 2019 episode of the podcast *Titans of Nuclear* (in which proponents of nuclear technology are invited to sing its praises), the host Bret Kugelmass asked an official from GE Hitachi:[212] "And why not just build it [a nuclear reactor] in Uganda where they don't even have a regulator?... why not just skip the whole regulatory hassle [and] build the same thing you would have built here but just…in Uganda [and] not have the billion dollar price tag?"

80. In 2002, leaking boric acid almost ate through the steel in a key part of a nuclear reactor—the pressure vessel head—at the Davis-Besse nuclear plant in the state of Ohio.[213]

81. There remained only a thin stainless-steel lining that protected the nuclear reactor from "a meltdown with a large release of radiation to the atmosphere."[214]

82. Just prior to the discovery of the hole, the DavisBesse plant received the highest ratings possible in the US Nuclear Regulatory Commission's Reactor Oversight Process. [215]

---

[209] IEAC, "International Energy Advisory Council," Seoul International Energy Advisory Council, November 19, 2017, https://www.ieac.info/Seoul-International-Energy-Advisory-Council-SIEAC.
[210] IER, "Regulations Hurt Economics of Nuclear Power," *Institute for Energy Research* (blog), January 19, 2018, https://www.instituteforenergyresearch.org/nuclear/regulations-hurt-economics-nuclear-power/.
[211] Steve Kidd, "Is Climate Change the Worst Argument for Nuclear?," *Nuclear Engineering International*, January 21, 2015, https://www.neimagazine.com/opinion/opinionis-climate-change-the-worst-argument-for-nuclear-4493537/.
[212] *Ep. 180 - Glen Watford , GE Hitachi Nuclear Energy*, 2019, https://www.youtube.com/watch?v=sH026hXti0U; the nuclear industry's callous disregard for the health of African uranium miners and other workers is documented in detail by historian Gabrielle Hecht in *Being Nuclear*.
[213] Frank von Hippel, "The Uncertain Future of Nuclear Energy" (Princeton: International Panel on Fissile Materials, 2010), 62.
[214] "'Close Call: Who's Making Sure Our Nuclear Plants Are Safe?' and Doris Lessing," *NOW with Bill Moyers* (Public Broadcasting Service (PBS), January 24, 2003), https://billmoyers.com/content/nuclear-plant-safety-doris-lessing/.
[215] Keystone, "Nuclear Power Joint Fact-Finding" (Keystone, CO: The Keystone Center, 2007), 65.

83. The plant was to be shut down by December 2001 for a full inspection, but the operating organization got NRC's approval to postpone full inspection by some months.[216]

84. The NRC's inspector general attributed this approval "in large part" to wanting to lessen the financial impact on the utility.[217]

85. The Rebuild Japan Initiative Foundation's Independent Investigation Commission, for example, identified "the sweetheart relationships and revolving door that connected the regulatory bodies and electric companies, academics, and other stakeholders in the nuclear community" as one cause of the Fukushima accident.[218]

86. Westinghouse officials regularly hailed this approach as a "significant innovation."[219]

87. Belief in modular construction was the basis of Westinghouse's projection that the AP1000 reactor would take three years to build.[220]

88. And that it would cost the $2 billion figure mentioned earlier.[221]

89. These were then recycled by lobbyists —for example, by the Nuclear Energy Institute— in congressional testimony.[222]

90. A former member of the Georgia Public Service Commission, the state utility authority overseeing the Vogtle nuclear power plant, summed it up aptly to the *Wall Street Journal* in July 2015: "Modular construction has not worked out to be the solution that the utilities promised." [223]

91. A recent examination by a group from the Massachusetts Institute of Technology showed that in fact costs had increased with time.[224]

---

[216] S. Tina Ghosh and George Apostolakis, "Organizational Contributions to Nuclear Power Plant Safety," *Nuclear Engineering and Technology* 37, no. 3 (2005): 208.
[217] NRC Inspector General, "NRC's Regulation of Davis Besse Regarding Damage to the Reactor Vessel Head" (Rockville, MD: Nuclear Regulatory Commission, December 30, 2002), 23.
[218] Funabashi and Kitazawa, "Fukushima in Review: A Complex Disaster, a Disastrous Response," 7.
[219] Regis A Matzie, "AP1000 Will Meet the Challenges of Near-Term Deployment," *Nuclear Engineering and Design* 238 (2008): 1860.
[220] Shulyak, "Westinghouse AP1000® Pwr: Meeting Customer Commitments and Market Needs."
[221] McConnell and Long, "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010," 5–41.
[222] Fertel, "Statement of Marvin S Fertel, Senior Vice President, Nuclear Generation, and Chief Nuclear Officer, Nuclear Energy Institute."
[223] Rebecca Smith, "Prefab Nuclear Plants Prove Just as Expensive," *Wall Street Journal*, July 27, 2015, http://www.wsj.com/articles/pre-fab-nuclear-plants-prove-just-as-expensive-1438040802.
[224] Philip Eash-Gates et al., "Sources of Cost Overrun in Nuclear Power Plant Construction Call for a New Approach to Engineering Design," *Joule* 4, no. 11 (2020): 2351–52, https://doi.org/10.1016/j.joule.2020.10.001.

92. Even though it has the largest fleet of nuclear power plants, it has not standardized its reactors, in turn because it has too many different actors to be able to build on earlier experiences.[225]

93. Adding to this is the charge of mismanagement, with the conservative Forbes magazine declaring in 1985 that the US nuclear power program "ranks as the largest managerial disaster in business history."[226]

94. It has one of the highest nuclear shares of any country.[227]

95. Policymaking has been tightly controlled by the government and a couple of large national institutions.[228]

96. Using official French government sources, he showed that in comparison with the set of six reactors built between 1971 and 1979, the four reactors built between 1984 and 1999 were over double the cost and took twice as long to construct.[229]

97. Per unit costs rose by a factor of 2.5 over the period he studied, despite "a most favorable setting"; more generally, he concluded "nuclear reactors across all countries with significant [programs] invariably exhibit negative learning, that is, cost increase rather than decline."[230]

98. With his characteristic emphasis on efficiency, Mycle Schneider told *Deutsche Welle* that "every euro invested in new nuclear power plants makes the climate crisis worse because now this money cannot be used to invest in efficient climate protection options."[231]

---

[225] Paul A. David and Geoffrey S. Rothwell, "Measuring Standardization: An Application to the American and French Nuclear Power Industries," *European Journal of Political Economy*, The economics of standardization, 12, no. 2 (September 1, 1996): 292, https://doi.org/10.1016/0176-2680(95)00018-6; Gordon Mackerron, "Nuclear Costs: Why Do They Keep Rising?," *Energy Policy* 20, no. 7 (1992): 644–45.
[226] James Cook, "Nuclear Follies," *Forbes*, February 11, 1985.
[227] David and Rothwell, "Measuring Standardization."
[228] James M. Jasper, *Nuclear Politics : Energy and the State in the United States, Sweden, and France* (Princeton, N.J.: Princeton University Press, 1990); Gabrielle Hecht, *The Radiance of France: Nuclear Power and National Identity after World War II*, Inside Technology (Cambridge, MA: MIT Press, 1998).
[229] Arnulf Grubler, "The Costs of the French Nuclear Scale-up: A Case of Negative Learning by Doing," *Energy Policy* 38, no. 9 (2010): 5175.
[230] Arnulf Grubler, "The French Pressurised Water Reactor Programme," in *Energy Technology Innovation: Learning from Historical Successes and Failures*, ed. Arnulf Grubler and Charlie Wilson (Cambridge: Cambridge University Press, 2013), 155–57, https://www.cambridge.org/core/books/energy-technology-innovation/french-pressurised-water-reactor-programme/98EA4FD866C2017E0E983DAF05054D88.
[231] Gero Rueter, "Nuclear Power: Too Expensive and Inefficient?," *Deutsche Welle*, March 11, 2021, https://www.dw.com/en/nuclear-climate-mycle-schneider-renewables-fukushima/a-56712368.

Chapter 3: Private Profits, Social Costs: Industry Strategies

1. *The object of Fisker, Montague and Montague was not to make a railway to Veracruz, but to float a company. Paul thought that Mr. Fisker seemed to be indifferent whether the railway should ever be constructed or not. It was clearly his idea that fortunes were to be made out of the concern before a spadeful of earth had been moved.* Anthony Trollope, *The Way We Live Now*[232]

2. *Finding new ways to privatize the commons and profit from disaster is what our current system is built to do; left to its own devices, it is capable of nothing else. Naomi Klein, This Changes Everything: Capitalism vs. the Climate*[233]

3. The fleet included a nearly $300,000 Aston Martin Vanquish and a $117,000 BMW M6.[234]

4. Speaking to the *Columbia Metropolitan*, the organization's president described Marsh as "a dedicated board member" who "brings a big heart" and genuine care "for children and for people who maybe don't have it as good as a lot of other folks do."[235]

5. AP News reported that his lawyers submitted ten letters detailing Marsh's record as a do-gooder "from helping the family of an employee killed on the job get financial and legal help to securing an air conditioner for a women's home and taking a week out of his busy executive schedule to volunteer for vacation Bible school." [236]

6. One doesn't know whether these letters influenced the judges, but Marsh received just a two-year sentence. [237]

---

[232] Anthony Trollope, *The Way We Live Now* (London: Chapman and Hall, 1875), 189.
[233] Naomi Klein, *This Changes Everything: Capitalism vs. the Climate* (New York: Simon & Schuster, 2014), 9.
[234] Tony Bartelme and John McDermott, "SCANA CEO Kevin Marsh Is at the Center of the Nuclear Project's Spectacular Failure. Who Is He?," *Post and Courier*, October 8, 2017, https://www.postandcourier.com/news/local_state_news/scana-ceo-kevin-marsh-is-at-the-center-of-the-nuclear-projects-spectacular-failure-who/article_8e709d20-a96f-11e7-840b-9b7a48a324a6.html.
[235] Page Ivey, "SCANA's Kevin Marsh," *Columbia Metropolitan*, May 2013, https://columbiametro.com/article/scanas-kevin-marsh/.
[236] Jeffrey Collins, "Former Exec Readies for 2 Years in Prison in Nuclear Debacle," *AP NEWS*, October 5, 2021, sec. Business, https://apnews.com/article/business-columbia-south-carolina-courts-c39d1b53fc7f183be72917ccdadd5384.
[237] Former SCANA CEO Sentenced to Two Years for Defrauding Ratepayers in Connection with Failed Nuclear Construction Project (U.S. Attorney's Office, District of South Carolina October 7, 2021).

7. As of 2008, *World Nuclear News* reported that the Yucca Mountain project had cost about $13.5 billion, split eighty-twenty between electricity consumers ("ratepayers") and citizens ("taxpayers").[238]

8. SCANA itself was acquired in 2019 by Dominion Energy, an even larger power company with a market capitalization of over $60 billion at that time.[239]

9. Marsh rose through the ranks, and in 1996 he became the senior vice president and chief financial officer of SCANA, then in 2006, the president and chief operating officer of SCE&G.[240]

10. He drew on the ideas of Michael Porter, a professor at the Harvard Business School, to promote the concept of a "nuclear cluster" in South Carolina.[241]

11. Duke, for its part, planned to build two AP1000 reactors at the Lee nuclear station, but eventually scrapped the idea after spending over half a billion dollars.[242]

12. In 2007, Santee Cooper and SCE&G joined hands with Duke Energy and another large electricity company, Progress Energy, to get South Carolina's legislature to pass the key catalyst for the proposed nuclear plant: the Base Load Review Act.[243]

13. It was so egregious that even the governor, Mark Sanford, a Republican, was opposed to the act, because it violated his free market ideology—he "wanted nuclear power to rise or fall without government help"—but he could not veto the bill, since the legislature would override it.[244]

14. Drafted with input from an attorney who worked with SCE&G, the Base Load Review Act read like a wish list that corporate executives would have dreamed up.[245]

---

[238] WNN, "Yucca Mountain Cost Estimate Rises to $96 Billion," *World Nuclear News*, August 6, 2008, https://www.world-nuclear-news.org/WR-Yucca_Mountain_cost_estimate_rises_to_96_billion_dollars-0608085.html.
[239] Saad A. Sulehri, "Dominion, SCANA Close Merger," *S&P Global Market Intelligence*, January 2, 2019, https://www.spglobal.com/marketintelligence/en/news-insights/trending/Qw7lje92dBpkkIQqfbTvAA2.
[240] Bryce Mursch, "SCE&G President Retiring," *WIS News*, April 27, 2006, https://www.wistv.com/story/4827813/sceg-president-retiring.
[241] Bartelme and McDermott, "SCANA CEO Kevin Marsh Is at the Center of the Nuclear Project's Spectacular Failure. Who Is He?"; Michael E. Porter, "Clusters and the New Economics of Competition," *Harvard Business Review*, November 1, 1998, https://hbr.org/1998/11/clusters-and-the-new-economics-of-competition.
[242] EWG, "Duke Energy's Epic Fails: $11.6 Billion in Scrapped Projects Since 2013," *Environmental Working Group.* (blog), August 31, 2020, https://www.ewg.org/research/duke-energys-epic-fails-116-billion-scrapped-projects-2013.
[243] "South Carolina Approves Bill for Early Recovery of Nuclear Development Costs," *Electric Utility Week*, April 30, 2007.
[244] Andrea Cooper, "A Nuclear Energy Meltdown Scrambles Southern Politics," *Sierra Club*, August 30, 2018.
[245] Avery G. Wilks and Cassie Cope, "How SC Lawmakers Passed a 2007 Law That Failed SC Power Customers," *The State*, August 5, 2017, https://www.thestate.com/news/politics-government/article165641762.html.

15. What could be charged included "evaluation, design, engineering, environmental and geotechnical analysis and permitting, contracting, other required permitting including early site permitting and combined operating license permitting, and initial site preparation costs and related consulting and professional costs"—in other words, just about everything.[246]

16. As a result, even though they were never to get any electricity from this facility, South Carolina customers found their monthly bills go up by about twenty-seven dollars, according to an in-depth article in *The State*, though that amount is being fought out in the legislature and the courts.[247]

17. In May 2008, Kevin Marsh wrote to the Public Service Commission and requested a "Certificate of Environmental Compatibility and Public Convenience and Necessity and Base Load Review Order" and to "authorize the Company to put into effect the rates" viewed by SCE&G as necessary for profitability.[248]

18. Marsh's testimony to the commission in December 2008 elaborated the necessity argument.[249]

19. A widely cited paper from 1962 by two economists, Harvey Averch and Leland Johnson, identified the problem with this arrangement: "The firm has an incentive to acquire additional capital if the allowable rate of return exceeds the cost of capital."[250]

20. Utilities, therefore, regularly gold-plated capital additions to earn more profit, as a 2003 paper in the *International Journal of Management* explains.[251]

21. In this plan, SCE&G claimed that its energy sales would increase by 22 percent between 2006 and 2016, and by nearly 30 percent by 2019.[252]

---

[246] "South Carolina Approves Bill for Early Recovery of Nuclear Development Costs."
[247] Avery G. Wilks and Cassie Cope, "How SC Lawmakers Passed a 2007 Law That Failed SC Power Customers," *The State*, August 5, 2017, https://www.thestate.com/news/politics-government/article165641762.html.
[248] SCE&G, "Combined Application for Certificate of Environmental Compatibility Public Convenience Compatibility, Public Convenience and Necessity and for a Base Load Review Order" (Columbia, South Carolina: Public Service Commission of South Carolina, May 30, 2008), 12–13, https://dms.psc.sc.gov/Attachments/Matter/3b3e3e6f-f48a-a3c5-50c13f96cfdba604.
[249] Kevin Marsh, "Direct Testimony on Behalf of South Carolina Electric & Gas Company" (Columbia, South Carolina: Public Service Commission of South Carolina, December 2008), https://www.nrc.gov/docs/ML0910/ML091060781.pdf.
[250] Harvey Averch and Leland L. Johnson, "Behavior of the Firm Under Regulatory Constraint," *The American Economic Review* 52, no. 5 (1962): 1059.
[251] Robert F. Cope, Rachelle F. Cope, and Daniel G. Hotard, "Stranded Production Costs in the United States Electric Power Industry: The Means to Continue an Over-Capitalization Strategy," *International Journal of Management* 20, no. 2 (June 1, 2003): 235.
[252] SCE&G, "2006 Integrated Resource Plan" (Columbia, South Carolina: South Carolina Electric & Gas Company, March 31, 2006), 1.

22. The AP1000 reactors, he told the commission, were "clearly … best suited for SCE&G's needs."[253]

23. Based on the information provided by Westinghouse and Stone & Webster, SCE&G initially projected the construction cost of the two nuclear reactors at $4.94 billion (in 2006 dollars, which is roughly $6.23 billion in 2020 dollars).[254]

24. Tom Clements from the environmental group Friends of the Earth pointed out in the *Bulletin of the Atomic Scientists* in 2021 that most of these groups proved "prescient in their early assessments of the project."[255]

25. Known for often using eye-catching props—at one rally, he held aloft a giant check for "limitless billions" made out to the SCE&G—he is one of the few citizens that consistently questioned the commission's greenlighting the V.C. Summer project and passing on costs to consumers.[256]

26. As he emailed me in 2012, "The nuclear industry wants total control and no discussion except on their terms. All the more reason for me to keep up asking questions and [not] accepting the status quo."[257]

27. When Friends of the Earth intervened before the Public Service Commission in August 2008, they argued that SCE&G's application should be denied.[258]

28. The decision was, as Clements characterized it to the *Associated Press*, "a clear sell-out of the public interest over the interests of SCE&G." [259]

29. Years later, Clements would exhort the commission to side "for once" with customers and require that SCE&G and its shareholders be forced to "bear a major portion of the cost increase."[260]

---

[253] Marsh, "Direct Testimony on Behalf of South Carolina Electric & Gas Company," 34.
[254] SCE&G, "V. C. Summer Nuclear Station, Units 2 and 3 COL Application, Part 1: General and Administrative Information," U.S. Nuclear Regulatory Commission, March 27, 2008, https://www.nrc.gov/reactors/new-reactors/col/summer.html. In addition, the cost of fueling the reactors was projected to be $151.5 million per year, again in 2006 dollars.
[255] Tom Clements, "US Attorney Details Illegal Acts in Construction Projects, Sealing the Fate of the "nuclear Renaissance"," *Bulletin of the Atomic Scientists*, August 31, 2021, https://thebulletin.org/2021/08/us-attorney-details-illegal-acts-at-construction-projects-sealing-the-fate-of-the-nuclear-renaissance/.
[256] Cooper, "A Nuclear Energy Meltdown Scrambles Southern Politics."
[257] Tom Clements, "Personal Email," October 11, 2012.
[258] Robert Guild, "Friends of the Earth Motion to Intervene," Letter to Public Service Commission of South Carolina, August 13, 2008, https://dms.psc.sc.gov/Attachments/Matter/3b3e3e6f-f48a-a3c5-50c13f96cfdba604.
[259] Associated Press, "South Carolina Commission Reconsiders Nuclear Power," *Deseret News*, November 30, 2008, https://www.deseret.com/2008/11/30/20288894/south-carolina-commission-reconsiders-nuclear-power.
[260] Tom Clements, "SCE&G Requests $852 Million Increase in Cost of VC Summer Nuclear Construction Project;" (Columbia, South Carolina: Savannah River Site Watch, June 2, 2016).

30. Shortly after the 2009 decision, Friends of the Earth legally challenged the Public Service Commission's approval, but the state's Supreme Court ruled for the commission.[261]

31. Clements also joined activists around the country to try and stop the federal nuclear subsidy programs, but that failed as well.[262]

32. The Nuclear Energy Institute approached Congress and lobbied for a 30 percent tax credit for just investing in building a new nuclear reactor instead of waiting until it produced electricity; as a backup, they suggested the deadline be pushed back to the start of 2025, according a 2014 Congressional Research Service report.[263]

33. After the concrete was poured to make the base for the reactor—traditionally, the marker for the official start of construction—Kevin Marsh called it an "exciting achievement."[264]

34. Later that year, he told Columbia Metropolitan about his belief that "customers will be served with that energy source 60 years down the road" and that "it will be a huge benefit to them to have clean, reliable, safe energy."[265]

35. By 2016, SC&G was projecting a cost increase of 51 percent, from $4.5 billion to $6.8 billion (in 2007 dollars) for its *share* of the project.[266]

36. Overall, the project cost was being reported as $16 billion by 2017.[267]

---

[261] Wayne Barber, "SC Supreme Court Upholds Utility's Early Recovery of New Nuke Costs," *SNL Energy Power Daily*, May 3, 2010.

[262] Southern Alliance for Clean Energy (Georgia); Sustainable Energy and Economic Development Coalition (Texas); Friends of the Earth (South Carolina); Nuclear Information and Resource Service (Maryland), "Experts: No Good Candidates Exist for Current Nuclear Reactor Loan Guarantee Bailout Funds, Much Less Tripled Amount Under Obama Budget Plan," PRNewswire, February 3, 2010, https://www.prnewswire.com/news-releases/experts-no-good-candidates-exist-for-current-nuclear-reactor-loan-guarantee-bailout-funds-much-less-tripled-amount-under-obama-budget-plan-83457822.html.

[263] Mark Holt, "Nuclear Energy Policy" (Washington, D. C.: Congressional Research Service, October 15, 2014), 22.

[264] Nuclear Street News Team, "Concrete Basemat Poured at New V.C. Summer Reactor," *Nuclear Street*, March 12, 2013, http://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2013/03/12/concrete-basemat-poured-at-new-v.c.-summer-reactor-031201.

[265] Ivey, "SCANA's Kevin Marsh."

[266] SCE&G, "Petition of South Carolina Electric & Gas Company for Updates and Revisions to Schedules" (Columbia, South Carolina: Public Service Commission of South Carolina, May 26, 2016), https://dms.psc.sc.gov/Attachments/Matter/5e9e64a6-9db1-4086-9341-b1b7325bca7d.

[267] Peter Maloney, "Westinghouse Will Not Object to Unsealing Contract for VC Summer Nuclear Project," *Utility Dive*, May 22, 2017, https://www.utilitydive.com/news/westinghouse-will-not-object-to-unsealing-contract-for-vc-summer-nuclear-pr/443180/.

37. Over the course of constructing the V.C. Summer and Vogtle projects, Reuters reported in May 2017, Westinghouse made "several thousand" technical and design changes.[268]

38. Once the project had been canceled, a SCE&G official acknowledged at a State Senate hearing that it never received "a fully integrated schedule" from Westinghouse. But this should have been expected.[269]

39. The steel supports for the 115-ton pressurizer, which helps control pressure levels, were too weak.[270]

40. After a lengthy investigation, the Nuclear Regulatory Commission concluded that "a former company official deliberately instructed subordinates to initially provide false statements as to the cause of the drop" reported *Nuclear Intelligence Weekly*.[271]

41. The NRC also found that the manufacturers had improperly labeled components, or had produced parts with wrong dimensions, and neglected required tests.[272]

42. Companies involved seemed "clueless" about the complexities involved in the manufacturing process, such as welding for nuclear reactor components, according to *Engineering News-Record*.[273]

43. So much so that a senior manager threw a letter opener at a junior official expressing concern about these problems and pushing the company to pause work and fix them.[274]

44. In 2015, workers were drilling into concrete when they went too far and damaged the containment vessel, a component critical to the safety of the reactor.[275]

45. SCE&G's schedule had not carefully considered the details of putting together the different modules of the reactor.[276]

---

[268] Tom Hals and Emily Flitter, "How Two Cutting Edge U.S. Nuclear Projects Bankrupted Westinghouse," *Reuters*, May 2, 2017, https://www.reuters.com/article/us-toshiba-accounting-westinghouse-nucle-idUSKBN17Y0CQ.
[269] Andrew Brown, "SCANA CEO Rushed from State Senate Hearing as Failure Review Begins on Abandoned $9 Billion Nuclear Plant Project," *Post and Courier*, August 22, 2017, http://www.postandcourier.com/business/scana-ceo-rushed-from-state-senate-hearing-as-failure-review/article_2f8ed058-8735-11e7-b0f7-0bfc9caf2aab.html.
[270] Brian Spegele, "Troubled Chinese Nuclear Project Illustrates Toshiba's Challenges," *Wall Street Journal*, December 29, 2016, https://www.wsj.com/articles/troubled-chinese-nuclear-project-illustrates-toshibas-challenges-1483051382.
[271] NIW, "United States," *Nuclear Intelligence Weekly*, April 24, 2015.
[272] Hals and Flitter, "How Two Cutting Edge U.S. Nuclear Projects Bankrupted Westinghouse."
[273] Richard Korman, "Witness to the Origins of a Huge Nuclear Construction Flop," *Engineering News-Record*, November 1, 2017, https://www.enr.com/articles/43325-witness-to-the-origins-of-a-huge-nuclear-construction-flop.
[274] Korman.
[275] Rosa Lin, "CB&I Drills Into More Trouble," *Nuclear Intelligence Weekly*, March 20, 2015.
[276] Emily Meredith, "More Trouble for the AP1000 In South Carolina," *Nuclear Intelligence Weekly*, July 11, 2014.

