Atoms for Peace or Atoms for Destruction:

America's Relationship with Nuclear Energy

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Why Nuclear?

My ultimate goal is that in the year 2045, 100 years after the detonation of the first atomic bomb and the birth of the nuclear age, the world will evaluate the role played by nuclear technologies and conclude that their overall impact was strongly positive.

- Senator Pete Domenici[1]

In post-World War II America, nuclear energy and technology were considered cutting-edge and futuristic. Like much of the optimism of the post-war era, the promise of nuclear power forecasted a future that many political leaders and the populace embraced: one of American ingenuity, boundless growth, and ceaseless imagination. On December 8, 1953, President Dwight D. Eisenhower delivered his "Atoms for Peace" speech to the United Nations General Assembly, remarking that nuclear technology was more than a weapon of mass destruction: it could bring peace through affordable and plentiful energy. Eisenhower presented nuclear energy as the "greatest of destructive forces that can be developed into a great boon for the benefit of all mankind."[2] The former general understood the public's skepticism of nuclear weapons and wanted to assuage their concerns by reframing a technology intended for mass destruction as a way to produce limitless and affordable energy.[3] The desire for an inexpensive power source to support a rapidly expanding country, combined with the nuclear arms race, fueled America's atomic age.

In 1954, Atomic Energy Commission Chairman Lewis Strauss famously envisioned that nuclear power would be "too cheap to meter."[4] In an address to a group of science writers,

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[1] Pete V. Domenici, Blythe J. Lyons, and Julian J. Steyn, *A Brighter Tomorrow: Fulfilling the Promise of Nuclear Energy* (Lanham, MD: Rowman & Littlefield, 2006), 3.
[2] Dwight D. Eisenhower, "Atoms for Peace" (speech, United Nations, December 8, 1953), International Atomic Energy Agency, https://www.iaea.org/about/history/atoms-for-peace-speech.
[3] Jesse Hicks , "Atoms for Peace: The Mixed Legacy of Eisenhower's Nuclear Gambit," Science History Institute (Science History Institute, August 6, 2019), https://www.sciencehistory.org/distillations/atoms-for-peace-the-mixed-legacy-of-eisenhowers-nuclear-gambit.
[4] Lewis L. Strauss, "Remarks for Delivery at the Founders' Day Dinner" (speech, New York, New York, September 16, 1954), Nuclear Regulatory Commission, https://www.nrc.gov/docs/ML1613/ML16131A120.pdf.

Chairman Strauss posited that atomic energy would be the cornerstone of affordable and abundant electricity throughout the U.S. His vision (shared in President Eisenhower's *Atoms for Peace*) was that:

> It is not too much to expect that our children will enjoy in their homes electrical energy too cheap to meter, --will know of great periodic regional famines in the world only as matters of history, -- will travel effortlessly over the seas and under them and through the air with a minimum of danger and at great speeds, -- and will experience a lifespan far longer than ours, as disease yields and man comes to understand what causes him to age. This is the forecast for an age of peace.[5]

Strauss' age of peace was rooted more in optimism than reality: he later clarified that his utopian vision was more likely to come to fruition by his "children's, children's, children."[6] Yet, following Strauss' reasoning and envisioned timeline, today's youth should be the ones enjoying nuclear-powered electricity that is too cheap to meter. Unfortunately for Strauss's vision anyway, this future has not been realized.

Nevertheless, a nuclear utopia was not limited to political leaders and scientists: it was written into the cultural fabric of the age. Walt Disney himself jumped on the pro-nuclear bandwagon: he devoted an episode of "Tomorrowland" to nuclear energy and published a read-along book entitled "Our Friend the Atom" in January 1957.[7] In these works, Disney created an

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[5] Ibid.

[6] "'Too Cheap to Meter': A History of the Phrase," U.S. NRC (Nuclear Regulatory Commission, September 24, 2021), https://www.nrc.gov/reading-rm/basic-ref/students/history-101/too-cheap-to-meter.html.

[7] David de Caires Watson, "Will Surprising UN Findings Reignite Optimism for Nuclear Power?," Medium (The Kernel, December 1, 2021), https://medium.com/generation-atomic/will-surprising-un-findings-reignite-optimism-for-nuclear-power-d0b9d84a5bf7.

"atomic Genie" capable of creating a nearly endless energy source if he was tamed inside a nuclear reactor (see Figure 1). The atomic Genie, a metaphor for atomic energy, offered:

> I give you the magic fire of the atom…an almost endless source of heat…Here we are, burning up our coal and oil only to produce power. But now we have a new source of power: clean, silent, plentiful.[8]

The three wishes for the atomic genie—safe power, food and health, and global peace—characterized America's midcentury optimism: they demonstrate the dreams of a unified if improbable future.[9] Walt Disney attempted to sell the public on the merits of nuclear energy, just as Eisenhower persuaded the UN and Strauss a group of prominent science reporters. The creator of Tomorrowland believed in an atomic energy-powered future, and even attempted to power Disneyworld with its own nuclear reactor before his death in 1966.[10]

[8] Ibid.
[9] Heinz Haber and Walt Disney, *Our Friend the Atom* (New York, NY: Golden Press, 1956), 9.
[10] Ibid.

Figure 1: The atomic genie. Based off of the "classic" genie mythology, it represented the untapped potential of nuclear energy and the need to "tame" it by building nuclear reactors. Source: "Our Friend, the Atom."

Contrasting and conflicting with such optimism, environmental destruction and decimation proved to be salient arguments against this initial wave of pro-nuclear messaging. Against the nuclear optimism of many mid-century proponents, a wave of skepticism and protest arose. While the anti-nuclear movement began as opposition to nuclear weapons, a planned nuclear power plant in Bodega Bay (near San Francisco, California) met strong opposition from the Sierra Club due to its proximity to fisheries and the San Andreas Fault.[11] Opposition coalesced around fears that if the reactor malfunctioned or was damaged by an earthquake, it could decimate a major city and alter Sonoma County's beautiful landscapes. Following a prolonged controversy, the Bodega Bay plans were scrapped in 1964.[12] Since its origins, the anti-

[11] Thomas Raymond Wellock, *Critical Masses: Opposition to Nuclear Power in California, 1958-1978* (Madison, WI: The University of Wisconsin Press, 1998), 27-28.
[12] Wellock, *Critical Masses*, 28.

nuclear power debate has centered around the possibility of death and environmental destruction. These fears have been fueled by real disasters: the scare from the 1979 Three Mile Island accident, casualties from the 1986 Chernobyl disaster, and the 2011 disaster at the Fukushima-Daiichi plant caused hundreds of thousands of people to evacuate and the meltdown in Chernobyl created an area unsafe for human habitation for over three thousand years.[13] The combination of these three events provided political validation for anti-nuclear activists and tainted pro-nuclear arguments. Despite these concerns, the promise of nuclear energy is inherently complex: it is capable of producing a nearly limitless amount of energy yet also able to destroy swathes of countryside and cities.

Today's political leadership and young adults are saddled with a difficult choice. Americans and other economically advanced countries enjoy unprecedented luxury: careful temperature regulation in our homes, cross-country air travel, and exotic foods sourced from around the world. To maintain this lifestyle, people have become reliant on carbon-emitting fossil fuels, setting the stage for increased carbon in our atmosphere that warms our climate and causes a wide range of environmental concerns.

Climate change, a consequence of greenhouse gas emissions, is causing accelerated global sea level rise, extreme weather patterns, and temperature increases that threaten communities across the nation and world.[14] A leading source of this unfolding environmental catastrophe is carbon-based energy production. According to the U.S. Energy Information Administration, fossil fuel combustion in accounted for 73 percent of total greenhouse gas

[13] Robyn White, "Chernobyl Aftermath: How Long Will Exclusion Zone Be Uninhabitable?," Newsweek (Newsweek, October 14, 2022), https://www.newsweek.com/chernobyl-aftermath-how-long-will-exclusion-zone-uninhabitable-1751834.
[14] "The Effects of Climate Change," NASA (National Aeronautics and Space Administration, November 11, 2022), https://climate.nasa.gov/effects/.

emissions in America in 2020.[15] These anthropogenic carbon emissions, which stem from fossil fuel-based energy production, are deepening the climate crisis and threatening natural resources and livelihoods.[16] In the United States, the record low water levels at Lake Mead, Nevada threaten Hoover Dam's ability to generate electricity and the water supply for much of Nevada, California, Colorado, and Arizona, which would impact over 30 million Americans in these states.[17] Climate change and today's level of greenhouse gas emissions pose serious threats to our way of life. However, changing our energy portfolio may provide avenues away from such destruction.

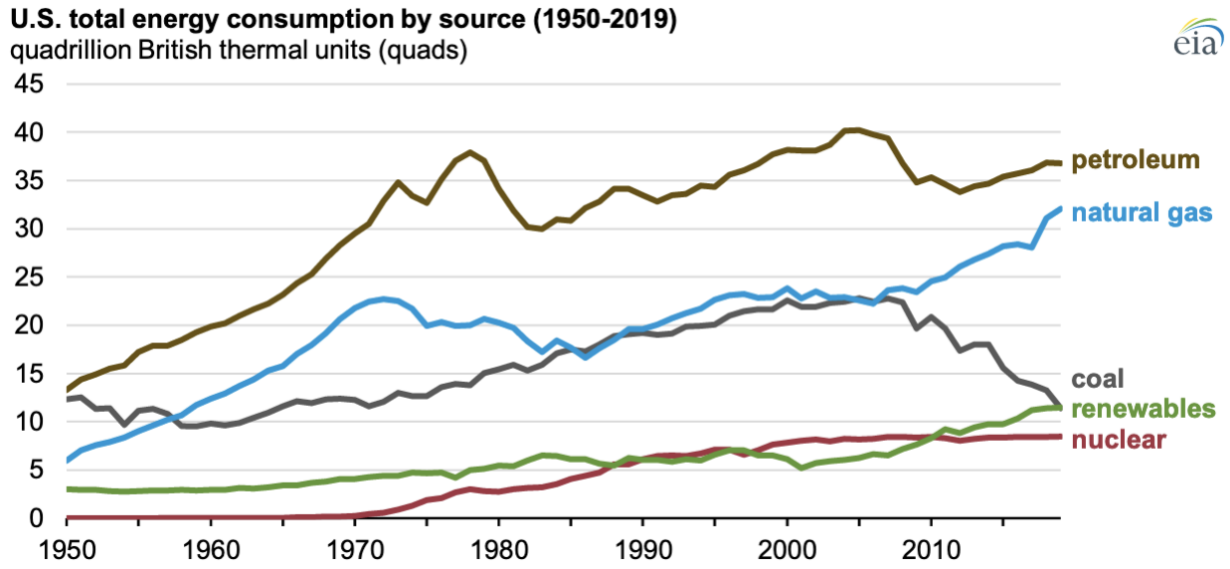

Figure 2: Energy consumption in the United States by energy source. The U.S. continues to consume more energy, although not at the same rate as in the 1960s, 1970s, and 1980s. Source: U.S. Energy Information Administration.

[15] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis," Where greenhouse gases come from - U.S. Energy Information Administration (EIA), June 24, 2022, https://www.eia.gov/energyexplained/energy-and-the-environment/where-greenhouse-gases-come-from.php.
[16] Ibid.
[17] "Water Level Dropping at Lake Mead, NV/AZ, USA: Global Warming Effects," Climate Hot Map (Union of Concerned Scientists, 2011), https://www.climatehotmap.org/global-warming-locations/lake-mead-nv-az-usa.html.

In the last four decades, federal and state-level policymakers have looked to renewable sources like wind, hydroelectric, and solar to provide clean and carbon-neutral energy.[18] Yet, despite the promise of renewables and alternative sources of energy, the drawback of these important sources is their energy capacity factor.[19] A capacity factor is a method of measuring how often a plant operates at maximum power, or how often it is producing energy. According to the Department of Energy, a plant with a "capacity factor of 100 percent means it's producing power all of the time."[20] In sum, they do not produce enough clean energy constantly to compete with fossil fuels.[21] Nuclear energy, on the other hand, produces a significant amount of energy that can allow the world to enjoy the comfortable lifestyle that many are accustomed to (see Figure 4, which examines New York's nuclear energy generation compared to other energy sources). According to the U.S. Energy Information Agency, nuclear power has a capacity factor of 92.5 percent, but wind energy's capacity factor is only 35.5 percent (see Figure 3).[22] In other words, forecasted capacities for alternative sources of clean energy are inadequate to meet current and foreseeable energy consumption levels: clean energy, for all its promise, is insufficient to meet the modern world's energy demands. Humans face an energy trap: reduce our energy consumption or watch climate change grow ever worse or identify an abundant source of clean energy production that allows us to live in a style that much of the world has come to expect. Civilization as we know it is in the balance.

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[18] Ronald Brownstein, "The Green-Energy Culture Wars in Red States," The Atlantic (Atlantic Media Company, March 30, 2022), https://www.theatlantic.com/politics/archive/2022/03/republican-fossil-fuels-renewable-energy/629420/.
[19] "What Is Generation Capacity?," Office of Nuclear Energy (U.S. Department of Energy, May 1, 2020), https://www.energy.gov/ne/articles/what-generation-capacity.
[20] Ibid.
[21] Ibid.
[22] Ibid.

Enter nuclear power, and the puzzle our energy trap presents: if nuclear power is a promising solution to global warming, why is it that in the United States we have not seen more nuclear power plants being built? Answers to this question lie in a combination of factors and their interplay in the American political system. In essence, poor public perception, effective anti-nuclear advocacy, and an arcane regulatory environment combine to make nuclear power plants too expensive to build. To try to understand the politics of nuclear energy, why we don't rely more heavily on nuclear power in the face of growing climate change, and whether nuclear truly does hold promise as a solution to the environmental crisis, this paper will examine how public opinion, the energy industry and special interest groups, and the cost and regulatory environment, against a backdrop of the high expense involved with building new nuclear power plants, pose potential setbacks to this once seemingly auspicious energy source.

Within American politics, the ongoing nuclear energy debate is demonstrative of a larger political theoretical proposition: policymakers are paralyzed by public opinion and bureaucracy is often an inefficient means of enacting safe yet flexible regulations. In our lives, the nuclear power conundrum (and solving climate change writ large) presents an even greater paradox. We engage in a globalized world with international air travel, abundant and internationally sourced food, and instant online shopping, yet many of the same innovations of the past two centuries that have dramatically improved the quality of our lives have also contributed greatly to climate change. Can technological advancements like nuclear energy provide pathways toward a greener future that offers a similar quality of life? Or are we doomed to an inevitable decline because of the competing motivations of environmental protection and ceaseless consumerism? The path toward a climate-friendly and prosperous future is riddled with difficult choices.

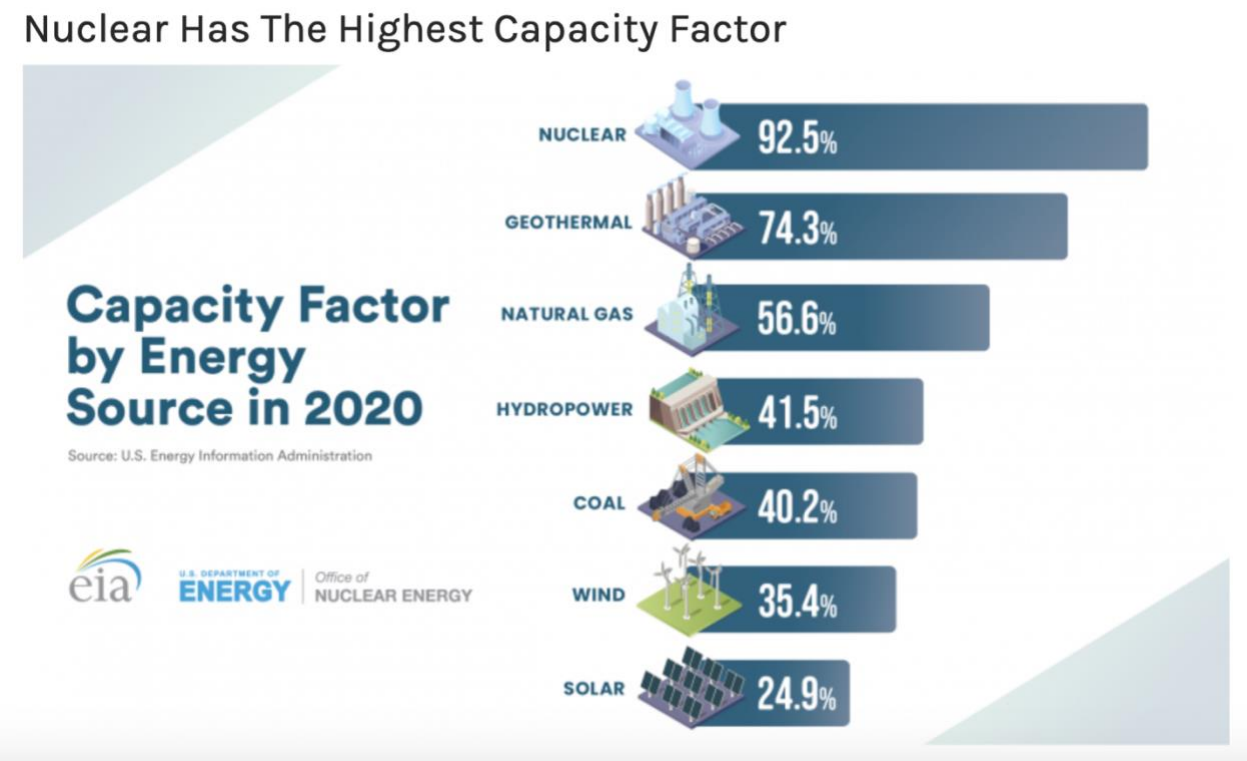

Figure 3: Nuclear power has the highest energy capacity factor out of renewable, nonrenewable, and alternative energy sources. Source: U.S. Energy Information Administration.

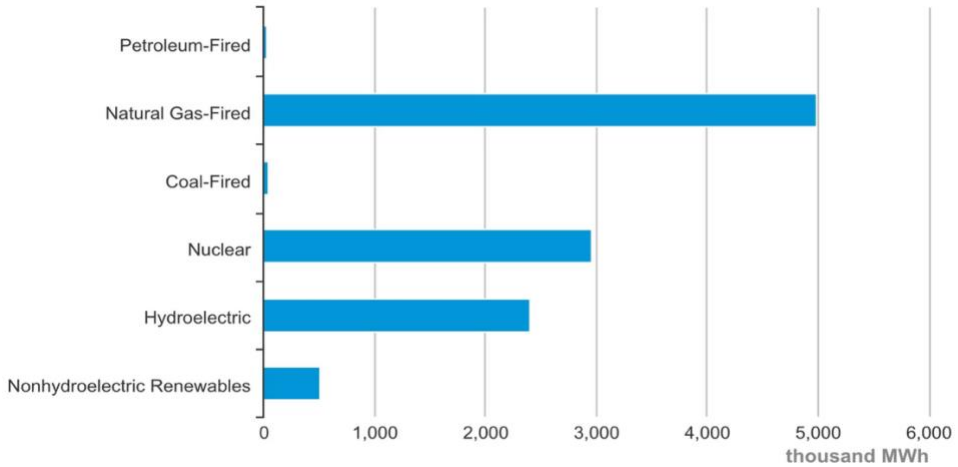

Figure 4: Nuclear energy produces a nearly limitless supply of energy, especially when compared to other energy sources. Using New York state as a guide, this figure demonstrates the large amount of energy generated by nuclear reactors despite being a relatively small piece of their energy portfolio. Source: Energy Information Administration, Electric Power Monthly.

