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REPORT

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CONNECTING NUCLEAR ENERGY'S PAST AND PRESENT: GUIDING MISSOURI'S FUTURE

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ADVANCING LIBERTY WITH RESPONSIBILITY
BY PROMOTING MARKET SOLUTIONS
FOR MISSOURI PUBLIC POLICY

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KEY TAKEAWAYS

- Nuclear energy currently provides nearly 20% of total U.S. electricity generation. However, the rate of new nuclear construction has slowed since the 1990s.
- After a decade-plus of stability, electricity demand is once again on the rise. The increase is being driven by data centers, artificial intelligence, and industrial manufacturing.
- Missouri is well positioned to capitalize on an American nuclear energy resurgence.
- To set the stage for advanced nuclear development, the Show-Me State should consider forming a Missouri nuclear advisory council and exploring consumer-regulated energy (CRE).

A POTENTIAL RESURGENCE FOR AMERICAN NUCLEAR ENERGY

At the height of World War II, hidden beneath the stands of Stagg Field in Chicago, America's best and brightest engineered the world's first self-sustaining, controlled nuclear reaction. This breakthrough in 1942 paved the way for the emergence of a new energy source in the United States: nuclear energy. From early use in nuclear submarines to its debut as a commercial power source in Shippingport, Pennsylvania, nuclear energy has powered American endeavors for generations.[1] Today, it remains a key player among the various sources used to generate electricity. In 2024, 94 operable reactors made up around 19% of the United States' total electricity generation.[2]

Nuclear energy's popularity is easily explained; it is powerful, consistent, and efficient. In terms of output, the Callaway Energy Center (Missouri's only nuclear power plant) alone makes up 26% of Ameren Missouri's electricity generation—enough to power 800,000 households.[3] Contributing to this high output is the fact that nuclear has the highest capacity factor of all energy sources, meaning that nuclear plants most consistently operate at maximum output, whereas coal, gas, solar, and wind plants often produce much less energy than their stated maximums. This is important to note as power plants are commonly classified in terms of their maximum, or "nameplate," capacity.

In 2024, nuclear energy had a capacity factor of 92%, significantly outperforming coal (43%), combined-cycle natural gas (60%), solar (23%), and wind (34%).[4] In addition to being powerful, consistent, and efficient, nuclear energy is also clean, as it does not emit any criteria pollutants (nitrogen oxides, sulfur oxides, particulate matter, carbon monoxide, and lead) as defined by the Environmental Protection Agency (EPA).[5]

Despite all of these strengths, nuclear construction has dwindled to a trickle compared to the surge during the Cold War Era, with net capacity actually decreasing in recent years.[6] Of the 94 total operating nuclear reactors in the United States, only seven were constructed after 1990: Seabrook-1 in New Hampshire (1990), Comanche Peak Units 1 & 2 in Texas (1990 & 1993), Watts Bar Units 1 & 2 in Tennessee (1996 & 2016), and Vogtle Units 3 & 4 in Georgia (2023 & 2024).[7]

Public fear stemming from incidents like the accidents at Three Mile Island and Chernobyl, coupled with severe regulation from the Nuclear Regulatory Commission (NRC), has contributed to stagnation in the development of new nuclear plants. However, in an era of growing electricity need, the American nuclear industry may rebound. According to the Department of Energy (DOE), electricity demand is expected to grow by between 15% and 20% over the next decade, and double by 2050.[8] The ICF (and independent consulting firm) predicts similar growth, with a 25% increase by 2030 and a 78% increase by 2050. Responding to these forecasts, the Biden administration in 2024 set a target of tripling U.S. nuclear capacity by 2050.[9] The Trump administration, through a 2025 executive order, set an even higher goal of quadrupling nuclear capacity by 2050.[10]

Driving much of this growth is an increasing need for always-available and powerful sources of electricity, particularly for powering data centers and artificial intelligence. In April 2024, Goldman Sachs forecasted that data centers would rise from 2.5% to 8% of all U.S. electricity usage by 2030.[11] A few months later, McKinsey & Company upped the ante, forecasting that data centers would capture 11% to 12% of total U.S. power demand by 2030.[12] While it is difficult to forecast load growth, rising demand is raising concerns about grid reliability.

Closures of existing assets, as nearly 30% of U.S. coal-fired power plants are projected to retire by 2035, also contribute to these concerns.[13] Missouri is no exception to the trend. Ameren Missouri, the Show-Me State's largest electric utility, relied on coal for 66% of its electricity generation in 2022. However, by 2045, Ameren plans to eliminate coal from its energy mix altogether,[14] although recent federal actions, such as the declaration of a "national energy emergency" and the EPA's 31-part deregulation effort by the Trump administration could alter these plans.[15]

Further, in May 2025, the Trump administration released numerous executive orders detailing the need to expand nuclear energy capacity in the interest of national security. Two excerpts from these orders capture the new urgency:

> The United States originally pioneered nuclear energy technology during a time of great peril. We now face a new set of challenges, including a global race to dominate in artificial intelligence, a growing need for energy independence, and access to uninterruptible power supplies for national security.
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> * * *
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> The Federal Government must utilize its full authority to accelerate the secure and responsible development, demonstration, deployment, and export of United States designed advanced nuclear technologies to bolster readiness and enhance American technological superiority. Additionally, the United States must further enhance our ability to export our nuclear technology to our allies and commercial partners, strengthening our shared ability to combat reliance on foreign adversaries through the use of safe, secure, and safeguarded nuclear technologies. Therefore, we must unleash the domestic nuclear industrial base and position American nuclear companies as the partners of choice for future energy growth throughout the world.[16]

In the midst of increasing energy demand and a potential global AI arms race, nuclear power is once again in headlines. National momentum is building, and Missouri is well positioned to take part in the resurgence. The Callaway Energy Center has operated reliably since 1984 and already generates 14% of the entire state's electricity.[17] Missouri University of Science and Technology ranks among the nation's top producers of nuclear engineers, and the University of Missouri's Research Reactor (MURR) is a global leader in nuclear research.[18] Moreover, the state's large number of existing and retired coal power plants offer cost-effective sites for advanced nuclear retrofits, with potential savings of up to 35% on construction costs.[19] Oak Ridge National Laboratory has highlighted numerous suitable sites in Missouri for new nuclear plants that could reliably power Missouri and its endeavors for decades.[20]

COMMON MISCONCEPTIONS SURROUNDING NUCLEAR ENERGY

It is important to address misconceptions related to nuclear power. Bisconti Research Inc.'s annual public opinion survey found an interesting correlation between knowledge of nuclear energy and support for its use. The survey presented a 10-question quiz on nuclear power and categorized respondents based on the number of correct answers. As shown in Table 1, higher knowledge was associated with greater support for nuclear energy.[21]

The following section discusses some of the more common misconceptions, many of which influence public opinion on nuclear energy:

Misconception 1: *"Nuclear energy is dangerous, and plants can explode like an atomic bomb."*

While it is understandable to worry about the safety of nuclear energy, nuclear power plants are much safer than most people realize. First, nuclear plants cannot explode like nuclear warheads. Arjun Makhijani, nuclear engineer and president of the Institute for Energy and Environmental Research, stated that "commercial reactors have just a few percent fissile material in them, and bombs have more than 90% [Uranium-235]." A bomb, Makhijani explained, needs nearly pure fissile material.[22]

Nuclear energy has shown itself to be extremely safe, especially in the United States. When comparing the ratio of deaths per unit of energy generated across various power sources, nuclear power is the safest source.[23] A few

Table 1: **National Survey of Nuclear Energy, Knowledge and Support, 2024**

	Strongly Favor	Somewhat Favor	Somewhat Oppose	Strongly Oppose	Number of Individuals
Low Knowledge (0–1 Correct)	14%	50%	25%	11%	347
Somewhat Low (2–3)	27%	51%	17%	5%	331
Somewhat High (4–5)	50%	39%	8%	2%	248
High Knowledge (6+)	70%	18%	11%	1%	74

Source: Bisconti Research Inc.

high-profile disasters have left the impression that nuclear energy is dangerous. Readers have undoubtedly heard of Chernobyl, Fukushima, and Three Mile Island. These names stand out in part because of how rare these events are.

