Solving the Energy Trilemma:

The Case for Nuclear as a Sustainable Investment

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I. Executive Summary

The nuclear energy industry is poised to play a pivotal role in helping the United States and the world address some of society's most pressing issues by effectively addressing the climate crisis and reducing or eliminating energy poverty while supporting the global economy.

Nuclear energy is critical as an energy resource because it has a zero-carbon footprint at the point of generation and is the world's most efficient and reliable power generation source. Without nuclear, there is no pathway to successfully addressing the energy trilemma reliability, affordability, and sustainability challenges and meeting climate, social, and economic goals.

In order to build nuclear energy generation sufficient to meet global demand, billions of dollars in investment capital focused on nuclear energy projects are needed, including investments in new technologies like small modular reactors (SMRs) and microreactors that will make nuclear energy safer and easier to deploy in remote areas and better able to service the emerging world. To attract necessary capital, however, financiers need to understand and recognize the environmental, social, and governance (ESG) performance of nuclear energy and acknowledge nuclear as an investible ESG asset.

From an environmental perspective, nuclear energy is an already-established, deployable resource that is critical to addressing greenhouse gas emissions, achieving climate goals, and improving air quality. Greater deployment of nuclear energy also presents an opportunity to enhance biodiversity, as it is a best-in-class performer with regard to lifecycle land use requirements. The U.S. nuclear industry has proven its ability to safely store generated waste, but additional opportunities to improve waste efficiency and public perceptions exist, including through technological advances, restoring domestic recycling capacity, permanent storage solutions, and increased public awareness of the nuclear industry's safety record regarding waste. Finally, the nuclear energy sector consumes water in an efficient manner, especially considering the amount of electricity it generates, and technological advances present opportunities for greater efficiencies in water-stressed areas.

With regard to the industry's social performance, as underscored by its resiliency during recent natural disasters and best-in-class reliability performance, nuclear power is a critical backbone of the nation's baseload electricity supply. Nuclear energy also contributes significantly to providing more affordable energy, is less vulnerable to commodity price spikes (which provides consumers with greater predictability and less volatility for energy costs), and could provide significant cost savings through future deployments as a low-carbon power generator as grid decarbonization policies are implemented. With a strong foundation provided by industry-led initiatives and a robust regulatory structure, the U.S. nuclear energy industry has also developed an outstanding safety record from both a community and workforce perspective.

Additionally, the U.S. nuclear industry is a significant contributor to both local and national jobs, economic growth, and tax revenue, and deployment of new nuclear technology could sustain and expand these benefits well into the future. Employees within the sector are the highest-paid wage earners across the entire energy industry, and receive benefits that are very competitive with other energy technologies. It is also a top performer for gender, race, and age diversity as compared to other electricity and fuel technologies. With regard to community engagement, recent research reflects highly positive attitudes toward nuclear power by those who live closest to the facilities, and further engagement and awareness efforts could improve regional and national attitudes even more.

While specific performance with respect to ESG categories will vary by individual company, the U.S. nuclear industry generally also performs well with regard to corporate governance. The industry rigorously implements risk and opportunity management programs and risk mitigation measures through mechanisms including internal governance processes as well as collaborations with industry-wide organizations. U.S. companies operating in this sector have enacted various programs and safeguards to minimize ethics-related risks and increase transparency and have taken a series of steps to implement sustainability throughout the supply chain.

In order to meet its potential for addressing critical environmental and social issues, the U.S. nuclear industry will need access to adequate financing. Climate finance is an internationally recognized tool necessary to fund large projects that contribute to greenhouse gas emissions reductions and climate resiliency. Green bonds have emerged as an important funding source for climate sustainable projects, including for nuclear as underscored by a recent issuance in support of an expanded power generation project in Canada. The European Union's (EU) decision to classify nuclear as a sustainable activity has provided additional momentum for the nuclear industry to access climate finance sources. These developments pave the way for U.S. nuclear energy projects, including those utilizing SMRs and microreactors, to receive billions in climate financing.

The financial sector has yet to recognize the nuclear industry as a unique sector for purposes of measuring ESG performance, and the fact that achievement of climate and economic goals will not be possible without nuclear. The financial community, including ESG rating agencies, to date has also not sufficiently acknowledged the strong ESG performance of the nuclear industry with respect to factors including its emissions and reliability performance and its strong social and governance attributes. Quite recently, however, financiers, analysts, and rating agencies have increasingly acknowledged that nuclear makes positive contributions to numerous ESG factors, especially its beneficial role in combatting climate change.

Similar recognition has emerged from governments in the United States and elsewhere around the world. In the United States, legislation signed into law through the Inflation Reduction Act and Bipartisan Infrastructure Law provide significant financial incentives to prevent existing nuclear facilities from prematurely shutting down and to encourage the development of future nuclear facilities including the deployment of advanced reactor technologies. Delayed closures of nuclear facilities in the United States and Europe reflect an increasing awareness of the critical role that nuclear energy plays in terms of electric power reliability.