America's Relationship with Nuclear Energy

Nuclear Energy History and Usage, From Weaponry to Energy

Nuclear power is a direct result of WWII technological advances. The nuclear fission technology developed during the Los Alamos, New Mexico based Manhattan Project was a natural fit to a growing post-war America: it produced the high amounts of energy needed for a booming population and increasing material abundance. It was the dawn of the atomic age, and Presidents Truman and Eisenhower wholeheartedly embraced this new energy source. The Atomic Energy Commission (AEC), a legacy of the Atomic Energy Act of 1946, was initially tasked with nuclear weapons development and production. However, President Eisenhower viewed the AEC as more than a defense program.

Eisenhower hoped that the nuclear energy regulated by the AEC would offer vast amounts of energy at affordable rates for a growing nation. Initially, his hopes were realized: America built many reactors in the years preceding the Cuban Missile Crisis (when the Soviet Union and United States nearly descended into nuclear war). However, concerns regarding nuclear proliferation, and fears of nuclear war and devastation signaled the beginning of the end of the atomic age. By the time of the Three Mile Island accident in 1979, nuclear energy had been set aside. The energy crisis of the 1970s was in full swing, and expensive and dangerous nuclear reactors were part of an extinguished American vision. In response to Three Mile Island, then-chairman of the House Interior Committee (the forerunner to today's House Natural Resources Committee) Morris Udall (D-AZ-2) remarked that "I'm not sure nuclear power can survive any more events of this kind." For the next few decades, the high capacity factor of nuclear energy—an argument used in the 1950s and today—received little press. The wide-eyed atomic-era optimism had dimmed to pessimism and doubt.

As American (and global) energy consumption increases, we need a clean form of energy to satisfy this demand. Despite a shift from the optimism of the mid-century "atomic age," nuclear power remains an important energy source. In today's context, atomic energy produces a significant amount of energy for a growing world. Approximately 20 percent of American commercial electricity comes from nuclear power. A current total of 93 functioning American reactors produce 95,492 megawatts (MW), enough to power nearly sixteen million homes.[23] In 2013 through 2019, annual nuclear generation capacity and electricity generation increased each year (except in 2017), even as reactors were decommissioned. This increase stems from power plant modifications (uprates) to increase capacity, allowing for the entire operating nuclear reactor fleet to maintain a relatively consistent total electricity generation capacity. These uprates, combined with high-capacity utilization rates helped nuclear power plants maintain a consistent share of about one-fifth of total annual U.S. electricity generation from 1990 through 2021.[24]

Nuclear power generates nearly 800 billion kilowatt hours (KWh) annually, producing more than half of the nation's carbon emissions-free electricity.[25] A standard nuclear reactor produces 1 KWh of electricity. Because of nuclear energy's high capacity factor of 92.5 percent (meaning that they are at maximum power production 92.5 percent of the year), one reactor cannot be replaced by a coal or renewable plant that also produces 1 KWh. Additionally, 1 nuclear reactor produces as much energy as 3-4 similarly sized solar, coal, or wind-powered facilities. In terms of climate-change inducing emissions, this means that atomic energy

[23] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis," U.S. nuclear industry - U.S. Energy Information Administration (EIA) (U.S. Energy Information Administration , April 18, 2022), https://www.eia.gov/energyexplained/nuclear/us-nuclear-industry.php.
[24] Ibid.
[25] "5 Fast Facts about Nuclear Energy," Office of Nuclear Energy (U.S. Department of Nuclear Energy, March 23, 2021), https://www.energy.gov/ne/articles/5-fast-facts-about-nuclear-energy.

production avoids approximately 470 million metric tons of carbon released into the atmosphere each year, or, according to one estimate, the equivalent of removing 100 million cars off the road.[26]

Critically, nuclear power does not produce carbon emissions while operating.[27] This is not to say that there are not carbon-related impacts of nuclear energy: mining for uranium and building reactors can emit carbon, and refining uranium poses other environmental concerns.[28] Figure 6 illustrates the carbon advantages of nuclear power: over the course of a reactor's life, nuclear produces approximately the same amount of carbon dioxide-equivalent emissions per unit of electricity as wind, and one-third of the emissions per unit of electricity when compared with solar.[29] Furthermore, Figure 7 offers several models of achieving a low carbon energy footprint by illustrating different combinations of energy sources and their emissions and capacity. When situated within the context of alternative energy, wind, hydroelectric, and solar alone are insufficient: we need nuclear to fill the gap.

However, nuclear energy creates radioactive waste. This waste presents unique challenges: it is difficult and expensive to safely store. Currently, over 90,000 metric tons of highly radioactive waste is stored near nuclear reactors in the United States.[30] The majority of this waste has not been permanently disposed of and waits in temporary storage containers at

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[26] "Climate," Nuclear Energy Institute (Nuclear Energy Institute), accessed February 3, 2023, https://www.nei.org/advantages/climate.
[27] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis," Nuclear power and the environment (U.S. Energy Information Administration, November 7, 2022), https://www.eia.gov/energyexplained/nuclear/nuclear-power-and-the-environment.php.
[28] Doug Brugge and Rob Goble, "The History of Uranium Mining and the Navajo People," *American Journal of Public Health* 92, no. 9 (March 4, 2002): pp. 1410-1419, https://doi.org/10.2105/ajph.92.9.1410.
[29] "World Nuclear Association," Nuclear energy and climate change (World Nuclear Association), accessed February 3, 2023, https://world-nuclear.org/nuclear-essentials/how-can-nuclear-combat-climate-change.aspx.
[30] Mitch Jacoby, "As Nuclear Waste Piles up, Scientists Seek the Best Long-Term Storage Solutions," Chemical and Engineering News (American Chemical Society, March 30, 2020), https://cen.acs.org/environment/pollution/nuclear-waste-pilesscientists-seek-best/98/i12.

nuclear power plants because no permanent geological repository has been finished.[31] The most well-known facility, Yucca Mountain, has been a lightning rod in Nevadan and national politics.[32] The concerns regarding the long-term storage of nuclear waste include degradation of the storage casks and leaking radioactive material into the environment, potentially exposing humans to toxic chemicals and contaminating the aquifers.[33] Permanent storage of spent fuel rods requires the waste to be safely stored for thousands of years. Dry cask storage, where spent fuel rods are bundled and placed into concrete and stainless steels containers, known as casks. While this method is secure in the short run, some scientists have expressed concerns that corrosion could reduce the efficacy of these casks and release harmful material.[34] Regardless of one's support for nuclear power, nuclear waste poses serious drawbacks to nuclear energy.

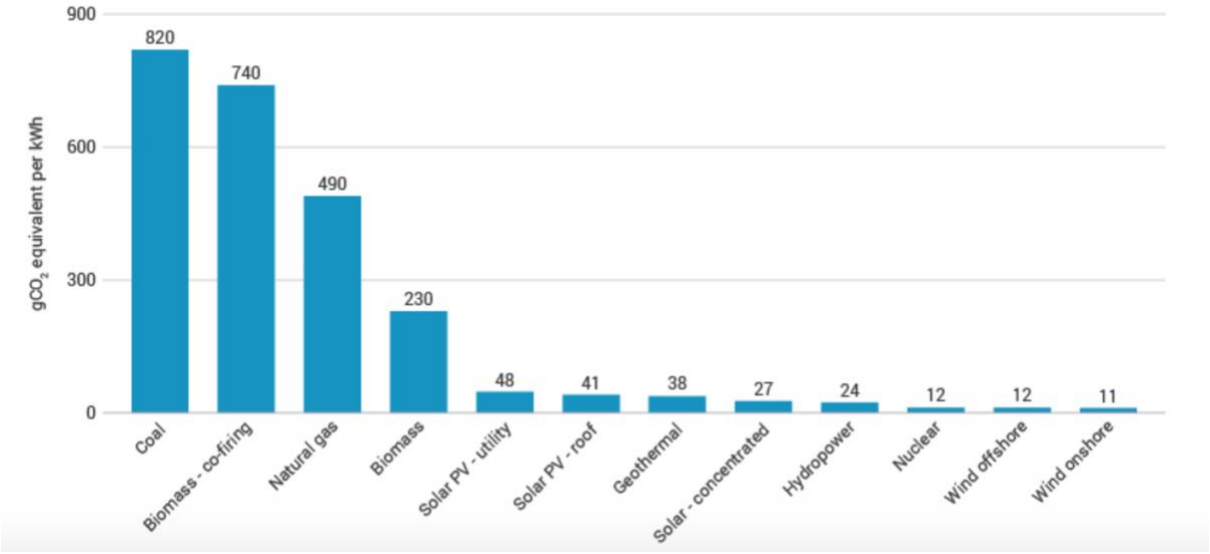

Figure 4: Nuclear power produces nearly the same amount of carbon dioxide-equivalent emissions per unit of electricity as wind, and one-third of the emissions per unit of electricity when compared with solar. Source: World Nuclear Organization.

[31] Ibid.
[32] Ibid.
[33] Ibid.
[34] Ibid.

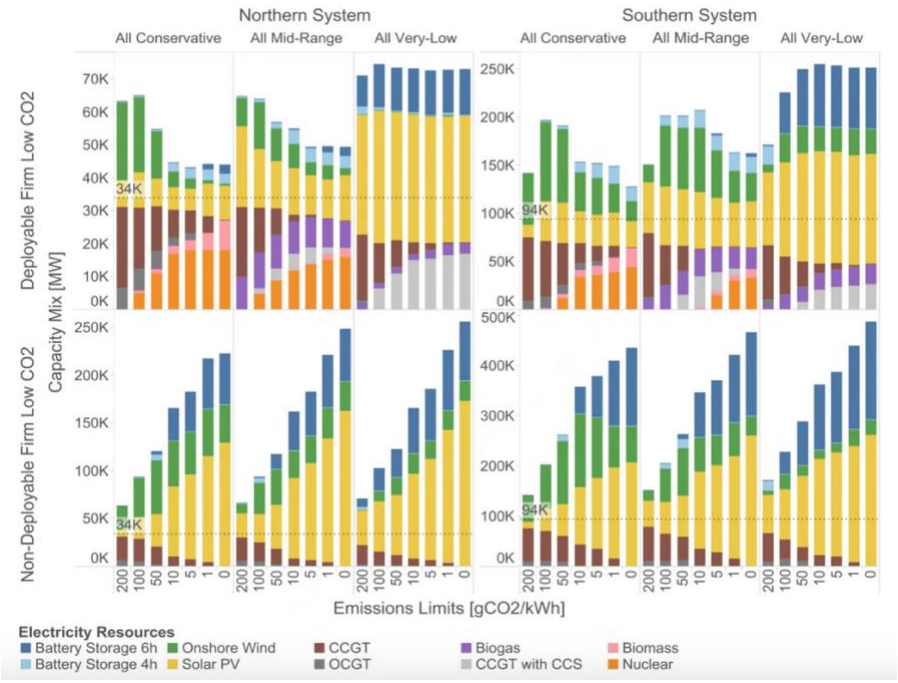

Figure 7: This figure compares emissions, battery resources, and energy sources. Least cost capacity mix for different carbon emission limits. In most models, least-cost decarbonization involves more than solar and wind. Source: The Role of Firm Low-Carbon Electricity Resources in Deep Decarbonization of Power Generation.

In the United States, the battle against climate change has been defined by a circular and often solution-less conversation about energy. The environmental movement of the 1960s and the energy crisis of the 1970s spurred interest away from traditional fossil fuels and toward renewable energy sources like solar and wind.[35] Classrooms, political debates, legislation, and press releases today tout the importance of such sources in fighting global warming and reducing greenhouse gas emissions.[36] Absent from many of these energy discussions is nuclear power.

A consequence of WWII era weapons-making, nuclear energy suffers from guilt by association. Nuclear weapons devastated the Japanese cities of Hiroshima and Nagasaki and were a key tenet of the Cold War superpower rivalry that fueled anxieties over this new

[35] Mark Fiege and Thomas Raymond Wellock, "Critical Masses: Opposition to Nuclear Power in California, 1958-1978," *The American Historical Review* 105, no. 4 (2000): p. 1349, https://doi.org/10.2307/2651508.
[36] Christina Nunez, "Renewable Energy, Facts and Information," National Geographic: Environment (National Geographic, May 3, 2021), https://www.nationalgeographic.com/environment/article/renewable-energy.

technology.[37] Fears of a detonated atomic bomb, built with the same scientific principles as a nuclear power plant, were characterized by historian Paul Boyer as "one of those categories of Being, like Space and Time, that, according to Kant, are built into of the very structure of our minds, giving shape and meaning to all our perceptions."[38] Moreover, the partial meltdown at the Three Mile Island power plant near Harrisburg, Pennsylvania was a turning point in American nuclear development.[39] On March 28, 1979, the Three Mile Island reactor's water pumps failed, preventing an adequate supply of water from reaching the core and subsequently causing the core to overheat.[40] While nearby residents only received an average radiation dose of 1 millirem above normal (x-ray exposure is 6 millirem), the accident was a leading factor in the decline of public support for nuclear power.[41] Local opposition to nuclear power skyrocketed, and commensurate protective regulations increased in the ensuing debate.[42] Subsequently, no new reactors were approved until 2012.[43]

National political discussions have offered little by way of substantive energy policy discussion regarding nuclear energy. More specifically, they rarely feature nuclear power. In the

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[37] Daniel Immerwahr, "Forgetting the Apocalypse: Why Our Nuclear Fears Faded – and Why That's Dangerous," The Guardian (Guardian News and Media, May 12, 2022), https://www.theguardian.com/world/2022/may/12/forgetting-the-apocalypse-why-our-nuclear-fears-faded-and-why-thats-dangerous.
[38] Ibid.
[39] "GC Documents Archives," IAEA (International Atomic Energy Agency), accessed October 11, 2022, https://www.iaea.org/gc-archives/gc.
[40] "Climate," Nuclear Energy Institute (Nuclear Energy Institute), accessed February 3, 2023, https://www.nei.org/advantages/climate.
[41] "Three Mile Island | TMI 2 | Three Mile Island Accident," World Nuclear Association (World Nuclear Association, April 2022), https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/three-mile-island-accident.aspx.
[42] Jon Gertner, "Atomic Balm?," The New York Times (The New York Times, July 16, 2006), https://www.nytimes.com/2006/07/16/magazine/16nuclear.html.
[43] Cam Abernathy, "Nuclear Street - Nuclear Power Plant News, Jobs, and Careers," NRC Approves Vogtle Reactor Construction - First New Nuclear Plant Approval in 34 Years (With new plant photos) - News - Nuclear Power News - Nuclear Street - Nuclear Power Plant News, Jobs, and Careers, February 9, 2012, http://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2012/02/09/nrc-approves-vogtle-reactor-construction-_2d00_-first-new-nuclear-plant-approval-in-34-years-_2800_with-new-plant-photos_2900_-020902#.Y0Q1-1LMKEs.

1964 presidential race, President Lyndon Baines Johnson famously aired the "Daisy Girl" television ad which focused on a girl holding a daisy while a nuclear bomb exploded, accusing Republican nominee Barry Goldwater of wanting to incite nuclear warfare. While not strictly centered around nuclear energy, the controversial advertisement encapsulated fears of nuclear fallout, which some feared could be heightened by atomic energy.[44] On the other hand, in 1981, President Ronald Reagan spared a nuclear energy research funding cut despite slashing solar energy funding by 67 percent and environmental conservation by 75 percent.[45] But despite the president's support for nuclear power research, the U.S. did not witness a resurgence in nuclear energy under the Reagan administration. The Three Mile Island accident loomed large in the American psyche, and the 1986 Chernobyl disaster hardly assuaged the public's fears.[46]

Post-Cold War optimism and positive economic outlook of the 1990s did not result in a nuclear power resurgence. While President George H.W. Bush took steps to protect the environment by passing the Clean Air Act of 1990, he was mostly silent on nuclear energy.[47] His successor, President Bill Clinton, did not support closing existing reactors but was reticent about building new ones.[48] According to a 1993 report by the International Atomic Energy Agency, President Clinton did not want to promote nuclear power because he did not view them as "economically competitive" and believed that they were unpopular.[49] The report noted that the president's views on nuclear power were "firmly in the mainstream of current American public

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[44] Mark Fiege and Thomas Raymond Wellock, "Critical Masses: Opposition to Nuclear Power in California, 1958-1978," *The American Historical Review* 105, no. 4 (2000): p. 1349, https://doi.org/10.2307/2651508.
[45] https://www.nytimes.com/1981/10/09/opinion/nuclear-reaganomics.html
[46] Jon Gertner, "Atomic Balm?," The New York Times (The New York Times, July 16, 2006), https://www.nytimes.com/2006/07/16/magazine/16nuclear.html.
[47] Amaury Laporte, "Remembering George H.W. Bush, the 'Environmental President,'" EESI (Environmental and Energy Study Institute (EESI), November 5, 2018), https://www.eesi.org/articles/view/remembering-george-h.w.-bush-the-environmental-president.
[48] J.E. McCraken, *U.S. Energy Policy under President Clinton*, International Atomic Energy Agency, 1993, abstract.
[49] Ibid.

opinion" at the time.[50] While not staunchly against nuclear power, President Clinton allowed current reactors to remain online but did little to encourage nuclear power development. For all of the economic productivity and optimism during much of the 1990s, the last decade of the twentieth century did not see a revival in nuclear energy.

President George W. Bush supported protecting and expanding America's nuclear reactor fleet. In his second term, President Bush signed one of the most significant pieces of nuclear energy legislation: the Energy Policy Act of 2005. This bill, a product of four years of negotiations, authorized "stand-by support" for six new reactors.[51] This stand-by support would cover the full cost of delays for the first two new reactors–up to $500 million each–and 50 percent of the delay costs–up to $250 million–each for reactors three through six.[52] Additionally, the Energy Policy Act funded the Advanced Fuel Cycle Initiative, which would promote research and development of advanced reactors and safer methods of storing spent fuel.[53] The bill was well-researched and well-written, but did not result in an increase in new nuclear power plants.[54] Instead, the United States has continued to close its reactors, with 14 plants slated to close from 2013 to 2025.[55]

President Barack Obama's record on nuclear power is mixed. While the president openly championed an "all-of-the-above" energy policy and affirmed his support for nuclear, he remained mum on reactor closings and was reticent to support large increases in nuclear subsidies.[56] As with several recent American presidents, President Obama was mostly silent on

[50] Ibid.
[51] Energy Policy Act of 2005.
[52] Ibid.
[53] Ibid.
[54] Ahmed Abdulla , "The Demise of US Nuclear Power in 4 Charts," The Conversation (The Conversation U.S., September 13, 2022), https://theconversation.com/the-demise-of-us-nuclear-power-in-4-charts-98817.
[55] Ibid.
[56] Ibid.

nuclear energy and instead focused on nuclear proliferation (namely with the 2015 Iran Nuclear Deal). While the two issues are linked, the conversation on nuclear energy has remained fairly quiet.

While strongly supportive of increasing fossil fuel extraction, President Donald Trump also supported expanding nuclear energy production. In January 2019, President Trump signed S. 512, the Nuclear Energy Innovation and Modernization Act (NEIMA) into law.[57] This bipartisan piece of legislation provides greater transparency into the licensing process for new reactors and the NRC's budgeting procedures.[58] It also requires the NRC to develop a framework that encourages innovation in reactor design.[59] Inevitably, it will take many years to fully understand the consequences of this law. Ultimately, the U.S. did not see an increase in new reactors under the Trump administration, and Trump—showing unusual restraint—rarely introduced the subject.