Of the three, Chernobyl was by far the most severe, and the primary causes were a flawed Soviet reactor design and operator error. Its effects are still felt today and many lives were lost. Fukushima's accident was related to a historic earthquake and tsunami, and its negative effects were nevertheless largely controlled.

In the case of Three Mile Island (the only of the three incidents to occur in the United States), there were no deaths. In fact, epidemiological studies of the population in the region surrounding the plant did not find any increase in cancer in the 20 years following the accident. Similarly, there were no findings of adverse effects on animal or plant life in the Three Mile Island area.[24] More detailed accounts of all three incidents can be found in Appendix A.

Misconception 2: *"Nuclear energy is bad for the environment."*

For some, nuclear energy conjures images of toxic waste. However, this view has more to do with 1980s horror movies than with reality; the truth is that nuclear energy is a zero-(or near-zero) emissions energy source, in terms of both pollutants and greenhouse gases.

Nuclear energy also requires less land to provide equivalent levels of power. To produce the same level of electricity, solar farms need 31 times more land, while onshore wind farms need 173 times more land.[25] Lovering et al. note in their study that, looking at total direct and indirect land use (which takes into account such factors as the amount of land used in mining, drilling, and siting), nuclear is by far the most efficient.[26]

Misconception 3: *"Nuclear plants expose the public to dangerous amounts of radiation."*

Nuclear plants are designed to prevent radiation from escaping the facility and entering the environment. Argonne National Laboratory notes that only 0.005% of the average American's yearly radiation dose comes from nuclear power. This is 100 times less than we get from coal (on average), 200 times less than the amount of radiation absorbed on a cross-country flight, and almost equivalent to eating one banana a year.[27]

The DOE notes that U.S. commercial reactors have generated more than 90,000 metric tons of spent fuel since the 1950s. Remarkably, all of this used fuel could fit on a single football field at a depth of approximately 10 yards, which illustrates the compact nature of nuclear waste. Additionally, the United States could reduce waste in terms of both volume and radioactivity if the industry recycled used fuel. Some claim that the United States could be powered exclusively by used nuclear fuel for 100 years if it were used to its fullest potential. This is due to the immense energy still stored in spent fuel that could be accessed by recycling for use in advanced reactors.[28] Only a small percentage of these fuels, about 4%, is truly unusable after each use.[29]

The absence of nuclear recycling in the United States is due to both historical and practical challenges stemming from Cold War–era fears of nuclear proliferation. In the 1970s, concerns grew over the possibility that the recycling process could be used to extract weapons-grade plutonium. To combat proliferation, President Carter halted the practice in 1977. By the time President Reagan lifted the ban in 1981, the United States had committed to light-water reactor designs that are not as conducive to using recycled fuel. However, momentum has been building again. Currently, the practical challenges associated with recycling spent fuel still render the process less economical than extracting new uranium.[30]

In the absence of recycling, spent fuel is currently being stored safely on-site at reactor facilities. There is still a need to secure a long-term solution for spent fuels.[31] Advances or changes to recycling practices could significantly reduce the amount of waste produced.

With common misconceptions addressed, the next section will provide an overview of how the American nuclear industry has evolved to its current state.

A BRIEF HISTORY OF AMERICAN NUCLEAR POWER

Less than a year after World War II ended, the United States began research into harnessing nuclear fission for peaceful purposes. To facilitate this transition, Congress established the Atomic Energy Commission (AEC) in 1946 to "foster and control the peacetime development of atomic science and technology."[32] The AEC became a staunch advocate of market-driven growth, stating, "our great hazard is that this great benefit to mankind will be killed aborning by unnecessary regulation."[33]

In the early years, optimism, favorable regulations, and a supportive AEC drove progress. However, with weapons testing in the Pacific, along with public alarm from the Castle Bravo Detonation (a 1954 U.S. thermonuclear test that caused unexpected fallout and civilian casualties), protests began forming at nuclear construction projects.[34] Public support has always been crucial for nuclear development, yet doubt and fear have been present since the industry's inception.

In the 1960s, the nuclear industry was expanding rapidly, and the AEC struggled to keep pace with the surge in licensing applications for larger, more complex reactor designs. At the same time, environmental concerns, particularly over thermal pollution (the heating of water sources) and radiation, began to make headlines. Even *Sports Illustrated* took aim at the AEC, criticizing its failure to address thermal pollution:

> What literally may become the "hottest" conservation fight in the history of the U.S. has begun. The fight is over nuclear power plants and the damage they can inflict on the natural environment. The opponents are the Atomic Energy Commission and utilities versus aroused fishermen, sailors, swimmers, homeowners and a growing number of scientists.[35]

Public support for the industry waned, especially among environmentalists. More conflict arose with the passage of one of the most impactful policies on American nuclear regulation, the National Environmental Policy Act (NEPA). In 1970, NEPA introduced rigorous environmental review requirements, forcing the AEC and license applicants to evaluate the total environmental impact of proposed plants. In the nuclear industry, time is money; delays and billable hours from the Nuclear Regulatory Commission (NRC) can translate into substantial upfront costs for developers, often before a single shovel hits the ground.[36] The level of detail required under NEPA has contributed to environmental reports that can span thousands of pages, adding significant time and complexity to the permitting process. Lawsuits, or even the threat of litigation and project delays from certain green groups, have also had a key role in the expanded scope and cost of NEPA compliance.[37] There have been numerous attempts to reform NEPA in recent years.[38] Most recently, in May 2025, the Trump administration issued two executive orders aimed at streamlining and reforming NEPA policies for nuclear projects, including provisions for categorical exclusions on certain federal sites (military and DOE) when justified by national security.[39]

The AEC resisted full implementation of NEPA, warning it would drastically lengthen the review process,[40] and the conflict came to a head in a 1971 environmental lawsuit over the Calvert Cliffs Nuclear Power Plant. That case resulted in a resounding defeat for the AEC, as the court ruled that the agency must fully implement NEPA. Ted Nordhaus, founder of the Breakthrough Institute, noted the impact that the Calvert Cliffs decision had on construction costs:

> But its [the Calvert Cliffs decision's] consequences for the U.S. nuclear industry were dramatic and immediate. . . . On average, reactors completed after the new rules were established took more than two years longer to complete and cost about 25% more than the reactors completed prior to the Calvert Cliffs decision.[41]

Public distrust and criticism of the AEC's resistance led to the passage of the Energy Reorganization Act of 1974, which split the AEC into the U.S. Energy Research and Development Administration and the U.S. Nuclear Regulatory Commission (NRC).[42]

In the wake of this restructuring, the NRC adopted a stricter regulatory stance, thereby increasing costs and construction time and deepening the challenges facing nuclear development in the United States. The formation of the NRC was driven largely by allegations of "regulatory capture" within the AEC, which was accused of prioritizing the interests of the nuclear industry over public safety. Many today argue that the NRC has overcompensated to avoid similar accusations. At the 2023 American Nuclear Society annual meeting, Jeffrey Merrifield, former NRC commissioner, discussed this exact idea.