Recognition by governments of nuclear energy's reliability, climate change, and broader ESG attributes is helping to create momentum in the private sector, including announcements regarding future development and use of advanced nuclear reactors and an ~$8 billion acquisition of one of the world's largest nuclear energy services businesses.

To successfully position nuclear for the future, a concerted public awareness and education outreach initiative is needed that highlights the above-mentioned benefits in order to change historical perceptions and secure public and private funding over the long-term. A similar effort should be launched and focused on key members of the financial services and investment community, as well as key regulators and decision-makers.

Even absent ESG considerations, as historical returns have underscored, nuclear is an investible asset. Furthermore, valuations naturally escalate as capital flows toward the technological solutions that society commits to in furtherance of meeting its most pressing needs. Lowering the cost of capital by factoring in a variety of ESG de-risking elements also drives up value, and removing regulatory and cost uncertainty and volatility creates a normalized cash flow that can be valued with more certainty. The case for investing in nuclear is thus even more compelling given nuclear's strong performance across various ESG topics, which could enhance valuation by reducing the cost of capital, particularly if nuclear's actual performance were better recognized by the investment community.

Evidence suggests that the financial community is starting to realize that nuclear energy is a significant part of addressing the energy trilemma through its reliability, affordability, and sustainability attributes. By better and more fully recognizing the performance of nuclear, including in critical areas like climate, reliability, and affordability, the financial community including ESG rating agencies will help enable the flow of capital necessary to meet the world's energy challenges through increased and accelerated deployment of nuclear power.

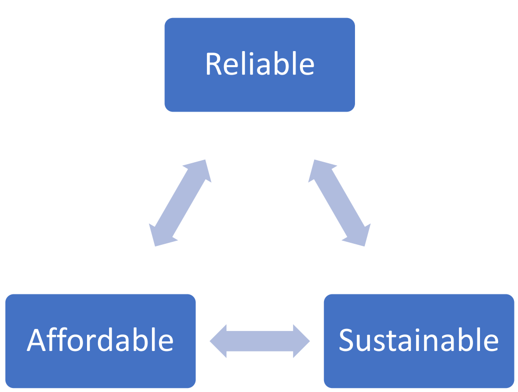
II. Introduction

The Energy Trilemma

When it comes to energy, people, governments, and investors want three things: reliability, affordability, and sustainability. Reliability refers to how easily energy is obtained and whether it is readily available when it is needed. Affordability refers to the cost of energy, and specifically whether the price is stable and reasonable for consumers. Sustainability refers to the manner in which energy is produced and its impact on society and the environment. For example, is the energy produced in a manner that benefits people and the environment and does not harm them, including through impacts on air quality, water quality, species habitat, and greenhouse gas emissions?

These three values make up what is referred to as the energy trilemma (see Figure 1). Notably, what impacts one value, such as sustainability, does not necessarily have the same impact on the other values such as reliability and affordability. While the public tends to value certain values over others based on the conditions of the time, all three are important.

Figure 1. Components of the Energy Trilemma.



These values also impact public policy decisions, and play a role in how the public views energy policy. Importantly, they play a significant role in the eyes of investors, who like the broader public may prefer one value over another. Over the past few decades, the importance that investors have placed on sustainability has increased significantly as some have sought to make decisions based on the impact of their investment on society and the planet, a concept known as impact investing. Over time, impact investing has become almost synonymous with the concept of Environmental, Social, and Governance, or ESG.

What is ESG?

ESG is an approach to evaluating the performance of an organization, project, or asset based on its goals and performance in areas beyond maximizing profits, namely in the areas of environmental performance and stewardship, social performance, and ethical, transparent, and effective corporate governance. Increasingly, ESG has become a critical factor in how investors evaluate companies.

ESG factors are comprised of the following:

E = environmental factors, or the energy and resources an organization takes in and the waste it discharges (*e.g.*, carbon emissions and climate change)

S = social factors, or the relationships an organization has with the communities where it operates (*e.g.*, diversity, equity, and inclusion and labor issues)

G = governance factors, or the internal system of practices, controls, and procedures an organization uses to govern itself and meet the needs of external stakeholders (*e.g.*, ethics, disclosure, and executive compensation)

ESG is the convergence of three developments that fused into one concept: 1) transparency and disclosure, which became regulatory requirements; 2) the environmental movement and climate change; and 3) corporate social responsibility.

Development of ESG

The roots of ESG go back as far as the Great Depression of the 1930s, when the public and governments called for greater transparency and disclosure of companies' financial performance. It also resulted in private corporations and governments developing greater standardization around and uniformity in financial accounting, including the establishment of the International Accounting Standards Board.

The environmental movement that first emerged in the 1960s amid concerns about clean air and water pollution and soil contamination, ultimately expanded in the 1970s through the 1990s to encompass concerns about climate change. As a consequence, companies began to quantify and disclose their environmental and climate-related impacts and performance, which in recent years has grown to include greenhouse gas emissions, carbon indices, and commitments to reducing emissions and addressing climate risks. Meanwhile, as an outgrowth of the transparency and disclosure trends that followed the Great Depression, in the 1970s the term materiality was defined through the judicial system, thereby enabling more effective and relevant disclosures.