46. While these problems and delays and consequent cost increases were mounting, the two major corporate entities involved at the back end became involved in a series of lawsuits and counter-lawsuits—a brawl, as the *Economist* bluntly characterized it.[277]

47. Ultimately, in 2016, Westinghouse purchased the nuclear construction unit Stone & Webster to avoid these lawsuits.[278]

48. The *New York Times* called it a "blow to nuclear power" and pointed out that it was companies like SCE&G that would find it hard, because they had to absorb losses that Westinghouse could not cover.[279]

49. During a conference call with investors immediately after the Westinghouse announcement, he stated, "Our commitment is still to try to finish these plants. That would be my preferred option. The least preferred option, I think realistically, is abandonment." [280]

50. In fact, the main contingency plan for SCE&G, reported the *Post and Courier*, was to hire a bankruptcy attorney out of concern for Westinghouse's financial status.[281]

51. In July 2017, Santee Cooper announced that its board had voted to suspend construction, and SCANA reluctantly followed suit.[282]

52. Ceasing work, Marsh told the *New York Times*, "was our least desired option, but this is the right thing to do at this time." [283]

53. The Base Load Review Act had generously allowed SCE&G to recoup even the "abandonment costs estimated at $4.9 billion" at a "guaranteed rate of return" of 10.25

---

[277] "Fallout: Westinghouse Files for Bankruptcy," *The Economist*, April 1, 2017, https://www.economist.com/business/2017/04/01/westinghouse-files-for-bankruptcy.
[278] Westinghouse, "Westinghouse Completes Acquisition of CB&I Stone & Webster Inc.," *News Releases* (blog), January 4, 2016, https://info.westinghousenuclear.com/news/westinghouse-completes-acquisition-of-cb-i-stone-webster-inc.
[279] Diane Cardwell and Jonathan Soble, "Westinghouse Files for Bankruptcy, in Blow to Nuclear Power," *The New York Times*, March 29, 2017.
[280] Sammy Fretwell, "SCANA, Santee Cooper to Reassess Reactors after Westinghouse Bankruptcy," *The State*, March 29, 2017.
[281] Andrew Brown and Tony Bartelme, "Documents: Failed South Carolina Nuclear Project Was Years and Millions of Hours Away from Completion," *Post and Courier*, September 8, 2017, http://www.postandcourier.com/business/documents-failed-south-carolina-nuclear-project-was-years-and-millions/article_9386379a-93dd-11e7-acf6-fbd8edabca48.html.
[282] Stephanie Cooke, "SCE&G to Reap Billions Off Reactor Project Cancellation," *Nuclear Intelligence Weekly*, August 4, 2017.
[283] Brad Plumer, "U.S. Nuclear Comeback Stalls as 2 South Carolina Reactors Are Abandoned," *New York Times*, July 31, 2017.

percent, and the company could be receiving money for "its costly mistake" according to *Nuclear Intelligence Weekly*.[284]

54. At that time, 18 percent of their monthly electricity bills already went to the abandoned nuclear reactors and associated costs.[285]

55. These bond holders had to be paid their financing costs, roughly a figure of $2 billion, as of 2018.[286]

56. In other words, the expenditure on the project has continued to increase even after it was abandoned.[287]

57. In 2019, Dominion agreed to pay $60 million and another $61 million in 2022.[288]

58. In all, at least $9 billion had been spent on construction, roughly $5 billion by SCE&G and $4 billion by Santee Cooper.[289]

59. In Florida, for example, customers paid nearly $900 million for the canceled Levy County units.[290]

60. Peter McCoy, who was then the chair of the House Utility Ratepayer Protection Committee and who was appointed by President Trump to the position of US attorney, seemed appalled that the ratepayers had to make up SCE&G's losses while investors continue to "make a 10.25% return."[291]

61. There were also "shareholder and customer lawsuits."[292]

---

[284] Cooke, "SCE&G to Reap Billions Off Reactor Project Cancellation."
[285] Cooke.
[286] Friends of the Earth and Sierra Club, 118.
[287] Tom Clements, "Personal Email," January 28, 2022.
[288] Associated Press, "$61 Million in Refunds for Customers in SC Nuclear Debacle," *US News & World Report*, May 4, 2022, http://www.usnews.com/news/us/articles/2022-05-04/61-million-in-refunds-for-customers-in-sc-nuclear-debacle.
[289] Friends of the Earth and Sierra Club, "Befor the Public Service Commission of South Carolina, Docket Nos. DOCKET NOS. 2017-207-E, 2017-305-E, and 2017-370-E – ORDER NO. 2018-804," Request for rate relief, December 21, 2018, https://dms.psc.sc.gov/Attachments/Order/43fc5723-29d6-4947-b1e9-9cbe744d5505.
[290] Peter A. Bradford, "Direct Testimony On Behalf of Southern Alliance for Clean Energy," https://cleanenergy.org/wp-content/uploads/PeterBradfordFinalTestimony_SACE17VCM_stamped_120117.pdf.
[291] Sweeney, "South Carolina Balances Deception, Frustration, Hope in VC Summer Fallout."
[292] Sweeney.

62. The head of SCE&G's accounting team, who resigned after refusing to support the company's lies, characterized internal documents and emails as "creative writing" when speaking to the *Charlotte Business Journal*.[293]

63. The SEC, for example, accused senior executives at SCANA of perpetrating "a historic securities fraud" and of "repeatedly [deceiving] investors, regulators, and the public."[294]

64. When the report concluded the project was "significantly off-schedule and overbudget," Marsh and his team suppressed it and never submitted it to the regulatory agencies, reported *Nuclear Intelligence Weekly*.[295]

65. Stephen Byrne was the first to be held accountable, and in July 2020, he pleaded guilty to criminal conspiracy fraud charges.[296]

66. In November 2020, Marsh pleaded guilty as well and was eventually sentenced to two years in prison.[297]

67. Two Westinghouse officials, Carl Churchman and Jeffrey Benjamin, were also indicted in 2021.[298]

68. The logic for pouring good money after bad was explained by Tim Echols, a member of the Georgia Public Service Commission and a strong supporter of the Vogtle project: "The moral of the [V.C. Summer project] story is that going over cost is bad, but canceling it is worse. That's the moral of the story, because all seven of the South Carolina commissioners have lost their job."[299]

69. Between 2009 and 2017, SCANA "paid over $2.5 billion in dividends to its investors" according to *Nuclear Intelligence Weekly*.[300]

---

[293] John Downey, "Former SCE&G Employee Gives Testimony That SCANA Executives Pressured Her to Lie on V.C. Summer Cost Increases," *Charlotte Business Journal*, November 21, 2018, https://www.bizjournals.com/charlotte/news/2018/11/21/former-sce-g-accountant-testifies-scana-execs.html.
[294] SEC, "United States Securities and Exchange Commission v. SCANA Corporation, Dominion Energy South Caolina, Inc. (f/k/a South Carolina Electric & Gas Company), Kevin B. Marsh, and Stephen A. Byrne" (Columbia, South Carolina: United States District Court, February 27, 2020), 1, https://www.sec.gov/litigation/complaints/2020/scana-complaint-022720.pdf.
[295] Stephanie Cooke, "US Criminal Probe Into Failed Nuclear Project Widens," *Energy Intelligence Weekly*, June 12, 2020, http://www.energyintel.com/pages/eig_article.aspx?DocId=1075317.
[296] John Monk and Joseph Bustos, "Top Ex-SCANA Official Stephen Byrne Pleads Guilty in SC Nuclear Fiasco Fraud Case," *The State*, July 23, 2020, https://www.thestate.com/news/local/crime/article244429397.html.
[297] John Monk, "Nuclear Fiasco: SCANA Ex-CEO to Plead Guilty to Fraud, Get Prison, Pay $5 Million," *The State*, November 24, 2020, https://www.thestate.com/news/politics-government/article247398515.html.
[298] Clements, "US Attorney Details Illegal Acts in Construction Projects, Sealing the Fate of the "nuclear Renaissance"."
[299] Phil Chaffee, "Georgia PSC Commissioner Echols on Vogtle Fatigue," *Nuclear Intelligence Weekly*, December 3, 2021, 7.
[300] Cooke, "US Criminal Probe Into Failed Nuclear Project Widens."

70. Executives also had what are called "golden parachutes" in corporate lingo—in other words, payments that would be automatically triggered in case of a sale of the company or a takeover. These payments were estimated at $28 million for Kevin Marsh.[301]

71. The grassroots environmental group Nuclear Watch South has been monitoring the financial reports of Georgia Power since 2008, and it documents an increase of annual profits by over 20 percent in the year 2011, when the charges for constructing the Vogtle reactors kicked into consumer bills.[302]

72. After that increase, profits have risen steadily from $1.1 billion in 2011 to around $1.8 billion in 2022.[303]

73. Indeed, the accounting firm PwC (otherwise known as Price Waterhouse Coopers) has identified "nuclear decommissioning" as "one of the fastest growing segments of the nuclear power industry".[304]

74. As detailed in the *World Nuclear Industry Status Report 2021*, the growth will likely be most rapid in the United States, home to the most nuclear reactors—and the oldest ones.[305]

75. In 2014, for example, Westinghouse officials—not that they have a lot of credibility—estimated annual revenues of a billion dollars from decommissioning.[306]

76. And a PwC analyst told *North Jersey Record* about the high "profitability potential" and highlighted the setting up of various hedge funds to invest in companies that deal with retired nuclear plants; some funds were worth hundreds of millions of dollars.[307]

---

[301] Avery G. Wilks, "Who Gets $60 Million When Nuke Project Fails? SCANA Execs with Golden Parachutes Could," *Myrtle Beach Sun News*, October 21, 2017, https://www.myrtlebeachonline.com/news/local/article180190446.html.

[302] "Georgia Power Profits 2008-2020," Nuclear Watch South, 2021, https://www.nonukesyall.org/pdfs/Georgia%20Power%20Profits%202008-2020.pdf.

[303] Nuclear Watch South, "Georgia Power Profits," SNAP! CRACKLE! POP! Vogtle Lurches Towards Babylon, May 2023, https://www.nonukesyall.org/Vogtle.html.

[304] PwC, "Nuclear Decommissioning Renaissance," PricewaterhouseCoopers, 2017, https://www.pwc.com/us/en/industries/capital-projects-infrastructure/asset-classes-sectors/nuclear-power-industry/nuclear-decommissioning-renaissance.html.

[305] Mycle Schneider and Antony Froggatt, "The World Nuclear Industry Status Report 2021" (Paris: Mycle Schneider Consulting, September 2021), 59, https://www.worldnuclearreport.org/.

[306] Heba Hashem, "Westinghouse: Taking Care of Business," *Nuclear Energy Insider*, February 12, 2014, http://analysis.nuclearenergyinsider.com/small-modular-reactors/westinghouse-taking-care-business.

[307] Christopher Maag, "Investors See Huge Profits from Old Nuclear Plants, but It Could Cost Taxpayers," *North Jersey Record*, June 20, 2019, https://amp.northjersey.com/amp/1456809001.

77. These decommissioning funds can be sizeable; in the case of the Pilgrim nuclear power station, it has more than $1 billion, reported a 2018 article in the *Boston Globe*.[308]

78. These casks are manufactured in the state of New Jersey, and Holtec was promised $260 million in tax breaks for locating its factory there.[309]

79. Six years or less after the reactor's final day at power is what the Holtec website promised in 2018.[310]

80. By all accounts, she did her job meticulously, trying to ensure that the public was not endangered by radiation.[311]

81. Lingle filed a whistleblower complaint with the Nuclear Regulatory Commission, but her story came to a sad end: soon after the commission "opened an investigation, she was found dead in her truck in her garage … [but the] coroner's office ruled that her death by carbon monoxide asphyxiation was an accident." [312]

82. This model is evidently quite lucrative, as evidenced by Holtec being joined by SNC-Lavalin—a Canadian company notorious for having indulged in corrupt practices in Libya—in 2018 to form a US-based joint venture company called Comprehensive Decommissioning International.[313]

83. In their 2022 article in the journal *Energy Research and Social Science*, Bell and Macfarlane argue that the "purpose is to streamline activities for the most competitive advantage, and thus financially benefit themselves and their subsidiaries." [314]

---

[308] David Abel, "Decommissioning of Pilgrim Nuclear Power Plant Being Transferred to Holtec International," *Boston Globe*, August 1, 2018, https://www.bostonglobe.com/metro/2018/08/01/decommissioning-pilgrim-nuclear-power-plant-being-transferred-holtec-international/VYyM3wDbJRJ51wZD8Te9yH/story.html.
[309] Jeff Pillets, "NJ's Loose Supervision of Big Business Tax Breaks," *NJ Spotlight News*, January 18, 2022, https://www.njspotlightnews.org/2022/01/holtec-international-nj-eda-big-business-tax-breaks-little-supervision-surprise-revelations/; Nancy Solomon and Jeff Pillets, "Emails Show How Much Pull Political Bosses Had Over State Tax Breaks," *ProPublica*, May 21, 2019, https://www.propublica.org/article/emails-show-how-much-pull-political-bosses-had-over-state-tax-breaks-new-jersey-norcross.
[310] Holtec, "Proto-Prompt Decommissioning Reaches Maturity as a Core Holtec Business Undertaking," Holtec International, May 16, 2018, https://holtecinternational.com/2018/05/16/proto-prompt-decommissioning-reaches-maturity-as-a-core-holtec-business-undertaking/.
[311] Brett Chase and Madison Hopkins, "Power Struggle" (Illinois: Better Government Association, December 20, 2017), https://projects.bettergov.org/power-struggle/index.html.
[312] Chase and Hopkins.
[313] WNN, "SNC-Lavalin, Holtec Create Decommissioning JV," *World Nuclear News*, July 19, 2018, https://www.world-nuclear-news.org/Articles/SNC-Lavalin,-Holtec-create-decommissioning-JV.
[314] Marissa Z. Bell and Allison Macfarlane, "'Fixing' the Nuclear Waste Problem? The New Political Economy of Spent Fuel Management in the United States," *Energy Research & Social Science* 91 (September 1, 2022): 102728, https://doi.org/10.1016/j.erss.2022.102728.

84. In the United States, these include communities that have already experienced radioactive fallout from nuclear weapons tests conducted in the mid-twentieth century and Indigenous communities subject to nuclear colonialism.[315]

85. In 2019, the World Nuclear Waste Report reported that as of 2008 the total cost "of research, construction and operation" of the proposed geologic repository at Yucca Mountain over a hypothetical "150 year period—from when work started in 1983 through to the facility's expected closure and decommissioning in 2133" was estimated at $96.2 billion (in 2007 dollars), including the $13.5 billion already spent as of 2008.[316]

86. In the United Kingdom, which is further along in the process of making more accurate estimates of its liabilities for decommissioning, the 2022 estimate ran to staggering £149 billion—over the next hundred years.[317]

87. Steve Thomas, a British energy analyst (see chapter 4), estimated the total bill to be as high as £260 billion.[318]

88. Most of this cost is associated with cleaning up Sellafield, home to a reprocessing plant (see chapter 1). [319]

89. But this task is so complex that the top official at the UK's Energy Department told the Public Accounts Committee in 2015 that it was "impossible to know" the ultimate costs.[320]

---

[315] Adrian Hedden and Thomas C. Zambito, "'Dumping Ground?': Human Impacts of New Mexico Nuclear Industry Haunt Proposed Waste Project," *Carlsbad Current-Argus*, February 5, 2022, https://www.currentargus.com/story/news/local/2022/02/05/human-impacts-new-mexico-nuclear-industry-haunts-proposed-waste-project/9171553002/; Kendra Chamberlain, "Nuclear Colonialism: Indigenous Opposition Grows against Proposal for Nation's Largest Nuclear Storage Facility in NM," *The NM Political Report*, November 14, 2019, https://nmpoliticalreport.com/2019/11/14/nuclear-colonialism-indigenous-opposition-grows-against-proposal-for-nations-largest-nuclear-storage-facility-in-nm/.

[316] WNN, "Yucca Mountain Cost Estimate Rises to $96 Billion," *World Nuclear News*, August 6, 2008, https://www.world-nuclear-news.org/WR-Yucca_Mountain_cost_estimate_rises_to_96_billion_dollars-0608085.html.

[317] Nuclear Decommissioning Authority, "Annual Report and Accounts 2021 to 2022" (London: Gov.UK, 2022), 140, https://www.gov.uk/government/publications/nuclear-decommissioning-authority-annual-report-and-accounts-2021-to-2022. This is the undiscounted figure. When discounted by a negative real discount rate (because the official discount rate is much lower than the inflation rate), the discounted figure is 237 billion pounds.

[318] Sandra Laville, "UK's Nuclear Waste Cleanup Operation Could Cost £260bn," *The Guardian*, September 23, 2022, https://www.theguardian.com/environment/2022/sep/23/uk-nuclear-waste-cleanup-decommissioning-power-stations.

[319] "Plutonium Separation in Nuclear Power Programs: Status, Problems, and Prospects of Civilian Reprocessing Around the World" (Princeton: International Panel on Fissile Materials, 2015), http://fissilematerials.org/library/rr14.pdf.

[320] Mark Leftly, "Ultimate Cost of Sellafield Clean-up 'Cannot Be Forecast,'" *The Independent*, March 12, 2015, sec. News, https://www.independent.co.uk/news/business/news/ultimate-cost-of-sellafield-cleanup-cannot-be-forecast-a138121.html.

90. The vast majority of decommissioning costs will be paid for by taxpayers of the day stretching out over the next century and more.[321]

91. Once our two new nuclear units are complete, we anticipate our generation mix will be about 30% nuclear, 30% natural gas and 30% scrubbed coal, with the balance in hydro and some biomass." [322]

92. In 2022, Dominion, the parent company for SCANA, owned twenty power plants fueled by some fossil fuel.[323]

93. For Duke Energy, the owner of most of the nuclear plants in the Carolinas, plants burning natural gas or coal constituted 74 percent of Duke's electrical power capacity (as of December 2021) and produced 61 percent of the electrical energy generated in 2021.[324]

94. Utilities have resorted to lobbying to defeat measures facilitating customers installing distributed renewables.[325]

95. An academic study published in *Nature Energy* in 2020 showed that around the world these companies have "hindered the transition of the global electricity sector towards renewables, which has to date mostly relied on non-utility actors (such as independent power producers) for expanding the use of renewables." [326]

---

[321] Stephen Thomas, "UK Decommissioning Funds: A Cautionary Tale," *Platts Power In Europe*, June 5, 2006.
[322] Kevin Marsh, "Nuclear or Natural Gas?," *Business: North Carolina*, November 1, 2013.
[323] Dominion Energy, "Power Stations," 2022, https://www.dominionenergy.com/projects-and-facilities/power-stations.
[324] Duke Energy, "2021 Duke Energy Annual Report" (Duke Energy, 2022), 14, https://p-micro.duke-energy.com/annual-report.
[325] For some examples, see Miranda Green, Mario Alejandro Ariza, and Annie Martin, "Leaked: US Power Companies Secretly Spending Millions to Protect Profits and Fight Clean Energy," *The Guardian*, July 27, 2022, https://www.theguardian.com/environment/2022/jul/27/leaked-us-leaked-power-companies-spending-profits-stop-clean-energy; Christian Roselund, "Arizona Public Service Attempts to Weaken Net Metering – Again," *Pv Magazine International*, June 1, 2016, https://www.pv-magazine.com/2016/06/01/breaking-arizona-public-service-attempts-to-weaken-net-metering-again_100024826/; Matt Kasper, "Documents Reveal Edison Electric Institute Campaign Against Solar," *Energy and Policy Institute* (blog), March 7, 2015, https://www.energyandpolicy.org/documents-reveal-edison-electric-institute-campaign-against-solar/; Bill Sweet, "Rooftop Solar Faces Growing Opposition from Utilities," *IEEE Spectrum*, September 16, 2013, sec. Energy, https://spectrum.ieee.org/solar-counterrevolution.
[326] Galina Alova, "Are Electric Utilities Greening Their Business?," *Behavioural and Social Sciences at Nature Portfolio* (blog), September 1, 2020, http://socialsciences.nature.com/posts/incumbents-in-the-face-of-the-energy-transition-how-electric-utilities-worldwide-are-greening-or-not-their-businesses; See also Galina Alova, "A Global Analysis of the Progress and Failure of Electric Utilities to Adapt Their Portfolios of Power-Generation Assets to the Energy Transition," *Nature Energy* 5, no. 11 (November 2020): 920–27, https://doi.org/10.1038/s41560-020-00686-5.

96. Electricity companies have also played a major role in promoting "climate denial, doubt, and delay" according to a 2022 paper in *Environmental Research Letters*.[327]

97. In early 2009, Poland's government revived its Soviet-era nuclear power dreams, announcing that a first reactor should operate by 2020.[328]

98. Later that year, economy minister Waldemar Pawlak announced that a consortium led by the utility company Polska Grupa Energetyczna (the Polish Energy Group) would be set up by the end of 2010.[329]

99. Polska Grupa Energetyczna signed an agreement with Westinghouse—yes, the same company involved in the South Carolina fiasco—to explore constructing AP1000 reactors in the country.[330]

100. Nothing much came of that understanding, even though the US Department of Commerce put its weight behind Westinghouse, sending trade policy missions to the country.[331]

101. In December 2021, Poland's nuclear planners selected two Baltic seaside villages as their preferred location.[332]

102. Determined to maximize its odds, Westinghouse rushed to sign agreements with ten Polish companies.[333]

103. In October 2020, when Ontario Power Generation agreed to explore building a GE Hitachi–designed reactor in Canada, GE Hitachi promptly announced its separate agreements "with five Canadian companies: Aecon Nuclear, BWXT Canada Ltd., Hatch Ltd., Black & Veatch, and Overland Contracting Canada," according to *WilmingtonBiz*.[334]

---

[327] Emily L. Williams et al., "The American Electric Utility Industry's Role in Promoting Climate Denial, Doubt, and Delay," *Environmental Research Letters* 17, no. 9 (September 2022): 094026, https://doi.org/10.1088/1748-9326/ac8ab3.
[328] Mycle Schneider et al., "The World Nuclear Industry Status Report 2009" (Paris: German Federal Ministry of Environment, Nature Conservation and Reactor Safety, 2009), 25.
[329] UIW, "Hard Financial Realities Force Re-Think on East European Newbuilds," *Uranium Intelligence Weekly*, August 24, 2009.
[330] UIW, "Poland," *Uranium Intelligence Weekly*, May 3, 2010.
[331] ITA, "2016 Top Markets Report: Civil Nuclear" (Washington, D. C.: U.S. Department of Commerce, International Trade Administration, May 2016), 29.
[332] "First Nuclear Power Plant in Poland to Be Built on the Baltic Sea Coast," *The First News*, December 22, 2021, https://www.thefirstnews.com/article/first-nuclear-power-plant-in-poland-to-be-built-on-the-baltic-sea-coast-26898.
[333] "Westinghouse Signs Strategic Partnerships in Poland to Build Country's First AP1000® Nuclear Plant," Westinghouse Electric Company, January 21, 2022, https://info.westinghousenuclear.com/news/westinghouse-strategic-partnerships-poland.
[334] Christina Haley O'Neal, "GE Hitachi Collaborates with Five Canadian Firms on SMR Designs," *WilmingtonBiz*, October 8, 2020,

104. In 1987, as the industry reeled from the simultaneous impact of the Chernobyl catastrophe and over-capacity in reactor building, Martin Spence explained in Capital and Class that nuclear companies formed "defensive alliances" at "both national and international levels" as they bided their "time and [waited] for an upturn." [335]

105. And in South Korea, where American nuclear companies and Korean business conglomerates (*chaebol*) joined hands due to a confluence of financial interests.[336]

106. In August 2022, Korea Hydro and Nuclear Power and Russia's Atomstroyexport entered into a $2.25 billion contract.[337]

107. Atomstroyexport had just begun building the El Dabaa plant in July 2022, five years after the contract—this one for $29.4 billion—was signed between Russia and Egypt.[338]

108. To smooth its entry into Indonesia, ThorCon, which is peddling a thorium-based nuclear plant built on a ship, signed agreements with the renowned Bandung Institute of Technology and a number of other universities.[339]

109. ThorCon's other partner is even more powerful: Indonesia's Defense Ministry.[340]

110. Increasingly, the two companies swap senior officials.[341]

111. For example, in May 2017, when India's cabinet, chaired by Prime Minister Narendra Modi, announced plans to construct ten nuclear reactors, the director of Larsen & Toubro

---

http://www.wilmingtonbiz.com/more_news/2020/10/08/ge_hitachi_collaborates_with_five_canadian_firms_on_smr_designs/21004.

[335] Martin Spence, "After Chernobyl," *Capital & Class* 11, no. 2 (July 1, 1987): 39, https://doi.org/10.1177/030981688703200104.

[336] Lauren Richardson, "Protesting Policy and Practice in South Korea's Nuclear Energy Industry," in *Learning from Fukushima*, ed. Peter Van Ness and Mel Gurtov (Canberra, Australia: ANU Press, 2017), 136.