This trend persisted in the 2020 presidential election. For instance, during a 2019 Democratic presidential primary town hall, most candidates remained silent on nuclear power despite the salience of climate change and energy costs to the nominating contest.[60] Senator Bernie Sanders (I-VT) was the only to offer an opinion, stating that he opposed renewing licenses for nuclear reactors. Later that year, Senator Elizabeth Warren (D-MA) reiterated that "we have to get the carbon out of the air and out of the water." She stated that "we need to keep

[57] "President Trump Signs Bipartisan Nuclear Energy Legislation into Law," U.S. Senate Committee on Environment and Public Works (U.S. Senate, January 14, 2019), https://www.epw.senate.gov/public/index.cfm/2019/1/president-trump-signs-bipartisan-nuclear-energy-legislation-into-law.
[58] Ibid.
[59] Ibid.
[60] David Roberts, "A Beginner's Guide to the Debate over Nuclear Power and Climate Change," Vox (Vox, September 6, 2019), https://www.vox.com/energy-and-environment/2019/9/6/20852313/december-democratic-debate-nuclear-power-energy.

some our nuclear in place" but vowed to "not build more nuclear."[61] Despite each candidate claiming that climate change posed an "existential threat" to the world, few delivered any policies regarding atomic energy.[62] Of the 2020 Democratic presidential candidates, only 7 supported expanding nuclear power. The remaining 19 candidates, including Pete Buttigieg and Joe Biden, did not support increasing the number of nuclear reactors or offered unclear responses.[63]

On the Republican side, the energy debate has leaned toward increased fossil fuel energy production and eschewing or denying the issue of climate change. In July 2022, Senator Joni Ernst (R-IA) blamed renewable energy for summer blackouts, remarking that "Biden blackouts' will make it impossible to run even fans and air conditioners on the hottest days of the summer."[64] More recently, however, Republicans have been more receptive to renewable and alternative energy than in previous years. In 2023, the House Natural Resources Committee, chaired by Rep. Bruce Westerman (R-AR-4), offered that Republicans "support an all-of the-above energy approach" encompassing energy sources such as "wind, solar, hydropower, nuclear, geothermal and biomass, along with clean coal and American-made oil and natural gas."[65]

Despite his lack of commitment during the campaign, President Biden's administration has taken steps to support nuclear power. On November 21, 2022, the White House announced that Diablo Canyon, the last online reactor in California, would receive the first round of funding

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[61] Ibid.
[62] Ibid.
[63] "Nuclear Power Plants: Where 2020 Democrats Stand," The Washington Post (WP Company, April 8, 2020), https://www.washingtonpost.com/graphics/politics/policy-2020/climate-change/nuclear-power/.
[64] Laura Benshoff, "Renewable Energy Is Maligned by Misinformation. It's a Distraction, Experts Say," NPR (National Public Radio, August 26, 2022), https://www.npr.org/2022/08/24/1110850169/misinformation-renewable-energy-gop-climate.
[65] "All-of-the-above Energy Approach," Committee on Natural Resources (Republican House Committee on Natural Resources), accessed February 3, 2023, https://naturalresources.house.gov/energy/default.aspx.

from the Civil Nuclear Credit Program (CNC).[66] The CNC, a product of the Bipartisan Infrastructure Law, is a $6 billion "strategic investment" designed to "preserve the existing U.S. nuclear power fleet."[67] This first round consisting of $1.1 billion is said to be "necessary if California is going to meet its ambitious clean energy goals while continuing to deliver reliable power," according to Senator Dianne Feinstein (D-CA).[68] Congressman Salud Carbajal (D-CA-24), who represents the Diablo Canyon facility in Congress, echoed these sentiments, claiming that supporting "the safe and temporary extension of the lifespan of Diablo Canyon" was essential in the face of a "deepening climate crisis."[69] While these steps do not mark a sea change in nuclear power policy and President Biden does not frequently promote nuclear power, his administration's policies indicate a new level of presidential support unseen since the Energy Policy Act of 2005. This support was echoed by Secretary of State Jennifer Granholm, who stated in 2021 that the United States "views nuclear energy as a pivotal technology in the global effort to lower emissions, expand economic opportunity, and ultimately combat climate change." US Climate Envoy John Kerry has been similarly supportive. "We don't get to net zero by 2050 without nuclear power in the mix." he told an audience recently. The green energy debate, once centered around wind and solar, is growing to include nuclear. But even if these signals from the Biden administration mark a substantial shift (it is too soon to tell), the history of nuclear power

[66] "Biden-Harris Administration Announces Major Investment to Preserve America's Clean Nuclear Energy Infrastructure," Energy.gov (U.S. Department of Energy, November 21, 2022), https://www.energy.gov/articles/biden-harris-administration-announces-major-investment-preserve-americas-clean-nuclear.
[67] "Civil Nuclear Credit Program," Energy.gov (U.S. Department of Energy), accessed December 15, 2022, https://www.energy.gov/gdo/civil-nuclear-credit-program.
[68] "Biden-Harris Administration Announces Major Investment to Preserve America's Clean Nuclear Energy Infrastructure," Energy.gov (U.S. Department of Energy, November 21, 2022), https://www.energy.gov/articles/biden-harris-administration-announces-major-investment-preserve-americas-clean-nuclear.
[69] Ibid.

development suggests a difficult political road ahead for the full potential of nuclear power to be unleashed, at the very least.

Research Question and Theory: Why is nuclear not on the table?

There are several approaches to unpacking the relative decline of nuclear power in the United States. These approaches introduce my research question: despite increasing concern for climate change, growing appetite for green energy, and new technological innovations, why are we not seeing a substantial increase in new American nuclear reactors? Answers to this question involve the role of public opinion, anti-nuclear special interest groups, the legal and regulatory environment, and the related exorbitant costs of building and operating nuclear reactors. The combination of low public opinion (an amalgam of so-called "not in my backyard" attitudes (NIMBYism), concerns over nuclear waste, and public interest in other energy sources), the anti-nuclear industry and lobbies, the complex legal and regulatory environment, and the subsequent the high cost of construction and operation have largely taken atomic energy out of the mainstream energy discussion and prevented the construction of new reactors. Public opinion appears to be the most important reason why the United States is not constructing additional nuclear power plants. American political institutions, especially Congress and the presidency, act in response to public opinion, where atomic energy is met with fear or ambivalence. In short, nuclear power is out of fashion in today's American energy lexicon.

Humans are their own worst enemies on the environment. We want it all—unlimited energy abundance, representative government that respects our wishes, and no nuclear power. This combination sets us on a difficult path, given our current carbon burn rates and the speed by which non-nuclear alternatives can keep up with our ever-growing modern energy demands. If

humans want to stave off our climate catastrophe, we will either need nuclear energy, the rapid advancement of some heretofore non-existent technology, or a radical reimagining of our consumption- and comfort-based lifestyles. If the latter two aren't possible and we find that nuclear is an essential component of a cleaner future, then we arrive at a tragic possibility that democracy is failing us: strong state intervention may be the only manner in which nuclear gets implemented; we either contradict our fundamental human nature, our core beliefs about democracy, or we watch the planet creep ever closer toward disaster.

Each reason—public opinion, lobbyists, regulations, costs—plays an important role in the dearth of new nuclear power plants in the United States. Politicians are—to one extent or another—motivated by public opinion and thus know that taking an openly pro-nuclear stance can cause public backlash. Moreover, a constituency's opposition toward building a new reactor in their community can force a representative's hand toward blocking such facility. Here, NIMBYism can push policymakers away from promoting and building nuclear power plants within their states or districts. If their electorate will not support a policy, an elected politician is unlikely to counter vehement opposition.[70]

Moreover, the energy and environmental industries and lobbies also play a role in preventing nuclear like reactors and their necessary waste storage facilities. Proposals like Yucca Mountain were killed (in part) by anti-nuclear lobbyists, and the Diablo Canyon reactor near San Luis Obispo, California, was saved at the eleventh hour from well-funded environmental opposition by Governor Gavin Newsom. Newsom cited concerns about increased carbon

[70] Peter Dizikes, "Giving the People What They Want?," MIT Political Science (Massachusetts Institute of Technology, February 21, 2021), https://polisci.mit.edu/news/2021/giving-people-what-they-want.

emissions that would result from decommissioning the aging power plant.[71] Nevertheless, the anti-nuclear interest groups remain key figures explaining the relative lack of American nuclear energy.

The labyrinthine legal and regulatory environment surrounding nuclear reactor construction is also viewed as a hindrance to building new power plants. The Nuclear Regulatory Commission's lengthy review process and Environmental Protection Agency's regulations make the approval process into a four to five year (even decade-long) prospect that is subject to appeal by outside parties.[72] These regulatory-induced delays increase construction costs and therefore make nuclear energy less palatable to utility companies. If the regulatory environment raises costs, the case for nuclear power becomes murkier and more tenuous.

Herein we see the basic rub of the nuclear power dilemma: nuclear energy holds tremendous potential as a solution to energy consumption needs and the climate crisis. While there are decidedly unique risks and hazards associated with nuclear power, risks are present in other forms of energy production as well. Politically, nuclear power has come in and out of favor in the decades since its inception. Atomic energy holds technological promise and yet is mired in political controversy. Let's unpack the politics of nuclear power that account for why we don't see more nuclear reactors put online.

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[71] Kavya Balaraman, "Clashes Brew over Diablo Canyon Extension Plan as 40 percent of Expected Renewables Fail to Come Online," Utility Dive (Industry Dive, August 29, 2022), https://www.utilitydive.com/news/diablo-canyon-nuclear-newsom-legislature/630661/.

[72] Matt Goldberg, "Unleashing Innovation: A Comparison of Regulatory Approval Processes ," Third Way (Third Way, April 13, 2016), https://www.thirdway.org/report/unleashing-innovation-a-comparison-of-regulatory-approval-processes.

Nuclear Energy Within Political Science

The Role of Public Opinion and Not In My Backyard Syndrome

For one answer to the question of why we don't see more nuclear power plants in the United States, we can look to political scientists like Richard Fenno, David Mayhew, and Beth Leech and apply their findings to the case of nuclear energy. In what has become a maxim in political science, David Mayhew stated that members of Congress are "single-minded seekers of reelection."[73] The threat of losing re-election often forces members Congress to avoid controversial policies that may be "good." A key component of this conundrum is the fact that members of Congress are national policymakers but local representatives.[74] Not only do federal lawmakers have national parties with a prescribed party platform, but they must also balance their party's ideology with that of their constituency. This duality translates to votes that may not promote the national public good but may be popular with a member's constituency.

Members of Congress face several internal and external motivations. For political scientist Richard Fenno, the combination of a desire to be re-elected, the importance of maintaining power, and the push to draft "good" public policy often serve as conflicting incentives.[75] To always prioritize re-election, a representative may trim her sails according to the passing winds of public opinion and potentially forgo unpopular yet potentially effective policies. David Mayhew expands upon Fenno's theory, stating that winning reelection is the "proximate goal" for members of Congress because it is the goal that must be "achieved over and over again if the other ends are to be entertained."[76] These "other ends" are maintaining power

[73] David R. Mayhew, *Congress: The Electoral Connection* (New Haven, CT: Yale University Press, 1974), 16.
[74] Matt Glassman, "Why Congress Doesn't Always Do the Right Thing," The New York Times (The New York Times, February 7, 2018), https://www.nytimes.com/2018/02/07/opinion/congress-incentives-public-good.html.
[75] Fenno, *Congressmen and Committees*, 1995.
[76] Mayhew, *The Electoral Connection*, 16.

and enacting "good" policy—Mayhew directly pulls these concepts from Fenno. However, some members of Congress can make themselves "safe", meaning that they are impossible to defeat so long as they maintain their efforts and voting record.[77] This does not mean that they are "unbeatable" no matter who their opponent is, but it means that if the member continues their relationship with their district and maintains a voting record consistent with a majority of their constituents' views, they likely to enjoy "uninterrupted electoral success."[78] This theory of reflecting the electorate's demands and keeping a consistent voting track record raises important questions: what happens when politicians advocate for pro-nuclear policies when their voters disagree? Do they lose reelection, at least in part, because of this? Is nuclear power support on most voters' radar? It is difficult (at best) to draw a causal link between these events, but it is key to understand their relationship. If policymakers are influenced by public opinion and prioritize reelection, (assuming public opinion is against a particular policy), then it is doubtful that they will pursue that policy.

Public perception and members of Congress are not a perfect dichotomy. This emphasis of public opinion or wholesale rejection can lead to simplistic calculations and philosophies that create imitation mavericks or dogmatic policymakers. Political strategist Dick Morris explained this phenomenon by positing:

> Too often, leaders don't think carefully before they take unpopular positions. Intellectually lazy, it's easier to revel in martyrdom (on the one hand) or to resort to demagoguery (on the other hand) than to think out in advance how to take an unpopular position... and survive. A politician can do what he thinks is right; he

[77] Mayhew, *The Electoral Connection*, 37.
[78] Ibid.

just has to be sophisticated in how he goes about it.[79]

Morris argues that members of Congress can vote against what their constituents support, so long as their messaging is strategic, and that they strike a balance between addressing local concerns and promoting controversial policies. In nuclear power's case, however, not every elected official has Dick Morris as their campaign strategist, and policymakers' reticence to oppose the public will makes them unlikely to promote unpopular pro-nuclear policies. We can therefore expect that the United States is not building additional nuclear power plants because of the relative unpopularity of nuclear energy and policymakers' hesitancy to support a policy unwelcome among many of their constituents.

With regards to nuclear energy, nuclear energy must meet several criteria to improve its public perception. In "Nuclear Power and Sustainable Energy Policy: Promises and Perils," author Ioannis Kessides highlights safety as a key factor hindering nuclear power.[80] The author cites that the damage from Chernobyl, a 1986 meltdown that immediately killed 31 workers and may kill up to 4,000 from radiation-induced cancers, mars public opinion of nuclear energy. For Kessides, the risk of nuclear fallout, coupled with potential weaponization of existing nuclear reactors, "indelibly marks" the history of nuclear energy.[81] Furthermore, Kessides claims that the issue of nuclear waste disposal is complicated by "political, social, technical, and economic reasons."[82] These reasons, which Kessides terms "institutional obstacles," include NIMBY-centered objections.[83] The author explains that the public is "averse" to storing radioactive waste near their communities, or "backyards," and that so long as the citizenry views nuclear power

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[79] Dick Morris, *The New Prince: Machiavelli Updated for the Twenty-First-Century* (Los Angeles, CA: Renaissance Books, 1999), 87.
[80] Ioannis N. Kessides, "Nuclear Power and Sustainable Energy Policy: Promises and Perils," *The World Bank Research Observer* 25, no. 2 (2010): 323–62, http://www.jstor.org/stable/40891378, 342.
[81] Ibid.
[82] Ibid.
[83] Kessides, "Nuclear Power and Sustainable Energy Policy," 344-5.

and its waste as a security threat to their towns, they will oppose it in their neighborhood. If many communities decide to fight a nuclear reactor or waste facility in their backyard, the chances of that facility being built are obviously reduced.

NIMBYism, while related to congressional action and public opinion philosophy, is usually couched in housing development terms. Tom O'Grady, a lecturer at University College London, explores the role of NIMBYism in redevelopment. O'Grady found that opposition to "housebuilding" primarily comes from a desire to "preserve the character of one's area and existing ways of life" and to insulate communities against "rapid changes that could result from new housing developments."[84] A new housing development could alter housing prices, affecting renters' capacity to afford increased rental payments and changing the character of a neighborhood.[85] For the author, NIMBYism transcends mere "asset protection:" residents tend to support "preserving" their community as they found it, meaning they want the people, architecture, and general feeling of their neighborhood to remain the same.[86] Building a new housing tract or commercial structure—affordable or otherwise—would be viewed unfavorably because it would change the character of their community. The nuclear issue is quite similar: building a new nuclear power plant is likely to alter the fabric of a community. To open a nuclear reactor, houses may be demolished, vistas may be obstructed, and residents may express concerns about radioactive waste storage. And the prospects of nuclear cooling towers as a backdrop to suburban neighborhoods is unlikely to be one that many homeowners would favor (see Figure 8). That community members oppose change to their neighborhoods—especially if

[84] Tom O'Grady, "NIMBYism as Place-Protective Action: The Politics of Housebuilding," *NIMBYism as Place-Protective Action: The Politics of Housebuilding* (University College London, 2020), file:///Users/tom/Downloads/NIMBYpercent20paperpercent20octpercent2020-1.pdf, 1.
[85] O'Grady, *NIMBYism as Place-Protective Action,* 3.
[86] Ibid.

they perceive that change as dangerous—is neither shocking nor new. It is, however, a serious threat to nuclear energy and a potential reason why increased concern regarding climate change has not resulted in new nuclear reactors.

Figure 8: This neighborhood in Pottstown, PA is adjacent to a nuclear reactor. The power plant does not provide for a great view—it's not hard to imagine why communities would resist one in their vicinity. Source: WBUR Radio, Boston, MA.

The Role of Industries and Lobbies

Political lobbying can have a significant impact on legislative outcomes. Political scientist Beth Leech reviews findings across the discipline on the influence and extent of lobbying and offers a framework from which to unpack the role of lobbies and industry in building/opposing nuclear power plants. Leech explains that while lobbyists can have sway over lawmakers, the relationship between a lobbyist and a "yes" or "no" vote on a bill is not 1:1. She notes that the extent of interest group influence is hotly debated, and for as many groups that

lobby for something, there are often groups fighting for the opposite side.[87] She argues that interest groups are "contingent," and that while an interest group can help pass a bill, a bill's passage indicates that another lobbying group failed to effectively oppose it, or perhaps was absent altogether.[88] Interest group influence is an "important" but not "sufficient" cause of a legislative victory or defeat.[89]

Additionally, lobbyists tend to meet with members of Congress sympathetic to their position. Interest groups traditionally lobby members who agree with their position, meaning that the impact of advocacy is blurred.[90] In sum, a lobbyist's power is often unclear because they seek out members who support their position. For David Austen-Smith and John R. Wright, the relationship between lobbies and policymakers is frequently "counteractive."[91] They propose that lobbying "friendly legislators" (members who agree with the organization's position) is both "strategic and counterproductive" because sympathetic members do not need to be persuaded to vote favorably on the issue at hand.[92] Similarly, lobbyists do not waste their time with strict opponents, as their minds are unlikely to change due to their own constituent positions or other factors. Instead, advocates coordinate with friendly supporters as a part of their coalition. Rather than persuading or changing the minds of recalcitrant opposition, lobbyists and policy advocates are most likely to engage in what political scientists Richard Hall and Alan Deardorff call "legislative subsidies."[93] That is, friends do lobby friends, not for the purposes of changing

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[87] Beth L. Leech, Sandy L. Maisel, and Jeffrey M. Berry, eds. 2010. The Oxford Handbook of American Political Parties and Interest Groups. New York: Oxford U. Press, 541.
[88] Ibid.
[89] Ibid.
[90] David Austen-Smith and John R. Wright, "Counteractive Lobbying," *American Journal of Political Science* 38, no. 1 (1994): 25–44. https://doi.org/10.2307/2111334, 26-28.
[91] Ibid.
[92] Ibid.
[93] Richard Hall and Alan Deardorff, Lobbying as Legislative Subsidy, *American Political Science Review*, 100. 69 – 84, (2006), 10.1017/S0003055406062010.

their minds, but to help them act as better lawmakers on their shared issue positions. Lobbying as legislative subsidy is to provide "policy information, political intelligence, and legislative labor to the enterprises of strategically selected legislators."[94] In other words, the influence of lobbying on policymakers is important, but those seeking a clear connection between lobbyist or advocate activities and lawmaker behavior will be left unsatisfied.

In the case of nuclear power, lobbies are likely to be important but not decisive. Part of this ambiguity rests on the common practice of meeting with "friendly" members of Congress, who will likely vote favorably on the policy regardless of the meeting. More broadly, lobbies provide policy research that members and staff may not have time to complete. The extent that this research influences policy outcomes is hard to define. Nevertheless, pro-nuclear interest groups and anti-nuclear interest groups are certainly present in the nuclear sphere. Within nuclear power, their role is important, albeit secondary toward advancing or hindering the building of new reactors.