In the late 1980s, a United Nations report titled "Our Common Future" embraced the concept of sustainable development, which ultimately helped lead to the disclosure of sustainability data and to companies publishing sustainability reports. The report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their needs."[1]

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[1] *See* "Report of the World Commission on Environment and Development: Our Common Future," *accessible at* https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf.

The term corporate social responsibility (CSR), which was first used in the 1950s, became a real movement and received widespread approval by the business community in the 1990s, when companies began to advertise their commitments and contributions to society.[2]

The term ESG specifically emerged from the "Who Cares Wins" conference in 2005, which brought together institutional investors, research analysts, asset managers, and regulators interested in the role that ESG-related factors could play in creating value. As institutional investors embraced and demanded ESG performance, the concept of ESG gained significant momentum.

For example, in 2006 ESG principles were mentioned in the United Nations' Principles for Responsible Investment (PRI). Investors that subsequently signed on to the PRI committed themselves to using responsible investment principles to guide investment decisions. This marked the first time that ESG data was used as a screening tool to evaluate corporate financial performance as part of investor due diligence. It also represented the advent of sustainable investments.[3]

In that regard, standards for ESG investing emerged in the mid to late 2010s, along with the development of corporate sustainability reports. By 2014, ~12% of public companies published sustainability reports.[4]

Then, in early 2020, BlackRock Chairman and CEO Larry Fink wrote a letter to investors on the "Fundamental Reshaping of Finance," placing sustainability at the center of the firm's investment approach.[5] That development was a tipping point that launched the ESG era as we know it and resulted in a surge of ESG commitments from investors, leading to unprecedented levels of ESG investing, which today exceeds ~$37 trillion in assets under management that meet ESG scrutiny.[6] By 2020, 92% of S&P 500 companies and 70% of Russell 1000 companies were publishing sustainability reports.[7]

Recently, United Nations climate change conferences and goals for reducing GHG emissions coupled with regulatory pressures spanning Europe, North America, and beyond have led companies to further enhance their ESG performance and disclosure. Against that backdrop, companies are increasingly taking steps to analyze the impacts that climate change might have on their assets and operations, including through climate scenario planning exercises and developing climate resiliency strategies.

Recent data suggests that increasing global economic uncertainties could result in a near-term reevaluation by companies of the resources they are committing to ESG programs and initiatives, with 50% of surveyed CEOs saying they are pausing or reconsidering existing or planned ESG efforts in the next six months and 34% stating they have already done so. However, that same data also showed that CEO sentiment that progress on ESG improves corporate financial performance rose from 37% in 2021 to 45% in 2022, and 69% of senior executives cited increased stakeholder demand for enhanced ESG

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[2] *See* "A Brief History of Corporate Social Responsibility in the US," The CSR Journal, September 26, 2019, *accessible at* https://thecsrjournal.in/a-brief-history-of-corporate-social-responsibility-in-the-us/.

[3] *See* Principles for Responsible Investment, *accessible at* https://www.unpri.org/about-us/about-the-pri.

[4] *See* G&A Institute's Publishes "2021 Sustainable Reporting in Focus" Trends Report, G&A Institute, December 1, 2021, *accessible at* https://www.sustainability-reports.com/ga-institutes-publishes-2021-sustainability-reporting-in-focus-trends-report/.

[5] *See* "A Fundamental Reshaping of Finance," BlackRock, *accessible at* https://www.blackrock.com/us/individual/larry-fink-ceo-letter.

[6] *See* "ESG Assets May Hit $53 Trillion by 2025, A Third of Global AUM," by Adeline Diab and Gina Martin, Bloomberg Intelligence, February 23, 2021, *accessible at* https://www.bloomberg.com/professional/blog/esg-assets-may-hit-53-trillion-by-2025-a-third-of-global-aum/.

[7] *See* G&A Institute's Publishes "2021 Sustainable Reporting in Focus" Trends Report, G&A Institute, December 1, 2021, *accessible at* https://www.sustainability-reports.com/ga-institutes-publishes-2021-sustainability-reporting-in-focus-trends-report/.

reporting and transparency.[8] In sum, the rate of adoption and implementation of ESG programs is unlikely to abate over the long-term.

The Growth of ESG and Its Linkage to Performance

ESG is a phenomenon largely driven by investors. It started with institutional investors, such as pension fund managers, who were seeking investments that were socially conscious and environmentally responsible. Prior to the pandemic, it began to broaden to include a broader swath of investors, including private equity funds, and during the pandemic became an even more significant component of investment strategies.

A critical reason for its durability has been its linkage to financial and operational performance. Done correctly, studies have consistently linked ESG and financial performance. For example, 58% of corporate studies show a positive interconnection between ESG and financial performance, with only 8% showing a negative correlation.[9]

A study by McKinsey & Co. showed that ESG creates value through top-line growth, cost reductions, reduced regulatory and legal interventions, employee product uplift, and investment and asset optimization.[10]

ESG has also been shown to be an effective risk mitigation tool, helping companies to identify risks and establish procedures and processes to mitigate them.