He emphasized that Congress to this day wants nuclear power because it's good for our country. There is an expectation that the agency is supposed to enable the technologies as long as they can be considered safe. However, he further discusses how the NRC holds itself remote from applicants, in the name of independence and to insulate itself from the charge of regulatory capture—that is, being unduly influenced by those it regulates. Merrifield continued that the NRC will always be independent, because it makes the final decision—but in general, "the agency does not know when to stop."[43]

With the NRC's strict oversight, barriers to nuclear plant construction grew. Further, as fear and distrust of nuclear energy continued to increase, two incidents brought nuclear energy to a breaking point—the crises at Three Mile Island (1979) and Chernobyl (1986).

Three-Mile Island is regarded as "the most serious accident in U.S. commercial nuclear power plant operating history" and it left a lasting impression.[44]

On March 28, 1979, theoretical fears about a large-scale accident became a reality. In Harrisburg, Pennsylvania, Unit 2 at the Three Mile Island (TMI) Nuclear Station began to experience a partial meltdown (meaning the reactor core was literally melting from being too hot) due to a combination of mechanical malfunctions and human error. As mentioned earlier, a detailed account of the incident appears in Appendix A. While there was no loss of life or adverse effects on the environment, the event focused attention on the possibility of a catastrophic nuclear accident.

The NRC responded to TMI by ordering a shutdown and investigation into certain pressurized water reactors and created a task force that wrote the "TMI Action Plan," focusing heavily on nuclear safety requirements. These new regulations, which applied to currently operating plants and those that were under construction, included "hundreds of new regulations covering everything from containment to fire protection to backup cooling to systems for shutting plants down." The NRC also mandated new training, control room changes, emergency preparedness requirements (to coordinate with government authorities), and full-time inspectors at each plant.[45]

Lovering, Yip, and Nordhaus (2016) observe an enormous increase in overnight construction costs (as if construction of the plant were completed in one night—without financing, interest, or inflation costs that would be associated with delays) following the implementation of these regulations. They note in their study:

> When the full cost experience of US nuclear power is shown with construction duration experience, we observe distinctive trends that change after the Three Mile Island accident. . . . [F]or reactors that were under construction during Three Mile Island

> and eventually completed afterwards. . . . median costs are 2.8 times higher than pre-TMI costs and median durations are 2.2 times higher than pre-TMI durations.[46]

While the nuclear industry was still reeling from the damage the TMI incident caused, a much more serious accident occurred on the other side of the world. On April 25, 1986, the Soviet Chernobyl-4 reactor underwent a serious meltdown and release of radiation that harmed human life and the environment surrounding the reactor.[47] The short and long-term effects on health and the environment were significant and unique. Following the disaster, U.S. public opposition to nuclear power intensified. A May 1986 poll found that 78% of respondents opposed the construction of more nuclear plants in the United States.[48] Public trust has taken decades to recover.

TMI and Chernobyl strongly impacted the trajectory of the American nuclear industry, but it is still necessary to discuss the most recent large-scale accident, Fukushima. On March 11, 2011, Japan was hit by a 9.0 magnitude earthquake—the fourth largest in the world since 1900. The disaster escalated as a 15-metre (nearly 50-foot) tsunami struck Japan, flooded the site, and disabled the power supply and cooling of three Fukushima Daiichi reactors.[49] This led to core meltdowns and a release of radiation in the environment. Unlike Chernobyl, Fukushima's containment structures limited the release of the most long-lived isotopes. Radiation levels were initially elevated, but these levels declined in the following years.[50]

A detailed breakdown of the TMI, Chernobyl, and Fukushima events is presented in Appendix A. These accidents still weigh heavily on the American nuclear industry, and legacy regulations have limited the expansion of nuclear energy.

In 2023 and 2024, two large-scale nuclear reactors in Georgia were completed—Vogtle Units 3 and 4. These were America's first newly built reactors in decades.[51] Yet even amid this success, overregulation caused problems.

One example of the problems relates to the plants' rebar installation (part of setting the foundation). Jeffrey Merrifield, former commissioner of the NRC, noted that the rebar process, although important, does not require perfect precision, as it will be buried under three feet of concrete.[52] However, the NRC required precise measurements between each piece of rebar and ordered the destruction of completed concrete by sledgehammer to ensure that the rebuilt structure met exact specifications. According to Merrifield, "[There was] no safety value whatsoever and it was totally non–risk informed." Onerous regulations that do not improve safety need to be eliminated, and the enforcement attitude should be reevaluated to ensure it is reasonable and serves its intended purpose.[53]

The history of nuclear energy in the United States is marked by significant strides alternating with setbacks related to regulatory hurdles, controversies, and public fear. From the early days of optimism to the deep scars left by TMI and Chernobyl, these pivotal moments have shaped the American nuclear industry and continue to inform policy and practice today.

FAVORABLE CURRENT TRENDS

In the 20th century and into the early 21st century, the United States saw tremendous growth in gross domestic product, population, and electricity demand. In the period between 1920 and 2007, electricity consumption steadily increased more than a hundred-fold. However, from 2008 to the present day, electricity consumption remained stable (primarily because of increased energy efficiency for everything from appliances to buildings), but new growth is on the horizon.[54]

As mentioned earlier, the DOE forecasts 15% to 20% growth in energy demand over the next decade, with potential demand doubling by 2050. Meeting this demand will likely require a significant buildout, which may include replacing shuttered coal plants that had provided round-the-clock energy. Examples of this are already emerging, such as the replacement of the Duke Belews Creek Plant in North Carolina with two SMRs.[55] Nuclear is a reliable, clean, and proven option, and favorable trends point to an opportunity for nuclear resurgence in the United States in which Missouri could take part.

Public Support

Nuclear reactors have reliably, cleanly, and safely powered American progress for decades, and this consistency is helping reshape public perception. According to Pew Research Center, since 2020, the share of U.S. adults who support more nuclear construction has risen from 43% to 57% in 2023 (with the share of Republicans rising from 54% to 67%).[56] Bisconti Research has also seen favorability for nuclear energy jump from 49% in 1983 to 77% in 2024.[57] Further, 71% of Americans agree that the United States should "definitely build more nuclear power plants in the future," up from 47% in 1998. Strong opposition is starting to diminish, and this is reflected not only in citizen surveys, but also in Washington, D.C.

Nuclear energy has emerged as a rare point of political agreement, as both the Biden and Trump administrations have endorsed more nuclear power. The Biden administration's recent "U.S. Nuclear Energy Deployment Framework" regards nuclear power as essential for combating climate change and achieving net-zero greenhouse gas emissions by 2050:

> Expanding domestic nuclear energy production has a key role to play in helping to avoid the worst impacts of climate change by enabling the nation to achieve a net-zero greenhouse gas (GHG) emission economy no later than 2050. Nuclear power delivers safe, clean, reliable, and affordable electricity.[58]

Meanwhile, the Trump administration's endorsement of nuclear power focuses on its reliability, capacity, and contribution to national security. In his first term, President Trump advocated keeping plants open, investing in SMRs, and continuing to modernize the NRC. This support has expanded in Trump's second term, with the administration calling for vast nuclear deployment to secure American energy dominance and national security.[59] President Trump's Secretary of Energy, Chris Wright, signed his first secretarial order in February 2025, which stated:

> The long-awaited American nuclear renaissance must launch during President Trump's administration. As global energy demand continues to grow, America must lead the commercialization of affordable and abundant nuclear energy. As such, the Department will work diligently and creatively to enable the rapid deployment and export of next-generation nuclear technology.[60]

These two administrations have differing reasons for supporting nuclear power, but they agree on the need. Outside the Oval Office, the passage of the ADVANCE Act is intended to spur advanced nuclear construction and streamline regulations. This bill flew through the U.S. Congress in June 2024, with an 88–2 vote in the Senate and a 393–13 vote in the House of Representatives before being signed by President Biden.[61] Even private corporations such as Microsoft, Google, Amazon, and Meta have identified nuclear power as a potential way to meet their energy needs.[62]

Lastly, as mentioned earlier, the need for nuclear energy has been magnified by a potential global AI arms race. If justified for national security interests, reform, construction, and deployment may happen at a more rapid pace.