[337] Kim Tong-Hyung, "S Korea Signs $2.25 Billion Deal with Russia Nuclear Company," *Washington Post*, August 25, 2022, https://www.washingtonpost.com/business/skorea-signs-225-billion-deal-with-russia-nuclear-company/2022/08/25/8b19a4ee-245f-11ed-a72f-1e7149072fbc_story.html.

[338] Phil Chaffee, "Rosatom Locks in $30 Billion Nuclear Deal in Egypt," *Nuclear Intelligence Weekly*, December 15, 2017.

[339] "UNS Signs Partnership Agreement with ThorCon International in Nuclear," *Universitas Sebelas Maret* (blog), January 9, 2021, https://uns.ac.id/en/uns-signs-partnership-agreement-with-thorcon-international-in-nuclear/; WIB, "ThorCon, ITB Sign MOU on R&D of Nuclear Technology," *Petromindo*, July 23, 2021, https://www.petromindo.com/index.php/news/article/thorcon-itb-sign-mou-on-r-d-of-nuclear-technology.

[340] Norman Harsono, "Thorcon, Defense Ministry to Cooperate on Thorium Nuclear Reactor," *The Jakarta Post*, July 28, 2020, https://www.thejakartapost.com/news/2020/07/28/thorcon-defense-ministry-to-cooperate-on-thorium-nuclear-reactor.html.

[341] C. F. Yu, "Is China Moving Toward More Industry Consolidation?," *Nuclear Intelligence Weekly*, January 24, 2020.

called the move "bold and historic,"[342] while the chief operating officer of Godrej & Boyce, termed it a "visionary" step.[343]

112. Godrej & Boyce's praise may also be motivated by a vision of future profits: they got a contract for ₹4.7 billion in 2021.[344]

113. In June 2020, as the oil and gas industry reeled from the economic and social impacts of the COVID-19 pandemic, the Nuclear Economics Consulting Group published a report advising "oil and gas majors" to invest in new nuclear plants, specifically small modular and advanced reactors.[345]

114. It then went on to advice these companies to invest in nuclear power to dispel "their perceived (and sometimes actual) climate change insouciance".[346]

115. In April 2022, the Utilities Solid Waste Activities Group, comprising electric utilities with fossil fuel assets, sued the Biden administration over its attempts to stop leakage from ponds holding ash from coal plants.[347]

116. More generally, the group would like to get rid of requirements for the safe disposal of ash from coal-fired power plants.[348]

117. *Nuclear Intelligence Weekly* reported the logic put forward by Brookfield's CEO to financial analysts: "Our job is sort of done here, and we're on to the next five great investments where we think we can replicate the same type of outcome. To do that, though, we need to recycle capital, generate capital. That's our business."[349]

---

[342] Reuters, "Indian Cabinet Approves Plans to Build 10 Nuclear Reactors," *Reuters India*, May 18, 2017, http://in.reuters.com/article/india-nuclear-idINKCN18D21V.

[343] Bureau, "Rs 70,000-Crore Investment Proposal to Set Off Chain Reaction in N-Energy," *Economic Times*, May 18, 2017, http://epaperbeta.timesofindia.com/Article.aspx?eid=31818&articlexml=Rs-70000-crore-Investment-Proposal-to-Set-Off-18052017001069.

[344] "Godrej & Boyce Bags Orders Worth Rs 468 Cr from Nuclear Power Corporation of India," *Construction Business Today* (blog), July 19, 2021, https://constructionbusinesstoday.com/news/godrej-boyce-bags-orders-worth-rs-468-cr-from-nuclear-power-corporation-of-india/.

[345] NECG, "How Oil & Gas Majors Could Turn the Tide against Global Warming" (Washington, D. C.: Nuclear Economics Consulting Group, June 11, 2020), https://nuclear-economics.com/wp-content/uploads/2020/06/2020-06-NECG-Report-on-OGM-in-nuclear-power.pdf.

[346] NECG, 5–6.

[347] James Bruggers, "Two US Electrical Grid Operators Claim That New Rules For Coal Ash Could Make Electricity Supplies Less Reliable," *Inside Climate News* (blog), April 23, 2022, https://weather.co/climate-change/two-us-electrical-grid-operators-claim-that-new-rules-for-coal-ash-could-make-electricity-supplies-less-reliable/.

[348] Matt Kasper, "Meet the Other Secretive Utility Groups That Target EPA Rules after Utility Air Regulatory Group Disbands," *Energy and Policy Institute* (blog), May 13, 2019, https://www.energyandpolicy.org/uwag-and-uswag-the-secretive-utility-groups-that-target-epa-rules/ These rules were proposed by the Obama Administration in 2010 following the largest toxic waste spill in U.S. history at a Tennessee Valley Authority power plant that resulted in a billion gallons of coal ash sludge destroying land and homes. .

[349] Phil Chaffee, "Brookfield Puts Westinghouse Up for Sale," *Nuclear Intelligence Weekly*, May 13, 2022, 4.

118. Two of these, about Westinghouse being "the only alternative to Russian companies to supply fuel to Russian reactors outside Russia," and about how Westinghouse might export AP1000 reactors to Poland or the Czech Republic, explain the timing—Brookfield announced the sale just two months after Russia's attack on Ukraine explain the timing—Brookfield announced the sale just two months after Russia's attack on Ukraine.[350]

Chapter 4: Enabling Moneymaking, Singing Praise: Governments and Nuclear Power

1. *We are on a pathway to global warming of more than double the 1.5-degree limit agreed in Paris … Some government and business leaders are saying one thing—but doing another. Simply put, they are lying … And the results will be catastrophic.* U.N. Secretary-General Antonio Guterres, April 2022[351]

2. *[The] neoliberal state facilitates a vast and ongoing redistribution of resources from public to private coffers. The idea is simple: wealth and power are accumulated by a few in the act of dispossessing—that is, stealing from—the population at large. Of course, our status-quo stories aren't wont to call it "stealing," given the fact that it's perfectly legal.* Julie Wilson, *Neoliberalism*[352]

3. Governments promote the interests of nuclear energy producers by providing subsidies of different kinds,[353] and skewing electricity markets.

4. That project would not have proceeded if it had not been subsidized by taxpayers[354], if consumers had not been forced to pay higher electricity tariffs to procure nuclear power instead of cheaper alternatives, and if rich investors had not been enticed to put in billions of pounds—all measures only the British Parliament and politicians could deliver.

5. Introduced as part of the 1918 document that declared the aims and values of the party, this clause committed Labour to public ownership—and was seen widely as the party's commitment to socialism.[355]

---

[350] Chaffee, "Brookfield Puts Westinghouse Up for Sale."
[351] AP, "World Hurtling to Climate Danger Zone, Major Report Warns, as U.N. Chief Chides Leaders for 'Lying' about Efforts," *CBS News*, April 4, 2022, https://www.cbsnews.com/news/climate-change-un-report-governments-business-lying-efforts/.
[352] Julie A Wilson, *Neoliberalism* (New York & London: Routledge, 2018), 69.
[353] Koplow, "Energy Subsidies: Global Estimates, Causes of Variance, and Gaps for the Nuclear Fuel Cycle"; Doug Koplow, "Nuclear Power: Still Not Viable Without Subsidies" (Cambridge, MA: Union of Concerned Scientists, February 2011).
[354] "UK to Give 2 Bln Pound Guarantee for Hinkley Point Nuclear Power," *Reuters*, September 20, 2015, https://af.reuters.com/article/idAFL5N11Q0HK20150920.
[355] Aisha Gani, "Clause IV: A Brief History," *The Guardian*, August 9, 2015, https://www.theguardian.com/politics/2015/aug/09/clause-iv-of-labour-party-constitution-what-is-all-the-fuss-about-reinstating-it.

6. By contrast, Blair committed Labour to "the enterprise of the market and the rigour of competition," as a 2020 article in *Jacobin* explained.[356]

7. It will be "the most expensive mistake in the history of privatization," the *Guardian* reported him declaring.[357]

8. In 1987, he attacked the Conservatives for their plans to construct more reactors, pointing out that "radioactive waste is itself a major environmental problem. And one for which we have no easy answer at present." [358]

9. During the 1997 elections, the Labour platform stated: "We see no economic case for the building of any new nuclear power stations." [359]

10. Blair changed his position once he came to power, ordering a unit he had set up in his own office to carry out a review of energy policy.[360]

11. Why did he change? One really doesn't know, but British journalist Jonathan Leakey has argued that this shift was a result of Blair appointing Sir David King, an evangelist for nuclear power, as his chief scientific advisor.[361]

12. Once Blair had flipped, though, he came up with a number of rationalizations for his advocacy of nuclear power, mostly focusing on the need to lower emissions and to reduce imports of fuels—what is glibly referred to as "energy security." [362]

13. The policy reversal was remarkably rapid, carried out undemocratically over a space of a few years and in the face of clear evidence of the problems with the proposed strategy.[363]

14. In 2001, the Independent reported that an early draft of the review Blair commissioned had concluded that "nuclear power seems likely to remain more expensive than fossil-

---

[356] Paul Heideman, "The Third Way Is the Past. Socialism Is the Future.," *Jacobin*, January 19, 2020, https://jacobin.com/2020/01/third-way-democratic-socialism-tony-blair-bill-clinton-uk.
[357] Patrick Donovan, "Blair Attacks Nuclear Power Privatisation," *The Guardian*, January 10, 1989.
[358] Jonathan Leake, "The Man Who Flipped a Nation," *Bulletin of the Atomic Scientists* 63, no. 2 (March 1, 2007): 24–29, https://doi.org/10.1080/00963402.2007.11461059.
[359] Christian Schulze, "Conclusion: Explaining Nuclear Policy Reversals," in *The Politics of Nuclear Energy in Western Europe*, ed. Wolfgang C. Müller and Paul W. Thurner (Oxford: Oxford University Press, 2017), 286–360, https://academic.oup.com/book/27715/chapter/197885164.
[360] Stephen Thomas, "The Hinkley Point Decision: An Analysis of the Policy Process," *Energy Policy* 96 (September 1, 2016): 422, https://doi.org/10.1016/j.enpol.2016.06.021.
[361] Leake, "The Man Who Flipped a Nation."
[362] Patrick Wintour and David Adam, "Blair Presses the Nuclear Button," *The Guardian*, May 17, 2006, https://www.theguardian.com/environment/2006/may/17/energy.business.
[363] Emily Cox, Philip Johnstone, and Andy Stirling, "Understanding the Intensity of UK Policy Commitments to Nuclear Power," SSRN Scholarly Paper (Sussex, UK, September 26, 2016), https://doi.org/10.2139/ssrn.2837691.

fuelled generation" and that "nowhere in the world have new nuclear power stations yet been financed within a liberalised electricity market." [364]

15. When the report was finally published in 2003, it acknowledged the unattractive economics and the unresolved problem of nuclear waste but committed to keeping the option open.[365]

16. BNFL, for example, was unable to meet its liabilities, an estimated £34 billion, for cleaning up the radioactive messes at the many facilities it owned.[366]

17. British Energy issued an insolvency alert after its stock price fell from a high of £7.30 in 1999 to a low of £0.54 in 2002.[367]

18. And on September 24, 2002, Blair told the UK Parliament that Iraq was acquiring nuclear weapons and other weapons of mass destruction, thereby committing his country to the Bush administration's disastrous attack on Iraq.[368]

19. Once those storms had died down, in November 2005, Blair went back to the business of promoting nuclear energy, starting with a speech to the UK's wealthy, the Confederation of British Industry.[369]

20. There, Blair characterized the role of government as setting "the climate for business," and investing "taxpayers' money to create the right human and physical capital."[370]

21. By July 2006, the evidently fast-paced review delivered what Blair promised. It concluded that "new nuclear power stations would make a significant contribution to meeting our energy policy goals."[371]

---

[364] Colin Brown and Geoffrey Lean, "Blair Wants UK to Keep Nuclear Power," *The Independent*, December 16, 2001, https://www.independent.co.uk/climate-change/news/blair-wants-uk-to-keep-nuclear-power-9198699.html.
[365] DTI, "Our Energy Future - Creating a Low Carbon Economy," Presented to Parliament by the Secretary of State for Trade and Industry by Command of Her Majesty (London: United Kingdom Department of Trade and Industry, February 2003), 44.
[366] Thomas, "The Hinkley Point Decision," 422.
[367] Andrew Taylor and Jean Eaglesham, "British Energy Issues Insolvency Alert," *Financial TImes*, September 6, 2002, 1.
[368] Tony Blair, "Iraq and Weapons of Mass Destruction," *Hansard*, September 24, 2002, https://api.parliament.uk/historic-hansard/commons/2002/sep/24/iraq-and-weapons-of-mass-destruction.
[369] "Nuclear Protest Hits Blair Speech," *BBC News*, November 29, 2005, http://news.bbc.co.uk/2/hi/uk_news/politics/4478946.stm This followed some drama. A little before Blair's scheduled speech, two Greenpeace protestors climbed up into the roof of the hall that was the scheduled location and unfurled a banner saying "Nuclear: Wrong Answer". After some delay, the organizers moved the meeting to a different room.
[370] Tony Blair, "Speech to the CBI Conference," https://webarchive.nationalarchives.gov.uk/ukgwa/20080909042552/http://www.number10.gov.uk/Page8606.
[371] DTI, "The Energy Challenge" (London: United Kingdom Department of Trade and Industry, July 2006), 17, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/272376/6887.pdf.

22. Fueled by this hype, the report simply assumed that the capital cost of building a reactor would be between £850 and £1,600 per kilowatt, and the cost of electricity from these would be in the range of £30 to £44 per megawatt-hour.[372]

23. Construction costs were made more explicit in a white paper published in 2008, which assumed that a single 1.6 GW reactor would cost somewhere between £2.0 billion and £3.6 billion to build.[373]

24. It went on to warn about the "risk of cost over-runs in construction" but averred that its analysis was "based on conservative assumptions."[374]

25. As Jonathan Swift put it three centuries ago, "Falsehood flies, and the Truth comes limping after it; so that when Men come to be undeceiv'd, it is too late; the Jest is over, and the Tale has had its Effect."[375]

26. Prime Minister Gordon Brown, Tony Blair's successor, helped the process along by publicly calling for eight new nuclear plants within the next fifteen years—that is, by 2023.[376]

27. By 2010, Ed Miliband, the energy and climate change secretary, was calling for "a more interventionist energy policy."[377]

28. The interventions included changes to the planning system, regulatory process, and the emissions trading system, all meant to enable easier business for nuclear companies.[378]

29. For example, a new Infrastructure Planning Commission was set up to "fast track" applications, and in 2009, two proposed nuclear power plants, one each at Hinkley Point and Sizewell, were chosen among the first round of projects.[379]

30. In October 2010, Minister of Energy Chris Huhne promised to "create the right environment for business to invest in the energy market."[380]

---

[372] DTI, 113–14.
[373] Department for Business, Enterprise & Regulatory Reform, "Nuclear Industrial Strategy," 61.
[374] Department for Business, Enterprise & Regulatory Reform, 62.
[375] Garson O'Toole, "A Lie Can Travel Halfway Around the World While the Truth Is Putting On Its Shoes," *Quote Investigator* (blog), July 13, 2014, https://quoteinvestigator.com/2014/07/13/truth/.
[376] Michael White, "Brown Calls for Eight New Nuclear Plants," *The Guardian*, July 13, 2008, sec. Environment, https://www.theguardian.com/environment/2008/jul/14/nuclearpower.gordonbrown.
[377] Robin Pagnamenta, "Labour Prepares to Tear up 12 Years of Energy Policy," *The Times*, February 1, 2010, https://www.thetimes.co.uk/article/labour-prepares-to-tear-up-12-years-of-energy-policy-5qd2knrz8m3.
[378] Thomas, "The Hinkley Point Decision," 424.
[379] UIW, "United Kingdom," *Uranium Intelligence Weekly*, October 26, 2009.
[380] Chris Huhne, "Written Ministerial Statement on Energy Policy" (London: Department of Energy & Climate Change, October 18, 2010), https://www.gov.uk/government/news/written-ministerial-statement-on-energy-policy-the-rt-hon-chris-huhne-mp-18-october-2010.

31. Although he presumably knew that the government's nuclear power plans would never move forward without subsidies, he asserted that "there will be no public subsidy for new nuclear power."[381]

32. It took until 2015 for the government to admit, using a double-negative clause, that it was "not continuing the 'no public subsidy policy' of the previous administration."[382]

33. EDF had purchased British Energy in 2008 for £12.4 billion.[383]

34. As part of the deal, EDF agreed to meet the costs associated with nuclear waste management and decommissioning for any new plants it builds in Britain but refused to take on most of the costs of waste and decommissioning work for existing reactors.[384]

35. But this fixed price, Steve Thomas explained in a 2016 paper in *Energy Policy*, would come partly "from the market" and partly from "a consumer subsidy," with the proportion depending on what the market price of electricity was on any given day.[385]

36. How much was this fixed price to be? This was the subject of what the *New York Times* described as "months of dickering between the British government and EDF" in a March 2013 article.[386]

37. The figure was linked to inflation, which means that it amounts to £127.11 in September 2023 prices, using the inflation rates recorded by the Bank of England.[387]

38. The £92.50 figure was also just over twice the average wholesale electricity prices in the UK, which was £46 per megawatt-hour in 2012.[388]

39. Just the previous year, the chair of the government's Energy and Climate Change Select Committee had publicly called upon the prime minister to clearly confirm "that nuclear is

---

[381] Huhne.
[382] DECC, "Hinkley Point C to Power Six Million UK Homes," Department of Energy & Climate Change, Government of UK, October 21, 2015, https://www.gov.uk/government/news/hinkley-point-c-to-power-six-million-uk-homes.
[383] Terry Macalister and Graeme Wearden, "EDF to Buy British Energy for £12.4bn," *The Guardian*, September 24, 2008, sec. Business, https://www.theguardian.com/business/2008/sep/24/britishenergy.edf.nuclear.
[384] "Nuclear Power," *The Times*, September 25, 2008.
[385] Thomas, "The Hinkley Point Decision," 425.
[386] Stanley Reed and Stephen Castle, "Britain's Plans for New Nuclear Plant Approach a Decisive Point, 4 Years Late," *The New York Times*, March 15, 2013.
[387] "Inflation Calculator," Bank of England, October 18, 2023, https://www.bankofengland.co.uk/monetary-policy/inflation/inflation-calculator.
[388] Keith Tovey, "The Changing Price of Wholesale UK Electricity over More than a Decade," Institution of Civil Engineers (ICE), April 24, 2017, https://www.ice.org.uk/engineering-resources/briefing-sheets/the-changing-price-of-wholesale-uk-electricity-over-more-than-a-decade/.

a part of the policy and the Government is going to do what's necessary to incentivise it."[389]

40. In the case of Hinkley Point, the cost more than doubled from the theoretical value of £3.6 billion per reactor assumed in the energy policy review to £8 billion in 2013.[390]

41. The company unsuccessfully tried to enter the US nuclear power plant market, with plans to build a plant in Calvert Cliffs, Maryland, that came to naught.[391]

42. Speaking to *Bloomberg Business* in 2013, its CFO admitted to a loss of €2 billion between 2009 and 2012 because of the escapade.[392]

43. There he offered a £2 billion guarantee toward Hinkley Point to entice the Chinese government to invest in the nuclear power station.[393]

44. The following month, China took a one-third stake in Hinkley Point.[394]

45. The decision to involve China was, and continues to be, contested based on geopolitical grounds and on concerns that the Chinese may be able to interfere with the British grid.[395]

46. As a senior official put it in 2013, "History has given China an opportunity to overtake the world's nuclear energy and nuclear technology powers."[396]

---

[389] Craig Robinson, "Sizewell: Calls for Prime Minister David Cameron to Confirm Commitment to Nuclear Power after MP Warns Sizewell C 'Might Never Happen,'" *East Anglian Daily Times*, June 13, 2012, https://www.eadt.co.uk/news/business/21760594.sizewell-calls-prime-minister-david-cameron-confirm-commitment-nuclear-power-mp-warns-sizewell-c-might-never-happen/; this was Tim Yeo, who later on "boasted of trading influence for cash" to an undercover reporter. See Timur Moon, "Lobbying Scandal: Tory MP Tim Yeo 'Boasted of Trading Influence for Cash,'" *International Business Times*, June 9, 2013, https://www.ibtimes.co.uk/tim-yeo-lobbying-scandal-sting-476467.

[390] Farrell, "Hinkley Point: Nuclear Power Plant Gamble Worries Economic Analysts."

[391] Nina Sovich, "EDF and Constellation Poised to Pull Power Plug," *Reuters*, October 11, 2010, https://www.reuters.com/article/us-edf-constellation-idINTRE69A30920101011; Associated Press, "EDF Shares Fall on Nuclear News," *Maryland Daily Record* (blog), October 11, 2010, https://thedailyrecord.com/2010/10/11/edf-shares-fall-on-nuclear-news/.

[392] Tara Patel, "EDF Writing 'Last Chapter' on Nuclear in U.S., Piquemal Says," *Bloomberg Business*, July 30, 2013, https://www.bloomberg.com/news/articles/2013-07-30/edf-writing-last-chapter-on-nuclear-in-u-s-piquemal-says.

[393] BBC, "UK Guarantees £2bn Nuclear Plant Deal as China Investment Announced," *BBC News*, September 21, 2015, http://www.bbc.com/news/uk-england-somerset-34306997.

[394] Christopher Adams, "China 'to Take One-Third Stake' in UK's Hinkley Point Nuclear Project," *CNBC*, October 19, 2015, https://www.cnbc.com/2015/10/19/as-xi-visits-uk-china-to-take-stake-in-hinkley-nuclear-project.html.

[395] For example, in 2015 Osborne also announced £50m to set up a joint research centre for nuclear energy, but this centre was then axed in 2021 by the Tories themselves. Rebecca Camber, "Tech Deal with China for a £50million Lab in Manchester Will Be Axed," *Daily Mail*, June 5, 2021, sec. News, https://www.dailymail.co.uk/news/article-9654127/Tech-deal-China-50million-lab-Manchester-axed-weeks.html.

[396] David Stanway, "Analysis: China Needs Western Help for Nuclear Export Ambitions," *Reuters*, December 17, 2013, http://www.reuters.com/article/us-nuclear-britain-china-analysis-idUSBRE9BG06B20131217.

47. As a Chinese academic explained it to *Xinhua*, China's official press agency, "Success in the British market will set a good example for … future exploration of other foreign markets, like Southeast Asia, the Middle East and Africa."[397]

48. Those "top-up payments," a report from the House of Commons Committee of Public Accounts estimated, will "cost consumers around £30 billion over the 35-year contract."[398]

49. The International Institute for Sustainable Development estimated in 2016 that if loan guarantees and decommissioning costs are taken into account, EDF could be receiving as much as £58 billion in subsidies.[399]

50. They would "also compensate nuclear investors if the project were scrapped," reported the *Observer*.[400]

51. For its part, EDF explicitly admitted the RAB mechanism would "make the project more attractive" to investors.[401].

52. Instead, under the RAB model, consumers provide the financing for projects "at zero interest," bearing "some of the risk associated with construction costs," but without being "paid to hold these risks in the way investors would be."[402]

53. The French government has routinely propped up EDF, including with an injection of €2.2 billion in 2022.[403]

---

[397] Xinhua, "Nuclear Co-Op a New Front for China's Diplomacy," *China Daily*, December 9, 2013, http://www.chinadaily.com.cn/china/2013-12/09/content_17162150.htm.

[398] Committee of Public Accounts, "Hinkley Point C: Third Report of Session 2017–19" (London: U.K. House of Commons, November 22, 2017), 4, https://www.parliament.uk/business/committees/committees-a-z/commons-select/public-accounts-committee/inquiries/parliament-2017/hinkley-point-c-17-19/publications/.

[399] Richard Bridle and Clement Attwood, "It's Official: The United Kingdom Is to Subsidize Nuclear Power, but at What Cost?," Global Subsidies Initiative (Winnipeg, Canada: International Institute for Sustainable Development, February 2016), https://www.iisd.org/publications/report/its-official-united-kingdom-subsidize-nuclear-power-what-cost.

[400] Jillian Ambrose, "Despite Hinkley, the New Plan for Nuclear Is Hardly Better than the Old One," *The Observer*, July 27, 2019, https://www.theguardian.com/business/2019/jul/27/despite-hinkley-new-plan-nuclear-hardly-better-than-old-one.

[401] Sarah Chambers, "Electricity Customers Could Face £6 Charge to Fund Sizewell C Build," *East Anglian Daily Times*, June 11, 2019, https://www.eadt.co.uk/business/suffolk-nuclear-plant-could-be-funded-by-new-charge-on-electricity-bill-1-6099304.

[402] Ambrose, "Despite Hinkley, the New Plan for Nuclear Is Hardly Better than the Old One."

[403] Benjamin Mallet and Christian Lowe, "French State to Inject over 2 Bln Euros into Troubled EDF," *Reuters*, February 18, 2022, sec. Energy, https://www.reuters.com/business/energy/frances-edf-announces-25-bln-euro-rights-issue-fix-cashflow-crunch-2022-02-18/.