Additionally, ESG has helped companies improve communications within their organizations because it forces different parts of an organization to communicate among themselves to address common goals and objectives. This in turn can improve employee morale by giving employees a common cause around which to rally. Strong ESG performance is also linked to improving employee retention because it makes employees feel better about their organization and their roles within it. It similarly helps with recruitment because job seekers, especially younger ones, are increasingly assessing the ESG performance of prospective employers.

The importance of ESG is also growing because of global considerations like climate risk-related regulatory pressures, investor risks, and shifts in societal norms and economic challenges. A new generation of investors, including millennials and younger investors, are asking more of their investments and their environmental, social, and governance performance.

Data and technology have also served to support the ESG movement, as this data can provide valuable insights as to how companies perform, how they manage their environmental footprint, how they are governed, how they treat their employees, and how they interact with the communities in which they

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[8] *See* "Global CEOs See a 'Mild and Short' Recession, Yet Optimistic About Global Economy Over 3-Year Horizon," Press Release, KPMG, October 4, 2022, *accessible at* https://home.kpmg/xx/en/home/media/press-releases/2022/09/global-ceo-short-recession-optimistic-global-economy-over-3-years.html.

[9] *See* "ESG and Financial Performance: Uncovering the Relationship by Aggregating Evidence from 1,000 Plus Studies Published Between 2015-2020, by Tensie Whelan, Ulrich Atz, Tracy Van Holt, and Casey Clark, CFA, Rockefeller Asset Management and NYU Stern Center for Sustainable Business, *accessible at* https://www.stern.nyu.edu/sites/default/files/assets/documents/ESG%20Paper%20Aug%202021.pdf.

[10] *See* "Five Ways that ESG Creates Value," by Witold Henisz, Tim Koller, and Robin Nuttall, McKinsey Quarterly, November 2019, *accessible at* https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Strategy%20and%20Corporate%20Finance/Our%20Insights/Five%20ways%20that%20ESG%20creates%20value/Five-ways-that-ESG-creates-value.ashx.

operate. As more data is disclosed and distilled, greater insights can be achieved and greater analysis can be performed using data analytics.

ESG performance is also being driven by greater expectations from the marketplace, including investors, shareholders, and customers. Those expectations are impacting the way people within organizations view their obligations and driving greater scrutiny of ESG performance. Consider the following statistics:

- 91% of business leaders believe their company has a responsibility to act on ESG issues;
- 86% of employees prefer to support or work for companies that care about the same issues they do; and
- 83% of consumers think companies should be actively shaping ESG best practices[11]

Increasing Regulatory Pressures

Increasingly, regulatory pressure, including evaluation of mandatory reporting for public companies, is driving ESG performance. For instance, earlier this year the U.S. Securities and Exchange Commission (SEC) issued a proposed rule for mandatory climate data disclosures. An SEC proposed rule on human capital disclosures that could address areas including health and safety, diversity, and compensation is expected in the coming months.

In Europe, the European Union (EU) requires companies to comply with increasingly stringent ESG obligations and "do their best to qualify as sustainable." The EU Taxonomy Regulation, which took effect on January 1, 2022, requires companies to determine whether their activities contribute to climate change mitigation and adaptation and disclose how their obligations contribute to sustainability.

The EU Green Deal, a set of legislative proposals being implemented across member states, creates a mandatory disclosure of carbon indices and establishes a carbon border adjustment tax (CBAM) whereby all imports will be assessed in terms of their carbon index and carbon tariffs applied to commodities and products that do not meet EU standards for carbon indices.

These actions in the United States and Europe are consequential to all companies that plan to provide goods or services in these markets or do business with companies located there. Over time, it is anticipated that more countries will adopt mandatory ESG and carbon disclosure requirements, which will impact global trade. In this environment, companies and industries that have ESG programs in place and a lower carbon footprint will be more competitive.

There has also been a backlash against ESG, especially amongst conservative policymakers and fossil energy-producing states. Much of this is due to a belief that ESG targets fossil energy sources and that ESG requirements are unnecessarily burdensome to companies, especially smaller ones. In that regard, laws and proposed policies have been advanced that would block certain banks and investment funds from participating in pension fund and other investment opportunities in certain states like Texas, Louisiana, and West Virginia.[12]

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[11] *See* "Beyond Compliance: Consumers and Employees Want Business To Do More on ESG," PwC, *accessible at* https://www.pwc.com/us/en/services/consulting/library/consumer-intelligence-series/consumer-and-employee-esg-expectations.html.
[12] *See* "Why the ESG vs. GOP War Over Energy and Climate Change Is Going Nowhere," by Tim Mullaney, CNBC, October 6, 2022, *accessible at* https://www.cnbc.com/2022/10/05/why-the-esg-vs-gop-war-over-climate-change-is-going-nowhere.html.