The Role of the Regulatory Environment

The bureaucracy is designed to implement guardrails in policymaking by stipulating regulatory processes and frameworks to foster safe and effective public policy.[95] In the nuclear regulatory environment, the evolution of its governing agencies suggests a consistent mission to protect nuclear innovation while maintaining a safe nuclear fleet. In 1946, the Atomic Energy Commission was established to promote the "utilization of atomic energy for peaceful purposes to the maximum extent consistent with the common defense and security and with the health and safety of the public."[96] By 1974—when the AEC was abolished and largely absorbed into the

[94] Ibid.
[95] "Summary of the Atomic Energy Act." EPA. Environmental Protection Agency, March 21, 2022. https://www.epa.gov/laws-regulations/summary-atomic-energy-act.
[96] Ibid.

Nuclear Regulatory Commission, the latter agency sought to "license and regulate the Nation's civilian use of radioactive materials to provide reasonable assurance of adequate protection of public health and safety and to promote the common defense and security and to protect the environment."[97] America's nuclear power plants have been safe—only the Three Mile Island accident tarnishes this legacy. But if one understands safe reactors as newer facilities using well-researched designs and environmental protection as key to reducing greenhouse gas emissions, then the regulatory infrastructure may fall short. Preventing new reactors from opening and keeping older ones online may not be safe at all. Likewise, stymieing the advancement of a green and highly productive energy source may come at the expense of fighting climate change.

Broadly speaking, regulatory agencies are a necessity of modern nations and for effective policymaking. Political theorist Morstein Marx delineates that "public administration" is key to the "general effectiveness of government."[98] The "welfare state" – where the government underwrites and manages the public good – is a "practical reality" of modern government.[99] For Marx, the bureaucracy is simply the "organization of personnel" to keep the government functioning.[100] Active bureaucratic malfeasance is rare, and passive malfeasance (including institutional gridlock) is a consequence of the need for a large executive branch (or administrative state) to create and enforce policies. Following Marx's logic, the NRC's regulatory framework (much of which was written in the 1950s by the AEC) would not serve as a hindrance to the construction of new nuclear power plants. Instead, it should protect the

[97] "About NRC," NRC Web (Nuclear Regulatory Commission, January 25, 2022), https://www.nrc.gov/about-nrc.html.
[98] Morstein Fritz Marx, *The Administrative State* (Chicago, IL: University of Chicago Press, 1967), 2.
[99] Ibid.
[100] Marx, *The Administrative State*, 9.

citizenry from a potentially dangerous meltdown by providing the expert personnel necessary in our modern and complex world.

German sociologist Max Weber anticipated Marx's view of the regulatory environment. Weber contends that the ultimate goal of bureaucracy is to avoid corruption.[101] Weber elaborates on this point, stating that bureaucracy must adhere to strict protocol because of the increased complexity in politics writ large.[102] The German theorist argues that an administrative component in government is a necessary tenet of advanced societies, and while bureaucracy presents challenges to liberty, it is nevertheless essential to maintain the rule of law. A hierarchical "Weberian Bureaucracy" is not, in theory anyway, a roadblock to public policy, but rather a necessary element of a complex political world.[103] Therefore, a competent administrative state with appropriate oversight not only an important part of American government but a net positive in ensuring the U.S. enacts well-researched and effective policies. Following this reasoning, the NRC ideally should exemplify the Weberian example of strong bureaucracy managed by expert personnel. It is thus a requirement of an orderly and safe society.

Furthermore, regulatory agencies can be expected to function efficiently to meet their goals. For Richard Posner, author of "Theories of Economic Regulation," the "regulatory process" should operate "relatively efficiently" to achieve their goals, which are the product of negotiation between interest groups.[104] He argues that bureaucracies are not dysfunctional because they specialize in particular fields—allowing them to dive deeper within their subject

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[101] William D. Rubenstein and Patrick von Maravic, "Max Weber, Bureaucracy, and Corruption." In The Good Cause: Theoretical Perspectives on Corruption, edited by Gjalt de Graaf, Patrick von Maravić, and Pieter Wagenaar, 1st ed., 21–35. Verlag Barbara Budrich, 2010. http://www.jstor.org/stable/j.ctvbj7k5p.6.
[102] Ibid.
[103] Liesbet Hooghe (2001). *The European Commission and the Integration of Europe: Images of Governance*. Cambridge University Press. pp. 40.
[104] Richard A. Posner, "Theories of Economic Regulation." *The Bell Journal of Economics and Management Science* 5, no. 2 (1974): 335–58. https://doi.org/10.2307/3003113, 350.

than a legislature—and their isolation from electoral politics, reducing biases and responsiveness to transient political winds.[105] This benevolent view of the regulatory process relies upon an economic understanding of government. Posner acknowledges that he views bureaucracies as rational actors operating efficiently and the inherent shortcomings within this perspective: the research supporting this position is not "systematic."[106] However, this understanding of regulatory framework is missing a key ingredient: government does not always operate like a business. This is not a condemnation of our bureaucratic institutions but rather a maxim of democratic rule. If they were to solely maximize efficiency, the people may lose social programs that cost the government money yet are a necessary aspect of a compassionate society. In terms of nuclear energy, the regulatory environment is not a group of agencies operating efficiently but rather a well-intentioned assemblage that often hinders advancement.

In a more modern context, the bureaucracy's role in policymaking can be characterized by several theories. These understandings of the nature of regulations include new institutionalism and new governance, which examine the links between the bureaucracy and Congress. New institutionalism, as described by Christopher Carrigan and Cary Coglianese, centers around a complex relationship between members of Congress, the executive branch, and interest groups serving in advising and oversight roles over regulatory agencies.[107] The impact of new institutionalism on understanding bureaucratic actions and the nature of the regulatory framework writ large is substantial: it has "made clear" how agencies avoid "capture" from wrongdoing, it has elucidated how appointments and hearings influence agency behavior, and

[105] Ibid.
[106] Posner, "Theories of Economic Regulation," 353.
[107] Christopher Carrigan and Cary Coglianese, "The Politics of Regulation: From New Institutionalism to New Governance," Annual Review (Annual Review of Political Science, 2011), https://www.annualreviews.org/doi/pdf/10.1146/annurev.polisci.032408.171344, 109-10.

the impacts—positive and negative, intended and unintended—of oversight on the bureaucracy.[108] New governance encompasses several regulation methods:

- management-based regulation, which requires regulated entities to gather information and develop plans to solve regulatory problems but not necessarily to take other steps imposed by government or even to implement their own plans;
- information disclosure requirements, which mandate the release of information but not necessarily any substantive behavioral change;
- and voluntary programs and self-regulation initiatives, which have no formal mandated requirements.[109]

Carrigan and Coglianese claim that each of these tools "can and do" advance public policy and reduce administration costs, the latter of which is often wielded as a counterargument to additional regulation.[110] With regards to nuclear power, the regulatory framework adopts a combination of management-based regulation and information disclosure requirements. The NRC develops regulations alongside the DOE and its subsidiaries but does not typically implement their owns plans without congressional action. They also require information releases about new reactors, proposed facilities, and ongoing plans but rarely update regulations substantially. The use of information disclosure requirements without changing behavior or regulatory framework is a key theoretical explanation of the relationship between nuclear power and the American bureaucracy: often times transparent and competent yet simultaneously outmoded. Put differently, the bureaucracy is treading water but not swimming forward.

[108] Carrigan and Coglianese, "The Politics of Regulation," 113.
[109] Carrigan and Coglianese, "The Politics of Regulation," 114.
[110] Carrigan and Coglianese, "The Politics of Regulation," 119.

This stagnation is further echoed in a 2018 policy study by R Street's William Murray. Murray depicts the "regulatory regime" at the NRC and DOE as overly focused on the "safety and upkeep of operating reactor" which, in his view, comes "at the expense of new generations of reactor technology."[111] This emphasis on safety comes from a technological preference toward light water reactors (LWRs) within the current Office for New Reactors, a department of the NRC and consistently "inflexible" guidelines (a legacy of Three Mile Island, Chernobyl, and Fukushima).[112] The regulatory architecture, which Murray believes should be designed to advance safe and innovative technology, has therefore fallen short. Nuclear power is therefore demonstrative of Murray's philosophy of bureaucracy: well-intentioned and competent but hardly effective at promoting the industry it seeks to protect. The regulatory environment should be a model for efficient and objective policymaking but is likely to fall short.

In sum, we should expect that public opinion and NIMBYism hinders nuclear power and that lobbies, while secondary, remain critical forces against nuclear energy advancement. The regulatory environment, while established and operating in good faith, paralyzes the advancement of nuclear power plants. With these broader theories of institutions and institutional behavior in mind, let's unpack nuclear energy within American politics.

Methodology and Research Protocol

This paper draws upon many primary and secondary sources. It relies on Congressional Research Service reports, public opinion polling from Pew Research and Gallup, over 20 interviews with relevant policymakers on and off Capitol Hill, publications by energy policy

[111] William Murray, "Step Change: Improvements to U.S. Nuclear Power Regulation," R Street Institute, 2018. http://www.jstor.org/stable/resrep30559, 1.
[112] Ibid.

experts, and articles from leading newspapers, journals, and think tanks. These will provide the multitude of perspectives necessary to understand the state of the nuclear policy discussion and provide an empirical basis for answering the primary research question.

An interview protocol was developed with a primary thesis adviser over several meetings (see Appendix 1). During these meetings, questions were drafted that closely followed my research structure and hypotheses. Between each meeting, these questions were revised. The procedure based on advice and experience the adviser gleaned over years of public policy interviews and work in Washington, DC. After the questions and protocol were finalized, I attached it as part of an application to the Washington and Lee University Institutional Review Board (IRB) to receive permission to conduct interviews with human subjects. The interviews began after receiving permission from the IRB (IRB number 52700713).

During the interviews, participants were asked a series of questions pertaining to the various components of the nuclear policy debate. Each interview began with my research question. Following this introductory question, participants were asked each interview question, time permitting, with variations to allow for follow-up questions on particular subjects. The protocol included questions about the role of the regulatory environment, Congress, public opinion, and interest groups in determining why the United States is not experiencing a significant increase in nuclear power plants.

If time was running short, the meeting focused on questions that most closely pertained to their background. For instance, congressional staff were asked more probing questions about the regulatory environment and the role of Congress while advocacy and lobbying professionals were asked more specifically about the role of special interest groups and industries in the nuclear power arena. At the conclusion of each interview, each interviewee was asked if they

knew of other policy experts that would be willing to speak with me about their experience and knowledge regarding atomic energy policy. This final question expanded the list of sources and build the balanced portfolio of experts needed to craft well-balanced data for analysis.

Participants were selected from personal contacts on Capitol Hill through congressional internships, Washington and Lee University alumni working in relevant fields, and policy leaders identified through research. Additionally, interviewees were recruited from consulting Congressional directories and through a snowball process whereby interviewees were asked to recommend additional persons that might be contacted. Participants were also be recruited from my thesis adviser's contact lists based on working in Congress and in public policy in Washington, D.C.. Potential subjects were contacted via an email that briefly describes the research purpose and requests an interview.

The interviews are intended to shed light on the theoretical expectation that public opinion will be a primary factor hindering the advancement of new nuclear power plants. Public perception, coupled with NIMBYism when building reactors and waste facilities, has been a major component of this research prior to the interviews. The cost and role of the regulatory environment, which are closely related, are a secondary yet critical roadblock for nuclear power. Thus far, this research demonstrates that nuclear power plants are expensive to build, partly because of a complex regulatory framework that causes frequent construction delays. Furthermore, we can expect that lobbies and industries will be a less significant factor in restricting American nuclear energy. Lobbies are important, as people are active in advocating for and against nuclear reactors. However, given the empirical literature which suggests the role of lobbies is not as strong as popular perception often has it, interviews are intended to draw out greater detail of the role between lobbying and the development (or not) of nuclear power. While

they have played an important role in providing research to lawmakers, it is otherwise difficult to identify their precise impact on the development of new nuclear power plants, or lack thereof.

Findings and Analysis: Nuclear Power is Promising but Often Hindered

Public Opinion: Nuclear Power is Controversial

Public opinion remains a critical reason why the United States is not constructing additional nuclear power plants. In the case of public opinion, nuclear energy is held back by half-hearted support and ardent opposition. With regards to nuclear power, public opinion's role is multifaceted: it influences policymakers, leads to NIMBY disputes, and is closely linked to public misinformation. In short, public opinion and public relations are driving factors behind nuclear power's American malaise. This hesitancy, nevertheless, is neither universal nor permanent: the U.S. attitude toward nuclear may be changing.

As early as 1988, public opinion weighed heavily on policymakers' decisions regarding atomic energy production. In New York, fear of nuclear power amongst the citizenry convinced then-Governor Mario Cuomo to close the Shoreham reactor.[113] In the wake of Three Mile Island and Chernobyl, the Suffolk County power plant faced considerable public opposition despite being online for only four years. Vincent Tese, the New York state government's chief negotiator said that "public opinion recognized (the safety concerns), and that caused the downfall of Shoreham."[114] Citing concerns that the county could not be safely evacuated in the event of an accident, the Suffolk County legislature and Governor Cuomo vetoed any Long Island Lighting Company (LILCO) evacuation proposal.[115] After receiving little aid from Congress, the plant

[113] Robert Crabbe, "Voters Shut down Nuclear Power Plant," UPI (United Press International, June 12, 1989), https://www.upi.com/Archives/1989/06/12/Voters-shut-down-nuclear-power-plant/6089613627200/.
[114] Ibid.
[115] Ibid.

was effectively killed. Here, public opinion and NIMBYism were key players behind Shoreham's closure. Long Island residents feared a potential nuclear disaster before Chernobyl, and the Soviet Union's poor handling of the meltdown did little to assuage them. As elected officials, Cuomo and the county legislature would have been unwise to oppose a policy with such vehement opposition. The unpopularity of nuclear power (especially in residents' neighborhoods) proved fatal to a brand-new reactor. Shoreham was the first nuclear power plant to be decommissioned in the United States.

For decades, public perceptions of nuclear power have prevented it from attaining widespread popularity. Americans have cited concerns about nuclear waste management and costs of nuclear subsidies, and an ever-present NIMBY mindset makes the alternative energy source unappealing to many Americans.[116] Nevertheless, atomic energy has rejoined the conversation amid rising gas prices, conflict in Ukraine, climate change, and a renewed bipartisan push for energy independence from foreign oil in the name of national security and environmentalism. Opponents of nuclear energy couch their concerns on waste storage. This approach is not unreasonable: nuclear waste is radioactive, and leaks in inadequate storage facilities could be catastrophic.

Support for nuclear power is often associated with Americans with a college degree and Republican or right-leaning voter registration or identification. The educational gap is relatively large: 57 percent of college educated Americans supported it compared to 45 percent of non-college educated Americans. Moreover, this 2022 Gallup survey found that 60 percent of Republicans favor nuclear energy compared to just 39 percent of Democrats and 55 percent of

[116] Ariel Cohen, "Nimbyism Is a Bipartisan Energy Problem," Forbes (Forbes Magazine, September 15, 2022), https://www.forbes.com/sites/arielcohen/2022/09/14/nimbyism-is-a-bipartisan-energy-problem/?sh=2f5051a83f73.

independents, which is a similar gap found by Gallup research over the past twenty years. Gallup concluded that Democratic hesitancy is predicated upon liberal-leaning environmental groups' opposition to atomic energy, environmental questions about waste storage, and a preference for wind and solar.

Gallup's conclusions are not unique. A 2022 Pew Research survey also concluded that support for nuclear energy is closely associated with partisan lean and affiliation. Republicans and right-leaning independents are 10 percent more likely than Democrats and Democratic leaning Americans, 42 percent versus 32 percent, to respond that the government should encourage nuclear power production.[117] Furthermore, 45 percent of conservative Republicans say the government should encourage nuclear energy production, while 36 percent of moderate and liberal Republicans say the same.[118] On the other hand, Democrats are 13 percent more likely than Republicans to say the government should discourage this activity (31 percent versus 18 percent).[119] Overall, the Pew Research poll found that 35 percent of adults believed that the government should encourage (subsidize) nuclear reactors while 26 percent said that they should discourage it. 37 percent responded that the government should neither encourage nor discourage atomic energy production. This comes as 69 percent of Americans favored the US making attempts to become carbon neutral by 2050. Notably, the same Pew Research study found that men are nearly twice as likely to favor increased governmental support for nuclear energy compared to women (46 percent to 25 percent).[120] A March 2022 Pew Research survey found that men are nearly twice as likely to favor increased governmental support for nuclear energy

[117] Ibid.
[118] Ibid.
[119] Ibid.
[120] Rebecca Leppert, "Americans Continue to Express Mixed Views about Nuclear Power," Pew Research Center (Pew Research Center, March 23, 2022), https://www.pewresearch.org/fact-tank/2022/03/23/americans-continue-to-express-mixed-views-about-nuclear-power/.

compared to women (46 percent to 25 percent).[121] In a 2022 Gallup poll, 62 percent of men endorse atomic energy compared to just 39 percent of women. In other words, support for nuclear power falls tends to fall upon political and gender lines despite broader support for governmental climate action.

Any movement toward green energy is often coupled with NIMBYism. The dislike of putting energy generators—regardless of design—near one's community or within view of a neighborhood is not unique to nuclear power. Former Massachusetts Senators Ted Kennedy and John Kerry famously opposed installing wind turbines off Nantucket Sound, with the former claiming the project would cause "environmental problems" and depress tourism.[122] Kerry remarked that "you can't just have someone plunk something down wherever the hell they want" and questioned "whether this is the best location."[123] Unlike wind and solar energy where aesthetics are at play, nuclear power's safety concerns fuel this "Not in My Back Yard" syndrome. To be clear, nuclear reactors are not attractive neighbors. Nevertheless, nuclear power concerns transcend a reactor's physical appearance—many people are concerned about their personal safety.

The proposed nuclear waste storage facility in Yucca Mountain, Nevada, clearly illustrates the obstacle that public opinion poses for nuclear energy. After decades of geologic surveys and congressional hearings, the federal government pushed to store nuclear waste in the mountain, citing its seismic safety and lack of water. Nevadans, led by Republican Governor Kenny Guinn and Democratic Senator Harry Reid, killed the plan. Silver State residents

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[121] Rebecca Leppert, "Americans Continue to Express Mixed Views about Nuclear Power," Pew Research Center (Pew Research Center, March 23, 2022), https://www.pewresearch.org/fact-tank/2022/03/23/americans-continue-to-express-mixed-views-about-nuclear-power/.
[122] Kate Sheppard, "Blowing in the Wind," Mother Jones (Foundation for National Progress, December 4, 2009), https://www.motherjones.com/politics/2009/12/john-kerry-cape-wind/.
[123] Ibid.

vehemently opposed the plan and emphasized that non-Department of Energy government scientists were concerned about potential corrosion within the tunnel storage network.[124] Twenty years after President Bush's 2002 endorsement of Yucca Mountain, the project remains unfinished and unpopular.

"Not in my backyard" syndrome is not unique to nuclear safety concerns. In Louisa County, Virginia, the North Anna reactor also faced NIMBYism, though the outcry was weaker and stemmed from the impact of the cooling equipment as much as the perceived danger from a nuclear reactor. In an interview with a Richmond, Virginia energy expert, the lifelong Virginian explained that NIMBYism played an important role when debating to put the Richmond-area plant online. However, he characterized this opposition as a "land concern" because the facility required a reservoir, Lake Anna, to hold water for the cooling equipment. This necessitated using additional land, causing "environmental and NIMBY concerns," according to the Richmond energy policy expert. In sum, the "not in my backyard" syndrome encompasses more than fears of nuclear meltdowns: people don't like seeing their natural landscapes disrupted for a nuclear power plant.