Regulation

Many of the regulations governing nuclear energy were put in place between 1970 and 1990, as public concern about the dangers of radiation—including potential accidents and thermal pollution—grew. Events such as the Calvert Cliffs Decision and the accident at TMI prompted the creation of a rigorous set of regulations. These regulations, often fueled by fear, contributed to soaring costs and extended licensing timelines that stifled new development. Importantly, construction costs in countries such as France and South Korea—which do not have such stringent regulataions—have not increased as they have in the United States, suggesting that regulatory reform could lower costs in the United States.[63]

Despite these challenges, a recent trend toward reducing regulations has been encouraging. Four developments—the ADVANCE Act, executive orders from the second Trump administration, Rule 53, and the passage of Senate Bill 4 in Missouri—could spur development of nuclear energy in the state. The ADVANCE Act, President

Trump's executive orders, and Rule 53 each represent distinct federal approaches to reforming nuclear regulation through the U.S. Congress, the executive branch, and the NRC, respectively. Senate Bill 4, meanwhile, passed in Missouri with the goal of providing financial flexibility for new large-scale energy projects.

The Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act, signed into law in July 2024, contains provisions designed to address some of the regulatory challenges facing nuclear energy development. The ADVANCE Act includes the following provisions:

1. *Limiting costs for licensee reviews:* The act limits NRC billing so that it covers only "mission-direct" program salaries and benefits, excluding indirect costs like travel, support, and administrative expenses. These indirect costs currently fall on nuclear developers, but under the new framework, the federal government would absorb these costs for advanced reactors. While concerns over taxpayer dollars are valid, this measure defrays the expenses from a truly burdensome set of federal regulations.
2. *Establishing an award program for nuclear pioneers:* Establishes an award program for pioneers in the advanced nuclear field, including those who are the first developers to receive an operating license for an advanced nuclear reactor or the first to use spent nuclear fuel to power their advanced nuclear reactor.
3. *Streamlining the licensing process for transitioning covered sites:* Directs the NRC to develop and implement strategies (or at least to begin rulemaking within two years) to enable efficient, timely, and predictable licensing reviews for converting "covered sites" (such as land formerly used for coal plants or industry) into nuclear reactor sites.
4. *Expediting licensing for applicants using an existing design or existing/former nuclear site:* Mandate that the NRC establish and carry out an expedited procedure for issuing a "combined license"—meaning an applicant who is using a previously approved design or is applying to be sited at or adjacent to a location where a licensed commercial nuclear reactor operates or previously operated.
5. *Increasing the NRC's workforce:* Establish traineeship and apprenticeship programs and increase flexibility in recruitment (particularly for those in critical and highly specialized licensing and regulatory oversight positions) to target staffing issues.
6. *Updating the NRC mission statement:* The NRC's mission will now explicitly emphasize the need to create efficient licensing and regulations that can facilitate the construction and deployment of new nuclear reactors.[64]

These provisions are intended to mitigate delays, reduce costs, and accelerate the construction of new reactors. One of President Trump's new executive orders directly reinforces the policy shift from the ADVANCE Act, stating:

Just as the Congress directed, the NRC's mission shall include facilitating nuclear power while ensuring reactor safety. When carrying out its licensing and related regulatory functions, the NRC shall consider the benefits of increased availability of, and innovation in, nuclear power to our economic and national security in addition to safety, health, and environmental considerations.[65]

This alignment between congressional intent and executive action was evident in May 2025 when the Trump administration issued four executive orders designed to accelerate American nuclear expansion—particularly through NEPA reform, NRC modernization, reevaluation of radiation exposure standards, and the justification of expedited deployment in the interest of national security.[66] These orders reflect a broader strategy to dramatically scale up nuclear energy, with President Trump calling for the United States to quadruple its nuclear construction over the next 25 years in pursuit of national security and "energy dominance." Given their scope and potential impact, these executive orders warrant detailed discussion.

There are four executive orders, all issued on May 23, 2025.

1. *Deploying Advanced Nuclear Reactor Technologies for National Security*
2. *Reinvigorating the Nuclear Industrial Base*
3. *Ordering the Reform of the Nuclear Regulatory Commission*
4. *Reforming Nuclear Reactor Testing at the Department of Energy*

One of the many notable provisions is the directive to rapidly deploy advanced nuclear reactors at both military installations and DOE facilities. Specifically, the orders set a goal for the Department of Defense (DoD) to begin operating a nuclear reactor at a domestic military base by September 30, 2028, and for the DOE to deploy an advanced nuclear reactor at a designated site within 30 months of the order's issuance.[67]

Both the DoD and DOE have extensive histories in the development and use of nuclear energy. The U.S. Navy's Naval Nuclear Propulsion Program, a joint effort between the Navy and DOE, has been essential in building this expertise. Over its 75-year history, the program has operated 273 reactor plants. As of 2023, the U.S. Navy operates 99 reactors and 79 nuclear-powered warships.[68]

To facilitate these deployments, President Trump also directed the DoD and DOE to consult with the Council of Environmental Quality to apply existing and establish new categorical exclusions of NEPA for advanced nuclear reactor technologies on certain federal sites. Further, the Secretary of Energy shall, in consultation with the Chair of the Council on Environmental Quality, take action to reform DOE compliance with NEPA and use all available authorities to "eliminate or expedite the Department's environmental reviews."[69]

If these entities can successfully collaborate to bring next-generation reactors online, this could trigger a broader wave of nuclear construction across the country. Another executive order that reforms the NRC requires the commission to "establish an expedited pathway to approve reactor designs that the DoD or DOE have tested and demonstrated." Importantly, regulatory review for these designs would focus solely on new risks, not previously addressed ones, eliminating redundant reviews and further accelerating deployment. If these projects make strong progress, perhaps Missouri could start considering potential locations for those designs.[70]

The same executive order details sweeping reforms of the NRC's operations and regulations. Arguing that the NRC has historically overcorrected for "the most remote risks," the order instructs the NRC to work with the Department of Government Efficiency (DOGE) to reorganize to better support innovation and expedite licensing. Key revisions include:

- Undertaking a wholesale review of regulations and guidance documents
- Establishing fixed deadlines for activities
- Adopting science-based radiation limits (discussed later in this report)
- Establishing stringent thresholds for when the NRC can demand changes once construction has begun
- Reducing the Advisory Committee on Reactor Safeguards to the statutory minimum for membership and required reviews.[71]

Finally, the executive orders outline a broader agenda to support the nuclear fuel cycle and industrial base. This includes advancing nuclear waste management, expanding the procurement of uranium and related materials, prioritizing nuclear fuel recycling, strengthening workforce development, enhancing national lab testing capacity, supporting U.S. nuclear exports, and expanding loan access for new nuclear projects.[72]

These changes, alongside the ADVANCE Act, demonstrate a resolve to revive the American nuclear industry through coordinated legislative and executive action.

Meanwhile, at the NRC, a new licensing process, Part 53, is undergoing revisions and fine-tuning through public review as of this writing. In 2019, the Nuclear Energy Innovation and Modernization Act (NEIMA) mandated that the NRC create a new regulatory framework specifically aimed at advanced nuclear technologies (distinct from the existing Part 50 and Part 52 processes). Part 53 is intended to be "technologyneutral," meaning that it can be applied to different types of reactors. In addition, the new rules "are supposed to set requirements but not prescribe how they are met."[73] After internal review and edits, the proposed rule was posted for public comment. National laboratories, industry groups, developers, and policy organizations, such as the Breakthrough Institute have submitted proposed revisions.[74] The final rule is required to be completed by December 2027, and has the potential to "reduce unnecessary regulatory burdens, and provide a clear pathway for innovative nuclear technologies."[75]

Improvement of all these regulations could facilitate the construction of small modular reactors (SMRs). An SMR is essentially a smaller (300 megawatts or fewer), more compact version of a nuclear reactor. SMRs require less space than traditional reactors; in fact, an SMR slated for construction in Tennessee will occupy an area roughly the size of a football field.[76] Their modular design allows for prefabrication, meaning major components can be manufactured in a factory and shipped to the installation site, reducing costs and shortening construction timelines.[77] At the federal level, continued regulatory reform is needed to create an efficient licensing process for these innovative technologies (such as with Rule 53).