ESG and the Energy Trilemma

The energy trilemma factors strongly in ESG. Perhaps no sector in the economy is unaffected by ESG. This is most obvious when it comes to sustainability, since so much of ESG focuses on climate change, air and water quality, land use, and species habitat. At the same time, however, as underscored by recent geopolitical developments, weather-related events, and grid reliability challenges in the United States, affordability and reliability are also strongly aligned with ESG as discussed later in this report. As the world moves toward greater use of intermittent, renewable energy sources, the importance of reliability and grid resiliency will only increase further.

Nuclear energy effectively addresses all three facets of the energy trilemma, with subsequent sections of this report demonstrating its strong performance in terms of both sustainability and investibility.

The Emerging State of Nuclear Energy

Nuclear energy is experiencing a revival in the United States and globally due to a number of important factors. Nuclear energy, which currently provides about 20 percent of the power consumed in the United States, has seen its share of the nation's electricity supply slowly falling.[13] However, its reliability, consistency, and high capacity factor[14] are making it more attractive to investors and utilities that need reliable power.

The other major factor influencing the reputation of nuclear energy is its low greenhouse gas (GHG) emissions footprint. Nuclear is a zero GHG emission technology at the generation point, an incredibly important qualification in a world that is seeking to decarbonize and reduce GHG emissions while growing economically and providing electricity to people in emerging nations who have for years been living in energy poverty.

For years, however, and as noted by investors and financiers in preparation of this report, nuclear energy has been seen by investors, governments, and the public as an energy source that is outdated, expensive, and wrought with issues such as waste storage, nuclear proliferation, and meltdown fears. This perception was fueled by incidents including Three Mile Island in Pennsylvania, Chernobyl in the former Soviet Union, and Fukushima in Japan, as well as expenditures associated with long regulatory processes and project cost overruns.

Yet, there has always been a core, supportive investor base that appreciates the safe, longer term, and highly regulated aspects of nuclear as an energy source. They tend to be large cap money managers, insurance companies, and pension funds. In the case of nuclear power generators, some have issued stand-alone bonds, which tend to pay higher coupons and therefore provide greater return on investment.

For the large bulk of the investment community, investment in nuclear was not in vogue. Investors were looking at "clean energy," and that meant renewables. There was a belief that nuclear assets stymied the growth of renewables, a belief that had more to do with perception than reality.

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[13] *See* "U.S. Nuclear Electricity Generation Continues to Decline As More Reactors Decline," U.S. Energy Information Administration, April 8, 2022, *accessible at* https://www.eia.gov/todayinenergy/detail.php?id=51978.
[14] Capacity factor is the ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period. *See* Glossary, Capacity Factor, U.S. Energy Information Administration, *accessible at* https://www.eia.gov/tools/glossary/index.php?id=Capacity_factor.

Then, things began to change. First, there was the recognition and emphasis that states were placing on nuclear assets. They began to be seen as reliable at a time when reliability was becoming a growing concern. There was also the issue of local impacts. As plans were made to shut down nuclear facilities, states and local communities began to look at the economic impacts, lost local property taxes, and the loss of high-paying jobs with wages up to $110,000 per year.

Investors began to realize that nuclear was a solution to many problems. It is reliable, a zero GHG-emitting electricity generation technology, and provides baseload power where other intermittent sources fall short. Then, the EU taxonomy debate led to nuclear energy being labeled sustainable, which was hailed as a game changer for investors in nuclear. Investors are now saying "I'm okay with nuclear," one financier observed. Other investors noted the success of Constellation Energy, which they termed as "extremely profitable" and the closest thing to a pure play nuclear energy investment.

The Attractiveness of Advanced Technology

In Waynesboro, GA, Southern Company's Vogtle plant recently received and began loading nuclear fuel rods at one of its two new reactors scheduled to begin production in 2023.[15] While the new reactors were built using traditional methods, nuclear energy has started to become more attractive to investors as they look to the future.

For example, there is a growing set of investors who want to invest in Small Modular Reactors (SMRs), highly advanced reactors that produce up to 300 MW per unit, are portable, and can serve smaller, more isolated populations. SMRs are emerging as solutions for bringing low-carbon energy sources to remote areas, including the developing world, and are seen as an opportunity to bring nuclear into the world of more localized distributed generation.

A series of recent developments have underscored the momentum for SMRs. In early 2022, the Tennessee Valley Authority (TVA) announced the kick-off of a program involving the installation of multiple advanced SMR reactors, starting with their Clinch River site in Tennessee.[16]

In July 2022, the U.S. Nuclear Regulatory Commission announced it would issue a rule to certify NuScale's SMR design for use in the United States.[17] NuScale has signed an agreement with Doosan Enerbility Co., Ltd. to produce materials to begin construction of the first commercial deployment of its VOYGR SMR power plant for the Utah Associated Municipal Power Systems' Carbon Free Power Project at Idaho National Lab.[18]

Several observers see commercial deployment of SMRs in 2030 and beyond as technology advancement and market forces, including high electricity prices, demand for low carbon energy, and the need for reliable baseload generation pave the way for their deployment. Other promising areas of potential future deployment and application of advanced nuclear technology include nuclear medicine, desalination, industrial heating, and hydrogen production.