54. In April, the Biden administration offered $6 billion through its Infrastructure Investment and Jobs Act.[404]

55. Three months later, the Inflation Reduction Act included a "zero-emission nuclear power production credit" that offers up to $30 billion to nuclear utilities according to the Congressional Budget Office.[405]

56. The Nuclear Information and Resource Service offers a higher estimate: $53.5 billion through 2032; what is more, these "taxpayer dollars would accrue to a very small number of large power corporations and utility holding companies. Over 85% of the total would be claimed by 12 companies … with $20.0 billion … by one corporation, Constellation, which owns 21 merchant reactors."[406]

57. This was in addition to $75 million the previous month.[407]

58. In November 2021, Illinois offered $694 million to Exelon to keep reactors operating.[408]

59. All of this is on top of earlier bailouts to the tune of roughly $14 billion in the last decade from New York ($7.6 billion), Illinois ($2.4 billion), New Jersey ($2.7 billion), and Connecticut ($1.6 billion).[409]

60. As reported in *Utility Dive*, Perry called upon states to craft tax and regulatory policy to send "the message that capital is welcome in your state."[410]

---

[404] Timothy Gardner, "Biden Administration Launches $6 Bln Nuclear Power Credit Program," *Reuters*, April 20, 2022, https://www.reuters.com/world/us/biden-admin-launches-6-bln-nuclear-power-credit-program-2022-04-20/.
[405] CBO, "Estimated Budgetary Effects of H.R. 5376, the Inflation Reduction Act of 2022" (Washington, D. C.: Congressional Budget Office, August 5, 2022), https://www.cbo.gov/system/files/2022-08/hr5376_IR_Act_8-3-22.pdf.
[406] NIRS, "Cost of Proposed Nuclear Energy Subsidies: Inflation Reduction Act of 2022" (Takoma Park, MD: Nuclear Information and Resource Service, July 28, 2022), https://www.nirs.org/nirs-statement-in-response-to-the-inflation-reduction-act-climate-compromises-and-sacrifices-are-not-justifiable/.
[407] Nadia Lopez, "California Budgets $75 Million to Keep Last Nuclear Plant Operating to Avoid Blackouts," *Times of San Diego*, July 4, 2022, https://timesofsandiego.com/business/2022/07/03/california-budgets-75-million-to-keep-last-nuclear-plant-operating-to-avoid-blackouts/; for a detailed look at this decision, see Sara Nelson and M. V. Ramana, "Managing Decline: Devaluation and Just Transition at Diablo Canyon Nuclear Power Plant," *Environment and Planning A: Economy and Space* 55, no. 8 (2023): 1951–69, https://doi.org/DOI: 10.1177/0308518X231167865.
[408] Catherine Clifford, "Why Illinois Paid $694 Million to Keep Nuclear Plants Open," *CNBC*, November 20, 2021, https://www.cnbc.com/2021/11/20/illinois-nuclear-power-subsidy-of-694-million-imperfect-compromise.html.
[409] Grant Smith and Bill Walker, "States Stick Ratepayers With $15 Billion To Rescue Nukes," Environmental Working Group, July 2, 2019, https://www.ewg.org/news-insights/news/states-stick-ratepayers-15-billion-rescue-nukes.
[410] Catherine Morehouse, "DOE Has No 'regulatory or Statutory Ability' to Create Coal, Nuclear Bailout, Says Perry," *Utility Dive*, June 12, 2019, https://www.utilitydive.com/news/doe-has-no-regulatory-or-statutory-ability-to-create-coal-nuclear-bailou/556687/.

61. Nuclear vendors have always competed fiercely for reactor orders.[411]

62. As the *New York Times* reported in 2004: In recent months, a procession of political leaders has pressed China to favor power plant designs and equipment from their home countries. They have included President Jacques Chirac of France; former Prime Minister Jean Chretien of Canada; Viktor Khristenko, who was named fuel and energy minister in Russia on Tuesday; and dozens of less-prominent officials. President Bush even raised the virtues of American nuclear technology with the Chinese prime minister, Wen Jiabao.[412]

63. A few years later, South Korean president Lee Myung-bak visited the United Arab Emirates to successfully advocate for the Barakah nuclear plant contract.[413]

64. The deal "couldn't have been achieved without President Lee's active salesmanship and the strong support of the government," the CEO of Korea Electric Power Corporation later acknowledged.[414]

65. Thanks to WikiLeaks publishing a cable from the US embassy in Beijing, we know that officials pushed the government to do more: "Effective advocacy for US nuclear suppliers is essential to ensuring access to China's rapidly growing civil nuclear power market … Regardless of how the United States decides to advocate, it should be done continuously and from a high level in order to keep up with the French and Russians." [415]

66. During the Trump presidency, government officials pushed hard on Eastern European states to purchase US nuclear reactors, signing agreements with Bulgaria and Romania in October 2020.[416]

---

[411] Peter Pringle and James Spigelman, *The Nuclear Barons* (New York: Holt Rinehart and Winston, 1981); William Walker and Måns Lönnroth, *Nuclear Power Struggles: Industrial Competition and Proliferation Control* (London: Allen & Unwin, 1983); Cooke, *In Mortal Hands: A Cautionary History of the Nuclear Age*.

[412] Chris Buckley, "Chance to Revive Sales Draws Nuclear Industry to China," *New York Times*, March 10, 2004.

[413] Margaret Coker, "Korean Team to Build U.A.E. Nuclear Plants," *Wall Street Journal*, December 28, 2009, sec. Business, http://www.wsj.com/articles/SB10001424052748704905704574621653002992302.

[414] Ki-Shan Park and Françoise Chevalier, "The Winning Strategy of the Late-Comer: How Korea Was Awarded the UAE Nuclear Power Contract," *International Review of Business Research Papers* 6, no. 2 (2010): 224.

[415] U.S. Embassy Beijing, "Effective Nuclear Advocacy in China," Wikileaks, August 29, 2008, https://wikileaks.org/plusd/cables/08BEIJING3362_a.html; Andrea Noelani Brower discusses similar U.S. government efforts to influence other countries policies towards agricultural biotechnology in support of private corporations in *Seeds of Occupation, Seeds of Possibility: The Agrochemical-GMO Industry in Hawai'i* (Morgantown: West Virginia University Press, 2022), 35–36.

[416] Nuclear News Staff, "U.S. Replaces China on Romania's Cernavoda Project," *American Nuclear Society Newswire*, October 12, 2020, https://www.ans.org/news/article-2276/us-replaces-china-on-romanias-cernavoda-project/; Nuclear News Staff, "U.S., Bulgaria Ink Civil Nuclear MOU," *American Nuclear Society Newswire*, October 27, 2020, https://www.ans.org/news/article-2323/us-bulgaria-ink-civil-nuclear-mou/.

67. The Biden administration followed up with a $14 million grant to Romania to encourage it to embark on building (US) small modular reactors.[417]

68. Canada's Export Development Corporation, for example, has loaned money to India, Pakistan, Argentina, Romania, South Korea, and China as part of its strategy to promote CANDU reactors.[418]

69. The United States provided such financing for fifty of the sixty-three export orders for US nuclear reactors between 1955 and 1980.[419]

70. It is "the only government development agency in the world" to do so, suggests the *Hill*.[420]

71. And of course, this change was touted as "crucial to meeting climate and energy leadership goals," ironically by two senators, Lisa Murkowski and Joe Manchin, well known for their support for fossil fuel industries.[421]

72. In Bangladesh, it loaned 90 percent of the cost of two VVER-1200 reactors, and this loan is to be paid back over "the next 28 years with an 8-year grace period," clearly an investment for the long term.[422]

73. Rosatom is paying the full cost of constructing and operating four VVER reactors in Turkey, hoping to make its money by selling electricity—the build-own-operate model.[423]

74. As *Nuclear Intelligence Weekly* explained in 2015: "Rosatom has managed to muscle out competitors in tentative newbuild markets from Bangladesh to Algeria through the use of the government pen: in each case it has pushed through a series of bilateral agreements,

---

[417] Nuclearelectrica, "$14 Million Grant Announced by President Biden for the Development of Small Modular Reactors (SMRs) in Romania," June 27, 2022, https://www.nuclearelectrica.ro/2022/06/27/14-million-grant-announced-by-president-biden-for-the-development-of-small-modular-reactors-smrs-in-romania/?lang=en; Nuclearelectrica, "Nuclearelectrica & NuScale Working Meeting Following the $14 Million Grant Announced by President Biden for the Development of Small Modular Reactors (SMRs) in Romania," July 6, 2022, https://www.nuclearelectrica.ro/2022/07/06/nuclearelectrica-nuscale-working-meeting-following-the-14-million-grant-announced-by-president-biden-for-the-development-of-small-modular-reactors-smrs-in-romania/?lang=en.

[418] Duane Bratt, *The Politics of CANDU Exports* (Toronto: University of Toronto Press, 2006), 79.

[419] Mar Rubio-Varas, "The Changing Economic Context Influencing Nuclear Decisions," in *Engaging the Atom: The History of Nuclear Energy and Society in Europe from the 1950s to the Present*, ed. Arne Kaijser et al. (West Virginia University Press, 2021), 67, http://www.wvupressonline.com/node/878.

[420] Rebecca Beitsch, "Trump Administration Seeks to Use Global Aid for Nuclear Projects," *The Hill*, June 11, 2020, https://thehill.com/policy/energy-environment/502361-trump-administration-seeks-to-use-global-aid-for-nuclear-projects.

[421] Beitsch.

[422] Fakruddin Mehedi, "Rooppur Nuclear Power Plant Unit Sale Rate Tk 3.5," *The Asian Age*, April 11, 2016, http://dailyasianage.com/news/15846/?regenerate.

[423] IEA, "Turkey 2021 - Energy Policy Review" (International Energy Agency, March 2021), 161, https://www.iea.org/reports/turkey-2021.

with each one more detailed than the previous … pushing for enough intergovernmental deals that a commercial contract is ultimately inevitable." [424]

75. A year after the Fukushima disaster started, the head of Russia's nuclear supply company, Rosatom, announced having foreign orders worth $50 billion.[425]

76. By September 2015, that had increased six-fold. The Kremlin website recorded Rosatom's CEO crowing about "orders for 30 nuclear power plant units in 12 different countries … worth a total value of more than $300 billion" to President Vladimir Putin.[426]

77. Political scientists Jessica Liao and Saori Katada, for example, detail similar dynamics in the case of highspeed rail projects funded by China and Japan in Southeast Asia.[427]

78. In a 2014 article in *Monthly Review*, political economist Patrick Bond has described the "granting, via a corrupting tender process, of small contracts to fledgling African entrepreneurs" in South Africa, a practice devised by the ruling African National Congress and termed "tenderpreneurship." [428]

79. For its part, the ANC loves these "big acquisitions from foreign governments, because it can charge rent from the investor, some of which invariably finds its way back into party coffers," journalist Tim Cohen points out.[429]

80. In China, governments of provinces like Hunan, Hubei, and Jiangxi have attempted to pressure the national government to build nuclear plants in their provinces.[430]

---

[424] Ameena Bakr, Phil Chaffee, and Gary Peach, "Egypt: Moscow's Push to Lock In Nuclear Contract," *Nuclear Intelligence Weekly*, October 16, 2015.
[425] Alissa de Carbonnel, "Russia Doubles Nuclear Exports despite Fukushima," *Reuters*, March 23, 2012, http://af.reuters.com/article/energyOilNews/idAFL6E8EN4WP20120323?sp=true.
[426] Team of the Official Website of the President of Russia, "Meeting with CEO of Rosatom State Atomic Energy Corporation Sergei Kiriyenko," President of Russia, September 25, 2015, http://en.kremlin.ru/events/president/news/50373.
[427] Jessica C. Liao and Saori N. Katada, "Geoeconomics, Easy Money, and Political Opportunism: The Perils under China and Japan's High-Speed Rail Competition," *Contemporary Politics* 27, no. 1 (January 1, 2021): 1–22, https://doi.org/10.1080/13569775.2020.1816626.
[428] Patrick Bond, "South Africa's Resource Curses and Growing Social Resistance," *Monthly Review*, April 1, 2014, https://monthlyreview.org/2014/04/01/south-africas-resource-curses-growing-social-resistance/.
[429] Tim Cohen, "The Three Reasons Why the ANC Is Stuck on Nuclear Power," *Daily Maverick*, April 24, 2022, https://www.dailymaverick.co.za/opinionista/2022-04-24-the-three-reasons-why-the-anc-is-stuck-on-nuclear-power/.
[430] Yi-Chong Xu, "The Struggle for Safe Nuclear Expansion in China," *Energy Policy* 73 (2014): 21–29, https://doi.org/10.1016/j.enpol.2014.05.045; ZHW, "Hunan, Hubei Huyu Chongqi Neilu Hedian Xiangmu Anquan Xing Rengyou Zhengyi [Hunan, Hubei Call for the Restarting of Inland Nuclear Power Projects—Safety Still Controversial]," ChinaPower.com [Zhongguo hedian wang], March 16, 2015, http://np.chinapower.com.cn/201503/16/0044739.html.

81. Part of their motivation has been the economic benefits that flow from these reactors that are paid for by national-level state-owned enterprises.[431]

82. An example is a public letter from the heads of state of the Czech Republic, Romania, France, Slovakia, Hungary, Slovenia, and Poland to the European Commission calling for nuclear power to be included as part of the EU climate and energy policy strategy.[432]

83. In Canada, where I live, some of the loudest expressions of support for nuclear power come from Alberta and Saskatchewan, the two largest producers of oil and the two provinces who generate their electricity overwhelmingly (over 80 percent in 2019) from fossil fuels.[433]

84. In the case of Alberta, this is the third round of government talk about using nuclear technology to extract fossil fuels from its oil sands. The earlier phase was during the first decade of this century, amid fanfare for a so-called nuclear renaissance. But that idea was dead by 2011.[434]

85. In *Stupid to the Last Drop*, investigative journalist William Marsden described how during the late 1950s the Alberta government supported Project Oil Sands, a plan to explode hydrogen bombs in order to boost oil production.[435]

86. Thus, for example, Bangladesh's science and technology minister justified a deal with Russia to import two reactors by arguing that the purpose was "to ease the power crisis that hampers our economic activities."[436]

87. In South Africa, a nuclear project management company explained: "The Cape provinces need large scale reliable power, and the only option is nuclear."[437]

---

[431] King and Ramana, "The China Syndrome? Nuclear Power Growth and Safety After Fukushima."
[432] Heads of State, "Joint Letter from the Czech Republic, French Republic, Hungary, Republic of Poland, Romania, Slovak Republic and Republic of Slovenia on the Role of Nuclear Power in the EU Climate and Energy Policy," March 19, 2021, https://www.euractiv.com/wp-content/uploads/sites/2/2021/03/Nuclear-letter-march-2021.pdf.
[433] CER, "Provincial and Territorial Energy Profiles," Canada Energy Regulator, July 28, 2022, https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/index.html.
[434] Chris Turner, "The Big Decision," *Alberta Views*, October 1, 2008, https://albertaviews.ca/the-big-decision/; CBC, "Bruce Power Dropping Alberta Nuclear Plant Proposal," *Canadian Broadcasting Corporation*, December 13, 2011, https://www.cbc.ca/news/canada/edmonton/bruce-power-dropping-alberta-nuclear-plant-proposal-1.1046668.
[435] William Marsden, *Stupid to the Last Drop: How Alberta Is Bringing Environmental Armageddon to Canada*, Reprint edition (Toronto: Vintage Canada, 2008), 2–24, 34–41.
[436] BBC, "Nuclear Power Deal in Bangladesh," *British Broadcasting Corporation*, November 2, 2011, http://www.bbc.co.uk/news/world-asia-15552687.
[437] K.R. Kemm et al., "Nuclear Power Is Essential for National Progress" (Pretoria, South Africa: Nuclear Africa (Pty) Ltd, May 2015), 8, http://www.nuclearafrica.co.za/pdf/nuclearAfricaArticles/NuclearPowerIsEssentialForNationalProgress.pdf.

88. For example, the UK energy secretary Ed Davey declared in 2013: "If people at home want to be able to keep watching the television, be able to turn the kettle on and benefit from electricity, we've got to make these investments. It's essential to keep the lights on and to power British business."[438]

89. The "keeping the UK's lights on" talking point matched what was put out by the Hinkley Point C media team.[439]

90. The same fear was mobilized in California, amid a heat wave in September 2022, by Governor Gavin Newsom to promise PG&E a $1.4 billion forgivable loan.[440]

91. Likewise, in California, nuclear reactors produce roughly 8.5 percent of the total electricity generated within California in 2022, whereas renewable energy sources, without including large hydro dams, contributed around 35 percent.[441]

92. For example, in 2014, Jordan's energy minister claimed that electricity demand will triple by the year 2030 to make a case for acquiring reactors.[442]

93. But such projections are never realized. Indonesia's energy demand in 1996 was significantly lower than even the IAEA's low projection.[443]

94. By providing reliable and affordable electricity, nuclear energy helps keep business competitive and power future worldwide job growth."[444]

95. More recently, the nuclear industry and its supporters have regularly argued for supporting the development of small modular reactors, because of their supposed potential for job creation.[445]

---

[438] Peter Dominiczak, "New Nuclear Plant 'Needed to Keep the Lights On,'" *Telegraph*, October 21, 2013, sec. News, http://www.telegraph.co.uk/news/earth/energy/nuclearpower/10393043/New-nuclear-plant-needed-to-keep-the-lights-on.html.

[439] Hinkley Point C media team, "Why Building Hinkley Point C Is Essential to Secure the UK's Energy Future," *EDF Energy* (blog), September 18, 2015, http://www.edfenergy.com/energy/nuclear-new-build-projects/hinkley-point-c/news-views/hpc-essential-energy-future.

[440] Catherine Clifford, "California Lawmakers Vote to Extend Diablo Canyon Nuclear Plant Operations as State Battles Energy Emergency," *CNBC*, September 1, 2022, https://www.cnbc.com/2022/09/01/california-lawmakers-vote-to-keep-diablo-canyon-nuclear-plant-open.html.

[441] CEC, "Electricity Generation Capacity and Energy," California Energy Commission, 2022, https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/electric-generation-capacity-and-energy.

[442] See Ramana and Ahmad, "Wishful Thinking and Real Problems: Small Modular Reactors, Planning Constraints, and Nuclear Power in Jordan" and references therein.

[443] Cogswell et al.

[444] "World Nuclear Review" (The Energy Times, July 2010), 10, https://teitimes.com/protected/tei-times-july-2010.

[445] Pete Lyons, "Challenges: Nuclear Power Today and Megawatt Size Reactors," 2016, https://arpa-e.energy.gov/?q=workshop/safe-and-secure-megawatt-size-nuclear-power-workshop; EPI, "Economic and Employment Impacts of Small Modular Reactors" (Boise, Idaho: Energy Policy Institute, June 2010); Expert Finance Working Group on Small Reactors, "Market Framework for Financing Small Nuclear" (London:

96. Maria Korsnick, CEO of the Nuclear Energy Institute, the industry's lobbying organization, revealed to *Bloomberg* in 2017: "If you look at what we're passionate about, I would say jobs, jobs, jobs … It's going to resonate very well with the current administration."[446]

97. Around the same time, another US lobbying organization, Nuclear Innovation Alliance, claimed that "a U.S. SMR industry could create or sustain hundreds of thousands of American jobs." [447]

98. In 2013, for example, Prime Minister David Cameron talked up the deal with EDF as allowing for "the creation of 25,000 jobs, which is brilliant news for the South West and for the country as a whole." [448]

99. That number came directly from EDF. [449]

100. For example, in 2017, an official from Turkey's Energy and Natural Resources Ministry announced, "About 10,000 people will be employed while the Akkuyu NPP's construction is most intensive, and about 3,500 jobs will be provided during operation. The majority will consist of Turkish citizens." [450]

101. Russian officials added even more enticement by promising not only the involvement of "thousands of professionals" in Akkuyu but also the prospect of exports: "Turkish companies will gain relevant experience to participate in tenders for the construction of nuclear power plants in different countries."[451]

Department for Business, Energy & Industrial Strategy, 2018), https://www.gov.uk/government/publications/market-framework-for-financing-small-nuclear; "A Call to Action: A Canadian Roadmap for Small Modular Reactors" (Ottawa: Canadian Small Modular Reactor Roadmap Steering Committee, 2018), https://smrroadmap.ca/wp-content/uploads/2018/11/SMRroadmap_EN_nov6_Web-1.pdf; Matteo Castia, "Rolls-Royce: SMR Consortium Would Make 40,000 Jobs," *MarketWatch*, November 11, 2020, https://www.marketwatch.com/story/rolls-royce-smr-consortium-would-make-40000-jobs-2020-11-11.

[446] Jonathan Crawford, "Trump and U.S. Nuclear Power Find Common Ground in Jobs Push," *Bloomberg.Com*, February 7, 2017, https://www.bloomberg.com/news/articles/2017-02-07/trump-and-u-s-nuclear-power-find-common-ground-in-jobs-push.

[447] NIA, "New Report Calls for Reforms to Support Small Modular Reactor Development," *Nuclear Innovation Alliance Press Release*, October 11, 2017, https://www.nuclearinnovationalliance.org/single-post/2017/10/11/New-Report-Calls-for-Reforms-to-Support-Small-Modular-Reactor-Development.

[448] "Hinkley Point Deal Could Bring 25,000 Jobs – Cameron," *Insider Media Ltd*, October 21, 2013, https://www.insidermedia.com/news/south-west/101021-hinkley-point-deal-could-bring-25000-jobs-cameron.

[449] EDF, "Hinkley Point C," *News from EDF Energy*, December 2011, https://www.edfenergy.com/file/2020/download.

[450] Anadolu, "Akkuyu Nuclear Power Plant to Boost Employment," *Daily Sabah*, December 12, 2017, sec. Business, https://www.dailysabah.com/energy/2017/12/12/akkuyu-nuclear-power-plant-to-boost-employment.

[451] "No Need to Fear Turkey's Akkuyu Nuke Plant: Plant's CEO," *Anadolu Agency*, May 26, 2015, https://www.iene.eu/no-need-to-fear-turkeys-akkuyu-nuke-plant-plants-ceo-p1742.html.

102. In 2011, Australia's then prime minister, Julia Gillard, pushed a change in export policy to India, arguing that India would generate 40 percent of its electricity with nuclear energy by 2050 and "having access to this market is good for Australian jobs."[452]

103. Nuclear power has never constituted more than 3.2 percent of India's electricity supply and is unlikely to amount to much more.[453]

104. The academic literature is clear that nuclear power generates fewer jobs than renewables like solar and wind energy per unit of energy generated.[454]

105. This explains proposals for nuclear reactor designs operating in a completely automated fashion, or with minimal operators.[455]

106. In Erdoğan's words, "In 2023, we will commission the first reactor at this plant, and Turkey will thus join the countries that use atomic energy. In 2023, we will mark the 100th anniversary of our republic with the successful completion of this project."[456]

107. At a 2015 launch function for the Akkuyu plant, Turkey's energy minister Taner Yıldız proclaimed, "Development cannot take place in a country without nuclear energy."[457]

108. And in 2007, an AKP parliament member, Mustafa Ozturk, stated: "Nuclear power plants reflect the strength, the level of development, and the prestige of a country. We have been late for 40 years in shifting to nuclear technology, thus, we have to be successful in bringing this high-tech to our country."[458]

109. In a November 2017 meeting of the Chinese Society for Electrical Engineering, Shi Lishan, deputy director of the Nuclear Power Division of the National Energy

---

[452] WNN, "Gillard: Drop Ban on Uranium Sales to India," *World Nuclear News*, November 15, 2011, https://www.world-nuclear-news.org/Articles/Gillard-Drop-ban-on-uranium-sales-to-India.
[453] Ramana, *The Power of Promise: Examining Nuclear Energy in India*.
[454] Zoltán Kis, Nikul Pandya, and Rembrandt H. E. M. Koppelaar, "Electricity Generation Technologies: Comparison of Materials Use, Energy Return on Investment, Jobs Creation and CO2 Emissions Reduction," *Energy Policy* 120 (September 1, 2018): 144–57, https://doi.org/10.1016/j.enpol.2018.05.033; Max Wei, Shana Patadia, and Daniel M. Kammen, "Putting Renewables and Energy Efficiency to Work: How Many Jobs Can the Clean Energy Industry Generate in the US?," *Energy Policy* 38, no. 2 (February 1, 2010): 919–31, https://doi.org/10.1016/j.enpol.2009.10.044.
[455] Examples are E. Teller, M. Ishikawa, and L. Wood, "Completely Automated Nuclear Reactors for Long-Term Operation" (Lawrence Livermore National Lab., 1996), http://inis.iaea.org/Search/search.aspx?orig_q=RN:27063138; and Carper and Schmid, "The Little Reactor That Could?"
[456] Official Website of the President of Russia, "Akkuyu Nuclear Power Plant Ground-Breaking Ceremony," President of Russia, April 3, 2018, http://en.kremlin.ru/events/president/news/57190.
[457] DS, "Turkey Launches Construction of First Nuclear Power Plant, Akkuyu in Mersin," *Daily Sabah*, April 14, 2015, http://www.dailysabah.com/energy/2015/04/14/turkey-launches-construction-of-first-nuclear-power-plant-akkuyu-in-mersin.
[458] Sevgi Balkan-Sahin, "Nuclear Energy as a Hegemonic Discourse in Turkey," *Journal of Balkan and Near Eastern Studies* 21, no. 4 (July 4, 2019): 443–61, https://doi.org/10.1080/19448953.2018.1506282.