In Missouri, Senate Bill 4 was signed into law in 2025. Senate Bill 4 is a large omnibus bill with many components, but arguably the biggest change is granting electric utility companies increased financial flexibility and predictability in exchange for stronger oversight from the Missouri Public Service Commission (MPSC). The construction-work-in-progress law (CWIP) was a key policy included in the omnibus.[78] The CWIP provision will primarily apply to natural gas projects, but a pathway appears to be available for it to also apply to nuclear and other resources through the Missouri Public Service Commission (MPSC). If applicable to nuclear projects, this alternative financing strategy should be particularly useful for capital-intensive nuclear reactors, as it could reduce financial risk for utilities and potentially lower total project costs by allowing firms to rely more on revenue rather than loans. With the CWIP provision, ratepayers need to be protected in a monopoly utility market, and a deeper breakdown of consumer safeguards for CWIP appears in Appendix B. However, it should be emphasized that the applicability of Senate Bill 4 to nuclear projects is currently uncertain.

MISSOURI'S OPPORTUNITY TO LEAD IN NUCLEAR

Missouri is well positioned to participate in the emerging nuclear resurgence, with both the infrastructure and human capital to be a significant player in the field:

- Missouri has a strong nuclear workforce pipeline, with the Missouri University of Science and Technology in Rolla ranking among the nation's top producers of nuclear engineers (10th most).[79] This local talent pool could be a draw for developers, as it could provide a level of assurance that projects can consistently be staffed with skilled professionals.
- The state also leads in nuclear research; the University of Missouri's MURR is one of the world's premier research reactors. Leading in research can foster innovation and attract top talent in the field.
- There is existing, successful, and long-standing infrastructure present at the Callaway Energy Center, but our advantages in infrastructure go beyond Callaway. Missouri also has several retired or retiring coal plants that could be retrofitted into advanced nuclear reactors. The DOE has reported coal-to-nuclear transitions can save up to 35% on construction costs.[80]

Missouri's longstanding advantages in nuclear infrastructure and human capital may be easier to leverage now that national policy is shifting in a direction that could make nuclear plant construction feasible again. However, progress on this front is still dependent on continued reform at the federal level.

Market Distortions in the Energy Sector

It is no secret that the federal government has a significant influence over the U.S. energy sector through subsidies, regulations, and taxes. One of the primary drawbacks of such heavy government involvement is that it distorts competition, diminishing the incentive to innovate and often leading to overinvestment in uneconomic or outdated technology. Subsidies can hinder private efforts to develop innovative solutions for spent fuel, high construction costs, and other challenges.

In fact, part of the urgency behind energy policy is a result of subsidy-driven market distortions that have contributed to nearly 30% of U.S. coal-fired power plants being projected to retire by 2035, with Missouri being no exception to the trend.[81] However, with the Trump administration's declaration of a national energy emergency and implementation of a 31-part deregulation plan from the U.S. Environmental Protection Agency (EPA), this trend may be changing.[82]

Some coal plants may be approaching or have already passed their useful life. Others are shutting down prematurely due to pressure from the federal government and incentives to replace depreciated (paid off) assets with brand-new, heavily subsidized equipment. In a regulated monopoly market, utilities generate profit through the creation and depreciation of new electricity infrastructure.[83]

For nuclear energy to compete on a level playing field, market-distorting subsidies must be addressed. In 2024, subsidies for wind and solar totaled $31.4 billion, exceeding all other energy sources combined.[84] A repeal or strong paring back of the Inflation Reduction Act's (IRA's) energy subsidies is needed.[85] For a breakdown of the distribution of total subsidies and support by the federal government in recent years, see Figure 1, which is based on data from a 2023 report by the Energy Information Administration (EIA).[86]

These excessive subsidies create significant distortions in the energy market. Federal subsidies for renewables during this period were more than three times the combined support given to natural gas, coal, and nuclear power. Expanding nuclear subsidies in response would not solve the problem; real market competition requires reducing subsidies across the board, especially in the heavily favored renewable sector. Until that happens, it will be difficult for a free market to function effectively in the energy sector.

Government interference does not have to define American energy. The free market can bring innovation to a field, such as nuclear power plant construction, which has stagnated in recent years. Space travel is one good example of a fading industry that was revitalized by opening it up to market forces. SpaceX has outperformed NASA in a sector where few expected private endeavors to surpass a long-time government institution.[87] A freer energy market could accelerate nuclear innovation, too.

Federal Reform on Radiation Standards

As the Institute for Energy Research notes, modern advancements should have made nuclear energy safer and more affordable; however, an outdated regulatory framework has had the opposite effect, driving costs higher and delaying projects.[88]

The Calvert Cliffs Decision and TMI led to significantly increased regulatory burden on American nuclear power. The federal government needs to continue improving a regulatory system that is currently defined by uncertainty, setbacks, delays, and cost overruns. The ADVANCE Act and President Trump's 2025 executive orders were key steps forward, and Rule 53 has the potential to establish a more balanced safety standard, easing regulatory compliance for developers.

Jack Spencer of the Heritage Foundation, in his book *Nuclear Revolution*, identifies two radiation standards that have added considerable difficulties in the licensing process. First, the EPA started basing its risk assessments on the linear no-threshold (LNT) model in 1975. According to Spencer:

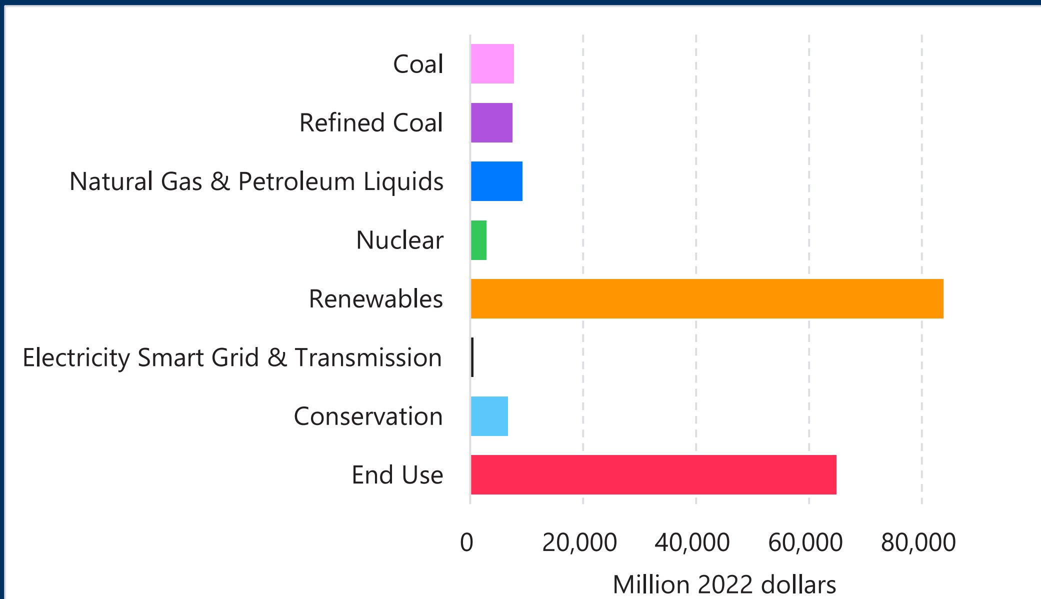
> LNT assumes that the risk of cancer due to a low-dose exposure is proportional to a dose with no threshold. In other words, the LNT model assumes that ionizing radiation is always harmful and that there is no threshold below which radiation exposure is safe.[89]