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[15] *See* "Vogtle Unit 3 Starts Nuclear Fuel Load," Press Release, Southern Company, October 14, 2022, *accessible at* https://southerncompany.mediaroom.com/2022-10-14-Vogtle-Unit-3-starts-nuclear-fuel-load.

[16] See "TVA Unveils Major New Nuclear Program, First SMR at Clinch River Site," by Sonal Patel, POWER Magazine, February 10, 2022, *accessible at* https://www.powermag.com/tva-unveils-major-new-nuclear-program-first-smr-at-clinch-river-site/.

[17] *See* "NRC To Issue Rule Certifying NuScale Small Modular Reactor," Press Release, U.S. Nuclear Regulatory Commission, July 29, 2022, *accessible at* https://www.nrc.gov/docs/ML2221/ML22215A208.pdf.

[18] See Carbon Free Power Project, NuScale Power, *accessible at* https://www.nuscalepower.com/projects/carbon-free-power-project.

Highlighting the importance of access to private capital finance and the growth of financing mechanisms to the success of advanced nuclear technology, in August 2022, TerraPower, a nuclear innovation company founded by Bill Gates, announced the close of an equity raise with a minimum yield of $750 million to be applied to advanced nuclear technology for power generation and nuclear medicine. The fundraise was co-led by South Korean energy provider SK Inc., which contributed $250 million.[19] TerraPower is working with GE Hitachi Nuclear Energy to demonstrate its Natrium nuclear reactor technology at a soon-to-be-retired coal plant in Wyoming. The system utilizes a smaller reactor and a molten salt energy storage system that enables a microreactor to boost energy output over short periods of time.[20]

Investors and innovators are also becoming increasingly interested in the use of nuclear energy for producing near-zero carbon hydrogen. The market has been focused on "green hydrogen" production where renewable energy is used to provide the power for electrolysis to create zero-carbon hydrogen. The market has also been focused on nuclear energy playing the same role to produce zero-carbon hydrogen, known as "pink hydrogen."

An important announcement was made in September 2022 by Bloom Energy, which plans to install an electrolyzer at Xcel Energy's Prairie Island Nuclear Generating Plant in Welch, MN to create a pathway for producing clean hydrogen using nuclear power. It is in the process of engineering a 240 kW demonstration facility that will be built in 2023, with a goal of being operational in early 2024.[21]

Also in September 2022, the U.S. Air Force announced its decision to request proposals for a nuclear microreactor to provide supplemental power at Eielson Air Force Base in Alaska. The announcement implements a statutory provision passed by Congress that requires the construction and operation of a microreactor at a U.S. Department of Defense facility by the end of 2027. Deputy Assistant Secretary of the Air Force for Environment, Safety, and Infrastructure Nancy Balkus called the development "a critical next step in furthering the development and deployment of reliable and clean energy technology at Department of the Air Force installations."[22]

Government Support for Nuclear and Its Positive Impact on Investment

Another important development that has given investors greater confidence in nuclear has been the realization by national and state governments that nuclear energy plays a critical and irreplaceable role in energy supply, grid reliability, and sustainability. As a result, the trend toward shutting down nuclear facilities in North America and Europe has recently reversed.

For example, in September 2022, Germany announced it would temporarily halt the closing of two nuclear plants in response to the cutoff of Russian gas and high energy prices,[23] and in October

[19] *See* "TerraPower Announces $750 Million Secured in Fundraise," Press Release, TerraPower, August 15, 2022, *accessible at* https://www.terrapower.com/fundraise/.
[20] See "Bill Gates' Company TerraPower Raises $750 Million for Nuclear Energy and Medicine Innovation," by Catherine Clifford, CNBC, August 15, 2022, *accessible at* https://www.cnbc.com/2022/08/15/bill-gates-nuclear-company-terrapower-raises-750-million.html.
[21] See "Xcel Taps Bloom Energy to Install Electrolyzer at Prairie Island Nuclear Generating Plant," by Dave Kovaleski, DailyEnergyInsider, September 21, 2022, *accessible at* https://dailyenergyinsider.com/news/36778-xcel-taps-bloom-energy-to-install-electrolyzer-at-prairie-island-nuclear-generating-plant/.
[22] *See* "Request for Proposal Released for Eielson Air Force Base Micro-Reactor Pilot Program," Press Release, U.S. Air Force, September 26, 2022, *accessible at* https://www.safie.hq.af.mil/News/Article-Display/Article/3169035/request-for-proposal-released-for-eielson-air-force-base-micro-reactor-pilot-pr/.
[23] *See* "Germany to Delay Phase-Out of Nuclear Plants to Shore Up Energy Security," by Kate Connolly, The Guardian, September 5, 2022, *accessible at* https://www.theguardian.com/world/2022/sep/05/germany-to-delay-phase-out-of-nuclear-plants-to-shore-up-energy-security.

announced plans to temporarily halt the closing of all three of the country's nuclear plants.[24] Additionally, France is continuing to pursue nuclear power with enthusiasm as its Energy Ministry recently announced its pursuit of legislation to streamline the bureaucracy around nuclear projects, while pushing for construction of its next generation EPR2 reactor prior to May 2027.[25]

U.S. Energy Secretary Jennifer Granholm recently toured the Idaho National Laboratory, an important nuclear energy research lab where SMR technology is being developed, and said that nuclear was "a clear path" to "getting to net zero and addressing climate change." She said that that around the world "people are looking to us to help them reach their goals with nuclear," noting that about 100 nuclear power plants provide about 20% of the nation's power and 50% of the nation's zero carbon-emitting energy.[26]

Two major pieces of legislation recently passed by the U.S. Congress and signed into law by President Biden contain provisions that further demonstrate the U.S. government's support for continued use and future deployment of nuclear energy as clean and reliable energy.