Moreover, the NIMBYism that many nuclear energy experts note as a roadblock to nuclear reactors also translates to opposition of nuclear waste storage facilities. During an interview with an internationally recognized nuclear policy analyst, the expert emphasized that storing waste near neighborhoods and cities was political suicide. They elucidated that while residents may support nuclear reactors near their homes, they do not maintain this open attitude because they fear potential health consequences from toxic waste. She cited that many Americans view nuclear waste as a "poorly stored liquid" that could easily contaminate water

[124] Tom Gorman, "Nevada Governor Vetoes Nuclear Waste Dump Site," Los Angeles Times (Los Angeles Times, April 9, 2002), https://www.latimes.com/archives/la-xpm-2002-apr-09-mn-36917-story.html.

supplies and raise carcinogen levels in their communities. These concerns are well founded: while nuclear waste is stored in solid form, water contamination and radiation-caused illnesses are major acknowledgements when siting any waste facility, regardless of size or security level. Furthermore, the fact that local opposition to nuclear encompasses waste and power plants is demonstrative of a broader yet appreciable obstacle for American nuclear energy production. Atomic energy, even if supported by the broader body politic, is unfeasible without community support. As several interviewees have attested, support of the American people is a necessary but not sufficient goal to advancing nuclear energy. Ultimately, approval must come from a reactor's neighbors.

Disapproval among reactors' neighbors, however, is hardly unilateral. Throughout an interview with an experienced professor of energy policy, the participant emphasized that existing nuclear power plants often have supportive neighbors. In fact, her research found that people who lived close to a nuclear reactor were often more supportive of nuclear energy than those that lived farther away. The professor cited that these people, known as "plant neighbors," described the nearest nuclear power plant to them favorably, with over 90 percent supporting their local reactor and believing it to be safe. While the studies she cited and conducted were sponsored by NEI, the policy expert conducted nine national surveys regarding nuclear power plant approval and has found similar results each year. Thematic throughout the nuclear policy debate is the issue of public relations: nuclear energy, a result of weapon-building innovation, conjures up images of total destruction of cities and neighborhoods. During several interviews, the participants offered that plant neighbors, many of whom work at the reactor or are familiar with those who do, are more knowledgeable and thus less susceptible to anti-nuclear messaging. However, plant neighbors also have a vested interest: if they work at the power plant, they will

likely oppose its closure because they are dependent upon its operation for income. While the "not in my backyard" argument against nuclear energy does not fully capture fission energy's setbacks, it is key to understanding that the relationship between public perception and atomic energy leads to challenges for those seeking public support for nuclear power plants.

The deficiencies within NIMBY-based conclusions are also borne out in public opinion data collected in areas adjacent to nuclear power plants. In Diablo Canyon's California State Senate district, which includes San Luis Obispo County and much of California's Central Coast, polling conducted by Fairbank, Maslin, Maullin, Metz & Associates (FM3) found 66 percent of constituents support keeping Diablo Canyon online past 2025 (when it was scheduled for decommissioning), with 46 percent of those "strongly supporting" it.[125] Only 24 percent of respondents opposed the proposal, with 15 percent "strongly opposing" the effort.[126] When asked to examine the costs and advantages of nuclear energy, voters answered that the "benefits of nuclear energy outweigh the risks" by a 43-point margin. More precisely, 62 percent said that the benefits of nuclear energy outweigh the risks, while only 19 percent claimed the opposite.[127] With regards to electoral consequences, 48 percent of the district's electorate responded that they were "more likely" to vote for Senate candidate who supported extending the reactor's license.[128] In fact, the poll found that more voters were apathetic (23 percent) about a state legislator's support than viewed it as a detriment (20 percent).[129] Put differently, a state legislator representing Diablo Canyon would be unlikely to face political consequences purely because of

[125] Dave Metz and Miranda Everitt, "Voter Views of Extending Diablo Canyon Operations in State Senate District 17," FM3 Opinion Research and Strategy (FM3 Opinion Research and Strategy, August 24, 2022), https://carbonfreeca.org/wp-content/uploads/2022/06/2022-06-09_Brattle-Report-on-Impacts-of-Diablo-Extension.pdf.
[126] Ibid.
[127] Ibid.
[128] Ibid.
[129] Ibid.

his or her support. The political ramifications for supporting nuclear power in this district—where nuclear power is important—do not seem to be significant. No state or federal representative has lost re-election here in over a decade.

In San Luis Obispo County, California, where the Diablo Canyon reactor is located, a Carbon Free California poll found that 74 percent of voters support continued operation of Diablo Canyon, with 56 percent of respondents "strongly" supporting efforts to keep the power plant online.[130] This support is echoed across California, with 58 percent of participants supporting continued operation of California's last existing nuclear power plant, while only 32 percent oppose.[131] In response to this data, the lead climatologist at Data for Progress—who assisted Carbon Free California polling efforts—concluded that California voters view Diablo Canyon and nuclear power as a clear avenue to "reduce electricity costs, enhance grid reliability, and meet our emissions reduction goals."[132]

Similar results are found in Pennsylvania state polling, where the Three Mile Island accident occurred over forty years ago. A 2022 Nuclear Powers Pennsylvania poll found over 80 percent of participants supporting efforts to maintain the state's fleet of nuclear reactors.[133] A similar percentage of respondents (80 percent) believed that preserving Pennsylvania's 4 operating reactors was "important" to help achieve the state's carbon-reduction goals.[134] Here, it is important to note that this poll was conducted by a pro-nuclear interest group, but the

[130] "Poll: Strong Local and Statewide Support for Diablo Canyon Nuclear Power Plant," Carbon Free California (Cision Distribution, May 19, 2022), https://www.prnewswire.com/news-releases/poll-strong-local-and-statewide-support-for-diablo-canyon-nuclear-power-plant-301551747.html
[131] Ibid.
[132] Ibid.
[133] "8 Of 10 Likely Pennsylvania Voters - across All Political Affiliations - Believe Nuclear Energy Is Critical to Maintaining Energy Security in the U.S.," Nuclear Powers Pennsylvania (Nuclear Powers Pennsylvania, July 6, 2022), https://nuclearpowerspennsylvania.com/8-of-10-likely-pennsylvania-voters-across-all-political-affiliations-believe-nuclear-energy-is-critical-to-maintaining-energy-security-in-the-u-s/.
[134] Ibid.

overwhelming support for nuclear energy—especially within respondents' home state—suggests that support for nuclear power may not be political suicide. Rather, increasing public support for nuclear is a question of framing and public relations.

Atomic energy is often seen as a public relations nightmare and is consequently often mistrusted. Throughout several interviews with Republican and Democratic congressional staff, nuclear power messaging was described as a critical setback. One Republican member of Congress claimed that nuclear power's unpopularity "all stemmed back from the word nuclear." He proposed that current and future energy policy should rebrand nuclear power as "fission or fusion energy" instead of nuclear or atomic. These words, in the member's and various staffers' minds, depicted visions of weapons of mass destruction and nuclear fallout instead of energy capable of improving the lives of millions of people. The videos and graphics from Chernobyl and Fukushima further this association of nuclear energy as a nuclear weapon. In particular, the HBO documentary *Chernobyl* displayed horrific and haunting images of one of the world's worst nuclear catastrophes. One GOP staff member described the footage from this disaster as creating a "stigma" around nuclear power. He posited that well-meaning viewers watch the documentary and get the "wrong idea" about nuclear energy. In his view, footage of *Chernobyl* and of other nuclear accidents "deeply engrain" anti-nuclear sentiment within American "culture." This intrinsic mistrust, the GOP staffer claims, is because the U.S. never centered its energy production around nuclear. He expanded that France, which relies upon nuclear power plants for seventy percent of its energy supply, is "used to nuclear power" and is therefore less fearful of it. This high level of public trust is partially predicated on government ownership of their reactors—the French government owns eighty-five percent of Electricité de France (EDF),

the company managing their nuclear power plants.[135] While reactors are regulated by government agencies, American nuclear plants are run by private companies that lack the credibility of the federal government. In short, the public relations issue with atomic energy is multifold: it suffers from poor messaging, misinformation, and mistrust. Nevertheless, there is a notable revival in nuclear power interest within Congress, potentially indicating a lack of concern for electoral repercussions. In November 2022, Republican representatives Jay Obernolte (R-CA-23) and Jeff Duncan (R-SC-3) introduced the *Blueprint for Nuclear Innovation and Competitiveness*, a plan delineating nuclear policy priorities, including "modernizing the NRC," improving the licensing process, and addressing financing concerns.[136] [137]

Policymakers are motivated by public opinion, where nuclear power often falls on deaf ears. Because politicians prioritize re-election above all else, taking unpopular stances is considered an unnecessary risk.[138] In an interview with a Southern California congressman, the representative contended that nuclear energy's negative reputation stems from the controversial history that makes it possible.[139] He explained that the American people associate nuclear energy with nuclear weapons because they share elements like Plutonium and Uranium, radioactive substances that are lethal if poorly contained.[140] Likewise, the congressman and his Senior Legislative Assistant elucidated that the myriad of heart-wrenching photographs and testimonies

[135] "Nuclear Power in France," Nuclear Power in France | French Nuclear Energy - World Nuclear Association (World Nuclear Association, December 2022), https://www.world-nuclear.org/information-library/country-profiles/countries-a-f/france.aspx.
[136] Emily Carlin, "Rep. Obernolte Joins Jeff Duncan on Blueprint for Nuclear Innovation and Competitiveness," Representative Jay Obernolte (U.S House of Representatives, November 16, 2022), https://obernolte.house.gov/media/press-releases/rep-obernolte-joins-jeff-duncan-blueprint-nuclear-innovation-and.
[137] The author interned for Congressman Obernolte's district and Washington, DC offices. He is also a part-time resident within the congressman's congressional district in Crestline, CA.
[138] Richard F. Fenno, *Congressmen in Committees* (Berkeley, CA: University of California Press, 1995).
[139] Morel, "Congressional Appetite for Alternative Energy with Congressman Jay Obernolte," Personal, May 25, 2021.
[140] Ibid.

stemming from the Chernobyl, Fukushima, and Three Mile Island meltdowns have proven salient in public perception of nuclear energy.[141] They are correct: in the past decade, Gallup polling has indicated that a majority or plurality of the American people oppose the construction of nuclear power plants in the US.[142] In past decades, nuclear power proponents have relied upon stalwart supporters like the late New Mexico Senator Pete Domenici. Without such a leader, their cause is more difficult. As chairman of the Senate Committee on Energy and Natural Resources and veteran lawmaker, Domenici worked on a bipartisan basis to build uranium plants in his home state and convince many skeptics of nuclear power's potential to give Americans "a cleaner, healthier, sustainable and self-sufficient energy future."[143] The New Mexican's assuaging words are precisely what nuclear proponents desperately need. Without convincing the public, nuclear energy will be derided by pundits and partisans as a dangerous and impractical solution. In other words, complex scientific arguments and silence are insufficient defenders: they need a knowledgeable and persuasive rhetorician to change the minds of the American people.

Domenici's support of nuclear power over fossil fuels jeopardized his political career. In *The Emergence of a Senate Leader: Pete Domenici and the Reagan Budget*, Richard Fenno describes Senator Domenici's sudden "independence" from the New Mexico oil and gas industry to be "costly" to the New Mexican senator—in terms of the "short-run loss of intense electoral support" and the "long-run expenditure of resources" necessary to "win back" these groups.[144]

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[141] Ibid.
[142] Jonathon Baron and Stephen Herzog, "Public Opinion on Nuclear Energy and Nuclear Weapons: The Attitudinal Nexus in the United States," Energy Research & Social Science (Elsevier, June 6, 2020), https://www.sciencedirect.com/science/article/pii/S2214629620301432.
[143] Pete V. Domenici, Blythe Lyons, and Julian J. Steyn, A Brighter Tomorrow: Fulfilling the Promise of Nuclear Energy (Lanham, MD: Rowman & Littlefield, 2006).
[144] Richard F. Fenno, *The Emergence of a Senate Leader: Pete Domenici and the Reagan Budget* (Washington, D.C.: Congressional Quarterly, 1991), 8.

New Mexico, an important oil and gas producing state, had hoped that Domenici would continue to support fossil fuel production, and vaulted the Albuquerque native into the Senate decisively in 1972. In a compromise energy bill in 1978, the senator had voted to phase out controls, which was not supported by oil and gas workers and companies.[145] Despite his controversial vote, Senator Domenici was re-elected with over fifty-three percent of the vote, his smallest vote share in what would become a thirty-six year career in the U.S. Senate. Regarding his vote and the related conundrum between national policymaking and appeasing constituents' demands, Domenici remarked:

> The oil and gas people of this state were mad at me. And they had been my strongest supporters. Up until the end, I voted with them; and the money was coming in. Every other member of the (New Mexico) delegation voted against the compromise. The day after my vote, the money was shut off—just like that. They know I'm involved in making energy policy. But they'd rather have someone who committed himself before hand to vote their way all the time than have a senator who is helping make policy.[146]

A disciplined politician and a product of a less-partisan era, the longtime New Mexico senator may have gotten a pass on his vote. As a Republican, he held his Senate seat for six terms despite a clear Democratic trend in his state. Domenici, the patron saint of nuclear power, grew to become one of the strongest nuclear energy advocates in the Senate. This reward for "good policy" may be less common in a more politically divided nation.

If Domenici was able to thread the needle of public opinion and his support for nuclear power, this is not easily achieved by others. Not all members of Congress are forgiven by their electorate for supporting controversial energy policies, especially ones unpopular with their

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[145] Ibid.
[146] Ibid.

constituency. During the 2010 midterm elections, Democrats who supported President Barack Obama's energy reform policies suffered decisive defeats at the ballot box. Many of these lawmakers represented increasingly conservative districts reliant on a prosperous fossil fuel industry. Fellow New Mexican Harry Teague did not receive the forgiveness that Domenici did. A congressman from southern New Mexico (where much of the state's oil is drilled), the moderate Democrat voted for H.R. 2454, the American Clean Energy and Security Act of 2009, which included cap-and-trade legislation and increased efforts to transition to alternative energy.[147] Teague lost in 2010 to Steve Pearce, the congressman that the Democrat had defeated two years earlier.[148] Pearce's spokesman described the cap and trade vote as the "galvanizing symbol that got people's attention" in New Mexico's second congressional district. A supporter of the fossil fuel industry, Rep. Pearce never lost reelection in this oil and gas dependent constituency.

Virginia congressman Rich Boucher (D-VA-9) met a similar fate. Like his colleague, Rep. Boucher voted in favor of H.R. 2454 and was defeated by a pro-fossil fuel Republican.[149] Boucher, who represented a conservative coal mining district in the Virginia panhandle, lost to the Virginia House of Delegates Majority Leader Morgan Griffith, a climate change denier. The Virginia Democrat was hardly alone: over two dozen Democrats who supported H.R. 2454 lost in 2010.[150] While proving a causal relationship between a member's vote and their re-election result is difficult at best, the perception that a representative is voting against their constituents' demands can be damaging. In this case, Rep. Boucher's district was trending toward Republicans

[147] Ibid.
[148] Ibid.
[149] Ibid.
[150] Darren Samuelsohn and Robin Bravender, "Day of Reckoning for Climate Vote," Politico (Politico, LLC, November 3, 2010), https://www.politico.com/story/2010/11/day-of-reckoning-for-climate-vote-044617#ixzz14G0EOqgi.

(John McCain won it by nineteen percentage points in 2008) and the national environment was strongly Republican. Nevertheless, Boucher's former chief of staff cited the bill as a principal reason why his boss lost his race, stating that he didn't "think there's any question about it, cap and trade was the issue in the campaign."[151] A more partisan electorate may be less forgiving of politicians who vote their conscience over their electorate's demands. Given nuclear energy's middling public approval and disapproval from environmental and fossil fuel groups alike, the influence of public may be preventing Congress from putting more nuclear reactors online.

In situating this research within Fenno and Mayhew's arguments, we can claim that public opinion plays a principal role in furthering and preventing specific policies. It is not that support for nuclear power leads to automatic defeat amidst an opposing electorate, but lawmakers who stand opposed to their constituents on issues of high salience, such as nuclear power, add substantial risk to their prospects for reelection. Members of Congress are strongly influenced by public opinion and nuclear energy's approval ratings are often mediocre. As a case study into American politics, nuclear power is demonstrative of our theory that public perception can hinder the advancement of individual policies.

Lobbying/Interest Groups: Necessary but Not Sufficient

While involved in the policymaking sphere, nuclear special interest groups take a back seat to public opinion/NIMBYism, cost, and the regulatory framework. This is not to say that interest groups are not important players in the nuclear policy arena: they provide research and staff to push for and against policy initiatives. Moreover, they help shape the nuclear energy narrative by producing writeups, books, and speeches that can convince nuclear skeptics or push against pro-nuclear advocates. As in many policy fields, the range of nuclear energy interest

[151] Ibid.

groups span from industry organizations like the Nuclear Energy Institute, to antinuclear activist organizations like Greenpeace and grassroots organizations like Environmental Progress and the Union for Concerned Scientists. This is consistent with much of the literature regarding the role of interest groups: Leech cites that interest group influence is an "important" but not "sufficient" cause of a legislative victory or defeat. While they can shape narratives and play critical roles, pinning the passage or failure of a bill exclusively on the impact of lobbies is difficult at best.

Non-nuclear energy interest groups and industries have played a role in stymieing efforts to build new nuclear reactors. While lobbies blocking nuclear power plants have notched key victories, the nuclear power industry has been left in its wake. The American Petroleum Institute is part of an emerging coalition of environmentalists, industries, and fossil fuel lobbies opposing nuclear subsidies.[152] From a grassroots perspective, the Natural Resources Defense Council (NRDC), has opposed nuclear "bailouts" and only supported subsidies when renewables received funding.[153] Anti-nuclear interest groups like the NRDC claim that nuclear power is "neither clean nor renewable" and not on the same "playing field" as renewable sources like wind and solar.[154] To the extent that these groups have hindered nuclear power plants, however, is less clear, according to interviews with congressional staff. Three Mile Island, Chernobyl, and Fukushima have remained potent counterarguments to the safety of nuclear reactors, according to several Republican and Democratic congressional staffers. When questioning the efficacy of nuclear energy, several Democratic staffers pointed toward environmental safety concerns that anti-

[152] Marie Cusick, "Struggling Nuclear Industry Lobbies State Governments for Help," NPR (National Public Radio, May 16, 2017), https://www.npr.org/2017/05/16/528657268/struggling-nuclear-industry-lobbies-state-governments-for-help.
[153] Ibid.
[154] Ibid.

nuclear lobbies cite when lobbying against nuclear power. While interest opposition seems to be associated with a decline of new reactors online, a causal relationship is less certain

In an interview with a Republican congressional staffer, the role of the pro and anti-nuclear industry and lobbies were considered "secondary." The staffer described that lobbyists meet with members, bring scientists, and provide key research that the member and staff do not have time for. They "explain the importance" of nuclear power and offer "scientific projections" of future technology, like nuclear fusion. By introducing lawmakers to expert nuclear scientists and policy analysts, the nuclear industry can more fully explain their position with quantitative and qualitative reports. In other words, they offer their research to persuade or support sympathetic members. The staffer noted that the member has not taken or been offered meetings with anti-nuclear interest groups.

Interest groups have played an important role in state-level nuclear politics. In New York and Illinois, the nuclear industry has received subsidies from the state government to keep them competitive in the energy market. These states, along with South Carolina, are seen as leaders in building new nuclear energy infrastructure. As natural gas continues to be an affordable alternative (and solar and wind technologies develop), the anti-nuclear coalition will continue to win legislative and policy battles. The unique combination of grassroots groups like Greenpeace, fossil fuel industries, and solar and wind lobbies like the American Clean Power Association makes for a powerful and unique coalition. This is not to say that the pro-nuclear lobbies are ineffective. Interviews with pro-nuclear lobbyists and employees at pro-nuclear energy special interest groups have cited their efforts in favor of the passage of the Inflation Reduction Act as key to advancing nuclear energy and giving nuclear power plants a lifeline.