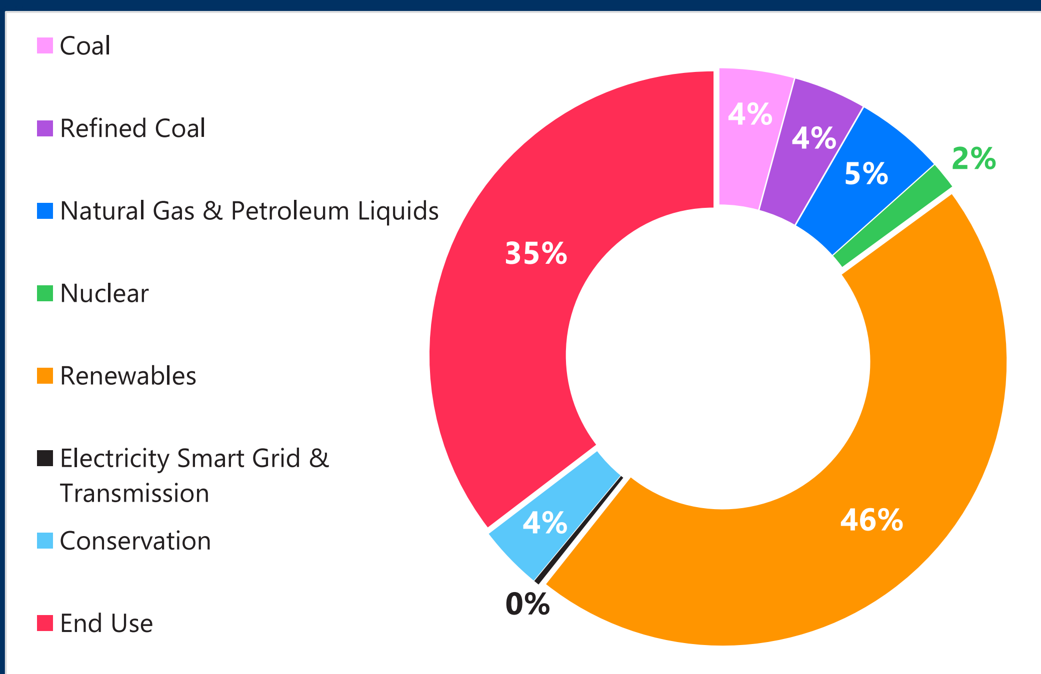
Spencer notes that "countless studies and decades of experience show that LNT is wrong." Further, LNT is also paired with a second concept, "as low as [is] reasonably achievable" (ALARA). This practice means "making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as [is] practical" considering technological and other limitations.[90] Such a subjective regulatory standard amounts to a seemingly nonexistent quantitative limit, where developers must continue to spend money or risk having their proposal rejected at the next step in the licensing process, even if it is safe for the public. These regulations should be revised to better align with actual risk assessments. This need is directly addressed in one of President Trump's new executive orders, Ordering the Reform of the Nuclear Regulatory Commission. Specifically, this order critiques the NRC's longstanding reliance on this model, stating:

Figure 1

Quantified Energy-Specific Subsidies and Support by Type, FY 2016-2022

Nearly half of all federal subsidies and support from 2016 to 2022 were directed towards renewables.





Source: Energy Information Administration (EIA). End-use subsidies are largely comprised of subsidies to construct more energy-efficient residential buildings, along with subsidies for electric vehicles, fuel-cell electric vehicles, and others. Conservation subsidies consisted mostly of credits for improving energy efficiency in existing homes.

> The NRC utilizes safety models that posit there is no safe threshold of radiation exposure and that harm is directly proportional to the amount of exposure. Those models lack sound scientific basis and produce irrational results, such as requiring that nuclear plants protect against radiation below naturally occurring levels.[91]

To address this concern, the order directs the NRC to act:

> [The NRC shall] adopt science-based radiation limits. In particular, the NRC shall reconsider reliance on the linear no-threshold (LNT) model for radiation exposure and the "as low as reasonably achievable" standard, which is predicated on LNT. Those models are flawed, as discussed in section 1 of this order. In reconsidering those limits, the NRC shall specifically consider adopting determinate radiation limits, and in doing so shall consult with the Department of Defense (DoD), the Department of Energy (DOE), and the Environmental Protection Agency.[92]

This directive signals an intent to replace outdated and subjective models with fixed, predictable, and scientifically grounded exposure thresholds. If implemented effectively, it could help overcome a barrier that has historically constrained American nuclear expansion.

While federal reforms have already led to meaningful progress in improving the regulatory landscape, further improvements will only strengthen the case for nuclear investment. Missouri does not have to sit on its hands waiting for Washington to continue to act; the state can take proactive steps now to position itself as a competitive destination for nuclear energy. Below are two policies Missouri should consider at this time.

1. A Missouri Nuclear Advisory Council

In 2023, Governor Bill Lee of Tennessee established a nuclear advisory council through executive order to inform legislative actions for addressing regulatory, education, and workforce barriers, and also to implement strategies for financing, waste storage, and development opportunities.[93] Tennessee's advisory council has already helped attract major investments in advanced nuclear projects and provided actionable recommendations.

For example, the council recommended amending a regulatory statute to classify nuclear energy production facilities as Certified Green Energy Production Facilities, which appropriately acknowledges the emissions-free nature of nuclear energy.[94] While Tennessee allocated $50 million for grants and assistance, Missouri would not need to provide subsidies and could focus instead on removing regulatory and bureaucratic barriers to development.

Missouri has attractive features for advanced nuclear development, and there is a need for more always-available (baseload) power. By forming an advisory council, the state could signal its openness to both domestic and international developers without relying on subsidies. Subsidies offer financial support and reduce risk for investors, but a council can provide accessible information (reducing costs and uncertainty) and signal the state's resolve and intentions (reducing uncertainty) at no cost to taxpayers.

The council could streamline the decision-making process for nuclear developers and utilities by centralizing and presenting critical information about Missouri's energy landscape. By offering clear insights into state attitudes, potential bottlenecks, plant closures, tax burdens, unique opportunities, potential sites, regulation, fault lines, and other factors that can affect nuclear construction, the council could reduce the complexities of evaluating and comparing potential sites and partnerships in multiple states and even other countries. For example, Union Electric studied more than 70 sites in four states before the Callaway County site was selected. A council could help streamline this process in the future and make Missouri more attractive as a site for next-generation reactors.[95] This transparency could ultimately help reduce the duplication of effort by interested parties. Providing all stakeholders with better information would help set the stage for competition, economic development, and market-driven decisions in Missouri.

Membership: Tennessee's advisory council consisted of a diverse group of stakeholders from the public and private sectors. Missouri can build on this model, which includes:

- Directors of interested state departments: Environment and Conservation, Economic Development, and Emergency Management
- Officials from the state legislature, congressional delegation, and local government
- Experts from higher education, utilities, workforce development, the energy production sector, and the nuclear industry
- Representation from the regional national laboratory
- Additional members, as determined necessary by the governor (Tennessee opted to include more experts and scientists)[96]

Rather than dictating policy, this council would serve as a platform for information sharing, bringing together the brightest minds to identify opportunities, help developers clear regulatory hurdles, and highlight Missouri's strengths as a destination for nuclear investment.

Providing Missouri-Specific Research: For instance, a nuclear advisory council could identify potential locations for large or small advanced reactors, with a focus on retrofitting coal plants and adding one or more new reactors at Callaway.