The Bipartisan Infrastructure Law, enacted in November 2021, established a $6 billion Civil Nuclear Credit Program that helps avoid premature retirements of nuclear power facilities. It allows "owners or operators of commercial U.S. reactors to apply for certification and competitively bid on credits to help support their continued operations."[27]

Additionally, the Inflation Reduction Act (IRA), signed into law in August 2022, also contained provisions that benefit U.S. nuclear energy. For example, a production tax credit of up to $15 per mWh is available for nuclear facilities in service in 2024 and is available through 2032, with a goal of "keeping existing reactors competitive with other power generators." It also provides tax incentives for advanced reactor technology, giving new nuclear generators the choice of a $25 per megawatt-hour technology-neutral production tax credit for the first 10 years of the life of a facility's operation or a tax credit of 30 percent on new zero-carbon facilities that become operational in 2025 or beyond. Both options are eligible for an additional 10 percent bonus if they are built on a brownfield site or in a fossil fuel community. Additional credits are available if nuclear energy is used to produce pink hydrogen.[28]

The IRA also makes $700 million available for the development of high-assay, low enriched uranium, or HALEU needed to support advanced reactors like the U.S. Department of Energy (DOE) demonstration projects by TerraPower and X-energy. Finally, the IRA additionally provides $150 million to support research and development at DOE labs that could also support nuclear energy.[29]

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[24] *See* "Germany Pushes to Extend Lifespan of Three Nuclear Plants – Letter," by Andreas Rinke, Riham Alkousaa, and Tom Käckenhoff, Reuters, October 17, 2022, *accessible at* https://www.reuters.com/business/energy/germany-create-legal-basis-extend-lifespan-three-nuclear-plants-letter-2022-10-17/.

[25] *See* "France Crafts Law to Streamline Red Tape Around Nuclear Reactor Construction," by Benjamin Mallet and Dominique Vidalon, Reuters, September 27, 2022, *accessible at* https://www.reuters.com/business/energy/france-expects-build-first-new-epr2-reactor-before-may-2027-ministry-official-2022-09-27/.

[26] *See* "Granholm Says Nuclear Key to Meeting Energy Goals," The Associated Press, August 5, 2022, *accessible at* https://journalrecord.com/2022/08/05/granholm-says-nuclear-key-to-meeting-energy-goals/.

[27] *See* "DOE Establishes $6 Billion Program to Preserve America's Clean Nuclear Energy Infrastructure," Press Release, U.S. Department of Energy, February 11, 2022, *accessible at* https://www.energy.gov/articles/doe-establishes-6-billion-program-preserve-americas-clean-nuclear-energy-infrastructure.

[28] *See* "Inflation Reduction Act Keeps Momentum Building for Nuclear Power," Office of Nuclear Energy, U.S. Department of Energy, September 8, 2022, *accessible at* https://www.energy.gov/ne/articles/inflation-reduction-act-keeps-momentum-building-nuclear-power.

[29] *See* "Inflation Reduction Act Keeps Momentum Building for Nuclear Power," Office of Nuclear Energy, U.S. Department of Energy, September 8, 2022, *accessible at* https://www.energy.gov/ne/articles/inflation-reduction-act-keeps-momentum-building-nuclear-power.

State-level developments underscore how policymakers of all political stripes see the attributes that nuclear energy possesses in terms of reliability, affordability, and sustainability. For example, in September 2022, California Governor Gavin Newsom signed legislation that delays a scheduled 2025 shutdown of the state's Diablo Canyon nuclear facility for at least five years.[30] In Michigan, Governor Gretchen Whitmer sent a letter to U.S. Energy Secretary Jennifer Granholm seeking her support for restarting the 800 MW Palisades nuclear power plant that was closed in May 2022 after operating for 50 years.[31]

In September 2022, Virginia Governor Glenn Youngkin released a comprehensive energy plan for the Commonwealth that endorsed an "all-of-the-above" approach to energy supply, including expansion of nuclear energy and a goal of installing an SMR in southwest Virginia within 10 years.[32]

Bank of America Securities expressed the momentum nuclear is facing in its recent report "Why We're Ever More Positive on Nuclear: Not a Renaissance But a Clean New Day." The report cited the IRA provisions as evidence of nuclear gaining momentum, and noted that the production tax credits could result in expanded capacity, foster nuclear power's use to produce hydrogen, and potentially help foster new nuclear facilities and SMRs. While the report was cautious, it noted a number of nuclear energy's attributes, including its cost versus other fuel sources with higher volatility.[33]

Amid these developments, in a July 2022 poll conducted by the Nuclear Energy Institute, member utilities estimated that there would be demand for 300 small modular reactors by 2050, with NEI noting that actual deployments will be well north of that number.[34]

The situation that Europe is facing from a loss of Russian gas supply is only furthering the case for nuclear to address energy security and climate goals. As the Trans-Atlantic Alliance looks for ways to secure clean and reliable forms of energy that are less vulnerable to geopolitical events and threats, that trend is expected to continue and even strengthen well into the future.