To this point, pro-nuclear interest groups have played a vital role in passing the Biden administration's energy policy. In an interview with a nuclear lobby expert, the staffer noted that "advocacy matters a lot" in passing nuclear policy. They cited that their organization's efforts were "hugely impactful" on the passage of the Inflation Reduction Act of 2022. According to the staffer, the lobbying group had been working on the pro-nuclear credits within the bill for over a decade and that the IRA represented a culmination of a decade's worth of advocacy and lobbying. Within the IRA's $369 billion in climate change provisions, the bill offers a nuclear energy production tax credit of up to $15 per megawatt-hour for the electricity produced by plants (assuming that labor and wage requirements are met) that a pro-nuclear advocate described as essential to "level the playing field" between solar and nuclear. The work between the nuclear lobby and the Biden Administration has proved helpful in advancing nuclear power plants in the United States. High profile lobbies, like NEI, are not the only interest groups informing the nuclear energy sphere.

The pro-nuclear lobby can also advocate at the expense of other green energy sources. For instance, Michael Shellenberger is not only a pro-nuclear advocate, but he is also an ardent anti-renewable energy activist. Shellenberger, a Democrat-turned Independent and two-time California gubernatorial candidate, has turned his environmental advocacy into a crusade against wind and solar energy. During an interview with an executive of a Virginia energy policy firm, the interviewee described Shellenberger as a "pain in the neck" for solar and wind energy and that he was "overtly paid off" by the nuclear industry. The executive expanded upon the California's grass-roots organizing as "playing off into people's fear" about the perceived unreliability of solar and wind and that Shellenberger, a rising national figure, is a frequent talking point at meetings across Virginia, where clients and colleagues consistently inquire about

the former politician's "misleading" statements. In other words, Shellenberger is a different form of advocate but no less effective at promulgating his narrative. With the combination of large industry groups and grassroots organizing, the nuclear energy lobby is an important, if secondary player in a competitive energy arena.

The same holds true for pro-nuclear advocacy. The anti-nuclear campaign has decades of proven messaging and political success. While often considered a minority within the energy sector, the anti-nuclear industry—spanning from left-wing environmentalists to conservative fossil fuel advocates—have convinced both political parties to remain mum on nuclear power (according to several interviews). For instance, a seasoned and internationally renowned nuclear expert characterized the anti-nuclear lobby as "small in number" but not "diminutive in stature." When elaborating on this point, she stated that nuclear opposition has been "very powerful and effective" on political leaders and the public. By drawing connections between nuclear weapons and fallout to power plants, lobbyists were able to depict seemingly innocuous and safe reactors as lethal. These conclusions are supported elsewhere: an interview with a House defense staffer also described a concerted, bipartisan anti-nuclear effort. With Democratic lawmakers, anti-nuclear interest groups targeted fears of nuclear meltdown and environmental disaster. With Republican lawmakers, the staffer noted, anti-nuclear lobbyists emphasize the exorbitant costs of nuclear power and the affordability of fossil fuels. Just as supporting nuclear energy can be bipartisan, political and industry-based opposition is equally ideologically inclusive.

Pro-nuclear advocacy played a key role in saving California's last nuclear reactor. During interviews with Diablo Canyon employees and California-based nuclear advocates, each participant noted that to keep a reactor online, the "best thing to have" was a lobbyist. Moreover, they elaborated that lobbying and advocacy have grown "significantly" in the last several years,

providing more voices in support of nuclear power. In Diablo Canyon's case, interviewees cited grassroots organizing and meeting with local and national leaders were essential in keeping the reactor online. Without these groups, California's last nuclear power plant—which was already scheduled for decommissioning—may have been another victim of America's nuclear power decline. If Diablo Canyon is any guide, then nuclear lobbies have been critical in shaping the nuclear energy debate. While a 1:1 relationship between special interest groups and policy outcomes is unclear, the interviews and research demonstrate that industries, lobbies, and interest groups remain crucial in hindering and advancing nuclear power. They may not be the principal reason why we do not see more nuclear reactors, but they are a major reason nonetheless.

Within Leech's arguments, lobbying is an influential aspect of politics but is rarely the motivating factor behind policy decisions. After over a dozen interviews, we can conclude that special interest groups, industries, and lobbies play an active role in the nuclear energy arena. Our theory is therefore correct: with regards to hindering nuclear advancement, they are not as critical as public opinion, cost, and the regulatory environment, but remain key players in shaping the debate through research and meeting with policymakers. As a case study into American politics, the relationship between nuclear energy and special interest groups substantiates the theory that industries can influence policy. In the case of nuclear power, they have been less of a roadblock and more of a help.

Legal/Regulatory Environment: A Major Impediment

The nuclear legal and regulatory environment, while well-intentioned, is often seen as a hindrance to new nuclear power development. After World War II and Eisenhower's "Atoms for Peace" initiative, Congress passed the Atomic Energy Act of 1954, which implemented a framework to research, develop, and construct nuclear reactors and a domestic atomic energy

industry.[155] This act, in tandem with the Atomic Energy Act of 1946, established the AEC as the primary regulatory body for this novel technology. The AEC, tasked with licensing nuclear reactors, was renowned for controversy among applicants and the public, and for its conflict of interest between nuclear reactor and weapons development (this tension was ultimately resolved in 1975 by replacing the AEC with the Nuclear Regulatory Commission, separating arms development from domestic power plants).[156] Before the NRC's creation, the licensing and approval process for a nuclear reactor were conducted by a three-person panel, known as the Atomic Safety and Licensing Board (ASLB).[157] This panel comprised of a lawyer (who led the trial-like proceedings), a mechanical or nuclear engineer, and an environmental scientist. Its proceedings were overseen by the Atomic Safety and Licensing Appeal Board (ASLAB), who reviewed proposals and the approval process to avoid appeals and legal blowback.[158] This relatively democratic process was adequate, but additional regulations and legislation made the so-called "nuclear courtroom" inadequate. In sum, the AEC was outdated for an increasingly complex nuclear arena. Despite efforts to update the regulatory environment, the same issues of out-of-date regulatory infrastructure have plagued the U.S. for decades and continue to do so today.

After President Nixon signed the National Environmental Policy Act (NEPA) in 1969, the AEC (and by extension, the ASLB) was forced to comply with additional environmental regulations. These new rules included a mandatory Environmental Impact Statement which forced contractors to produce a document detailing the existing site, the proposed project, and

[155] John F. Ahearne, *The Future of Nuclear Power in the United States* (Washington, DC: Federation of American Scientists, 2012), 45.
[156] Ahearne, *The Future of Nuclear Power*, 46.
[157] Ahearne, *The Future of Nuclear Power*, 47.
[158] Ibid.

any potential changes that the reactor would impose on the environment.[159] While the AEC took these policies in stride, NEPA created an additional roadblock to new nuclear plants, one that was innocuous on its own but burdensome when coupled with an increasingly stringent legal and regulatory environment.

Furthermore, bureaucratic roadblocks combined with Congressional backlash have hindered nuclear power's growth. Citing concerns about nuclear waste storage and the commensurate difficulties associated with building new projects, bureaucrats and politicians, left and right, have opposed atomic energy. According to an interview with a senior adviser to former Secretary of Energy Rick Perry, the Department of Energy's efforts to build permanent waste management facilities have been stalled for decades. In particular, the 1982 Nuclear Waste Policy Act delineated that the federal government was to locate specific places in the country to bury used nuclear fuel, known as deep geologic disposal, and build a permanent facility for radioactive waste by 1998.[160] Burying nuclear waste was (and is) considered to be the safest method of storage, but the ensuing scientific reports took five years to complete, and the House of Representatives was led by Speaker Jim Wright of Texas and Majority Leader Tom Foley of Washington, both from two of the three states considered to have optimal locations to build waste storage facilities. Neither wanted the nuclear waste site in their state and consequently stalled construction and funding.

The remaining site in Yucca Mountain, Nevada, had a fierce opponent in then-junior Senator Harry Reid.[161] Reid objected to building a radioactive waste plant in the Silver State entirely, prompting a decades-long controversy between the Department of Energy, the

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[159] Ahearne, *The Future of Nuclear Power*, 48.
[160] Geoffrey Brumfiel, "We're Storing Radioactive Waste Where Now?," Slate Magazine (Slate, January 30, 2013), https://slate.com/technology/2013/01/nuclear-waste-storage-why-did-yucca-mountain-fail-and-what-next.html.
[161] Ibid.

president, and Congress and thus delaying resources and the completion of Yucca Mountain.[162] It was ultimately scrapped in 2010 by President Obama with Senator Reid's emphatic encouragement. Today, the Yucca Mountain facility remains mothballed despite being one of the most well-documented places in the country and meeting EPA standards for preventing waste from contaminating air and water supplies.[163] Quite simply, politicians and bureaucrats postponed funding and research to advance political interests above the national need for a clean and consistent source of energy.

The regulatory system presents significant concerns for the advancement of American nuclear reactors. During the 1980s and 1990s, the NRC's licensing procedures and lengthy court appeals processes created an environment that hindered efforts to build new power plants. From 1991-1997, the NRC considered the Louisiana Energy Services' (LES) application without rendering a decision.[164] The licensing approval process, which lacked any specific timeframe, led to "unpredictable" delays that "effectively kill(ed)" license renewals or new construction.[165] Without a stipulated timeline (even allowing for construction delays), the profitability of nuclear power plants was bleak. However, the NRC has improved this unpredictability. After Senator Domenici's 1998 Senate report containing recommendations, then-NRC Chairman Shirley Ann Jackson improved the regulatory process.[166] These changes included a published licensing schedule intending to improve predictability. Statements from former Chairman Jackson reflect this shift:

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[162] Robert Gauthier, "Harry Reid vs Yucca Mountain," Chicago Tribune (Tribune Newspapers, May 23, 2019), https://www.chicagotribune.com/opinion/editorials/ct-yucca-nuclear-edit-1103-20141031-story.html.
[163] Gauthier, "Harry Reid vs Yucca Mountain."
[164] Domenici, *A Brighter Tomorrow*, 71.
[165] Ibid.
[166] Domenici, *A Brighter Tomorrow*, 76-7.

> We believe that accelerating our efforts toward a risk-informed and, where appropriate, performance-based regulatory approach will both enhance our safety decisions and provide a coherent basis for our regulatory process… I have made the theme of risk-informed regulation central to my tenure as the NRC Chairman. In fact, the Commission (NRC) is committed to the goal of using risk information and risk analysis as part of a policy framework that applies to all phases of our nuclear regulatory oversight, including rulemaking, licensing, inspection, assessment, and enforcement.[167]

While notable, these changes have not resulted in an increase in new nuclear reactors, nor were they intended to.[168] In reality, the U.S. has only seen one nuclear power plant completed since 1996, with two more reactors on the way by 2024.[169] Like much of the federal regulatory environment, the NRC aims to promote safe policies and ensure competent oversight. However, as several interviewees have attested, the NRC has prioritized safety at the expense of any new nuclear reactors. In *A Brighter Tomorrow,* Domenici argues that the legal and regulatory environment, led by the NRC, has significantly restricted America's nuclear energy program.[170] For example, the author cites a "shift" in the NRC's "regulatory culture" from promoting a "strong safety ethic" to "creating more regulations."[171] Senator Domenici claimed that it can take up to fourteen years to build a reactor in the United States, while an equally safe facility is built in Japan or France in six.[172] Congress intended the licensing process to ensure safe reactors,

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[167] Shirley Jackson, chairman, Nuclear Regulatory Commission, to the Subcommittee on Clean Air, Wetlands, Private Property, and Nuclear Safety of the Committee on Environment and Public Works on July 30, 1998, 5.
[168] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis," U.S. nuclear industry - U.S. Energy Information Administration (EIA) (U.S. Energy Information Administration, April 18, 2022), https://www.eia.gov/energyexplained/nuclear/us-nuclear-industry.php.
[169] Ibid.
[170] Domenici, Lyons, and Steyn, *A Brighter Tomorrow*, 71.
[171] Domenici, Lyons, and Steyn, *A Brighter Tomorrow*, 72-3.
[172] Domenici, Lyons, and Steyn, *A Brighter Tomorrow*, 71.

Domenici concluded, not to prevent them from being built entirely.[173] To the extent that the NRC has promoted safe regulations, it has been mostly successful: the U.S. has not witnessed a nuclear accident since Three Mile Island. To the extent that the NRC has encouraged building new reactors or been equipped to handle accidents, however, the picture is less rosy.

In the case of the regulatory framework, prioritizing safety has not always been successful. In the aftermath of the Three Mile Island Accident in 1979, the NRC was criticized in investigation reports for, among other transgressions, "ineffective handling of generic (safety) issues."[174] After developing protocol to address these "generic issues," the Government Accountability Office (GAO) evaluated the NRC's new procedures and found that the commission made "overall progress" but was overwhelmed by the fact that there were more new issues identified than resolved.[175] Quantitatively, the GAO explains that 11 new generic issues are identified per year.[176] If the NRC continued to find and solve these issues at the current pace, the GAO found, it would take 10 years for the NRC to resolve the 186 remaining issues.[177] Despite improvements on identifying and rectifying internal issues, the NRC only planned to solve 12 generic issues between 1984 and 1986, leaving 60 identified (many of which were high priority) unresolved.[178] To one degree or another, the NRC was not equipped to process the Pandora's Box of issues associated with a partial nuclear meltdown.

The debate between active and passive malfeasance within the regulatory process remains contentious. In an interview with a Virginia energy executive, the CEO described the

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[173] Ibid.
[174] Charles Bowker, *Report to the Congress of the United States: Management Weaknesses Affect Nuclear Regulatory Commission Efforts To Address Safety Issues Common To Nuclear Power Plants* (Washington, DC: Government Accountability Office, 1984), pp. 1-64, 5.
[175] Bowker, *Report to the Congress of the United States*, 6.
[176] Ibid.
[177] Ibid.
[178] Bowker, *Report to the Congress of the United States*, 6-7.

NRC as having a "huge impact" on nuclear energy, but their regulations were a result of legitimate safety concerns and the large scale of most reactors. The prospective dangers and size of nuclear power plants and waste facilities require a powerful bureaucracy with a sophisticated licensing process. While the NRC's licensing process could afford to be more streamlined, the executive elucidated that construction costs and location concerns (NIMBYism and room for cooling water/equipment) posed a greater impediment to new power plants than the regulatory environment itself. However, this lukewarm assessment of the NRC is far from universal. During an interview with a Western U.S. Republican staffer, the staff member remarked that the NRC's licensing process creates a "significant issue" for building new reactors. The "precautions" that the regulatory commission stipulates increases the reactor's timeline from planning to going online, impacting the bottom line for energy companies. The dysfunction within the NRC's licensing protocol for new reactors are a well-documented concern. Multiple interviews, including one with a staff member at a high-profile nuclear lobbying firm, stated that the NRC's licensing and approval process were "major hurdles" for American nuclear power plants and they "significantly hindered efforts" to put new reactors online. Renewed interest in nuclear power, however, has led to over a dozen applications for licenses in the next year. The NRC's readiness to process these applications expediently remains to be seen.

Additionally, the NRC is poorly equipped to assess Small Modular Reactors (SMRs) and other unorthodox nuclear technologies. Amy Roma, a partner with Hogan Lovells law firm with experience on dozens of nuclear reactor license applications, posited that today's regulatory framework is a "square peg in a round hole" for "advanced reactor designs."[179] Roma remarked

[179] Daniel Moore, "Push for Small Nuclear Reactors Runs into Regulators' Old Rules," Bloomberg Law (Bloomberg Industry Group, February 7, 2022), https://news.bloomberglaw.com/environment-and-energy/push-for-small-nuclear-reactors-runs-into-regulators-old-rules.

that the NRC is "largely divorced of actually understanding—in depth—the technology."[180] The current regulatory practices are a holdover from the 1950s, when the AEC was beginning its oversight process of the first reactors.[181] The new framework will not be introduced until the mid-2020s, when the AEC-era guidelines will be over seventy years old. Today, SMRs and alternative substance plants like helium and molten salt reactors bear little resemblance to the ones encouraged by President Eisenhower. This technological and regulatory discrepancy is key to understanding the lack of new nuclear power plants in America. No energy company has been awarded licenses for SMRs (an aforementioned promising and more affordable alternative to our older, larger reactors) because the commission requires data from similar American plants before issuing a license.[182] Because no SMRs have been constructed in the United States, none have been licensed. In other words, the NRC is using circular reasoning: the U.S. has not built any, so under their current rules, they cannot approve any SMRs. In lieu of building new reactors built in Europe but not in America, the NRC's unyielding licensing process and arcane rules present an uphill battle for new atomic power plants.

The NRC that Domenici envisioned has not come to fruition. Instead, it has been a roadblock to nuclear power's advancement and continues to keep outdated regulations on the books. Perhaps part of this issue is the fact that Domenici retired from the Senate in 2009 and few members of Congress have emphasized nuclear power to the same extent that he did. However, interviews ranging from industry officials, policy experts, and congressional staffers have mostly indicated that the NRC suffers from many of the same shortcomings that Senator

[180] Ibid.
[181] Ibid.
[182] Ibid.

Domenici identified over two decades ago. Despite the New Mexico senator's efforts, the case for nuclear power is still complicated by an ineffective regulatory environment.

Recent changes in the NRC framework are unlikely to yield a more streamlined process. Three years ago, Congress passed the Nuclear Energy Innovation and Modernization Act, which authorized the NRC to update the licensing process and modernize the regulatory framework to allow for newer reactor designs.[183] On September 30, 2022, the NRC released a 1252 page draft that the Breakthrough Institute found "largely replicates the failed licensing rules that have hobbled the legacy nuclear industry for decades."[184] In this proposed update, the "risk-informed" and "performance-based" licensing framework necessary to build newer and less-expensive reactors was forsaken in favor of a copied-and-pasted framework with provisions dating back over fifty years.[185] Despite Congress directing the NRC to build a licensing process capable of processing and approving smaller reactors with alternative designs, the regulatory commission has largely stuck to the status quo. By ignoring Congress' efforts to streamline and modernize the licensing framework, the NRC may stymie efforts to build any new power plants in the name of safety. While regulating reactors to ensure safety remains a central goal of any worthwhile regulatory framework, sticking to outmoded designs and the subsequent outdated licensing framework is counterproductive to advancing additional safe nuclear power plants and technology. Preventing nuclear accidents is a universal goal, but if the NRC is favoring outdated designs at the expense of newer ones, they are neither advancing nuclear energy nor promoting safe reactors. They are instead impeding new power plants that could replace older reactors.

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[183] "Nuclear Power in France," Nuclear Power in France | French Nuclear Energy - World Nuclear Association (World Nuclear Association, December 2022), https://www.world-nuclear.org/information-library/country-profiles/countries-a-f/france.aspx.
[184] Ibid.
[185] Ted Nordhaus and Adam Stein, "NRC Staff Whiffs on Nuclear Licensing Modernization," The Breakthrough Institute (The Breakthrough Institute, December 12, 2022), https://thebreakthrough.org/blog/nrc-staff-whiffs-on-nuclear-licensing-modernization.