A DOE-sponsored study reviewed all retired and retiring coal plants in the country and found that 80% of the reviewed coal plants in the United States have the "basic characteristics" needed to host an advanced nuclear reactor.[97] In Missouri specifically, Oak Ridge National Laboratory identified seven coal power plant sites as suitable for repurposing, with the potential to place multiple nuclear reactors ranging in output from 600 megawatts (MW) to 1,117 MW.[98]

As noted earlier, coal-to-nuclear transitions can save up to 35% on construction costs, and the federal government is prioritizing converting covered sites (such as land formerly used for coal plants or industry) into nuclear sites in the ADVANCE Act. Conducting Missouri-specific research on potential transition opportunities could attract developers to the state.

Coal-to-nuclear transitions are already happening elsewhere. In Wyoming, a new TerraPower advanced nuclear reactor is currently being built in a coal-to-nuclear transition project.[99] Additionally, the White House in its 2024 "Nuclear Deployment Framework" has identified significant opportunities for siting SMRs at existing coal-fired power plant and nuclear reactor locations. It notes:[100]

> Such coal-to-nuclear transitions are particularly compelling for the ability to re-use existing transmission, water, and land-based infrastructure to reduce costs and leverage the existing workforce, ensuring that good-paying jobs remain in communities as they transition to new, clean sources of power generation.

Lastly, Oak Ridge National Laboratory identified that Missouri also has space for an additional 600 MW at the Callaway Energy Center.[101] Bringing an advanced reactor or an SMR to Missouri is a real possibility, and costs and construction times are likely to be reduced because the site is partially complete, a workforce is established, physical security already exists, and support from the local community is likely.

While a council would not dictate policy or provide financial incentives, it could help facilitate economic development without charging taxpayers.

Building Partnerships: The council could engage with national and international stakeholders, including reactor developers, supply chain companies, and research institutions.

The nuclear industry is complex and often requires partnerships beyond state and national borders. Countries such as South Korea and France have established supply chains and advanced reactor designs, and a council could help identify partners and provide a clear point of contact for nuclear projects.[102] Appendix C includes deeper discussion on the international success of South Korean nuclear projects with the APR-1400 advanced nuclear reactor.

An advisory council is a straightforward strategy that could help inform development and regulatory reform and signal openness to bringing needed nuclear power to Missouri.

2. Consumer-Regulated Electricity

A complementary policy to Missouri's energy landscape is consumer-regulated electricity (CRE). CRE, while still a developing policy area, would allow private investors to create new, independent electric power systems (encompassing both generation and transmission) using their own capital. These private grids would be scaled specifically to meet demand growth from large consumers. For a CRE entity to operate effectively, it would need to be free from restrictions imposed by the Missouri Public Service Commission (MPSC) (but it should be noted that they would still be subject to federal regulation from the NRC and other organizations). That means CRE entities would need to be unconnected to the regular grid and only serve new, large industrial and commercial customers.

Much of the anxiety about grid reliability stems from the rapid growth of large energy consumers such as data centers and industrial manufacturers. However, it is difficult for utilities to accurately forecast the necessary supply to power future endeavors. Rather than relying solely on a single, unified grid to meet all customers' demand, CRE would allow private investors to meet this need using their own capital.[103] Further, since much of the demand growth is coming from specific, large customers, CRE could reduce the burden residential ratepayers may face in supporting new supply for these large customers.

As Travis Fisher (director of energy and environmental studies at the CATO Institute) argues, these private grids—disentangled from the massive regulatory red tape that ensnares public utilities—could be developed more quickly, infusing competition and innovation into the energy sector.[104] By acting as "private energy islands" for new, large energy consumers, CRE could relieve strain on the primary grid and ratepayers while offering options for those new customers to secure reliable power tailored to their needs.

This idea aligns with growing momentum in the private sector to pair SMRs with corporations seeking stable, carbon-free energy sources. Companies like Google and Microsoft have already scrambled to secure nuclear power through strategies such as power purchase agreements (PPAs). For example, a PPA allowed Microsoft to contract for the energy output from Three Mile Island over a 20-year period.[105] However, these agreements are still subject to state regulatory constraints. CRE would take this concept a step further,[106] helping to more quickly match demand with supply.[107]

Further, if America is on the verge of a global AI arms race, then the rapid deployment of advanced nuclear power (free from as much regulation as possible) may prove critical for new projects. CRE could help facilitate this deployment and establish Missouri as an attractive location for advancing federal national security objectives.

Pairing this approach with a nuclear advisory council could provide useful insights into potential opportunities for these private developers. Importantly, this strategy would complement rather than disrupt the existing energy framework through private investment, without relying on taxpayer dollars.

Bringing CRE to the Show-Me State would likely require a modification of state statute to declare that new private utilities—if they are not connected to existing infrastructure—not be subject to monopoly regulation. New Hampshire is one state that has moved forward with this idea.[108] While further study is needed, CRE represents an opportunity to introduce competitive forces into Missouri's energy sector and facilitate the deployment of next-generation nuclear technology.

CONCLUSION

This paper has examined both historical trends and current developments to assess Missouri's potential to play a leading role in America's nuclear resurgence.

Today, public support for nuclear energy is at a historic high, with key regulatory changes underway to expedite the industry's growth. Federal entities, including the NRC, Congress, and the DOE, along with both the previous and current presidential administrations, have supported a strong nuclear buildout. The conditions are ripe for a true renaissance in American nuclear power, and Missouri has the infrastructure and intellectual capital necessary to take part.

To set the stage for nuclear development, Missouri should form a nuclear advisory council and explore the potential of CRE to strengthen its energy grid and position itself as a hub for talent, jobs, and investment in an industry that will be crucial to the nation's economic, environmental, and national security future.

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APPENDIX A: THREE MILE ISLAND, CHERNOBYL, AND FUKUSHIMA

What Happened at Three Mile Island?

Below is a step-by-step walkthrough of the Three Mile Island (TMI) incident.[109]

1) As the reactor (Unit 2) was undergoing its normal routine, a mechanical/electrical issue occurred, which stopped the cooling pumps from sending water to the steam generators.

2) Immediately, the generator and reactor automatically shut down.

3) Since the reactor was still extremely hot (it was operating at almost maximum capacity), a pressure relief valve needed to be opened to relieve excess pressure. Once pressure returned to normal levels, it was supposed to close.

4) This is where the trouble began. The valve failed to close, but monitoring instruments indicated that the valve was closed.

5) As the valve remained "secretly" open, needed reactor coolant began to escape from the core, and it remained hot. This is known as a "loss-of-coolant" accident.

6) Nevertheless, emergency core cooling systems were activated and began to cool down the reactor according to design.

7) As the emergency cooling water began to fill the reactor core, there was uncertainty and fear from the operators. First, they feared that the water could fill up the pressurizer entirely, so they decreased the flow of emergency water. Second, due to lack of instrumentation, it was unclear whether or not the reactor was covered in water or not.

8) Because of this uncertainty, the operators decreased the flow of emergency cooling water, and eventually manually shut the pumps off.

9) However, the reactor was not covered in sufficient coolant or cooling water, and 45% of the reactor in TMI Unit 2 melted.

During efforts to cool down the reactor and clean up the mess, a hydrogen bubble formed that created great fear around the United States. Although the containment system had worked completely to this point, this hydrogen bubble in the core had the potential to become flammable, explode, blow open the containment system, and release large amounts of radiation into the outside world. Headlines warned of a potential "hydrogen explosion," and in turn, 144,000 people evacuated the area over five days.[110]

Nothing came of the hydrogen bubble, and the incident was cleaned up (at significant cost) with great care and effectiveness. Moreover, this accident was a testimony to the effectiveness of passive safeguards, as emergency systems and the containment prevented any significant radiation release or leakage into the ground.