Administration, announced, "Nuclear power is a symbolic industry and indicator of a country's industrialization and modernization, as well as a comprehensive manifestation of the country's level of processing and manufacturing, social management capabilities, and safety management. Large countries must have a nuclear industry" (according to Google Translate).[459]

110. In Canada, the government department responsible for promoting nuclear technology proclaims on its website: "Nuclear energy technology is a hallmark of the world's leading industrial nations."[460]

111. While French President Emmanuel Macron averred, "Everything that makes France an independent, listened-to and respected power is based on the nuclear industry."[461]

112. In the case of the Hinkley Point deal, the UK House of Commons Committee of Public Accounts was quite blunt: "Consumers are locked into an expensive deal lasting 35 years … [They] are left footing the bill and the poorest consumers will be hit hardest. Yet in all the negotiations no part of Government was really championing the consumer interest."[462]

113. An August 2022 report from the Dalton Nuclear Institute at the University of Manchester says explicitly that "the state" should be "creating an environment in which the private sector is willing to make the huge capital investments associated with delivering nuclear energy."[463]

114. The UK safety regulator had essentially signed off on the project in July 2022.[464]

115. And the British government is doing its bit to woo them, starting with corporations and funders in the United Arab Emirates, Australia, and Saudi Arabia.[465]

---

[459] SEW, "Shi Lishan, Deputy Director of Nuclear Power Division: Nuclear Power Positioning Should Have Strategic Thinking, Take Precautions and Grasp the Direction of Technology Development," Southern Energy Watch, November 18, 2017, https://mp.weixin.qq.com/s?__biz=MjM5OTY4NjAwMQ==&mid=2650091373&idx=2&sn=1c151c0fb7402e2bc76418c2d228d948&chksm=bf3635738841bc65a7ac1001dfa758bc17275564be5fe59e44c1578ec08cec45de150469294d.

[460] NRCAN, "The Canadian Nuclear Energy Technology," Natural Resources Canada, December 19, 2016, http://www.nrcan.gc.ca/energy/uranium-nuclear/7713.

[461] WNN, "Macron Stresses Importance of Nuclear Energy for France," *World Nuclear News*, December 9, 2020, https://www.world-nuclear-news.org/Articles/Macron-stresses-importance-of-nuclear-energy-for-F.

[462] Committee of Public Accounts, "Hinkley Point C: Third Report of Session 2017–19," 3.

[463] William Bodel et al., "Delivering Advanced Nuclear Energy" (Manchester: Dalton Nuclear Institute, The University of Manchester, August 2022), 3, https://www.dalton.manchester.ac.uk/delivering-advanced-nuclear/.

[464] Office for Nuclear Regulation, "Sizewell C," New Reactor Licensing, July 2022, https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c.htm.

[465] Molly Blackall, Ben Gartside, and David Connett, "UK Tapping up Saudi and UAE Investors for Sizewell C as It Struggles to Bring in Nuclear Funds," *I News*, September 4, 2022, https://inews.co.uk/news/sizewell-c-nuclear-power-energy-money-funding-investment-boris-johnson-1831509.

116. As a Department for Business, Energy, and Industrial Strategy official put it, "The Government is fully committed to boosting our domestic energy security through nuclear power." [466]

117. In June 2017, at an event called "Unleashing American Energy," he proudly announced "six brand-new initiatives to propel this new era of American energy dominance," then elaborating, "First, we will begin to revive and expand our nuclear energy sector—which I'm so happy about—which produces clean, renewable, and emissions-free energy."[467]

Chapter 5: May the Atom be a Soldier: Nuclear Power for War

1. *Nuclear power must not only be safe but must also be used solely for peaceful purposes.* International Atomic Energy Agency[468]

2. *And Denial Is Not a River in Egypt.* Anonymous graffito, 1986[469]

3. He was responsible for the lightest and smallest fission bomb ever made, at just fifty pounds (the Davy Crockett), and the largest-yield fission bomb ever exploded (the Super Oralloy Bomb).[470]

4. Ted had focused the flash of light produced during a nuclear weapons explosion to light a Pall Mall cigarette.[471]

5. Things changed in the mid-1960s after a stint at the US Department of Defence, where Ted began to see how nuclear technology could be abused by governments, terrorists, and criminals—which aren't separate categories in my mind.[472]

6. By the 1970s, Ted's moral convictions against all nuclear technology were clear: "If it were possible to wave a wand and make fission impossible—fission of any kind—I would quickly wave the wand," he told journalist John McPhee.[473]

---

[466] Molly Blackall, Ben Gartside, and David Connett.
[467] Donald Trump, "Remarks by President Trump at the Unleashing American Energy Event" (Whitehouse, Washington, D. C., June 29, 2017), https://www.whitehouse.gov/briefings-statements/remarks-president-trump-unleashing-american-energy-event/.
[468] IAEA, "Climate Change and Nuclear Power 2015" (Vienna: International Atomic Energy Agency, 2015), 75.
[469] Garson O'Toole, "Denial Is Not a River in Egypt," *Quote Investigator* (blog), May 11, 2012, https://quoteinvestigator.com/2012/05/11/denial-not-river/.
[470] John McPhee, *The Curve of Binding Energy: A Journey into the Awesome and Alarming World of Theodore B. Taylor* (Farrar, Straus and Giroux, 1973), 8.
[471] Richard L. Miller, *Under the Cloud: The Decades of Nuclear Testing* (The Woodlands, Texas: Two Sixty Press, 1986), 154.
[472] "Theodore Brewster Taylor," in *Gale Literature: Contemporary Authors* (Farmington Hills, MI: Gale, 2005), https://link.gale.com/apps/doc/H1000097740/LitRC?u=ubcolumbia&sid=LitRC&xid=41a1cf99.
[473] McPhee, *The Curve of Binding Energy*, 120–21.

7. As he explained in a talk to the Nuclear Age Peace Foundation in 1996, the constructive and destructive uses of nuclear technology were so intimately related that "the benefits of the one are not accessible without greatly increasing the hazards of the other."[474]

8. The resulting *Report on the International Control of Atomic Energy* warned that "the development of atomic energy for peaceful purposes and the development of atomic energy for bombs are in much of their course interchangeable and interdependent."[475]

9. But there are also nuclear-powered aircraft carriers, nuclear-powered cruisers, and nuclear-powered icebreakers.[476]

10. As a 2020 analysis from the Idaho National Lab shows, the repeated manufacture meant that many of the problems with the initial versions of the design were overcome, at government expense.[477]

11. Over the next three decades, this design ended up dominating the nuclear power plant market, beating out various other alternatives that were proposed in other countries, and even designs proposed by rival developers in the United States.[478]

12. The interdependence of these two technologies was laid out in a March 1987 interview to the *Washington Post* by Pakistan's dictator, General Muhammad Zia-ul-Haq: "Once you have acquired the technology, which Pakistan has, you can do whatever you like. You can use it for peaceful purposes only; you can also utilize [it] for military purposes."[479]

13. Soon Saudi officials had announced plans to install 18,000 megawatts of nuclear generation capacity, equivalent to over fifteen large nuclear power plants, by 2032.[480]

---

[474] Theodore B. Taylor, "Nuclear Power and Nuclear Weapons," *Nuclear Age Peace Foundation* (blog), July 12, 1996, https://www.wagingpeace.org/nuclear-power-and-nuclear-weapons/.
[475] C. I. Barnard et al., "A Report on the International Control of Atomic Energy" (Washington, DC, 1946), www.ipfmlibrary.org/ach46.pdf.
[476] Junchong Yu, *Marine Nuclear Power Technology* (Springer Singapore, 2020), http://www.springer.com/us/book/9789811528934.
[477] Jason K. Hansen et al., "Retrospective Analysis of US LWR Technology Commercialization: Lessons for Today's Nuclear Industry" (Idaho National Lab. (INL), Idaho Falls, ID (United States), May 15, 2020), https://doi.org/10.2172/1635530.
[478] Robin Cowan, "Nuclear Power Reactors: A Study in Technological Lock-In," *The Journal of Economic History* 50, no. 3 (1990): 541–67.
[479] Richard M. Weintraub, "Zia Says Pakistan Capable of Building A-Weapon; He Denies Military Intent, but Remark Prompts a Warning From India," *Washington Post*, March 23, 1987.
[480] April Yee, "Saudi Arabia to Seek Bids for Its First Nuclear Reactor," *The National*, November 11, 2013, http://www.thenational.ae/business/industry-insights/energy/saudi-arabia-to-seek-bids-for-its-first-nuclear-reactor.

14. The announcement was welcomed by the nuclear industry, which was reeling from the impact of the Fukushima accident.[481]

15. A royal decree from April 2010 reasoned that "the development of atomic energy is essential to meet the Kingdom's growing requirements for energy to generate electricity, produce desalinated water and reduce reliance on depleting hydrocarbon resources."[482]

16. The answer had been floating in the air for years,[483] but the definitive confirmation came in March 2018.

17. A clear if pithy illustration of this desire to turn away from nuclear weapons toward nuclear energy is the Soviet slogan "May the atom be a worker, not a soldier."[484]

18. Speaking at the United Nations General Assembly in December 1953, President Eisenhower argued that "if the fearful trend of atomic military buildup can be reversed, this greatest of destructive forces can be developed into a great boon, for the benefit of all mankind" and went on to lay out various steps in order to "hasten the day when fear of the atom will begin to disappear from the minds of the people and the governments of the East and West."[485]

19. During the height of the hype about the nuclear renaissance in the first decade of this century, Anne Lauvergeon, then the head of France's Areva, asserted in a 2009 article in *Daedalus* that the growth of nuclear electricity does "not equate—and should not be equated—with increasing proliferation risks."[486]

20. An op-ed by Ted Nordhaus, co-author of An Ecomodernist Manifesto, illustrates this strain of argument by asserting that "the tendency to conflate nuclear energy with nuclear weapons" is "extremely misleading."[487]

---

[481] Daniel Fineren, "Nuclear Saudi Arabia a Lifeline for the Atomic Energy Industry," *Reuters*, April 23, 2013, https://uk.reuters.com/article/uk-saudi-nuclear/nuclear-saudi-arabia-a-lifeline-for-the-atomic-energy-industry-idUKLNE93M00M20130423.
[482] Steve Kidd, "Nuclear Power in the Middle East-Where and When?," *Nuclear Engineering International*, August 12, 2011, http://www.neimagazine.com/opinion/opinionnuclear-power-in-the-middle-east-where-and-when-.
[483] The Associated Press, "Saudi Arabia May Seek Nuclear Weapons, Prince Says," *The New York Times*, December 6, 2011, sec. World / Middle East, http://www.nytimes.com/2011/12/07/world/middleeast/saudi-arabia-may-seek-nuclear-weapons-prince-says.html.
[484] Joseph Lewin, "USSR Nuclear: Where Seldom Is Heard a Discouraging Word," *Oak Ridge National Laboratory Review*, Spring 1977, 22; Sonja D. Schmid, *Producing Power* (Cambridge, MA: MIT Press, 2015), 97–125.
[485] David Fischer, *History of the International Atomic Energy Agency: The First Forty Years* (Vienna: International Atomic Energy Agency, 1997), 494.
[486] Anne Lauvergeon, "The Nuclear Renaissance: An Opportunity to Enhance the Culture of Nonproliferation," *Daedalus* 138, no. 4 (September 1, 2009): 93, https://doi.org/10.1162/daed.2009.138.4.91.
[487] Nordhaus, "Time to Stop Confusing Nuclear Weapons with Nuclear Power."

21. The report's conclusion: "Public acceptance of nuclear power cannot be expected to increase substantially until the two nuclear technologies *are separated in people's minds*" (my emphasis).[488]

22. In December 2020, the Office of the President of France issued a statement providing three motivations for continuing to support its nuclear energy sector: "Our energy and ecological future depends on nuclear power; our economic and industrial future depends on nuclear power; and France's strategic future depends on nuclear power."[489]

23. But the *World Nuclear Industry Status Report 2020* documents the share of the country's electricity from nuclear reactors declining, from 78.5 percent in 2005 to just over 70 percent in 2019; not one French reactor was ranked among the top 100 units in the world.[490]

24. Électricité de France faced major debt problems and, in July 2020, the national Cour des Comptes (Court of Accounts) had publicly criticized the agency's project management skills.[491]

25. One of my colleagues at the school, Hal Feiveson, coined the term "latent proliferation" in his 1972 PhD thesis.[492]

26. What Hal described was how a country with nuclear power plants arrives at a point that is "short of the actual possession of nuclear weapons, but that can account for much of what has to be done technically to acquire them," as summarized by Ted in his 1996 lecture.[493]

27. As the US Department of Energy announced: "Virtually any combination of plutonium isotopes … can be used to make a nuclear weapon."[494]

28. Relative to plutonium-239, uranium-233 fissions spontaneously at a lower rate.[495]

---

[488] OTA, "Nuclear Power in an Age of Uncertainty," 239.
[489] WNN, "Macron Stresses Importance of Nuclear Energy for France."
[490] Schneider and Froggatt, "The World Nuclear Industry Status Report 2020."
[491] "La Cour Des Comptes, Un Obstacle Sur La Route Des EPR," *Energies France* (blog), July 9, 2020, https://www.energiesfrance.fr/la-cour-des-comptes-un-obstacle-sur-la-route-des-epr/.
[492] Harold. A Feiveson, "Latent Proliferation: The International Security Implications of Civilian Nuclear Power" (Princeton, N.J., Princeton University, 1972), http://fissilematerials.org/library/feiveson72.pdf.
[493] Taylor, "Nuclear Power and Nuclear Weapons."
[494] DoE, "Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives" (Washington, D. C.: U.S. Department of Energy, 1997), http://www.osti.gov/scitech/biblio/425259.
[495] J. Kang and Frank N Von Hippel, "U-232 and the Proliferation Resistance of U-233 in Spent Fuel," *Science & Global Security* 9, no. 1 (2001): 1–32.

29. While undesirable, this property does not completely preclude the use of uranium233 to make nuclear weapons, because it is possible to isolate pure streams of uranium-233.[496]

30. During the 1950s, as the country undertook its first economic planning exercises, its planning board took the help of a set of experts from Harvard University.[497]

31. Kilbridge's 1958 report, "The Prospect for Nuclear Power in Pakistan," identified the major concern: "Probably not more than 10 persons in all Pakistan … have any extensive training in nuclear technology, and … not many more [have] the basic education necessary to absorb such training."[498]

32. Pakistan's neighbor India also benefited from US training with over 1,100 scientists and engineers going to the Argonne Laboratory and other facilities between 1955 and 1974.[499]

33. As detailed in a March 2007 article in the *Boston Globe*, thirty-five Iranian students arrived there in the summer of 1975 to study nuclear engineering.[500]

34. In 1975, too, US Secretary of State Henry Kissinger signed a National Security Decision Memorandum, which laid the basis for the planned sale of nuclear reactors to Iran at an estimated cost of over $6 billion.[501]

35. Kissinger absolved himself to the *Washington Post* in 2005 by saying, "They were an allied country, and this was a commercial transaction. We didn't address the question of them one day moving toward nuclear weapons."[502]

36. In its 2007 article, the *Boston Globe* traced many of these MIT students and found a number who worked in the Iranian nuclear program.[503]

37. Nuclear energy proponents argue that "prospective employment in the civilian nuclear power sector is a core incentive to academic training and military careers in nuclear

---

[496] Eva Uribe, "Thorium Power Has a Protactinium Problem," *Bulletin of the Atomic Scientists*, August 6, 2018, https://thebulletin.org/2018/08/thorium-power-has-a-protactinium-problem/.
[497] Zia Mian, "Fevered with Dreams of the Future: The Coming of the Atomic Age to Pakistan," in *Nuclear Power and Atomic Publics: Society and Culture in India and Pakistan*, ed. Itty Abraham (Bloomington, Indiana: Indiana University Press, 2009), 20–40.
[498] Maurice D. Kilbridge, *The Prospect for Nuclear Power in Pakistan* (Washington, D. C.: National Planning Association, 1958), 41.
[499] Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*, 30.
[500] Farah Stockman, "Iran's Nuclear Vision First Glimpsed at MIT," *Boston Globe*, March 12, 2007, https://archive.boston.com/news/education/higher/articles/2007/03/12/irans_nuclear_vision_first_glimpsed_at_mit/.
[501] Zia Mian and Alexander Glaser, "A Frightening Nuclear Legacy," *Bulletin of the Atomic Scientists* 64, no. 4 (September 1, 2008): 42–57, https://doi.org/10.2968/064004010.
[502] Dafna Linzer, "Past Arguments Don't Square With Current Iran Policy," *Washington Post*, March 27, 2005.
[503] Stockman, "Iran's Nuclear Vision First Glimpsed at MIT."

energy" and "this supply chain of expertise is at least as essential as the material inputs."[504]

38. In addition, the Institute of Nuclear Power Operators, which offers advice to nuclear power plant owners on the safety of their facilities, is largely populated by former naval workers.[505]

39. Ostendorff worked in the navy from 1976 to 2002; during this stint, he worked on six submarines and commanded a nuclear attack submarine as well as a nuclear attack submarine squadron.[506]

40. In a 2019 podcast interview, he attributed his NRC appointment to precisely those factors.[507]

41. Another example is Admiral John Richardson, a former chief of US naval operations appointed to Exelon Corporation's board of directors in September 2019.[508]

42. Why exactly this experience and expertise are valuable to the company might be inferred from the accompanying statement about him joining "Exelon's Finance and Risk and Generation Oversight Committees."[509]

43. For context, Exelon had been lobbying the state of Illinois to subsidize its nuclear reactors (see chapters 2 and 4).[510]

---

[504] Randolph Bell, Jennifer T. Gordon, and Robert F. Ichord Jr., "Risks Are Stacking up against the U.S. Nuclear Industry," *Axios*, May 21, 2019, https://www.axios.com/risks-are-stacking-up-against-the-us-nuclear-industry-9295e06a-bdd6-4a96-8c20-c4eac520edbc.html.

[505] Robert Pool, *Beyond Engineering : How Society Shapes Technology* (New York, NY: Oxford University Press, 1997), 270–75.

[506] USNA, "Honorable William C. Ostendorff, Class of 1960 Distinguished Visiting Professor," United States Naval Academy, 2016, https://www.usna.edu/PoliSci/facultybio/ostendorf.php.

[507] *Bill's Transition to the NRC (Pt. 7)*, Titans of Nuclear, 2019, https://www.youtube.com/watch?v=akymZWps_q0.

[508] Exelon Corporation, "Exelon Appoints Admiral John Richardson to Board of Directors," *Newsroom*, September 3, 2019, https://www.exeloncorp.com:443/newsroom/exelon-appoints-admiral-john-richardson-to-board-of-directors.

[509] Exelon Corporation.

[510] Rebecca Smith, "Nuclear Power Goes Begging, Likely at Consumers' Expense; Operators of Nuclear Power Plants Are Seeking Rate Increases to Avoid Closures in Deregulated Market," *Wall Street Journal*, April 17, 2015; Aaron Larson, "Exelon Gets Its Christmas Wish—Illinois Legislation Will Save Nuclear Plants," *Power Magazine*, December 2, 2016, https://www.powermag.com/exelon-gets-its-christmas-wish-illinois-legislation-will-save-nuclear-plants/; Christopher Crane, "Illinois Legislature Must Move Quickly to Keep Electric Bills Low and Promote Green Energy," *Chicago Sun-Times*, December 28, 2020, https://chicago.suntimes.com/2020/12/28/22203089/exelon-illinois-green-energy-carbon-free-nuclear-power-plants-comed-legislature-christopher-crane; Jeffery and Ramana, "Big Money, Nuclear Subsidies, and Systemic Corruption."

44. When he retired, he was promptly appointed to the Defence Research and Development Organisation, which designs and manufactures the missiles that would deliver India's nuclear weapons.[511]

45. In his autobiography, Years of Pilgrimage, he recalled: "The defence forces took well to my induction. They respected me, as I was from the Bhabha Atomic Research Centre (BARC), an organization about which they were well-informed and proud of … Most importantly, the fact that I'd been involved in the development of a prototype weapon lent me a special status." [512]

46. Kenneth Bergeron's *Tritium on Ice* from 2002 points out that "its charter" involves both the "promotion of commercial nuclear power and production of nuclear weapons."[513]

47. The connection is common enough that in a 1996 paper in the journal *International Security*, the political scientist Scott Sagan advanced the idea of a domestic politics model of why countries acquire nuclear weapons, where these are used as "political tools" to "advance parochial domestic and bureaucratic interests."[514]

48. The Atomic Energy Commission was set up originally in the late 1940s to develop atomic energy for peaceful purposes.[515]

49. By the mid-1960s, as scholar Itty Abraham reveals in his papers in the *Economic and Political Weekly* and his book *The Making of the Indian Atomic Bomb*, leaders within the nuclear establishment started advancing a different rationale for continued patronage by the state: producing nuclear weapons.[516]

50. The Brazilian military, explain Togzhan Kassenova, Lucas Perez Florentino, and Matias Spektor in a 2020 report, "has become the institutional home to nuclear R&D and a

---

[511] IGCAR, "Dr. Placid Rodriguez, Former Director of IGCAR Kalpakkam Passes Away," *Indira Gandhi Centre for Atomic Research* (blog), 2008, http://www.igcar.gov.in/press_releases/placid.pdf.
[512] Raja Ramanna, *Years of Pilgrimage* (Delhi: Viking, 1991), 100.
[513] Kenneth D. Bergeron, *Tritium on Ice : The Dangerous New Alliance of Nuclear Weapons and Nuclear Power* (Cambridge, Mass. ; London: MIT Press, 2002), 11.
[514] Scott D. Sagan, "Why Do States Build Nuclear Weapons?: Three Models in Search of a Bomb," *International Security* 21, no. 3 (1996): 55.
[515] Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State*; M. V. Ramana, "La Trahison Des Clercs: Scientists and India's Nuclear Bomb," in *Prisoners of the Nuclear Dream*, ed. M.V. Ramana and C. Rammanohar Reddy (New Delhi: Orient Longman, 2003), 206–44.
[516] Itty Abraham, "Science and Secrecy in Making of Postcolonial State," *Economic and Political Weekly* XXXII (1997): 2136–46; Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State*; Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation*.

staunch advocate for nuclear power amid budget cuts and criticism from domestic and international actors." [517]

51. In the United States, the country that best exemplifies this tendency, the connection was identified in 1961, when outgoing President Dwight Eisenhower cautioned against the "unwarranted influence" and "misplaced power" arising out of the "conjunction of an immense military establishment and a large arms industry" in his farewell address.[518]

52. AECOM, for example, is a major contractor at the Lawrence Livermore National Laboratory, one of the United States' two nuclear weapon laboratories, and is involved with life extension programs for the B61 nuclear bomb and the W80-1 nuclear warhead.[519]

53. Its website also highlights its role as "engineer or constructor of record" in forty-nine nuclear power plants, including units in Spain, Italy, Brazil, Mexico, and Taiwan, not to mention the United States.[520]

54. Likewise, Fluor has contracts worth billions of dollars for the W88 nuclear warhead, while being heavily invested in the NuScale small modular reactor (see chapter 6).[521]

55. Finally, Jacobs Engineering has a twenty-five year £25.4 billion contract for maintenance of the UK Trident arsenal, is involved in multiple nuclear decommissioning projects, and has joined hands with Ultra Safe Nuclear Corporation to support the latter's small modular reactor design.[522]

56. According to the analyst and disarmament activist Andrew Lichterman's 2012 report on the company, it has reportedly "provided engineering and construction services at 88% of U.S. nuclear electricity generating plants." [523]

57. It also "received contracts to clean up Three Mile Island in Pennsylvania and Chernobyl in the Ukraine after the disastrous nuclear accidents at those facilities in 1979 and 1986,

---

[517] Togzhan Kassenova, Lucas Perez Florentino, and Matias Spektor, "Prospects for Nuclear Governance in Brazil" (São Paulo: FGV School of International Relations, 2020), 49, https://ri.fgv.br/en/news/2020-03-10/prospects-nuclear-governance-brazil.
[518] Dwight D. Eisenhower, "Farewell Address" (Washington, D. C., January 17, 1961), https://www.eisenhowerlibrary.gov/sites/default/files/research/online-documents/farewell-address/1961-01-17-press-release.pdf.
[519] Susi Snyder, "Producing Mass Destruction: Private Companies and the Nuclear Weapon Industry" (Utrecht: PAX, May 2019), 6.
[520] AECOM, "Highlighted Successes," Energy, 2023, https://aecom.com/markets/national-governments-2/energy/.
[521] Snyder, "Producing Mass Destruction: Private Companies and the Nuclear Weapon Industry," 7.
[522] Snyder, 8.
[523] Andrew Lichterman, "The Bechtel Corporation: San Francisco's Engineers of Empire" (Western States Legal Foundation, Spring 2012), http://www.wslfweb.org/docs/docs/Bechtel%20Nuclear%20Connections.pdf.

respectively," reports investigative journalist Sally Denton in her 2016 book *The Profiteers*.[524]

58. For example, its contract for constructing a chemical plant to deal with the large quantities of highly radioactive wastes at the Hanford site in Washington state, was valued at $12.2 billion in 2006.[525]

59. At Hanford, Bechtel and AECOM have had to pay millions of dollars in fines.[526]

60. Bechtel is also involved in the management or operations of many of the facilities that manufacture, test, and maintain the US nuclear arsenal, including the Los Alamos Laboratory, the Livermore Laboratory, the Pantex plant in Texas (where nuclear bombs and warheads are assembled, refurbished, and dismantled), the Y-12 plant in Tennessee (where the secondaries for thermonuclear weapons are made), and the Bettis and Knolls Atomic Power Laboratories (which provide research and technical support for the navy's nuclear submarines and aircraft carriers).[527]

61. This management structure is referred to as the government-owned and contractor-operated (GOCO) model, which has been very lucrative for Bechtel.[528]

62. That could be seen as a trade: another Bechtel executive, John McCone, became AEC chair at the same time.[529]

63. During the 1960s, Davis, while part of Bechtel, was also the chair of the Committee on Reactor Safety of the Atomic Industrial Forum, where he was involved in setting policies for where nuclear reactors should be sited.[530]

64. Davis eventually retired from Bechtel to become deputy secretary of energy under President Ronald Reagan.[531]

---

[524] Sally Denton, *The Profiteers: Bechtel and the Men Who Built the World* (New York: Simon & Schuster, 2016), 10.
[525] Shannon Dininny, "Hanford Plant Now $12.2 Billion," *Associated Press*, September 8, 2006, https://www.seattlepi.com/seattlenews/article/Hanford-plant-now-12-2-billion-1214008.php.
[526] USAO, "Bechtel & Aecom, U.S. Department of Energy (DOE) Contractors, Agree to Pay $57.75 Million to Resolve Claims of Time Charging Fraud at Doe's Hanford Waste Treatment Plant" (Spokane, WA: United States Attorney's Office for the Eastern District of Washington, September 22, 2020), https://www.justice.gov/usao-edwa/pr/bechtel-aecom-us-department-energy-doe-contractors-agree-pay-5775-million-resolve-0.
[527] Lichterman, "The Bechtel Corporation: San Francisco's Engineers of Empire," 2.
[528] Denton, *The Profiteers: Bechtel and the Men Who Built the World*, 157.
[529] William Greider, "The Boys From Bechtel," *Rolling Stone*, September 2, 1982, https://www.rollingstone.com/politics/politics-news/the-boys-from-bechtel-88449/.
[530] W. Kenneth Davis, "Statement before the Joint Committee on Atomic Energy, Congress of the United States" (Washington, D. C., June 13, 1961), https://www.nrc.gov/docs/ML0217/ML021720639.pdf.
[531] Denton, *The Profiteers: Bechtel and the Men Who Built the World*, 153–55.