The Weberian theory that bureaucracy is a net positive for a safe and functional society is not true in the case of nuclear power. At first blush, the NRC passes muster: an agency founded upon ensuring safe reactors is a sensible and wholly necessary component of nuclear energy. However, America's track record with nuclear regulations is flawed at best and ineffective at worst. The AEC became entangled by combining atomic weapons regulation and atomic energy, and the reforms that created the NRC still left the regulatory commission unprepared to handle the Three Mile Island accident five years later. Today, the regulatory framework is outdated and unequipped to handle SMRs and other recent technological developments. It is therefore difficult to maintain that the American nuclear bureaucracy has been a safeguard to promoting nuclear reactors when it was caught off-guard by a nuclear accident and has hindered the construction of new nuclear power plants. Situating the nuclear regulatory framework within Marx's and Weber's theories is to debunk them in this context because their optimistic views of the bureaucracy have not been corroborated by research. They may be valid in other public policy questions, but not in the case of American nuclear power. More broadly, the theory that the modern regulatory framework is insufficient at protecting and advancing safe, new reactors is largely correct. The regulatory agencies overseeing nuclear power development have not furthered its advancement: they have stymied most new reactors in the name of safety, and the consequence has been continued usage of older and outmoded power plants.

Cost: A Combination of the Above Factors that Ultimately Prevents Nuclear Power

The strict regulatory environment and consequent high cost of nuclear power remains a critical hindrance for any new nuclear power plant. The significant roadblocks and dysfunction within the NRC generate significant expenses for putting new nuclear reactors online. Together, the rarity of the materials required and scale of the engineering project necessary to bring one

online, combined with mediocre public approval numbers, effective anti-nuclear campaigns, and a complex regulatory framework, render nuclear power plants an expensive and complicated solution to our alternative energy needs.

While nuclear technology has significantly developed since Atoms for Peace, the cost of constructing a nuclear power plant continues to stymie nuclear construction. Cost continues to be a major hurdle for building nuclear reactors. Planned nuclear reactors are estimated to cost $5,500/kW to $8,100/kW, or between $6 billion and $9 billion for each 1,100 MW plant, making them cost prohibitive to build without extensive subsidies.[186] In Waynesboro, Georgia, the Vogtle Units 3 and 4 have continued to run overbudget and behind schedule. Vogtle, the only nuclear reactor under construction in America, is projected to cost its owners over $30 billion, more than double the initial projected cost determined in 2012. This sizable increase is due to poor initial cost projections, errors in construction, and a stringent legal and regulatory environment.[187] Vogtle's substandard construction work, including a leak in the third reactor's spent fuel pool and improperly separated electrical cables, set construction times back months, thereby raising costs. Critically, these financial setbacks have made shareholders like the Oglethorpe Power Corporation and the Municipal Electric Authority of Georgia reticent to continue funding a never-ending project. Unfortunately for nuclear power, Vogtle's case is not unique.

In neighboring South Carolina, the Virgil C. Summer Nuclear Power station faced numerous economic hurdles stemming from incompetence and needless errors. As part of a

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[186] David Schlissel and Bruce Biewald, "Nuclear Power Plant Construction Costs - July 2008 - Synapse Energy," Synapse Energy Economics (Synapse Energy Economics, Inc, July 2008), https://www.synapse-energy.com/sites/default/files/SynapsePaper.2008-07.0.Nuclear-Plant-Construction-Costs.A0022_0.pdf, 2.
[187] Jeff Amy, "'Outrageous' Price Tag: Plant Vogtle Cost Doubles to $28.5 Billion as Other Owners Balk," The Augusta Chronicle (Augusta Chronicle, November 4, 2021), https://www.augustachronicle.com/story/news/2021/11/04/georgia-power-nuclear-reactors-plant-vogtle-cost-doubles-energy-costs/6286729001/.

"nuclear renaissance", thirteen companies applied to the NRC for licensing to build over thirty new nuclear reactors from 2007 to 2009.[188] No reactors had been approved since the 1979 Three Mile Island partial meltdown, and funding from the Energy Policy Act of 2005 had stimulated new interest in a Cold War-era technology. Then-senator Pete Domenici (R-NM), chairman of the Senate Committee on Energy and Natural Resources and a proponent of atomic energy, said in a statement:

> When we passed the bill, I didn't dream that a year later utilities would have announced plans to build as many as 25 new nuclear power plants in the next 20 years. We verge on the nuclear power renaissance I have hoped for. We are revitalizing rural America, creating jobs in towns that haven't enjoyed enough prosperity.[189]

The nuclear energy advocate's optimism aged poorly. The Summer reactor, one of the 31 facilities planned, was an expansion of existing South Carolina plant that was seen as a "harbinger" of a nuclear resurgence. However, the project was ultimately cancelled because of mismanagement and faulty component manufacturing, causing delays that skyrocketed the plant's budget. Westinghouse, the project contractor, had "incompetence at every level": blueprints were drafted by unlicensed employees without engineer approval, incorrect parts were manufactured and ordered, and the site operated without a construction schedule.[190] By 2017, the construction cost ballooned to $25 billion and South Carolina Electric and Gas (SCE&G)

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[188] Ayesha Rascoe, "U.S. Approves First New Nuclear Plant in a Generation," Reuters (Thomson Reuters, February 9, 2012), https://www.reuters.com/article/us-usa-nuclear-nrc-idUSTRE8182J720120209.
[189] "Domenici Commemorates the Anniversary of EPACT 2005," U.S. Senate Committee on Energy and Natural Resources (U.S. Senate, August 8, 2006), https://www.energy.senate.gov/2006/8/press-AB0AEAB6-28D5-4BE6-8DD7-A4F606D38C92.
[190] Andrew Brown , "Early Signs of 'Incompetence at Every Level' Went Unheeded as South ...," The Post and Courier (Post and Courier, August 27, 2017), https://www.postandcourier.com/business/early-signs-of-incompetence-at-every-level-went-unheeded-as-south-carolina-rushed-toward-sexy/article_b47acd2c-89a5-11e7-830a-9364c7e7b71b.html.

abandoned the project, citing mismanagement and budget concerns.[191] This debacle, known as the Nukegate scandal, is demonstrative of the financial and logistical obstacles that nuclear power faces. If pro-nuclear power supporters want the rest of America to subscribe to Senator Domenici's nuclear vision, then the ever-present cost issue must be addressed.

However, the typical and simplistic "construction is always overbudget" theory is insufficient. According to a November 2020 MIT study, changes in safety regulations would only play a minor role in reducing construction costs.[192] The excess cost, researchers found, came more from last minute design changes based on "particular" site conditions or other "local circumstances."[193] If more reactor components (or the entire plant) were manufactured offsite, construction costs would be substantially reduced. The bureaucratic environment may only be a contributing factor toward raising reactor construction costs.

For nuclear energy, the capital cost of building a reactor and putting it online is especially high compared to other sources of energy.[194] In particular, the capital cost of first generation reactors (plants using initial designs from the 1950s and 1960s) and Generation II reactors built through 1980 were, on average, fifty percent higher than similarly-sized coal plants, accounting for inflation.[195] Furthermore, construction costs increased twenty-four percent annually compared to six percent annual increases for coal-powered plants during this period.[196] Over 120

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[191] Thad Moore, "Santee Cooper, SCE&G Pull Plug on Roughly $25 Billion Nuclear Plants in ...," The Post and Courier (Post and Courier, July 31, 2017), https://www.postandcourier.com/business/santee-cooper-sce-g-pull-plug-on-roughly-25-billion-nuclear-plants-in-south-carolina/article_c173c0fa-75fb-11e7-a086-cfcd325f82e7.html.
[192] Philip Eash-Gates, "Sources of Cost Overrun in Nuclear Power Plant Construction Call for a New Approach to Engineering Design," Joule (Cell Press, November 18, 2020), https://reader.elsevier.com/reader/sd/pii/S254243512030458X?token=096251AB28B56C00C4FD7C8EC5ED29F0101BEE781FDBC871D385C1050596BD614EBE6526C8B9AAF10FDA2FF7D7E34130&originRegion=us-east-1&originCreation=20221011144833.
[193] Ibid.
[194] Ahearne, *The Future of Nuclear Power in the United States*, 31.
[195] Ibid.
[196] Ibid.

nuclear reactors, half the reactors planned, never broke ground because construction companies cited a lack of profits.[197] When compared to coal or other fossil fuels, nuclear power plants struggled to make money in the 1960s and 1970s. The combination of an extensive regulatory environment and the sheer cost of construction (a consequence of a labyrinthine regulatory framework) made atomic energy an expensive proposition. The same story holds true today.

Nuclear energy is not without its important fiscal downsides. Stanford University professor Amory Lovins argues that nuclear energy is neither fiscally responsible nor environmentally sound. He claims that nuclear power has "bleak prospects because it has no business case."[198] New plants, the author cites, cost 3-8 times or 5-13 times more per kWh than unsubsidized new wind or solar power.[199] Furthermore, nuclear power produces 3-13 times fewer kWh per dollar and therefore displaces 3–13x less carbon per dollar than new renewables.[200] Lovins' argument rests upon nuclear energy's economic inefficiency: if atomic energy does not make financial sense, then it has no place in an actionable environmental plan. The Stanford professor expands upon this conundrum between environmentalism and fiscal responsibility. He cites that Congress' 2021 $6 billion nuclear subsidy only adds to current subsidies that add and often surpass nuclear construction costs.[201] Propping up "obsolete assets," Lovins writes, "blocks" more "climate-effective replacements" like solar and wind that save more carbon per dollar.[202] In the author's view, the "all-of-the-above" energy strategy peddled in Washington will

[197] Ibid.
[198] Amory B. Lovins, "Why Nuclear Power Is Bad for Your Wallet and the Climate," Bloomberg Law (Bloomberg Law, December 17, 2021), https://news.bloomberglaw.com/environment-and-energy/why-nuclear-power-is-bad-for-your-wallet-and-the-climate.
[199] Ibid.
[200] Ibid.
[201] Ibid.
[202] Ibid.

not solve the climate crisis: the urgency of global warming necessitates "judicious" investments into affordable and fast sources of clean energy.[203]

Professor Lovins' argument raises several crucial shortcomings of atomic energy. Principally, nuclear power's high construction and operational costs make it an unattractive choice given our climate crisis. As the author demonstrates, wind and solar are more economical and can therefore help us reduce carbon emissions expediently. Lovins adds a new perspective to the financial concerns of atomic energy: high costs are a legitimate fiscal barrier to new reactors, but they also indicate that we shouldn't build them at all. Because of their cost and subsequent delays, building nuclear power plants is not only fiscally unwise, but also environmentally unsound.

Congressional research substantiates concerns regarding the expenses of building nuclear reactors. A 2021 Congressional Research Service (CRS) report details the importance of cost in expanding nuclear power's market share. The report found that the price of constructing and operating a nuclear reactor in the United States is "significantly higher" than natural gas, wind, or solar powered energy facilities.[204] For instance, the overview notes that the Energy Information Administration (EIA) estimated that, for plants going online in 2026, the average cost of electricity generation from a nuclear power plant would be 6.3 cents per kWh while an advanced gas-fired plant would run 3.7 cents per kWh.[205] Solar photovoltaics, the EIA found, were 3 cents/kWh, and onshore wind would generate electricity at 3.7 cents/kWh.[206] According to this CRS report, the struggle for nuclear power is that its high costs prevent it from competing

[203] Ibid.
[204] "Nuclear Energy: Overview of Congressional Issues," Congressional Research Service, October 20, 2021, https://sgp.fas.org/crs/misc/R42853.pdf.
[205] Ibid.
[206] Ibid.

in the open energy market. As long as atomic energy production remains expensive, its chances of increasing its market share remain dim. Political factors such as public opinion, lobbying, and the regulatory environment are significant hinderances to the development of new nuclear power. If such obstacles can be overcome, nuclear power would then have to overcome a cost factor to be developed.

The cost of nuclear power plant construction is difficult to estimate, but suffice it to say, it is expensive. A 2008 Synapse report, authored by David Schlissel and Bruce Biewald, estimates the cost of constructing new nuclear reactors in the United States. The authors state that companies planning new reactors have estimated total costs to be between $5,500/kW to $8,100/kW or between $6 billion and $9 billion for each 1,100 MW plant.[207] According to the report, these costs are significantly higher than previously estimated. From 2000-2002, the nuclear industry and the DOE cited overnight costs to be between $1,200/kW to $1,500/kW for new nuclear units, meaning that total costs lie between $2 and $4 billion per 1,100 MW plant.[208] This discrepancy, the authors explain, is caused by "fierce worldwide competition" for the resources, commodities, and manufacturing capacity necessary for designing and building new power plants.[209] Moreover, the limited amount of manufacturers, suppliers, and engineers further increased building costs, as it creates an oligopoly. Therefore, the resulting longer lead times and increased costs are no surprise. In contrast, the costs of a similar natural gas power plant are between 1,100 and 1,200/kW.[210] While neither are cheap, nuclear reactors are hardly cost competitive.

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[207] Schlissel and Biewald, "Nuclear Power Plant Construction Costs,", https://www.synapse-energy.com/sites/default/files/SynapsePaper.2008-07.0.Nuclear-Plant-Construction-Costs.A0022_0.pdf, 2.
[208] Ibid.
[209] Schissel and Biewald, "Nuclear Power Plant Construction Costs," https://www.synapse-energy.com/sites/default/files/SynapsePaper.2008-07.0.Nuclear-Plant-Construction-Costs.A0022_0.pdf, 5
[210] EIA, "Average Construction Cost of Natural Gas Generators Installed in the United States in 2020, by plant type, chart, August 23, 2022.

For many scientists and energy companies, nuclear power is seen as fiscally impractical solution as compared to the more affordable options, solar and wind. For example, a 2008 "Business Risks and the Costs of Nuclear Power," illustrates how atomic energy has been relegated into the ash heap of history because of its excessive costs, risks, and delays. He pulls from the summary that:

> It has been an entire generation since nuclear power was seriously considered as an energy option in the U.S. It seems to have been forgotten that the reason U.S. utilities stopped ordering nuclear power plants was their conclusion that nuclear power's business risks and costs proved excessive.[211]

Nuclear energy is hindered by exorbitant materials and construction costs—reducing costs would make it more competitive on the open market. Likewise, the risks from building a nuclear power plant are numerous and costly. In other words, nuclear power's costs restrict this unique energy source. A meaningful reduction in cost—where the regulatory framework was streamlined—could have the opposite effect.

Size is another contributing factor toward a reactor's cost. It is not necessarily the case that large nuclear power plants, akin to the one at Pottstown, Pennsylvania (see Figure 8), are necessary. SMRs offer an alternative option to reduce construction costs and thereby encourage nuclear reactor development. This reactor design is a more cost-effective alternative because they are manufactured and assembled offsite to a common plan—unlike conventional large reactors that adhere to a unique blueprint. Adrian Cho, an author at the American Association for the Advancement of Science, cites that a normal large reactor costs at least $7 billion, while his plan (delineated in an interview between the author and nuclear engineer Jose Reyes) calls for

[211] Anne Christianson et al., "The Staggering Cost of New Nuclear Power," Center for American Progress, June 6, 2022, https://www.americanprogress.org/article/the-staggering-cost-of-new-nuclear-power/.

twelve SMRs stacked like "beer cans in a six pack" to form one power plant to the tune of $3 billion.[212] This cost difference is key: nuclear power success hinges (in part) on its affordability, as well as overcoming political obstacles such as public opinion, the work of lobbyists, and the regulatory environment.

The concern of affordability transcends outmoded reactor designs. In the Bulletin of the Atomic Scientists, researchers distilled the high costs of a nuclear reactors into two expenses: capital and operating.[213] Capital costs, like site preparation, commissioning, construction, and manufacturing, are much higher than those for coal, natural gas, and others because of the "strict licensing and design requirements."[214] The authors reiterate that these high costs make nuclear energy uncompetitive in the American market. More specifically, they cite the high discount rate in U.S. as crucial to holding back the nuclear energy sector. A discount rate is a "piece of the calculation of overall energy cost that reflects the capital costs of a project."[215] This rate, the authors claim, is higher in the United States and is higher than other forms of energy. Where governments have more fully subsidized nuclear energy, like Russia and China, nuclear power plants continue to be built.[216] To be sure, citing two authoritarian countries instead of two democratic ones complicates their argument, but the point stands: building nuclear reactors in America is cost-prohibitive compared to other nations. High construction expenses in the U.S. stem, in part, from a relative lack of subsidies. As France and China continue to prioritize

[212] Adrian Cho, "Smaller, Safer, Cheaper: One Company Aims to Reinvent the Nuclear Reactor and Save A Warming Planet," Science (American Association for the Advancement of Science, February 21, 2019), https://www.science.org/content/article/smaller-safer-cheaper-one-company-aims-reinvent-nuclear-reactor-and-save-warming-planet.
[213] John Mecklin, "Why Nuclear Power Plants Cost so Much-and What Can Be Done about It," Bulletin of the Atomic Scientists (Bulletin of the Atomic Scientists, June 21, 2019), https://thebulletin.org/2019/06/why-nuclear-power-plants-cost-so-much-and-what-can-be-done-about-it/.
[214] Ibid.
[215] Ibid.
[216] Ibid.

nuclear energy while the United States hesitates, the former countries will enjoy a growing and prosperous nuclear fleet because it is cost-competitive. If America wants to realize Eisenhower's and Disney's dreams of a nuclear-powered future, it must place nuclear power on an even market playing field.

Nuclear energy does not have to be cost-prohibitive. While expensive, new reactor designs and methods of energy storage can reduce costs by adhering to a common blueprint. According to an interview with a renewable energy analyst at the DOE, there has been renewed interest in building SMRs that are quickly built and more versatile to local geographic challenges. The analyst delineated that SMRs are manufactured off-site to a common design and easily assembled in a given location, meaning that utility companies would not have to build a unique reactor to a specific site. Power companies would have to modify the SMR to its intended location, but the construction times would likely decrease, which would result in lower overall expenses. Moreover, their small capacity requires fewer employees and thus reduces the cost of operation. At first blush, SMRs are a recipe for disaster: a nearly uniform blueprint ignores the individual geological drawbacks of a site, and a decreased staff can put financial savings ahead of safety. It is a tempting but largely invalid conclusion. Contractors are still able to adapt new facilities to their locations and the non-weapons grade uranium used in SMRs makes these reactors a poor target. Yet, even with cheaper nuclear reactors, the policy environment needs to be overcome. The current regulatory environment favors large reactors, contributing to the high cost of nuclear energy that has—in tandem with middling public approval ratings and anti-nuclear lobbies—put this promising energy source at the backseat of our clean energy portfolio.

Summary of Conclusions: Public Opinion, Industries, and Bureaucracy Make Nuclear Power Costly

Based on over twenty interviews, we can conclude that public opinion, industries and special interest groups, costs of planning and building a nuclear reactor, and the regulatory framework surrounding nuclear energy each contribute to the U.S.'s relative lack of new nuclear power plants. Despite an increasing concern for global warming, interest in green energy, and new technological innovations, America is not seeing a substantive increase in new nuclear reactors because of wavering public opinion, powerful lobbies and advocacy, antiquated and cumbersome regulations, and soaring planning and construction costs. Each of these factors are important, but in my research, none are as individually crucial as cost. If nuclear energy was cost-competitive, nuclear energy would be a significantly larger player on America's energy stage. But cost is not unrelated to the political environment. With each factor—NIMBYism, lobbying, the regulatory environment—costs are added, and an already expensive undertaking becomes increasingly cost-prohibitive.

Beyond cost, public opposition and NIMBYism are major political setbacks for nuclear power in America, and the arcane regulatory environment and well-funded interest groups play key roles in shaping the nuclear power debate. Nevertheless, the cost of building a nuclear power plant—a combination, in part, of the aforementioned factors—remains the principal reason why the United States is not seeing a substantial increase in new nuclear reactors put online. In my research, cost is an amalgam of community sentiments, lobbying, and labyrinthine regulations. Each factor raises planning and construction costs: if the public and grassroots advocates fight a new, neighboring reactor, the project is delayed and fought over in the courts. Likewise, a new power plant can be stymied by confusing and onerous regulatory framework. The combination of

these forces, therefore, indicates that the expenses behind planning and building a new nuclear reactor are the chief hindrance to America's transition to nuclear power.