What Happened at Chernobyl?

On April 25, 1986, the Soviet Chernobyl-4 reactor underwent a serious meltdown and release of radiation that affected human life and the surrounding environment.[111]

The Chernobyl Unit 4 reactor was a relatively new, but flawed, design, and the operators were conducting an unauthorized test (the exact reasoning for the test remains debated). During the test, most of the control rods were withdrawn to maintain power output, leading to an uncontrollable increase in the reactor's power. As the power surged, the operators tried to tame the reaction with the control rods. However, due to flawed design, these control rods with graphite tips initially increased reactivity when inserted. After operators slammed all the controls rods in at once, the pressure in the reactor rose dramatically, causing a massive explosion that destroyed the reactor and its containment structure.[112]

Following the explosion, a large and visible beam of blue light illuminated the sky above Unit 4, as it showered fission products from the inner core into the atmosphere. Firefighters rushed in and tried to put out the intense fires, with many going right up to the destroyed plant. However, these firefighters were not adequately protected to operate near these intense levels of radiation, and as a result, over two dozen perished from acute radiation syndrome.[113]

Death tolls from the Chernobyl accident are 30 initial deaths, and a potential of 4,000 additional deaths in the years following, according to the World Health Organization (although the exact total has frequently been the subject of speculation).[114] Due to the disaster, 116,000 people were immediately relocated, with around 350,000 relocations total.[115]

The Chernobyl event was a dangerous mix of poor reactor design and significant human error and terrified the entire world. The Soviet Union's secrecy around the event only amplified global fears. In Europe, the environmental movement quickly coined the phrase "Chernobyl is everywhere" when looking at other nuclear plants.[116]

What Happened at Fukushima?

While TMI and Chernobyl strongly impacted the trajectory of the American nuclear industry, it is still necessary to discuss the most recent large-scale accident, which occurred at Fukushima. On March 11, 2011, Japan was hit by a 9.0 magnitude earthquake—the fourth largest in the world since 1900. Subsequent inspection showed no significant damage to any of the Fukushima reactors from the earthquake.[117] However, the disaster escalated as a 15-metre (nearly 50-foot) tsunami struck Japan, flooded the site, and disabled the power supply and cooling of three Fukushima Daiichi reactors. Eight of the other reactors were able to achieve shutdown relatively safely. However, with 12 of 13 backup generators and cooling systems knocked offline, the three Daiichi reactors lost the ability to cool down, and "all three cores largely melted in the first three days." Thankfully, there were no deaths or cases of radiation sickness from the nuclear accident, but official figures have reported over 2,000 indirect deaths due to evacuation-related stress, displacement, and disrupted medical care.[118]

Radiation was released into the air, soil, rivers, and the ocean, with elevated levels immediately after the accident. In the ocean, radiation remained below regulatory safety thresholds and posed minimal risk to either marine life or humans, as less radiation was released than the natural levels of radiation in seawater.[119] In soil, water, crops, wildlife on land, and the air, elevated levels were observed but receded to near-normal levels through cleanup and time.[120] For example, in 2012, Japan reported that 71 of 10 million bags of rice were contaminated. By 2015, that number had dropped to zero out of 10 million.[121]

Fukushima's effects were far more limited than Chernobyl's, in part because there was partial containment at Fukushima, whereas Chernobyl had a complete release of inner core materials, including more dangerous, long-lived isotopes that were not observed in the Fukushima region.[122]

APPENDIX B: EVALUATION OF SENATE BILL 4, PASSED IN 2025

Safeguards for the New Construction Work in Progress Law in Missouri

It remains to be seen how Senate Bill (SB) 4 alters the energy landscape in Missouri.

With construction-work-in-progress (CWIP), it is important to protect the interest of ratepayers. A blank check for a monopoly utility would increase the risk of cost overruns and cancellations, so accountability provisions are necessary. While the Missouri Public Service Commission (MPSC) still retains authority to determine which rates are just, reasonable, and eligible to be included in customers' bills, it is important for policymakers to consider explicit consumer protections.[123] SB 4 already includes two key provisions—cost caps (limited by the estimated cost and completion date) and a refund mechanism (which would be activated if the plant is not put into operation). These should be effective in protecting ratepayers, but the MPSC could weigh other safeguards when utilities propose CWIP financing for future projects, including nuclear projects. Virginia also recently passed CWIP reform, and it instituted various safeguards, which include:

- Excluding 20% of development costs from early recovery
- Mandatory evaluation of federal funding opportunities from the Department of Energy
- Establishment of an annual cap on residential monthly bill increases ($1.40 per 1000 kWh)[124]

Further, the MPSC should evaluate how ratepayers could be compensated appropriately for early contributions and their role in risk-sharing—such as treating CWIP financing more like a bond system.

This could involve limiting or disallowing pre-operation profits, aligning profits with the operation and provision of power. Another approach might be reducing total cost recovery for utilities after the plant is put into operation, since it is a riskier investment that relies on ratepayers earlier. Potential mechanisms include:

- Offering credits for reduced rates post-operation that could function like a principal in a bond
- Shortening the depreciation period post-operation to account for profits earned during the pre-operation phase

If this strategy leads to cost savings for a project, ratepayers should receive a portion of those savings. These provisions could help strike a balance between protecting ratepayers and facilitating needed nuclear power plant construction. Utility companies argue that CWIP is required to build more nuclear generation in Missouri. If that's the case, adequate safeguards for state ratepayers are also required.

APPENDIX C: EVALUATING SOUTH KOREAN NUCLEAR SUCCESS WITH THE APR-1400

The Advanced Power Reactor 1400 (APR-1400) is a Korean-designed pressurized-water reactor developed by Korea Hydro & Nuclear Power (KHNP). Each reactor has a nameplate capacity of slightly over 1,400 megawatts (MW). The APR-1400 is one of the advanced reactor designs approved by the NRC and has played a prominent role in the global expansion of nuclear energy.

APR-1400 units are currently operational in South Korea and the United Arab Emirates (UAE). In both countries, the timeline between the start of construction and operation has ranged from 8 to 10 years. For these plants (which are each more powerful than Missouri's Callaway Energy Center), the consistency in construction is remarkable.[125] The UAE's Barakah plant, the first commercial nuclear facility in the Arab world, brought four APR-1400 units online in rapid succession:

- **2021**: Barakah Unit 1 begins full commercial operation
- **2022**: Barakah Unit 2 begins full commercial operation
- **2023**: Barakah Unit 3 begins full commercial operation
- **2024**: Barakah Unit 4 begins full commercial operation

South Korea has demonstrated similarly consistent timelines for construction (except when an anti-nuclear president sought to phase out nuclear energy in the country).[126]

Two APR-1400s began construction at Shin-Kori in 2008–2009, and they were fully operational by 2016 and 2019. Likewise, two units began construction at Shin-Hanul in 2012–2013, and they were fully operational around 10 years later.[127]

The reactors built in the UAE and South Korea suggest that there is a benefit in building multiple units simultaneously. A streamlined regulatory process is essential for the United States; however, global success also offers valuable insights. Lovering et al. observe in their study that South Korea is the only country to have lowered its "overnight" construction costs (that is, the price of labor, equipment, and materials, excluding costs related to financing, inflation, and delays) for nuclear plants since 1980.[128] A detailed analysis of the regulatory environment for nuclear energy in South Korea is beyond the scope of this paper but could provide useful information to reformers in the United States.

Finally, the APR-1400 could be a reactor design to consider for future deployment in Missouri. In an analysis for future North Carolina energy plans, the John Locke Foundation selected the APR-1400 (citing its success) as the primary reactor for evaluating various electricity generation scenarios in the state.[132] Missouri could consider a similar approach, and a nuclear advisory council could be useful in facilitating a potential international partnership.

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