65. Within the Reagan administration, journalist William Greider revealed in 1982, Davis worked to modify or eliminate the rules put in place under the Gerald Ford and Jimmy Carter administrations to regulate international trade in nuclear technologies that had been devised in response to India's first nuclear weapons test of 1974.[532]

66. He had already served two stints in US administrations: as secretary of labor and secretary of the treasury for President Richard Nixon.[533]

67. By 1983, the *New York Times* estimated they were spending up to $30 million annually, some of it coming directly from the monthly bills paid by electricity consumers.[534]

68. In 1988, *The New York Times* described the group as "the nuclear industry's main trade association."[535]

69. The Committee's placed "supposedly independent energy experts on radio and television talk shows" and submitted "letters to the editors and Op-Eds to dozens of newspapers throughout the country".[536]

70. During the Manhattan Project, it became a supplier of equipment to the US nuclear weapons program.[537]

71. In the 1950s, B&W went into the nuclear reactor business by supplying one for the first nuclear-powered merchant ship, *Savannah*.[538]

72. Around the same time, it entered the commercial nuclear power plant business, when it obtained the contract for the Indian Point 1 plant in New York.[539]

73. But its best-known project was the Three Mile Island plant in Pennsylvania,[540] which attained notoriety when unit 2 of the plant melted down in 1979.

---

[532] Greider, "The Boys From Bechtel."
[533] Rohan Pearce, "United States: How the Bush Gang Loots Iraq," *Green Left Weekly*, May 21, 2003.
[534] Margot Slade and Wayne Biddle, "Atomic Power's Big New Promo," *The New York Times*, May 29, 1983.
[535] Matthew L. Wald, "Nuclear Plant Drain Put At $100 Billion for U.S.," *The New York Times*, February 1, 1988.
[536] Denton, *The Profiteers: Bechtel and the Men Who Built the World*, 150.
[537] James P. Delgado, *Nuclear Dawn: The Atomic Bomb, from the Manhattan Project to the Cold War* (New York: Bloomsbury Publishing, 2011), 56. Its first contract was for the massive steel container—25 feet long, 12 feet in diameter, more than a foot in thickness and weighing 214 tons—that was to contain the plutonium and the explosive surrounding it at the first test of a nuclear weapon in July 1945 in Alamogordo. In the event, the container wasn't used because of the concern that when it vapourized, it would add to the radioactive fallout.
[538] Merril Eisenbud, *An Environmental Odyssey: People, Pollution, and Politics in the Life of a Practical Scientist* (Seattle, WA: University of Washington Press, 1990), 115.
[539] Robert L. Perry et al., "Development and Commercialization of the Light Water Reactor, 1946-1976" (Santa Monica, CA: RAND Corporation, 1977), 96, https://www.rand.org/pubs/reports/R2180.html.
[540] J Samuel Walker, *Three Mile Island a Nuclear Crisis in Historical Perspective* (Berkeley: University of California Press, 2004), 44.

74. A July 2017 company profile in *Forbes* magazine gushed, "BWXT not only is the sole provider of naval nuclear reactors, it is also the largest manufacturer of commercial nuclear components in North America, and a key provider of nuclear fuel to civil, military and commercial users."[541]

75. In Canada, BWXT obtained contracts worth hundreds of millions of dollars to supply fuel and nuclear components for ongoing or planned multibilliondollar nuclear reactor refurbishment projects in the province of Ontario (dressing it up as local economic stimulation in some cases).[542]

76. The argument has been particularly potent in the last decade because all the countries with nuclear weapons have been modernizing their arsenals, as detailed in the *Assuring Destruction Forever* series of reports put out by Reaching Critical Will.[543]

77. In 2011, as the Japanese nuclear industry was reeling from the catastrophic Fukushima accident, an official from the Liberal Democratic Party, which has dominated Japanese politics for decades, argued that Japan's capabilities in nuclear power and "leading-edge rocket technology" make it "possible to create nuclear weapons in the relatively short time of several months to a year."[544]

78. The very first of this series was the 2003 report on the future of nuclear energy, which identified the link between nuclear energy and nuclear weapons proliferation as one of the four unresolved problems associated with the technology.[545]

79. First, the "nuclear weapons stockpile requires a constant source of tritium (half-life about 12.5 years), provided by irradiating special fuel rods in one or two power reactors."[546]

---

[541] Loren Thompson, "BWXT Becomes The Nuclear Industry's Civil-Military-Commercial Growth Company," *Forbes*, July 25, 2017, https://www.forbes.com/sites/lorenthompson/2017/07/25/bwxt-becomes-the-nuclear-industrys-civil-military-commercial-growth-company/.

[542] "Bruce Power, BWXT Combine on MCR, Medical Isotopes Projects to Stimulate Made-in-Ontario Economic Recovery," *Bruce Power* (blog), September 9, 2020, https://www.brucepower.com/2020/09/09/bruce-power-bwxt-combine-on-mcr-medical-isotopes-projects-to-stimulate-made-in-ontario-economic-recovery/; OPG, "BWXT Plays Important Role in Darlington Nuclear Defuelling," Ontario Power Generation, January 13, 2017, https://www.opg.com/news/bwxt-important-role-darlington-defuelling/.

[543] Allison Pytlak and Ray Acheson, "Assuring Destruction Forever: 2020 Edition" (New York: Reaching Critical Will, 2020), https://www.reachingcriticalwill.org/images/documents/Publications/modernization/pakistan-2020.pdf; "Assuring Destruction Forever: Nuclear Weapon Modernization Around the World" (New York: Reaching Critical Will, 2012).

[544] Linda Sieg, "Japan Atomic Power Defenders: Keep Ability to Build Nuclear Weapons," *Reuters*, February 12, 2012, https://www.reuters.com/article/japan-nuclear-arms-idUSL4E8DA2ZK20120213.

[545] Ansolabehere et al., "The Future of Nuclear Power."

[546] EFI, "The U.S. Nuclear Energy Enterprise: A Key National Security Enabler" (Washington, D. C.: Energy Futures Initiative, Inc., August 2017), 16, https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5992f7e0bf629ad8f9d575ec/1502803938248/EFI+Nuclear+Report+FINAL+08.2017.pdf.

80. This supply chain has an inherent and very strong overlap with the commercial nuclear energy sector and has a strong presence in states with commercial nuclear power plants."[547]

81. Among their arguments was the claim that if these plants were not constructed, then "it would also stunt development of the nation's defense nuclear complex, because the engineering expertise on the energy side helps the defense side."[548]

82. The chorus grew louder the following month, when "several dozen retired generals and admirals, former State, Defense and Energy Department officials, three former chairmen of the Nuclear Regulatory Commission, and a sprinkling of former senators, governors, industrialists" wrote a "letter to Energy Secretary Rick Perry attesting to the connection between U.S. nuclear power plants and national security."[549]

83. The letter, which is hosted on the website of the Nuclear Energy Institute at the time of this writing, asserts that the "national security benefits of a strong domestic nuclear energy sector take many forms, many of which overlap" and highlights, among other points, the fact that "many of the companies that serve the civil nuclear sector also supply the nuclear Navy and major DOE programs."[550]

84. But for good measure, the Atlantic Council, another Washington-area think tank, set up something called the Nuclear Energy and National Security Coalition, "in order to increase awareness about nuclear energy as a cornerstone of national security."[551]

85. The following year, to no one's surprise, the group's report asserted: "The US civilian nuclear power industry is a strategic asset of vital importance to US national security."[552]

---

[547] EFI, 8.

[548] Amy Harder, "Nuclear Scramble on Tax Credits," *Axios*, June 16, 2017, https://www.axios.com/nuclear-scramble-on-tax-credits-1513303038-7c4178f7-f93a-4614-bb13-efbca70c4835.html.

[549] Victor Gilinsky and Henry Sokolski, "The 'Threat' of Nuclear Power Plant Closures," *The National Interest*, August 8, 2018, https://nationalinterest.org/feature/threat-nuclear-power-plant-closures-28262.

[550] Daniel F. Akerson and others, "Letter to The Honorable Rick Perry, Secretary of Energy, U.S. Department of Energy," June 26, 2018, https://www.nei.org/CorporateSite/media/filefolder/resources/letters-filings-comments/letter-secretary-energy-rick-perry-nuclear-national-security-20180626.pdf.

[551] David Waldman and Natalya Rudman, "Lightbridge Executive Chairman Ambassador Thomas Graham Selected to Co-Chair Newly Formed Nuclear Energy and National Security Coalition," *Yahoo Finance*, May 23, 2019, https://finance.yahoo.com/news/lightbridge-executive-chairman-ambassador-thomas-123000702.html.

[552] Mike Crapo et al., "US Nuclear Energy Leadership: Innovation And The Strategic Global Challenge" (Washington, D. C.: Atlantic Council Global Energy Center, May 2019), 4, https://www.atlanticcouncil.org/images/publications/US_Nuclear_Energy_Leadership-.pdf.

86. In a 2018 article in the *Electricity Journal*, three academics from the University of Georgia at Athens harkened back to Cold War history to contend that nuclear energy is "capable of reshaping the geopolitical contours of the world order."[553]

87. This was certainly the case during the Cold War. International relations scholar Lauren Richardson has argued that US nuclear power companies "viewed South Korea as an attractive business prospect" because they "had a specific agenda to promote the advancement of nuclear technology in noncommunist countries."[554]

88. British academics Phil Johnstone and Andy Stirling have documented how these interlinkages between the nuclear power and weapons programs started being publicly emphasized once the United Kingdom began grappling with the complexities of constructing the Hinkley Point nuclear power plant and analogous problems with building a new Trident nuclear-powered submarine.[555]

89. During the 2009 hearings of the Parliament House of Commons Innovation, Universities, Science and Skills Committee, the Institution of Nuclear Engineers and the British Nuclear Energy Society highlighted how the nuclear submarine program serves to train nuclear power plant personnel.[556]

90. The Dalton Nuclear Institute at the University of Manchester (see chapter 4 for another of its talking points) explained that the opposite is also true, that "reactor physicists" can "develop their skills and knowledge by researching civil systems" and "when necessary" use these for developing military systems.[557]

91. Once known the world over as a manufacturer of luxury cars before it sold this division to BMW, Rolls Royce now gets most of its revenues (over 70 percent in 2021) from civil aviation and defense, but is increasingly positioning itself as a sustainable power company.[558]

---

[553] David K. Gattie, Joshua L. Darnell, and Joshua N. K. Massey, "The Role of U.S. Nuclear Power in the 21st Century," *The Electricity Journal* 31, no. 10 (2018): 3–4, https://doi.org/10.1016/j.tej.2018.11.008.
[554] Lauren Richardson, "Protesting Policy and Practice in South Korea's Nuclear Energy Industry," in *Learning from Fukushima*, ed. Peter Van Ness and Mel Gurtov (Canberra, Australia: ANU Press, 2017), 136.
[555] Andy Stirling and Philip Johnstone, "A Global Picture of Industrial Interdependencies Between Civil and Military Nuclear Infrastructures," SSRN Scholarly Paper (Sussex, UK: Social Science Research Network, August 13, 2018), https://doi.org/10.2139/ssrn.3230021; Phil Johnstone and Andy Stirling, "Comparing Nuclear Trajectories in Germany and the United Kingdom: From Regimes to Democracies in Sociotechnical Transitions and Discontinuities," *Energy Research & Social Science* 59 (January 1, 2020): 101245, https://doi.org/10.1016/j.erss.2019.101245.
[556] Parliament House of Commons Innovation, Universities, Science and Skills Committee, *Engineering: Turning Ideas Into Reality, Fourth Report of Session 2008-09, Vol. 3: Oral and Written Evidence* (London: The Stationery Office, 2009), 445.
[557] Parliament House of Commons Innovation, Universities, Science and Skills Committee, 419.
[558] Rolls Royce, "Overview," About, 2022, https://www.rolls-royce.com/about.aspx.

92. As part of this reinvention, it is developing a nuclear reactor design called the UK SMR for which it sought and received funding from the British government.[559]

93. To advocate for government funding, Rolls Royce's 2017 introduction to its small modular reactor design promoted precisely the linkage between civilian and military nuclear technology, arguing that a government program on these reactor designs would "assist in sustaining the skills required for the Royal Navy's submarine programme."[560]

94. Rolls Royce offers an economic motivation by arguing that expanding "a nuclear-capable skilled workforce through a civil nuclear UK SMR programme would relieve the Ministry of Defence of the burden of developing and retaining skills and capability. This would free up valuable resources for other investments."[561]

95. The institute also went on to host two seminars in 2021 emphasizing the nexus between developing nuclear power plants for electricity generation and nuclear submarines.[562]

96. One question posed by Bagla was "Is your strategic need for plutonium not met by CIRUS and Dhruva [two reactors already producing plutonium for nuclear weapons]? Do you need additional capacity from civilian reactors?"[563]

Chapter 6: Magical Thinking and Billionaire Messiahs: New Technology as Solution?

1. *Right now it's only a notion. But I think I can get money to make it into a concept, and then turn it into an idea.* Annie Hall, 1977 [564]

2. *Those most responsible for creating the problem [of climate change] will see to it that they profit from the solution that they propose.* Arundhati Roy, 2019[565]

---

[559] Rolls Royce, "UK SMR: A National Endeavour" (Rolls Royce, September 11, 2017), https://www.uknuclearsmr.org/uk-smr-a-national-endeavour-report/; Rolls Royce, "Rolls-Royce Announces Funding Secured for Small Modular Reactors," Press releases, November 8, 2021, https://www.rolls-royce.com/media/press-releases/2021/08-11-2021-rr-announces-funding-secured-for-small-modular-reactors.aspx.
[560] Rolls Royce, "UK SMR: A National Endeavour," 4.
[561] Rolls Royce, 22.
[562] SIA, "Might Submarines Lead a Nuclear Industry in Australia? Continuing the Conversation," Submarine Institute of Australia, July 15, 2021, https://www.submarineinstitute.com/events/Nuclear-Seminar/.
[563] Pallava Bagla, "On the Record: Anil Kakodkar," *Indian Express*, February 8, 2006.
[564] "Annie Hall (1977) Movie Script," Springfield! Springfield!, accessed May 9, 2023, https://www.springfieldspringfield.co.uk/movie_script.php?movie=annie-hall.
[565] Arundhati Roy, "Capitalism Is 'a Form of Religion' Stopping Solutions to Climate Change & Inequality," *Democracy Now!*, May 13, 2019, https://www.democracynow.org/2019/5/13/arundhati_roy_capitalism_is_a_form.

3. About a decade ago, *Technology Review*, a magazine that comes out of the Massachusetts Institute of Technology, ran an article titled "What If We Could Build a Nuclear Reactor That Costs Half as Much, Consumes Nuclear Waste, and Will Never Melt Down?"[566]

4. In 2014, Founders Fund—a San Francisco– based venture capitalist company whose best-known partner is Silicon Valley billionaire Peter Thiel—chipped in $2 million as seed funding.[567]

5. The following year, Transatomic raised an additional $2.5 million from Founders Fund, Acadia Woods Partners, and Daniel Aegerter, chair of the Swiss fund Armada Investment AG.[568]

6. In 2016, the US Department of Energy also awarded $200,000 to Transatomic.[569]

7. Meanwhile, the founders of Transatomic and their employees advertised widely their design's safety and capacity to reduce the amount of waste.[570]

8. In other words, she portrayed the reactor as not just safe but domesticated, something that can be brought into one's kitchen.[571]

9. To top it all, in 2017, Oak Ridge, the Department of Energy laboratory with experience operating a molten salt reactor, albeit back in the 1960s, announced that its scientists had "verified the viability" of the Transatomic design to reduce nuclear waste substantially and described the reactor technology as "walk-away safe."[572]

---

[566] Kevin Bullis, "What If We Could Build a Nuclear Reactor That Costs Half as Much, Consumes Nuclear Waste, and Will Never Melt Down?," *Technology Review*, 2013, https://www.technologyreview.com/innovator/leslie-dewan/.

[567] Katie Fehrenbacher, "Nuclear Startup Transatomic Power Scores Seed Funding from Founders Fund," *Yahoo Finance*, August 5, 2014, http://finance.yahoo.com/news/nuclear-startup-transatomic-power-scores-170833215.html.

[568] Stephen Lacey, "Transatomic Power Pulls In $2.5M to Test Components for Its Molten Salt Nuclear Reactor," *Greentech Media*, February 10, 2015, sec. Energy, https://www.greentechmedia.com/articles/read/transatomic-power-pulls-in-2-5-million-to-test-equipment-for-molten-salt-nu.

[569] Andrew Coffman Smith, "Oak Ridge Lab Memo Confirms Transatomic's Molten Salt Reactor Cuts Waste," *SNL Energy Electric Utility Report*, February 13, 2017, https://www.spglobal.com/marketintelligence/en/news-insights/trending/lfwndmiymapgjegjjrzchq2.

[570] For example, in this chapter in an academic volume: Sean Robertson et al., "Transatomic Power," in *Molten Salt Reactors and Thorium Energy*, ed. Thomas J. Dolan (Woodhead Publishing, 2017), 581–98, https://doi.org/10.1016/B978-0-08-101126-3.00022-1.

[571] Kevin Gray, "Peter Thiel Goes Nuclear," *Popular Science*, December 7, 2015, https://www.popsci.com/peter-thiel-goes-nuclear.

[572] Smith, "Oak Ridge Lab Memo Confirms Transatomic's Molten Salt Reactor Cuts Waste."

10. As Smith told Technology Review in February 2017, Transatomic's assertion about how much electricity it could generate from a given amount of uranium was "obviously incorrect based on basic physics."[573]

11. The debacle at Transatomic, for example, did not prevent Founders Fund from investing in another nuclear startup—Radiant—which was developing a high-temperature gas-cooled reactor called Kaleidos.[574]

12. By 2015, Third Way, a pro-nuclear think tank, compiled a list of over forty-five companies that had received a total of $1.3 billion in private funding to develop reactors based on either nuclear fission or fusion.[575]

13. The following year, Third Way partnered with various national laboratories to host what it billed as "a first-of-its-kind Advanced Nuclear Summit and Showcase in Washington" featuring senior members of the US Senate.[576]

14. The images that Third Way generated made their way to a Strategic Vision document published by the Department of Energy's Office of Nuclear Energy in 2021.[577]

15. News media also highlighted the private sector investing in nuclear reactor startups.[578]

16. In 2014, Harvard Business School produced a case on NuScale Power with the subtitle "The Future of Small Modular Reactors," which envisioned a couple of hundred SMRs being built during the 2020–35 time frame.[579]

---

[573] James Temple, "Nuclear Energy Startup Transatomic Backtracks on Key Promises," *MIT Technology Review*, February 24, 2017, https://www.technologyreview.com/2017/02/24/68882/nuclear-energy-startup-transatomic-backtracks-on-key-promises/.

[574] Radiant Nuclear, "Radiant Industries Raises $40 Million to Build Full-Scale Reactor Prototype," *Company News and Development Updates* (blog), April 24, 2023, https://radiantnuclear.com/blog/series-b/.

[575] Samuel Brinton, "The Advanced Nuclear Industry" (Washington, D. C.: Third Way, June 15, 2015), https://www.thirdway.org/report/the-advanced-nuclear-industry.

[576] "Advanced Nuclear Summit & Showcase," Third Way, January 27, 2016, https://www.thirdway.org/events/advanced-nuclear-summit-showcase.

[577] DOE, "Office of Nuclear Energy: Strategic Vision" (Washington, D. C.: Department of Energy, January 2021), https://www.energy.gov/sites/prod/files/2021/01/f82/DOE-NE%20Strategic%20Vision%20-Web%20-%2001.08.2021.pdf.

[578] See, for example, Evan Halper, "California Entrepreneurs Push to Reinvent the Nuclear Industry," *Los Angeles Times*, December 4, 2015, http://www.latimes.com/nation/politics/la-na-climate-nuclear-energy-20151204-story.html; Richard Martin, "Advanced Nuclear Startup Terrestrial Energy Lands Initial Funding," *MIT Technology Review*, January 12, 2016, https://www.technologyreview.com/s/545406/advanced-nuclear-startup-terrestrial-energy-lands-initial-funding/.

[579] Richard H.K. Vietor, "NuScale Power-the Future of Small Modular Reactors" (Cambridge, MA: Harvard Business Publishing Education, October 6, 2014), https://hbsp.harvard.edu/product/715004-PDF-ENG.

17. Other prominent billionaires investing in, or simply promoting, nuclear power include Sam Altman and Elon Musk.[580]

18. Thiel has gone very far in planning for a climate-related doomsday—literally as far as purchasing a mansion in New Zealand because he expects it to be safer there in the event of an apocalypse, reveals a September 2018 article in *Bloomberg*.[581]

19. Bill Gates, for his part, wrote a book explaining "How to Avoid a Climate Disaster" and promoted it extensively.[582]

20. In a subsequent interview to CNBC in February 2021, Bill Gates announced: "There's a new generation of nuclear power that solves the economics, which has been the big, big problem."[583]

21. Founded in 2006, TerraPower has featured Gates as the chair of the board continuously, at least as of 2024.[584]

22. In June 2010, the *New York Times* reported that the company received $35 million in seed money from venture capital firms to develop the first of its nuclear power plant designs, the "traveling wave" reactor.[585]

23. Gates also promised to invest $1 billion from his personal coffers— and raise another $1 billion in private capital—to fund TerraPower directly.[586]

---

[580] Catherine Clifford, "Sam Altman Explains Why He's Helping to Take Nuclear Microreactor Company Oklo Public via SPAC," *CNBC*, July 11, 2023, https://www.cnbc.com/2023/07/11/sam-altman-talks-about-oklo-nuclear-microreactor-spac.html; Catherine Clifford, "Elon Musk: It's Possible to Make 'extremely Safe' Nuclear Plants," *CNBC*, July 22, 2021, https://www.cnbc.com/2021/07/22/elon-musk-its-possible-to-make-extremely-safe-nuclear-plants.html; "Elon Musk and the Frontier of Technology," *PBS: Think Tank*, December 13, 2007, https://www.pbs.org/thinktank/show_1292.html.