While cost is a leading impediment for nuclear energy, the regulatory environment and public opinion are substantial obstacles on their own. The Nuclear Regulatory Commission's guidelines have been described by engineers, policy experts, and nuclear power plant employees as outdated and complex. These complications hinder efforts to build nuclear reactors because they cause construction delays and restrict implementation of new reactor technology, like microreactors and SMRs. Similarly, public perception of nuclear power plants and radioactive waste weigh heavily in lawmaker's minds. A nuclear reactor must be built in one of the U.S.'s 435 congressional districts, and constituents have a long history of fighting new power plants or nuclear waste facilities in their communities. The NIMBY component of public opposition has forced the closure of functioning reactors and likely prevented planned reactors from going online. While special interest groups and advocacy have played a secondary role in preventing (and advancing) nuclear power, they are a critical research tool for lawmakers and staffers and have had a major impact on nuclear energy policy.

Overall, nuclear power is an important case study in the challenges, if not potential failings, of self-government and materialism. It remains unlikely that we can decrease our consumption of material goods, and one of the clearest solutions to our greenhouse gas issue—nuclear energy—remains hindered by a government paralyzed by public perception concerns, an inefficient regulatory framework, and persistently high construction costs. Nuclear energy is therefore an example of a larger political and social issue: democracy, while vital to protecting self-rule, civil rights, and individual liberties, is flawed at advancing effective if unpopular policies. Democracy, however, is not solely to blame. Capitalism typically favors high volume,

low cost options. Nuclear energy produces vast quantities of energy but is often cost prohibitive. Should we hope to successfully address greenhouse gas emissions and climate change, we should look to atomic energy as a single-issue case study as to where our nation's political and societal mechanisms fall short.

Recommendations

The regulatory environment is a critical impediment for nuclear energy. Nearly every interviewee indicated that the current regulatory framework is outdated and counterproductive: rather than advancing safe nuclear technology, the NRC has stopped progress on viable projects. Several interviewees described the regulatory framework as a "redoubt of 1950s-era guidelines" for reactor designs that are no longer built. To allow for new reactor designs, the NRC could abandon its existing regulatory framework and adopt "risk-informed, performance-based" testing.[217] Currently, the NRC uses prescriptive rules intended to approve large light water reactors, not SMRs, microreactors, or other alternative designs. By reforming the NRC's guidelines, the regulatory process would become more flexible to new and more affordable reactors. The fact that the nuclear licensing process has not (to date) licensed a new reactor design that was put online demonstrates that the regulatory framework is an impediment to new reactors'. If policymakers are serious about nuclear energy, a regulatory environment that prioritizes risk-informed licensing ahead of safety-at-all-costs is an environment that would likely spur additional and safe nuclear reactors. Streamlining the licensing process to include the past several decades of technological advancement would be a necessary reform if the goal is to increase the amount of new, secure reactors online.

[217] Nordhaus and Stein, "NRC Staff Whiffs on Nuclear Licensing Modernization," The Breakthrough Institute.

More specifically, the regulatory framework could also be modified to include fusion energy within its provisions. Nuclear fusion has several appealing properties: no special nuclear fuel (fission requires plutonium, uranium-233, or uranium enriched in the isotope-233 or in the isotope-235) or self-sustaining chain reactions, making fusion a safer option than the larger fission reactors stipulated in currently regulatory guidelines.[218] While fusion energy is not on the energy market, recent advances make a compelling case for its role in the future of nuclear energy. To omit it from the much-needed updates to the regulatory environment would be to suppress one of the most promising developments in nuclear power.[219]

However, to become a significant part of the U.S.'s green energy portfolio, atomic energy must be cost-competitive. Given the cost of nuclear energy and the potential for additional technological development, the federal government could provide additional subsidies and tax incentives to laboratories and utility companies. But in reality, reducing costs requires more than financial subsidies: the regulatory framework must be modernized to keep up with technological changes so that the latest technologies, including cost saving ones, can be pursued within existing regulatory guidelines. Nevertheless, as the research presented here indicates, federal subsidies and financial incentives directed toward developing new and more affordable reactor designs would help in lowering construction and operation costs of nuclear plants. To best mitigate cost, these subsidies would also extend to construction expenses. Offering federal aid to utility companies for nuclear plants would allow power companies to reconsider their method of energy production. If subsidies can put nuclear power on par with solar, wind, and oil and gas,

[218] Jay Obernolte, "I'm a Video Game Developer but This Technology to Drop Your Energy Bill $820 per Year Is No Fantasy," Fox News (FOX News Network, January 10, 2023), https://www.foxnews.com/opinion/video-game-developer-technology-drop-your-energy-bill-820-per-year-no-fantasy.
[219] Kenneth Chang, "Scientists Achieve Nuclear Fusion Breakthrough with Blast of 192 Lasers," The New York Times (The New York Times, December 13, 2022), https://www.nytimes.com/2022/12/13/science/nuclear-fusion-energy-breakthrough.html.

energy companies will be incentivized to build nuclear reactors because the material cost difference between various production methods will be reduced. Energy companies value profits over clean energy production: nudging them toward a power source that emits vast amounts of affordable and clean energy would benefit consumers, utility providers, and the environment.

While this paper has focused on the political obstacles facing American nuclear energy production, the application of atomic energy to combat environmental disasters warrants considerable additional research. In the Western United States, climate change and poor forest management have created an environment prone to crippling droughts and devastating wildfires. The dwindling amount of water left to fight these fires leaves the West in a precarious position: people and farms require the water to survive yet fighting an increasingly severe fire season demands a reliably plentiful water supply. California has begun to embrace desalination facilities, where ocean water is desalted and turned into potable water. The issue here is the amount of energy needed to operate desalination plant. During operation, the pressure required is approximately two times the osmotic pressure: for seawater, this translates to about 800–1,000 pounds per square inch.[220] The energy required to run pumps that can achieve these high pressures account for approximately 25 percent to 40 percent of the overall cost of water.[221] In this situation, a nuclear reactor (which provide large amount of constant energy) could be an ideal solution. Unlike nearly all other power plants, nuclear facilities cannot be turned off to adjust to fluctuating energy demands. By constructing nuclear reactors close to the shore (especially in less developed and high elevation areas), plants can channel unused energy to desalination facilities, a burgeoning water source for the parched American West.

[220] "Desalination," U.S. Department of Energy - Office of Energy Efficiency and Renewable Energy (U.S. Department of Energy, September 2019), https://www.energy.gov/sites/default/files/2019/09/f66/73355-7.pdf.
[221] Ibid.

This issue of providing water to the West also raises questions about the future of hydroelectric power. In 2021, a drought that affected much of the West reduced hydroelectric power generation.[222] In Shasta Lake and Oroville Lake, California's largest reservoirs, hydroelectric generation reached record lows in 2021.[223] At Shasta Lake, generation was 46 percent lower than the 10-year average, and Oroville Lake hit record low water levels that forced the neighboring Edward Hyatt hydro power plant to go offline for the first time in its history.[224] Additionally, power generation was down 81 percent at Oroville Lake compared to its 10-year average.[225] Hydroelectric power is not likely to be eliminated by drought, but the West's variable precipitation patterns—which may be exacerbated by climate change—make it difficult to defend. Nuclear power is also reliant on water but produces more energy and can use desalinated water from the ocean. If coupled with a desalination facility, nuclear power can be a key to fixing the West's water shortage and giving much of America a nearly-limitless supply of clean energy.

If nuclear energy is successfully repositioned in the public mind as safe and necessary to transition from fossil fuels, its regulatory framework is modernized, and made competitive to build on the open market, then nuclear power can be a major player in a green energy fueled America.

Future Research

Nuclear energy poses major questions affecting a global stage. In future research, I would like to explore how other nations have embraced (or rejected) nuclear power. In particular,

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[222] "Drought Effects on Hydroelectricity Generation in Western U.S. Differed by Region in 2021," Today in Energy (U.S. Energy Information Administration (EIA), March 30, 2022), https://www.eia.gov/todayinenergy/detail.php?id=51839.
[223] Ibid.
[224] Ibid.
[225] Ibid.

France has made fission energy a linchpin of their green energy infrastructure: nuclear power accounts for over seventy percent of their energy production.[226] Moreover, they have made efforts to streamline their regulatory framework by introducing legislation in 2022 exempting nuclear reactors from certain planning commissions.[227] These recent proposals, coupled with President Emmanuel Macron's push for nuclear energy as a means of divesting from Russian oil, have made France a leader in global nuclear energy production. In future analysis, I hope to broaden my scope of research to include a global analysis of which nations are prioritizing atomic energy and which nations have de-emphasized it. Understanding the international politics side of nuclear power and why certain countries have embraced it are vital to explaining the role of nuclear energy in today's climate arena.

The international relations aspect of nuclear power is not limited to which countries rely on it for clean energy. Equally important to global politics is warfare, and Russia's war against Ukraine posits several questions about nuclear energy in additional research. As Russia has taken control of Zaporizhzhia (Europe's largest nuclear reactor), European and American leaders raised legitimate concerns about the weaponization of nuclear power plants: nuclear reactors could be self-inflicted weapons if seized and compromised by enemy forces. While Russian actions have not resulted in a Chernobyl-level nuclear catastrophe, using power plants as weapons pokes a serious hole in the pro-nuclear fight: what nation wants to increase the number of risky assets on their territory? More broadly, who wants to return to Cold War-era anxiety over nuclear warfare? However, the Ukraine war offers more than pessimistic fears as fodder for

[226] "French Bill on Accelerating Nuclear New Build Progresses to Senate," French bill on accelerating nuclear new build progresses to Senate : Nuclear Policies - World Nuclear News (World Nuclear News, January 17, 2023), https://www.world-nuclear-news.org/Articles/French-bill-on-accelerating-nuclear-new-build-prog.
[227] Ibid.

future research. It provides a case study into a renewed interest in nuclear power as a substitute for fossil fuels.

Future research on the global appeal of nuclear energy should also examine Germany's divestment from nuclear energy, especially with regards to the Russia-Ukraine war. In this case, Germany's Green Party helped push Chancellors Angela Merkel and Olaf Scholz to decommission several reactors. The threat of increased reliance on Russian oil, however, have complicated this transition to renewable energy. The Russian invasion of Ukraine has caused energy prices to soar, and the years-long endeavor to close German nuclear plants left the country without a reliable and plentiful source of energy. Despite well-intentioned, environmentally conscious efforts, Germany became more reliant on CO_2 emitting fossil fuels after decommissioning several reactors.[228] Ironically, they slightly increased their greenhouse gas emissions in 2022 after proceeding with closing nuclear power plants. German interest in shuttering nuclear reactors has grinded to a halt, raising questions about that country's relationship with nuclear energy. Additional research would analyze the European nation's motivations for closing nuclear power plants and the alternative paths they pursue. More importantly, we should unpack this sudden change of heart: is public opinion changing? Does the threat of increased fossil fuel consumption (an agent of global warming) indicate that nuclear is a stronger ally against climate change? How or if did renewable energy fall short in providing a sufficient and reliable energy source? Perhaps Senator Domenici's hopes for a nuclear renaissance will be revived.

Similarly complex is the role of technological development toward affordable and safe nuclear energy production. In particular, fusion energy is a promising yet seemingly fantastical

[228] Melissa Eddy, "Why Germany Can't Just Pull the Plug on Russian Energy," The New York Times (The New York Times, April 5, 2022), https://www.nytimes.com/2022/04/05/business/germany-russia-oil-gas-coal.html.

goal. Nuclear fusion seems as if it is always just a decade away, proponents claim, but it has never been quite ready for implementation. This ambitious prediction, however, is more realistic than ever. The California-based Lawrence Livermore National Laboratory announced in December 2022 that they produced the first fusion reaction that created more energy than it consumed.[229] It was a culmination of over sixty years of research and experiments conducted around the globe and billions of dollars in funding.[230] If nuclear fusion becomes a financially and scientifically viable option, the future of atomic energy in American is bright. Because of these breakthroughs, fusion energy research is key to unpacking nuclear power's next steps. While not purely political, understanding fusion energy's development is a fascinating and requisite part of any forthcoming nuclear research.

Future research should also further examine the relationship that state governments have with nuclear power. The fight against Diablo Canyon, North Anna, Shoreham, and other reactors has come from local residents and activists, and building a reactor requires a utility company to meet with local leaders. Moreover, different states have promoted or discouraged nuclear energy. For instance, an interview with a nuclear policy expert noted that West Virginia lifted its moratorium on nuclear power plants, and Virginia has taken steps to encourage nuclear power production. Using several states as case studies and comparing their policies and results could be a valuable way in explaining the future of American nuclear energy production.

Final Thoughts

Nuclear energy is a promising alternative energy source. The United States, once a beacon for an atomic future, is poised to enjoy a nuclear renaissance. While public opinion

[229] Chang, "Scientists Achieve Nuclear Fusion Breakthrough with Blast of 192 Lasers," The New York Times, (https://www.nytimes.com/2022/12/13/science/nuclear-fusion-energy-breakthrough.html.
[230] Esme Stallard, "Breakthrough in Nuclear Fusion Energy Announced," BBC News (BBC, December 13, 2022), https://www.bbc.com/news/science-environment-63950962.

remains skeptical of nuclear power, to an extent, the push toward clean energy, the fight against climate change, and increased bipartisan support for energy security has ignited public interest in viable alternatives to fossil fuels. This resurgence, exemplified throughout interviews and exemplified in technological innovations, is not yet reflected in the regulatory framework or cost of construction. These reasons, coupled with tenuous public support, NIMBYism, and anti-nuclear interest groups, have hindered efforts to put new reactors online. The future of American nuclear power, however, is encouraging.

The United States enjoys one of the highest qualities of life in recorded history, yet Americans' consumer and personal comfort-driven habits pose serious environmental costs. Critically, the energy necessary to sustain our lifestyles common to modern society cannot be exclusively predicated on renewables: the energy capacity factor is too low, and fossil fuels emit greenhouse gases that continue to wreak environmental damage. All is not lost, however, if we borrow from President Eisenhower's and Walt Disney's midcentury optimism that sold many Americans on nuclear energy. We can harness our ingenuity and make nuclear power an affordable alternative. There is every reason to believe this is possible. If so, then the future of nuclear power is bright.

In his first inaugural address, President Reagan assuaged the American people that pessimism about our future is dangerous and unfounded. In an era of national uncertainty, he affirmed that:

> We're not, as some would have us believe, doomed to an inevitable decline. I do not believe in a fate that will fall on us no matter what we do. I do believe in a fate that will fall on us if we do nothing.

To be clear, Reagan was not referring to nuclear power or environmental action. But his words offer an important lesson regarding nuclear energy and climate change: there are solutions to our environmental woes, and atomic energy reigns chief among them as a safe and constant source of green energy. Surrendering to an impending climate disaster is neither an option for humanity's survival nor is it our destiny.

Walt Disney understood the choice between nuclear fallout and prosperity within in the context of postwar optimism. He knew that nuclear technology was capable of both mass destruction and bountiful clean energy. In *Our Friend, the Atom*, Disney explained that nuclear energy possesses "the powers of both creation and destruction. They could destroy civilization and much of mankind…our last and most important wish (peace and clean energy) will come true if we use the power of this knowledge…Then the atom will become truly our friend."[231]

But were Reagan and Disney right? Did they believe in an improbable future? Each viewed humankind and nuclear power, respectively, as a force for good if properly guided. This bright-eyed futurism is less prevalent today, making us more cognizant of our nation's shortcomings but also more pessimistic about our potential for growth.

Optimism and support for nuclear power are not unique to partisan ideologies. Conservatives, moderates, and liberals can each situate nuclear power within their broader world view. Protecting the environment does not have to be a uniquely liberal phenomenon and ensuring energy security is not solely conservative. Rather, supporting nuclear energy creates a bipartisan opportunity for leaders and the citizenry to unite around common concerns for our planet and our security. Now more than ever, we need an avenue for bipartisanship.

[231] Haber and Disney, *Our Friend the Atom*, 160.

As the climate crisis continues to worsen, humans are presented with a time of choosing— whether to continue to live comfortable lives with high rates of energy consumption or lead lives with fewer amenities and lower carbon emissions.[232] The promise of nuclear energy and new technological developments across the energy sector means that we do not have to make that choice. The choice instead becomes one of risk: do we risk the small chance of nuclear accidents and spend billions of dollars to have a limitless supply of clean energy, or do we risk overreliance on fossil fuels and lower energy-producing renewables that will not resolve our carbon emissions crisis? It is dubious to assume that we can change the scale of consumerism and materialism. If we cannot reduce our consumption and greed, then we must change the consequences of our insatiable desire for more.

Here, the consequences are greenhouse gas emissions and the impact they have on our climate. With nuclear power's capacity to supply us with bountiful green energy, the ability to reverse the consequences of our consumption is clear: nuclear can be a large component of a diverse energy portfolio. If the federal government can reduce the cost of nuclear energy, the future of American nuclear power is nearly unlimited. Climate change does not have to be today's sword of Damocles: it is merely a test of our ingenuity, democracy, decision-making, and spirit. Ultimately, the choice is ours.

[232] Ronald Reagan, "A Time for Choosing Speech, October 27, 1964," Ronald Reagan Presidential Library and Museum (National Archives), accessed February 26, 2023, https://www.reaganlibrary.gov/reagans/ronald-reagan/time-choosing-speech-october-27-1964.

Appendix A: Interview Protocol

Interview Protocol | Political Science Research on Nuclear Energy Policy

Tom Morel | Undergraduate at Washington and Lee University

This interview asks questions about nuclear energy policy in the United States. Nuclear energy is often seen as a promising transition from fossil fuels but raises important safety, political, and environmental concerns. The purpose of this research is to help better understand the role of nuclear energy in environmental policy and the factors that influence advancing or discouraging the development of new nuclear power plants.

Responses are confidential. Any information derived from this research project which personally identifies you will not be voluntarily released or disclosed without your separate consent, except as specifically required by law. Additionally, your responses are combined with those of many others and summarized in a report to further protect your anonymity.

Primary Research Question: Despite increasing concern for climate change, a growing appetite for green energy, and new technological innovations, why aren't we seeing a substantial increase in new American nuclear reactors?

Question 1

Public opinion is often considered a factor when determining when new nuclear power plants are put online. What role do you think public opinion plays in whether or not we develop new nuclear power plants? What do you think is the best balance between public opinion and good science in Congress? (time permitting)

Probe: As a follow up, when can lawmakers prioritize good science over public opinion?

Probe: In what ways has this relative lack of public support for nuclear power impacted the construction of new nuclear reactors in the United States?

Probe: What causes nuclear energy to be more or less popular?

Question 2

The bureaucracy, or regulatory environment, is a vital aspect to the development of new nuclear reactors. Specifically, how does the Nuclear Regulatory Commission (NRC) help or hinder the development of new nuclear power plants?

Question 3

Throughout the past two decades, Europe has taken different approaches to nuclear energy. After the Fukushima nuclear disaster in Japan, Germany began decommissioning their reactors while France has continued to expand their program. What allows other countries to either expanding or contract their nuclear energy program? How does this compare to the United States?

Probe (if time and comes up): Could the war in Ukraine push the United States to increase the amount of nuclear power plants?

Question 4

Congress plays a significant role in nuclear energy policymaking. In your view, where has Congress helped or hindered the advancement of nuclear reactors?

Question 5

What's the role of lobbying, advocacy, and special interests in either prohibiting or advancing the development of nuclear power plants?

Last Question: Who else should I talk to?

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