[581] Olivia Carville, "The Super Rich of Silicon Valley Have a Doomsday Escape Plan," *Bloomberg.Com*, September 5, 2018, https://www.bloomberg.com/features/2018-rich-new-zealand-doomsday-preppers/.

[582] Bill Gates, *How to Avoid a Climate Disaster: The Solutions We Have and the Breakthroughs We Need* (New York: Diversified Publishing, 2021).

[583] Catherine Clifford, "Bill Gates: Nuclear Power Will 'absolutely' Be Politically Acceptable Again — It's Safer than Oil, Coal, Natural Gas," *CNBC*, February 25, 2021, https://www.cnbc.com/2021/02/25/bill-gates-nuclear-power-will-absolutely-be-politically-acceptable.html.

[584] TerraPower, "Our People," TerraPower A Nuclear Innovation Company, 2023, https://www.terrapower.com/our-people/.

[585] Matthew L. Wald, "Developer of Novel Reactor Wins $35 Million Infusion," *The New York Times*, June 15, 2010, https://www.nytimes.com/2010/06/15/business/energy-environment/15nuke.html.

[586] Steven Mufson, "Bill Gates Comes to Washington — Selling the Promise of Nuclear Energy," *Washington Post*, January 25, 2019, sec. Health & Science, https://www.washingtonpost.com/national/health-science/bill-gates-comes-to-washington--selling-the-promise-of-nuclear-energy/2019/01/25/4bd9c030-1445-11e9-b6ad-9cfd62dbb0a8_story.html.

24. When the *Washington Post* requested an interview about his investment in the company, Gates declined.[587]

25. Likewise, the virtual reality tools used by companies like Westinghouse (described later) were funded by the DOE,[588] and carried out at another public university, The Pennsylvania State University.[589]

26. Answering them will not be easy, requiring "several million person-hours of design/engineering work" to reach "the level of technical confidence demanded by regulatory authorities" according to a 2018 report by a group of MIT nuclear engineers.[590]

27. A 2015 US Government Accountability Office report estimated that developing a new nuclear reactor design and obtaining the US Nuclear Regulatory Commission's certification "can cost up to $1 billion to $2 billion,"[591] a figure corroborated by the 2018 MIT report.[592]

28. In a November 2023 earnings call, the NuScale CEO declared that the company had invested more than $1.8 billion.[593]

29. For example, TerraPower, the company backed by Bill Gates, received a $40 million grant in 2016, followed by another $80 million in 2020, and $8.5 million in 2022, all from the Department of Energy.[594]

---

[587] Mufson.

[588] Vaughn Whisker and John Messner, "Generation IV Nuclear Energy Systems - Computer Integrated Construction," Computer Integrated Construction Research Group, 2015, http://www.pennstatecic.org/generation-iv-nuclear-energy-systems.html.

[589] Sai Yerrapathruni, "Using 4 D CAD and Immersive Virtual Environments to Improve Construction Planning" (State College, PA, The Pennsylvania State University, 2003), http://www.pennstatecic.org/generation-iv-nuclear-energy-systems.html.

[590] Jacopo Buongiorno et al., "The Future of Nuclear Power in a Carbon-Constrained World" (Massachusetts Institute of Technology, 2018), 86, https://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf.

[591] GAO, "Nuclear Reactors: Status and Challenges in Development and Deployment of New Commercial Concepts" (Washington, D. C.: U.S. Government Accountability Office, July 28, 2015), 3, https://www.gao.gov/products/gao-15-652.

[592] Buongiorno et al., "The Future of Nuclear Power in a Carbon-Constrained World," 86.

[593] Rachael Rajan, "Earnings Call: NuScale Reports Q3 2023 Results, Announces Strategic Partnerships and Progress in SMR Technology By Investing.Com," Investing.com, November 9, 2023, https://ca.investing.com/news/stock-market-news/earnings-call-nuscale-reports-q3-2023-results-announces-strategic-partnerships-and-progress-in-smr-technology-93CH-3173418.

[594] Alan Boyle, "Bill Gates' TerraPower Wins $8.5M in Federal Funding for Conversion of Used Nuclear Fuel," *GeekWire*, March 10, 2022, https://www.geekwire.com/2022/bill-gates-terrapower-wins-8-5m-in-federal-funding-for-conversion-of-used-nuclear-fuel/; Joniel Cha and William Freebairn, "US DOE Awards TerraPower, X-Energy $80 Million Each for Advanced Nuclear Reactors," *S&P Global Platts*, October 13, 2020, https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/101320-us-doe-awards-terrapower-

30. Further, the 2021 Infrastructure Investment and Jobs Act has earmarked $2.5 billion for nuclear projects, and a TerraPower nuclear project proposed for the state of Wyoming is expected to receive part of this funding.[595]

31. Bill Gates also paid numerous visits to China and nearly succeeded in getting the people of that country to invest their RMBs into his idea.[596]

32. Unfortunately for Gates, but luckily for the Chinese, that idea was stopped by America's waning diplomatic and trade relationship with China.[597]

33. A paper published in *Environmental Research Letters* in 2017 calculated that between 1998 and 2015, companies and institutions working on "advanced nuclear" reactors received about $2 billion in US government funding.[598]

34. The budget watchdog organization Taxpayers for Common Sense has calculated that between 2011 and 2021, the DOE has spent "more than $1.2 billion on SMRs" and has announced further awards over the next decade that could amount to "at least $5.5 billion more" than what has already been awarded.[599]

35. Rothrock's answer, in essence, was that investors make a lot of money when the company goes public, and this happens well before these reactors sell any energy.[600]

---

x-energy-80-million-each-for-advanced-nuclear-reactors; Mufson, "Bill Gates Comes to Washington — Selling the Promise of Nuclear Energy."

[595] Catherine Clifford, "Bill Gates' TerraPower Aims to Build Its First Advanced Nuclear Reactor in a Coal Town in Wyoming," *CNBC*, November 17, 2021, https://www.cnbc.com/2021/11/17/bill-gates-terrapower-builds-its-first-nuclear-reactor-in-a-coal-town.html; for more about the strategies used by Bill Gates to get public money, see Tim Schwab, *The Bill Gates Problem: Reckoning with the Myth of the Good Billionaire* (New York: Metropolitan Books, 2023).

[596] Carl O'Donnell, "Bill Gates' Nuclear Venture Hits Snag amid U.S. Restrictions on China Deals: WSJ," *Reuters*, January 1, 2019, https://www.reuters.com/article/us-terrapower-china-idUSKCN1OV1S5; Dan Yurman, "TerraPower Seeks Wisdom in China," American Nuclear Society, *Nuclear Newswire* (blog), December 15, 2011, https://www.ans.org/news/article-881/terrapower-seeks-wisdom-in-china/.

[597] Jay Greene, "Trump's Tech Battle With China Roils Bill Gates Nuclear Venture," *Wall Street Journal*, January 1, 2019, https://www.wsj.com/articles/trumps-tech-battle-with-china-roils-bill-gates-nuclear-venture-11546360589.

[598] A. Abdulla et al., "A Retrospective Analysis of Funding and Focus in US Advanced Fission Innovation," *Environmental Research Letters* 12, no. 8 (2017): 084016, https://doi.org/10.1088/1748-9326/aa7f10.

[599] Taxpayers for Common Sense, "Doubling Down: Taxpayers' Losing Bet on NuScale and Small Modular Reactors" (Taxpayers for Common Sense, December 14, 2021), https://www.taxpayer.net/energy-natural-resources/doubling-down-losing-bet-on-small-modular-reactors-nuclear/.

[600] Ray Rothrock, "Q & A" (Laying the Foundation for New and Advanced Nuclear Reactors in the United States Meeting 2, Online, January 25, 2021), https://www.nationalacademies.org/event/01-25-2021/laying-the-foundation-for-new-and-advanced-nuclear-reactors-in-the-united-states-meeting-2.

36. In July 2023, Oklo announced plans for a merger with a SPAC called AltC Acquisition Corporation, which was cofounded by Sam Altman, the CEO of the artificial intelligence company OpenAI; Altman is also the chair of Oklo's board.[601]

37. SPACs, explains a February 2021 article in *Harvard Business Review*, are "shell companies that have no operations or business plan other than to acquire a private company using the money raised through an IPO (Initial Public Offering), thereby enabling the latter to go public quickly."[602]

38. Even the US Securities and Exchange Commission has been concerned about the growth in SPAC transactions.[603]

39. The mPower design was developed by Babcock & Wilcox, a veteran of the nuclear business (more on this company in chapter 5). [604]

40. So, it was not surprising that it was the first company selected to receive up to $226 million under the 2012 DOE cost-share funding opportunity to "guide two small modular reactor designs through the nuclear regulatory process by 2022."[605]

41. When US DOE selected mPower, James Ferland, president of Babcock & Wilcox, pronounced that the award represented "another key milestone in the work to establish *the world's first commercially viable SMR nuclear plant*" (my emphasis).[606]

42. In 2013, the Tennessee Valley Authority, one of the country's large utilities, signed a contract geared toward "deploying up to four mPower SMR reactors."[607]

---

[601] Clifford, "Sam Altman Explains Why He's Helping to Take Nuclear Microreactor Company Oklo Public via SPAC."
[602] Ivana Naumovska, "The SPAC Bubble Is About to Burst," *Harvard Business Review*, February 18, 2021, https://hbr.org/2021/02/the-spac-bubble-is-about-to-burst.
[603] Thomas J. Krysa, Brooke D. Clarkson, and Adrian L. Jensen, "SEC Signals Enhanced Scrutiny of SPAC Transactions," *Foley & Lardner LLP*, April 2, 2021, https://www.foley.com/en/insights/publications/2021/04/sec-signals-enhanced-scrutiny-of-spac-transactions.
[604] B&W, "History of Power Production," Babcock & Wilcox, 2023, https://www.babcock.com/home/about/corporate/history/.
[605] Jeff McMahon, "Small Modular Nuclear Reactors By 2022 -- But No Market For Them," *Forbes*, May 23, 2012, http://www.forbes.com/sites/jeffmcmahon/2012/05/23/small-modular-reactors-by-2022-but-no-market-for-them/.
[606] Anonymous, "Growing Backing for Small Reactors," *Power Engineering International*, May 22, 2013, http://www.powerengineeringint.com/articles/print/volume-21/issue-5/features/growing-backing-for-small-reactors.html.
[607] BWXT, "B&W, TVA Sign Contract for Clinch River mPower Construction Permit," BWX Technologies, February 20, 2013, http://www.bwxt.com/news/2013/02/20/BW-TVA-Sign-Contract-for-Clinch-River-mPower-Construction-Permit.

43. The *New York Times* described the company as being "in the lead" in the race to develop SMRs, in part because it had the Energy Department and the Tennessee Valley Authority "in its camp."[608]

44. By 2014, Babcock & Wilcox had to admit that neither was forthcoming.[609]

45. A subsequent attempt to involve a partner firm, Bechtel Corporation, also ended in failure, and by 2017, Babcock & Wilcox had essentially abandoned the mPower project.[610]

46. According to nuclear enthusiast Rod Adams, Babcock & Wilcox spent "about $400 million" on the failed mPower project.[611]

47. In 2015, NuScale finally managed to reach an agreement with the Utah Associated Municipal Power Systems (UAMPS), a collection of small publicly owned municipal utilities in Utah, California, Idaho, Nevada, New Mexico, and Wyoming, to set up a power plant.[612]

48. In February 2018, UAMPS estimated that the then 720-megawatt project would cost about $4.2 billion.[613]

49. By 2020, that cost estimate had increased to $6.1 billion.[614]

50. The cost increase drove a number of UAMPS members to pull out of the project.[615]

---

[608] Matthew L. Wald, "Deal Advances Development of a Smaller Nuclear Reactor," *The New York Times*, February 20, 2013, http://www.nytimes.com/2013/02/21/business/tva-and-babcock-wilcox-in-nuclear-reactor-deal.html.
[609] Jason Ruiter, "Babcock & Wilcox Cuts Investment in mPower," NewsAdvance.com, April 14, 2014, http://www.newsadvance.com/news/local/babcock-wilcox-cuts-investment-in-mpower/article_d7998d52-c3d3-11e3-8fbb-0017a43b2370.html.
[610] Will Davis, "mPower Consortium Halts Project," *ANS Nuclear Cafe* (blog), March 16, 2017, http://ansnuclearcafe.org/2017/03/16/mpower-consortium-halts-project/.
[611] Rod Adams, "Bechtel And BWXT Quietly Terminate mPower Reactor Project," *Forbes* (blog), March 13, 2017, http://www.forbes.com/sites/rodadams/2017/03/13/bechtel-and-bwxt-quietly-terminate-mpower-reactor-project/.
[612] Douglas O. Hunter, "First U.S. Small Modular Reactor Inches Ahead," *EnergyBiz Magazine*, Fall 2015, https://energycentral.com/c/um/first-us-small-modular-reactor-inches-ahead.
[613] UAMPS, "Utah Associated Municipal Power Systems, Carbon Free Power Project, Budget & Plan of Finance, [January 11, 2018]" (City Council Meeting, Price City, Utah, February 28, 2018), https://www.utah.gov/pmn/files/374243.pdf.
[614] UAMPS, "Amended Budget & Plan of Finance" (Los Alamos: Utah Associated Municipal Power Systems, July 14, 2020), https://losalamos.legistar.com/LegislationDetail.aspx?ID=4614617&GUID=80F3BB19-BE25-49F0-88CB-2B226422A101&Options=&Search=; Ramana, "Eyes Wide Shut: Problems with the Utah Associated Municipal Power Systems Proposal to Construct NuScale Small Modular Nuclear Reactors."
[615] Sonal Patel, "Shakeup for 720-Mw Nuclear SMR Project as More Cities Withdraw Participation," *Power Magazine*, October 29, 2020, https://www.powermag.com/shakeup-for-720-mw-nuclear-smr-project-as-more-cities-withdraw-participation/; Patel, "NuScale Boosts SMR Module Capacity; UAMPS Mulls Downsizing Nuclear Project."

51. By January 2023, the cost estimate went up even further, to an eye-popping $9.3 billion for just 462 megawatts of power capacity.[616]

52. Finally, in November 2023, UAMPS and NuScale terminated the project because of insufficient interest.[617]

53. Back in 2008, when NuScale was incorporated as a company, its leading officials announced that one of its plants "could be producing electricity by 2015–16." [618]

54. In January 2023, NuScale expected that the first reactor will start producing power in 2029.[619]

55. NuScale also went public using the SPAC route by merging with Spring Valley Acquisition.[620]

56. Prospects for growth seemed bad enough that the company's chief financial officer and chief technical officer and other insiders sold $4.5 million worth of stocks in the summer of 2023.[621]

57. These so-called economies of scale are often touted by the nuclear industry: when South Carolina Electric & Gas Company made its case for building two AP1000 reactors, it pointed to Westinghouse developing the AP1000 design by applying "economies of scale to the AP600 design to reduce the cost per kW."[622]

58. Tony Roulstone, a nuclear engineer who has worked at the UK Atomic Energy Administration and Rolls Royce for decades, explains that the key idea is "to transfer

---

[616] UAMPS, "Talking Points," County of Los Alamos - Meeting of Board of Public Utilities on 1/11/2023 at 5:30 PM, January 2, 2023, https://losalamos.legistar.com/MeetingDetail.aspx?ID=1064272&GUID=89C48D4F-F0CE-42D1-B04D-4719B2EE31E5&Options=info|&Search=.

[617] UAMPS and NuScale, "Utah Associated Municipal Power Systems (UAMPS) and NuScale Power Agree to Terminate the Carbon Free Power Project (CFPP)," *Business Wire*, November 8, 2023, https://www.businesswire.com/news/home/20231108847712/en/Utah-Associated-Municipal-Power-Systems-UAMPS-and-NuScale-Power-Agree-to-Terminate-the-Carbon-Free-Power-Project-CFPP.

[618] Paul Lorenzini and Jose N. Reyes, "Power Plant Design - Compact and Bijou: A New Approach to Design," *Nuclear Engineering International*, October 2, 2008.

[619] UAMPS, "Talking Points."

[620] Elizabeth McCarthy, "NuScale Makes Public Debut but Requires 'a Lot of Financing' to Launch Small Nuclear Reactor in 2029," *Utility Dive*, June 1, 2022, https://www.utilitydive.com/news/nuscale-makes-public-debut-but-requires-a-lot-of-financing-to-launch-smal/624568/.

[621] Simply Wall St, "Shareholders Can't Ignore US$4.5m Of Sales By NuScale Power Insiders," July 12, 2023, https://simplywall.st/stocks/us/capital-goods/nyse-smr/nuscale-power/news/shareholders-cant-ignore-us45m-of-sales-by-nuscale-power-ins; GuruFocus, "CFO Chris Colbert Sells 89,786 Shares of NuScale Power Corp (SMR)," June 27, 2023, https://www.gurufocus.com/news/2029412/cfo-chris-colbert-sells-89786-shares-of-nuscale-power-corp-smr.

[622] SCE&G, "Combined Application for Certificate of Environmental Compatibility Public Convenience Compatibility, Public Convenience and Necessity and for a Base Load Review Order" (Columbia, South Carolina: Public Service Commission of South Carolina, May 30, 2008), https://dms.psc.sc.gov/Attachments/Matter/3b3e3e6f-f48a-a3c5-50c13f96cfdba604.

much of the complex construction work from site to factory conditions" because "productivity is much higher" in factories.[623]

59. When it started marketing the AP1000 and AP600 reactors, Westinghouse promised that it would reduce cost and the time taken to build these reactors by utilizing "modular construction techniques." [624]

60. Jill Clelland, a lead manager at Westinghouse, promised that the reactor could be built in "36 months."[625]

61. As discussed in chapter 2, reactor construction costs rose, not fell, as utilities built more reactors.[626]

62. Energy analyst Arjun Makhijani has highlighted the problem of recalls, the underbelly of mass manufacturing, as he put it.[627]

63. In 1961, the air force program was terminated, after it had spent more than $1 billion; as President Kennedy explained, "achieving a militarily useful aircraft" was not possible in the foreseeable future.[628]

64. During its launch in 1959, officials described the Savannah as "potentially the greatest revolution in maritime history."[629]

65. *Savannah* has been relegated to storage "in a remote corner of Baltimore Harbor" according to an April 2023 *National Geographic* article.[630]

66. The PM-3A reactor at McMurdo Sound in Antarctica, for example, developed "several malfunctions, including leaks in its primary system [and] cracks in the containment vessel," according to the official history of the army's nuclear power program.[631]

---

[623] Tony Roulstone, "How to Make Nuclear Power Affordable," *Modern Power Systems*, January 11, 2018, https://www.modernpowersystems.com/features/featurehow-to-make-nuclear-power-affordable-6024809/.
[624] W.E. Cummins, M.M. Corletti, and T.L. Schulz, "Westinghouse AP1000 Advanced Passive Plant," in *Proceedings of ICAPP 2003* (2003 International Congress on Advances in Nuclear Power Plants, Cordoba, Spain, 2003), http://toc.proceedings.com/34881webtoc.pdf.
[625] Jill Clelland, "A Resurgence in Commercial Nuclear Power," *Insight*, Summer 2006, 3.
[626] Grubler, "The French Pressurised Water Reactor Programme"; Jonathan G Koomey and Nathan E Hultman, "A Reactor-Level Analysis of Busbar Costs for US Nuclear Plants, 1970–2005," *Energy Policy* 35 (2007): 5630–42.
[627] Makhijani, "Light Water Designs of Small Modular Reactors: Facts and Analysis," 7–8.
[628] John F. Kennedy, "Special Message to the Congress on the Defense Budget," The American Presidency Project, March 28, 1961, https://www.presidency.ucsb.edu/documents/special-message-the-congress-the-defense-budget.
[629] William L. Laurence, "Savannah Will Develop Technology for Future Nuclear Ship Development," *New York Times*, July 26, 1959.
[630] Bill Newcott, "This Ship Was Supposed to Usher in an Age of Nuclear-Powered Travel," *National Geographic*, April 5, 2023, https://www.nationalgeographic.com/history/article/nuclear-ship-savannah-atoms-for-peace.
[631] Lawrence H. Suid, *The Army's Nuclear Power Program: The Evolution of a Support Agency* (New York: Praeger, 1990), 111.

67. Even as these military-funded efforts spluttered, the US Atomic Energy Commission funded the construction of several small power reactors, which were, at least in the eyes of the commission, suitable for use in rural areas and for foreign export.[632]

68. A December 1956 advertisement from its operator dubbed it "Rural America's First Atomic Power Plant."[633]

69. Its spokesperson told the Chicago Tribune in December 1971 that it didn't want "to spend the money, especially since the reactor has not been too economical because it is too small," adding that the reactor had produced power at twice the cost of power from coal-fired plants.[634]

70. The trend continues—several such units have been permanently shut down in recent years.[635]

71. Even nuclear power enthusiasts acknowledge that smaller nuclear plants "tend to be unprofitable more often than do large ones."[636]

72. It is also easy to be hopelessly wrong. Shortly after the first commercial nuclear power plant in the United States at Shippingport, Pennsylvania, started functioning, John Gray, the manager of the team that built the plant, presented their experience with that plant at the 1958 Atomic Industrial Forum meeting.[637]

73. That's because these reactor designs all benefitted from the US Department of Energy's Advanced Light Water Reactor Program initiated in the 1980s.[638]

74. That program aimed to "restore nuclear power as a viable option" in the 1990s, by producing "improved and simplified" reactor designs that were to be "economically

---

[632] Wendy Allen, "Nuclear Reactors for Generating Electricity: U.S. Development from 1946 to 1963" (Santa Monica: RAND Corporation, June 1977), 54.
[633] Rural Cooperative Power Association, "Electrical Engineer," *The Billings County Pioneer*, December 13, 1956, https://news.google.com/newspapers?nid=2132&dat=19561213&id=LfNkAAAAIBAJ&sjid=zoQNAAAAIBAJ&pg=2955,274639&hl=en.
[634] Casey Bukro, "AEC Will Dismantle Elk River Reactor," *Chicago Tribune*, December 29, 1971.
[635] Matthew L. Wald, "Nuclear Plants, Old and Uncompetitive, Are Closing Earlier than Expected," *The New York Times*, June 14, 2013, http://www.nytimes.com/2013/06/15/business/energy-environment/aging-nuclear-plants-are-closing-but-for-economic-reasons.html; Matthew Bandyk, "UBS Analysts: Longterm Contracted Nuclear Plants Also at Risk of Shutdown," *SNL Financial*, June 24, 2016.
[636] Steve Clemmer et al., "The Nuclear Power Dilemma: Declining Profits, Plant Closures, and the Threat of Rising Carbon Emissions" (Cambridge, MA: Union of Concerned Scientists, November 2018), 28.
[637] John W. Simpson, *Nuclear Power from Underseas to Outer Space* (La Grange Park, Ill: American Nuclear Society, 1994), 111.
[638] OTA, "Nuclear Power in an Age of Uncertainty"; A. Yu Gagarinski et al., "Advanced Light-Water Reactor: Russian Approaches," *IAEA Bulletin* 34, no. 2 (1992): 37–40; NRC, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs" (Washington, D.C.: Nuclear Regulatory Commission, April 2, 1993).

attractive, and constructable on a predictable and reasonable schedule," an official from the DOE told the 1990 American Power Conference.[639]

75. Perhaps the most prominent example of this variety of reactor is designed by X-energy, which describes itself as a "leading developer" of SMRs, offering "a Generation-IV reactor technology with a proven operational pedigree."[640]

76. The idea of high-temperature gas-cooled reactors dates back to 1944, even before the bombing of Hiroshima and Nagasaki, when Farrington Daniels proposed a "high temperature pebble pile" to produce plutonium for nuclear weapons.[641]

77. When it enters the reactor core, the reactivity of the system goes up because the water slows down neutrons.[642]

78. A standard measure of performance called load factor for the four commercial high-temperature gas-cooled reactors range from a maximum of 62 percent for the AVR in Germany to an abysmal 15.2 percent for the Fort St. Vrain reactor in the United States.[643]

79. Construction of the reactor started in September 1968 and the reactor reached criticality in January 1974, but its performance was so erratic that its owners waited for over five years before declaring it to be operating commercially.[644]

80. There was also a major safety problem with its control rods whose function is to regulate the rate at which fission reactions occur in the reactor.[645]

81. In 1988, the plant's owners decided to shut it down, telling the New York Times that despite their efforts, "it seldom runs."[646]

---

[639] F. A. Ross, "U. S. Department of Energy Advanced Light Water Reactor Program," *Proceedings of the American Power Conference* 52 (January 1, 1990), https://www.osti.gov/biblio/6081972.
[640] "Our Reactor," X-energy, June 12, 2023, https://x-energy.com/reactors/xe-100.
[641] F. Daniels, "Suggestions for a High-Temperature Pebble Pile"" (Chicago, U.S.A.: Metallurgical Laboratory, University of Chicago, October 25, 1944).
[642] J Wolters et al., "The Significance of Water Ingress Accidents in Small HTRs," *Nuclear Engineering and Design* 109, no. 1–2 (1988): 289–94; Rainer Moormann, "A Safety Re-Evaluation of the AVR Pebble Bed Reactor Operation and Its Consequences for Future HTR Concepts" (Jülich, Germany: Berichte des Forschungszentrums, 2008).
[643] IAEA, "Power Reactor Information System (PRIS) Database," n.d., http://www.iaea.org/programmes/a2/.
[644] IAEA.
[645] ORNL, "Fort Saint Vrain Gas Cooled Reactor Operational Experience" (Washington, D. C.: Nuclear Regulatory Commission, 2003).
[646] Matthew L. Wald, "Safest Reactor Is Closing Because It Rarely Runs," *The New York Times*, December 8, 1988.

82. The HTR-PM, China's demonstration high-temperature reactor, was to have been built between 2007 and 2010.[647]

83. At that time, officials predicted starting operations within "50 months." [648]

84. Instead, the HTR-PM took ten years to reach full power, and, in the first few months after reaching full power, operated with a load factor of around 10 percent.[649]

85. Hansen has written about fast neutron reactors in glowing terms in his book *Storms of my Grandchildren.*[650]

86. For his part, Bill Gates has funded a company (TerraPower) and raved about these reactor designs often—for example, during a 2021 CBS interview.[651]

87. There is a long history of such accidents starting with the 1955 partial core meltdown of the EBR-1 in Idaho, and the devastating accident in 1966 at the Fermi-1 demonstration fast reactor near Detroit, Michigan (see chapter 1).[652]

88. A particular concern with fast reactors are the so-called core disruptive accidents, where the core heats up, assumes a more critical configuration, and blows itself apart—a possibility first explored in 1956 by the Nobel Prize–winning physicist Hans Bethe.[653]

89. Plans for building the PFBR commenced in the early 1980s, after a quarter century of dreaming about breeder reactors.[654]

90. The reactor has been delayed repeatedly and the company building it claims it will start operating in 2024.[655]

---

[647] Zuoyi Zhang et al., "Design of Chinese Modular High-Temperature Gas-Cooled Reactor HTR-PM," in *2nd International Topical Meeting on High Temperature Reactor Technology*, 2004; Spencer Reiss, "Let a Thousand Reactors Bloom," *Wired Magazine*, September 1, 2004, https://www.wired.com/2004/09/china-5/.
[648] David Dalton, "China Begins Construction Of First Generation IV HTR-PM Unit," *NucNet* (blog), January 7, 2013, http://www.nucnet.org/all-the-news/2013/01/07/china-begins-construction-of-first-generation-iv-htr-pm-unit.
[649] Schneider and Froggatt, "The World Nuclear Industry Status Report 2023."
[650] James E. Hansen, *Storms of My Grandchildren: The Truth about the Coming Climate Catastrophe and Our Last Chance to Save Humanity* (New York: Bloomsbury USA, 2009).
[651] Anderson Cooper, "Bill Gates: How the World Can Avoid a Climate Disaster," *CBS: 60 Minutes*, February 15, 2021, https://www.cbsnews.com/news/bill-gates-climate-change-disaster-60-minutes-2021-02-14/.
[652] Fuller, *We Almost Lost Detroit*.
[653] Hans A Bethe and J. H Tait, "An Estimate of the Order of Magnitude of the Explosion When the Core of a Fast Reactor Collapses" (Harwell: United Kingdom Atomic Energy Agency, 1956).
[654] Ramana, *The Power of Promise: Examining Nuclear Energy in India*.
[655] Schneider and Froggatt, "The World Nuclear Industry Status Report 2023."

91. Countries around the world have pursued building such reactors, and the International Panel on Fissile Materials estimated the total spending at "tens of billions of dollars" in its 2010 report.[656]

92. A 2018 review from the US Idaho National Laboratory could recommend only that "a systematic development program be initiated."[657]

93. Even the US Atomic Energy Commission, which had funded the Oak Ridge reactor and related research for nearly two decades, raised difficult questions about the technology in a devastating 1972 report.[658]

94. Numerous technological challenges remain to be overcome, concluded a 2015 report from France's Institut de radioprotection et de sûreté nucléaire.[659]

95. As Edwin Lyman from the Union of Concerned Scientists explained in great detail in his comprehensive 2021 report, "advanced" isn't always better.[660]

96. Any such reactor would produce more plutonium for each unit of electricity generated; more importantly, spent fuel will contain a higher concentration of plutonium.[661]

97. A sodium-cooled fast reactor, as TerraPower and Bill Gates keep emphasizing, is not at any risk due to steam pressure building up, because it is cooled by sodium.[662]

98. Even in a very small microreactor (say, one that generates under ten megawatts of electricity), a severe accident can release enough radioactive materials to expose

---

[656] IPFM, "Fast Breeder Reactor Programs: History and Status," 6–7.
[657] R. N. Wright and T.L. Sham, "Status of Metallic Structural Materials for Molten Salt Reactors" (Idaho National Lab. (INL), Idaho Falls, ID (United States); Argonne National Lab. (ANL), Argonne, IL (United States), May 1, 2018), 21, https://doi.org/10.2172/1467482.
[658] AEC, "An Evaluation of the Molten Salt Breeder Reactor" (Washington, D. C.: Division of Reactor Development and Technology, US Atomic Energy Commission, September 1, 1972), https://doi.org/10.2172/4372873.
[659] IRSN, "Review of Generation IV Nuclear Energy Systems" (Paris: Institut de Radioprotection et de Sûreté Nucléaire, April 27, 2015), 140, http://www.irsn.fr/EN/newsroom/News/Pages/20150427_Generation-IV-nuclear-energy-systems-safety-potential-overview.aspx.
[660] Lyman, "'Advanced' Isn't Always Better: Assessing the Safety, Security, and Environmental Impacts of Non-Light-Water Nuclear Reactors."
[661] Glaser, Hopkins, and Ramana, "Resource Requirements and Proliferation Risks Associated with Small Modular Reactors."
[662] Catherine Clifford, "How Bill Gates' Company TerraPower Is Building next-Generation Nuclear Power," *CNBC*, April 8, 2021, https://www.cnbc.com/2021/04/08/bill-gates-terrapower-is-building-next-generation-nuclear-power.html.

members of the public to significant radiation doses, according to calculations in an April 2020 report from the Idaho National Laboratory.[663]

99. On the one hand, they trivialize the problem. The Nuclear Energy Institute, for example, says "the entire amount of waste created in the United States would fill one football field, 10 yards deep".[664]

100. For example, a company called Moltex has received over $50 million in funding from Canada's federal government.[665]

101. The government justified the funding to help "reduce storage of nuclear waste."[666]

102. And Oklo, a company going public using the SPAC route in the United States, advertises its reactors as running "off nuclear waste."[667]

103. Because of their smaller size, small modular reactors would produce more wastes of different kinds relative to currently operating gigawatt-scale reactors when these two reactor designs are weighted by how much electrical energy they produce.[668]

104. Likewise, "advanced" reactor designs that are not cooled with water will necessarily involve materials that are more problematic to manage, as my colleague Allison Macfarlane and her former postdoc Lindsay Krall have argued.[669]

---

[663] Troy P. Reiss, "Evaluation of Microreactor Inhalation Dose Consequences" (Idaho Falls, Idaho, USA: Idaho National Laboratory, April 30, 2020), https://www.osti.gov/biblio/1616677-evaluation-microreactor-inhalation-dose-consequences.

[664] Hannah Hickman, "What Happens to Nuclear Waste in the U.S.?," *Nuclear Energy Institute* (blog), November 19, 2019, https://www.nei.org/news/2019/what-happens-nuclear-waste-us.

[665] Jacques Poitras, "Feds to Put Millions into Small Nuclear Reactor Development in N.B.," *CBC News*, March 18, 2021, https://www.cbc.ca/news/canada/new-brunswick/feds-millions-small-nuclear-reactors-1.5955274; Jacques Poitras, "Nuclear Energy Company Gets $20M Boost from Province, Higgs Says," *CBC News*, February 10, 2021.

[666] Innovation, Science and Economic Development Canada, "Government of Canada Invests in Research and Technology to Create Jobs and Produce Non-Emitting Energy," news releases, Government of Canada, March 18, 2021, https://www.canada.ca/en/innovation-science-economic-development/news/2021/03/government-of-canada-invests-in-research-and-technology-to-create-jobs-and-produce-non-emitting-energy.html.

[667] Catherine Clifford, "Oklo Has Plan to Make Nuclear Reactors That Run Off Nuclear Waste," *CNBC*, June 28, 2021, https://www.cnbc.com/2021/06/28/oklo-planning-nuclear-micro-reactors-that-run-off-nuclear-waste.html?&qsearchterm=Cochran%20jake.

[668] Lindsay Krall, Allison Macfarlane, and Rodney C. Ewing, "Nuclear Waste from Small Modular Reactors," *Proceedings of the National Academy of Sciences* 119, no. 23 (May 31, 2022): e2111833119, https://doi.org/10.1073/pnas.2111833119.

[669] Lindsay Krall and Allison MacFarlane, "Burning Waste or Playing with Fire? Waste Management Considerations for Non-Traditional Reactors," *Bulletin of the Atomic Scientists*, August 31, 2018, https://thebulletin.org/2018/08/burning-waste-or-playing-with-fire-waste-management-considerations-for-non-traditional-reactors/.

105. Practically any mixture of plutonium isotopes is usable in nuclear weapons.[670]

106. As discussed in chapter 5, in order to operate reactors, the thorium has to be converted into uranium-233, and nuclear weapons can be made with uranium-233 just as well as they can utilize plutonium.[671]

107. The first vision involved the claim that new nuclear reactors would produce "energy with perfect reliability and complete safety," and the second vision posited that these machines would "deliver clean and plentiful electricity in a carbon constrained future."[672]

108. These are extraordinary claims and, as such, need extraordinary evidence to render them credible.[673]

109. For example, a 2019 article published by the Canadian Broadcasting Corporation about the nuclear industry's pitch that SMRs could make "Alberta's oilsands cleaner" announces: "The reactors *are* cheaper, can be built out of standardized units created in factory and assembled on site" (my emphasis).[674]

110. In a 2001 article in Insight, Jill Clelland, a lead manager at Westinghouse Electric, described how the company utilized computer-based tools—developed using public funding at a public university—to execute a "virtual construction project."[675]

111. As Clelland explained, "Visualization offers tremendous sales potential."[676]

112. The NRC explained that Oklo had "repeatedly failed to provide substantive information in response to NRC staff requests for additional information … on the maximum credible accident … for the Aurora design" and "the safety classification of structures, systems, and components."[677]

113. The Nuclear Innovation Alliance, a think tank, told CNBC that "the decision was a disappointment and a sign of outdated regulatory processes" adding the wishful claim

---

[670] J. Carson Mark, "Explosive Properties of Reactor-Grade Plutonium," *Science and Global Security* 4, no. 1 (1993): 111–24; DoE, "Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives."
[671] Kang and Von Hippel, "U-232 and the Proliferation Resistance of U-233 in Spent Fuel."
[672] Sovacool and Ramana, "Back to the Future: Small Modular Reactors, Nuclear Fantasies, and Symbolic Convergence," 104.
[673] Carl Sagan, *Broca's Brain: Reflections on the Romance of Science* (New York: Random House, 2011), 73.
[674] Sarah Rieger, "Small Nuclear Reactors Could Make Alberta's Oilsands Cleaner, Industry Experts Suggest," *CBC*, May 21, 2019, https://www.cbc.ca/news/canada/calgary/nuclear-power-oilsands-1.5142864.
[675] Jill Clelland, "Cutting Construction Costs," *Insight*, 2001.
[676] Clelland.
[677] NRC, "Subject: Oklo Inc. - Denial of the Aurora Combined Operating License Application for Failure to Supply Information," Nuclear Regulatory Commission, January 6, 2022, https://www.nrc.gov/docs/ML2135/ML21357A034.pdf.

that advanced "reactors are expected to be safer than any reactors to date and should be able to meet NRC's standards."[678]

114. Back in 2016, Jacob DeWitte, Oklo's CEO, told the US Senate's Committee on Energy and Natural Resources: "The regulatory process as it exists today is not well suited for these new technologies and the venture finance models that fund them."[679]

115. Speaking to *CoinDesk*, Ed Lyman from the Union of Concerned Scientists explained that Oklo, and some other new reactor companies, "just want the NRC to accept the reactor is going to be safer" and "essentially let them do whatever they want."[680]

116. In an interview with Y Combinator, the venture capital organization, DeWitte explained that "the receptiveness to what we were doing was so different out in Silicon Valley than it was on the East Coast. On the East Coast, we'd often be met with skepticism, people asking, 'Is that safe? How is that possible?' Out here, it was like, 'How can I help?'"[681]

117. The guide's proposals for energy policy include: "Stop the regulation of greenhouse gases" and "Overhaul nuclear energy regulation."[682]

118. Finally, there are nuclear boosters like Ted Nordhaus (see chapter 5), a signatory of the Ecomodernist Manifesto, who denounced the Nuclear Regulatory Commission for "the decline of the legacy nuclear industry" in an April 2023 article with Adam Stein in *Foreign Policy*.[683]

119. More recently, the 2019 Nuclear Energy Innovation and Modernization Act signed by former president Donald Trump forces the NRC to "reform" its fee structure and "develop a streamlined licensing process for advanced reactor designs."[684]

---

[678] Catherine Clifford, "Feds Deny Oklo's Application to Build an Advanced Nuclear Reactor in Idaho," *CNBC*, January 7, 2022, https://www.cnbc.com/2022/01/07/federal-regulators-deny-oklos-application-to-build-a-reactor-in-idaho.html.
[679] Jacob DeWitte, "Written Testimony Before the Committee on Energy and Natural Resources United States Senate," Status of Advanced Nuclear Reactor Technologies, May 17, 2016, https://www.energy.senate.gov/services/files/3BA637BA-6A6C-4DF9-9C7F-A0A2BBF8D8E0.
[680] DiCamillo, "Bitcoin Mining Firm Compass Inks Deal With Nuclear Microreactor Company Oklo."
[681] "Oklo's Jacob DeWitte on Building a Nuclear Reactor People Want," *Y Combinator* (blog), March 2, 2016, https://blog.ycombinator.com/jacob-dewitte-oklo-interview/.
[682] "Solutions," The Heritage Foundation, 2021, https://www.heritage.org/solutions.
[683] Ted Nordhaus and Adam Stein, "Will Washington Halt the Global Renaissance of Nuclear Power?," *Foreign Policy*, April 8, 2023.
[684] DOE, "President Trump Signs Bill to Modernize NRC Regulation," Office of Nuclear Energy, U.S. Department of Energy, January 30, 2019, https://www.energy.gov/ne/articles/president-trump-signs-bill-modernize-nrc-regulation.

120. “Reform” and “streamline” are code words—the nuclear industry and its friends are forcing the NRC to reduce its questioning and charge companies less, thus weakening its capacity to regulate.[685]

121. Terrestrial’s list of advisors features people like Stephen Harper, former prime minister of Canada; Ernest Moniz, former US secretary of energy; Ray Johnson, former chief technological officer for Lockheed Martin; Lord John Browne, former CEO of BP; Ray Rothrock, the venture capitalist mentioned earlier; and Robert Litterman, former head of risk at Goldman Sachs.[686]

122. Likewise, Moltex’s Advisory Committee includes representatives of the three corporations that operate nuclear power plants in Canada: Brett Plummer, vice president of nuclear and chief nuclear officer of NB Power; Dominique Minière, president of nuclear of Ontario Power Generation; and Mike Rencheck, president and CEO of Bruce Power.[687]

123. Instead, their actions are better described by what Walter Bagehot, editor of the *Economist*, wrote about the South Sea Bubble of the early eighteenth century: “At particular times a great many stupid people have a great deal of stupid money.”[688]

124. Elon Musk’s many predictions about Tesla’s self-driving cars and robotaxis are an example.[689]

125. The greater peril resulting from this phenomenon is the propensity of this “new generation of storytellers,” as Nicole Aschoff aptly describes them in her 2015 book *The New Prophets of Capital*, “to tell us what’s wrong with society and how to fix it.”[690]

126. As venture capitalist Ray Rothrock told the US Department of Energy’s Office of Nuclear Energy, even in the case of a risky project, “a great story” increases the confidence of the investor.[691]

---

[685] For a fascinating exploration of such inflitration into our vocabularies, see John Patrick Leary, *Keywords: The New Language of Capitalism* (Haymarket Books, 2019).
[686] Terrestrial, “Advisors,” Terrestrial Energy, 2023, https://www.terrestrialenergy.com/our-team/advisors/.
[687] Moltex, “Governance,” Moltex Energy, 2023, https://www.moltexenergy.com/governance/.
[688] Walter Bagehot, *Literary Studies*, ed. Richard Holt Hutton (London: Longmans, Green and Company, 1891), 2.
[689] Andrew J. Hawkins, “Here Are Elon Musk’s Wildest Predictions about Tesla’s Self-Driving Cars,” *The Verge*, April 22, 2019, https://www.theverge.com/2019/4/22/18510828/tesla-elon-musk-autonomy-day-investor-comments-self-driving-cars-predictions.
[690] Nicole Aschoff, *The New Prophets of Capital* (London ; Brooklyn, NY: Verso, 2015), 9–12.
[691] Office of Nuclear Energy, “Meeting Minutes” (Nuclear Energy Advisory Committee Meeting, Arlington, VA, July 9, 2018), https://www.energy.gov/ne/articles/neac-meeting-july-9-2018.

127. Speaking to CNBC about going public using the SPAC route, Sam Altman, CEO of OpenAI, explained how "the future can be radically better" provided one could "lower the cost of energy and lower the cost of intelligence."[692]

128. We really don't want that,' referring to the philosophy that restricting production, consumption and energy use is a way to conserve natural resources. 'I think it's insane and pretty immoral when people start calling for that.'"[693]

Conclusion

1. *when they don't know what to say and have completely given up on the play just like a finger they lift the machine and the spectators are satisfied.* Antiphanes[694]

2. Planning for Vogtle-3 and Vogtle-4 reactors started in 2005, during the heyday of what was promised to be a nuclear renaissance, and the first of these units began operating in 2023.[695]

3. Nuclear plants are better suited to baseload generation than to load following, as using them in the latter mode has technical and economic implications.[696]

4. One indication of the changing nature of the electricity market is the increasingly common occurrence of negative price bids on the energy spot market.[697]

5. Thomas Kuhn discussed the key challenge in such a transition in *The Structure of Scientific Revolutions (1962)*: those trained in one paradigm—energy planners in this case—find it very difficult to think outside that paradigm.[698]

---

[692] Clifford, "Sam Altman Explains Why He's Helping to Take Nuclear Microreactor Company Oklo Public via SPAC."
[693] Clifford.
[694] Francis M. Dunn, *Tragedy's End: Closure and Innovation in Euripidean Drama* (New York and Oxford: Oxford University Press, 1996), 27.
[695] Stanley Dunlap, "State Regulators to Hear Plant Vogtle Progress Report after Nuclear Expansion Stalls Again," *Georgia Recorder*, July 24, 2023, http://thecurrentga.org/2023/07/24/state-regulators-to-hear-plant-vogtle-progress-report-after-nuclear-expansion-stalls-again/.
[696] NEA, "Technical and Economic Aspects of Load Following with Nuclear Power Plants" (Paris: Nuclear Energy Agency, OECD and International Atomic Energy Agency, 2011); Jonas Persson et al., "Additional Costs for Load-Following Nuclear Power Plants: Experiences from Swedish, Finnish, German, and French Nuclear Power Plants" (Stockholm: Elforsk, 2012).
[697] Oleksandr Prokhorov and Dina Dreisbach, "The Impact of Renewables on the Incidents of Negative Prices in the Energy Spot Markets," *Energy Policy* 167 (August 1, 2022): 113073, https://doi.org/10.1016/j.enpol.2022.113073; Marco Nicolosi, "Wind Power Integration and Power System Flexibility-An Empirical Analysis of Extreme Events in Germany under the New Negative Price Regime," *Energy Policy* 38, no. 11 (2010): 7257–68, https://doi.org/10.1016/j.enpol.2010.08.002.
[698] Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago, U.S.A.: University of Chicago Press, 1962).

6. One can start by remembering that even during earlier decades, when there was little or no solar and wind power being produced, grid managers had to contend with variations in the supply of electricity.[699]

7. French nuclear plants were, on average, shut down for 96.2 days, 115.4 days, 103.8 days, and 152 days in 2019, 2020, 2021, and 2022.[700]

8. Unanticipated shutdowns will become more common as the frequency of climate change–linked extreme weather events increases.[701]

9. For example, in his 2016 study of a renewable energy system for the state of Maryland, energy analyst Arjun Makhijani highlighted the seasonal balance between solar energy (plentiful in summer, but not in winter) and offshore wind energy (more plentiful in winter).[702]

10. The second approach is to change the patterns of electricity demand.[703]

11. In October 2023, for example, the state of California announced that it had installed more than 6,600 megawatts of battery energy storage systems, up from 770 megawatts in 2019.[704]

12. The demand for these materials leads, in part, to the exploitation of miners in the Congo and the contamination of water in South America.[705]

13. How renewables impact people in countries like the Congo is completely predictable in light of what I have described earlier about how the communities most often subject to the environmental and public health impacts of the nuclear industry are politically weak, economically poor, and geographically far from the corridors of power.[706]

---

[699] Lovins and Ramana, "Three Myths About Renewable Energy and the Grid, Debunked."
[700] Schneider and Froggatt, "The World Nuclear Industry Status Report 2022," 83.
[701] Ahmad, "Increase in Frequency of Nuclear Power Outages Due to Changing Climate"; Ahmad, Covatariu, and Ramana, "A Stormy Future?"
[702] Arjun Makhijani, "Prosperous, Renewable Maryland: Roadmap for a Healthy, Economical, and Equitable Energy Future" (Takoma Park: Institute for Energy and Environmental Research, November 2016), 74, https://ieer.org/resource/energy-issues/prosperous-renewable-maryland-2016/.
[703] Amory B. Lovins, "Reliably Integrating Variable Renewables: Moving Grid Flexibility Resources from Models to Results," *The Electricity Journal* 30, no. 10 (December 1, 2017): 58–63, https://doi.org/10.1016/j.tej.2017.11.006.
[704] CEC, "California Sees Unprecedented Growth in Energy Storage, A Key Component in the State's Clean Energy Transition," California Energy Commission, October 24, 2023, https://www.energy.ca.gov/news/2023-10/california-sees-unprecedented-growth-energy-storage-key-component-states-clean.
[705] See for example, Siddharth Kara, *Cobalt Red: How the Blood of the Congo Powers Our Lives* (New York: St. Martin's Press, 2023); and Amit Katwala, "The Spiralling Environmental Cost of Our Lithium Battery Addiction," *Wired*, May 5, 2018, https://www.wired.co.uk/article/lithium-batteries-environment-impact.
[706] Ulrich Brand and Markus Wissen, *The Imperial Mode of Living: Everyday Life and the Ecological Crisis of Capitalism* (London ; New York: Verso, 2021); Martin Arboleda, *Planetary Mine: Territories of Extraction under*

14. At the risk of simplifying a vast literature, decoupling of carbon dioxide emissions from economic growth does not seem to be happening at a global scale, certainly not at a rate that is relevant to climate mitigation.[707]

15. The problem was well characterized by the cultural critic Fredric Jameson when he wrote on the pages of *New Left Review* in 2003: "Someone once said that it is easier to imagine the end of the world than to imagine the end of capitalism."[708]

Late Capitalism (London ; New York: Verso, 2020); Klein, *This Changes Everything*; Park and Sovacool, "The Contested Politics of the Asian Atom."

[707] Tim Jackson, *Prosperity without Growth: Foundations for the Economy of Tomorrow*, 2nd Edition (Abingdon, Oxon ; New York, NY: Routledge, 2017), https://www.routledge.com/Prosperity-without-Growth-Foundations-for-the-Economy-of-Tomorrow-2nd/Jackson/p/book/9781138935419; Jason Hickel and Giorgos Kallis, "Is Green Growth Possible?," *New Political Economy* 25, no. 4 (June 6, 2020): 469–86, https://doi.org/10.1080/13563467.2019.1598964; Dominik Wiedenhofer et al., "A Systematic Review of the Evidence on Decoupling of GDP, Resource Use and GHG Emissions, Part I: Bibliometric and Conceptual Mapping," *Environmental Research Letters* 15, no. 6 (2020), https://doi.org/10.1088/1748-9326/ab8429; Helmut Haberl et al., "A Systematic Review of the Evidence on Decoupling of GDP, Resource Use and GHG Emissions, Part II: Synthesizing the Insights," *Environmental Research Letters* 15, no. 6 (June 2020): 065003, https://doi.org/10.1088/1748-9326/ab842a.

[708] Fredric Jameson, "Future City," *New Left Review*, June 2003, https://newleftreview.org/issues/II21/articles/fredric-jameson-future-city; see also Mark Fisher, *Capitalist Realism: Is There No Alternative?* (Winchester, UK Washington, USA: Zero Books, 2009).