Perhaps nothing has given nuclear power a bigger boost in terms of investor support than the European Union's (EU) recent decision to label nuclear energy as "green" within its taxonomy, a list of activities it designates to be aligned with its climate goals.[35] That designation makes nuclear projects accessible for green finance mechanisms, including green bonds, which could attract billions of dollars in new investment capital to nuclear projects. More recently, South Korea included nuclear power in its taxonomy as well.[36]

Another significant development was the successful issuance of green bonds to Canada's Bruce Power, LP to refurbish six of eight units at its nuclear power station in Ontario. That issuance is the first for a

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[30] *See* "Newsom Signs Bill to Keep Diablo Canyon Nuclear Plant Open," by Michael Blood, The Associated Press, September 3, 2022, *accessible at* https://www.latimes.com/california/story/2022-09-03/newsom-signs-bill-to-keep-diablo-canyon-nuclear-plant-open.

[31] *See* "Michigan Governor Urges DOE to Support Palisades Nuclear Plant's Reopening," by Sonal Patel, POWER Magazine, September 12, 2022, *accessible at* https://www.powermag.com/michigan-governor-urges-doe-to-support-palisades-nuclear-plants-reopening/.

[32] *See* "Governor Glenn Youngkin Releases Virginia's Energy Plan," Press Release, Office of the Governor of Virginia, October 3, 2022, *accessible at* https://www.governor.virginia.gov/newsroom/news-releases/2022/october/name-940624-en.html.

[33] *See* "Why We're Ever More Positive on Nuclear: Not a Renaissance But a Clean New Day," Bank of America Securities, Sept. 8, 2022.

[34] *See* "Is Nuclear Energy Poised for an ESG-Fueled Comeback?," by Nico Portuondo, Energywire, October 4, 2022, *accessible at* https://subscriber.politicopro.com/article/eenews/2022/10/04/is-nuclear-energy-poised-for-an-esg-fueled-comeback-00054364.

[35] *See* "EU Lawmakers Remove Last Hurdle to Label Gas, Nuclear As Green," by John Ainger, Bloomberg, July 6, 2022, *accessible at* https://www.bloomberg.com/news/articles/2022-07-06/eu-lawmakers-remove-last-hurdle-for-gas-nuclear-as-green.

[36] *See* ""South Korea Follows EU's Lead on Classifying Gas and Nuclear as Green," by Simon Mundy, Financial Times, October 17, 2022, *accessible at* https://www.ft.com/content/d09c2e67-a25d-4874-9bd3-9d5aa35966b0.

nuclear project and will open the doors for future green bond support for nuclear power. Underscoring the potential benefits for nuclear, to date, more than $2 trillion has been raised through green bonds since they were first issued 15 years ago. [37] (see additional discussion of the EU taxonomy designation and green bond funding for nuclear in Chapter IV)

So how is the market reacting to all of these developments around nuclear? No greater evidence of its momentum as an ESG-fueled investment can be found than the recently announced ~$8 billion acquisition of Westinghouse Electric Company, one of the world's largest nuclear energy services businesses. Upon official closure of the transaction, the strategic partnership will be owned by Brookfield Renewable Partners (51%) and Cameco% (49%). The deal brings together one of the world's largest clean energy investors and the world's largest publicly traded supplier of uranium.[38]

Brookfield Renewable CEO Connor Teskey said that Westinghouse "has successfully refocused on providing core services to the nuclear industry and is ready for the next phase of growth," stating that "we see significant potential to grow the business and deliver on broader growth in the nuclear power sector through our strategic partnership with Cameco."[39]

Cameco President and CEO Tim Gitzel added that "[w]e're witnessing some of the best market fundamentals we've ever seen in the nuclear energy sector," with relevant market trends cited by Cameco including the following:

- Nuclear energy's role as a critical transition technology as one of the sole zero-emission, baseload sources of electricity currently available at scale;
- The resurgence and accelerated growth plans nuclear is realizing with new projects or plant extensions being pursued in 20 countries in Europe, the Americas, the Middle East, and Asia;
- Energy security pressures the world is experiencing as a result of geopolitical uncertainty that currently impact energy supply chains and future energy sources, which will substantially grow the opportunity for nuclear energy to supply Eastern Europe with energy traditionally supplied by Russia; and
- Decades of growth opportunities associated with the rollout of next-generation advanced nuclear technology and long-term nuclear energy storage solutions[40]

The transaction, and the financial community's reaction to it, demonstrates the viewpoint that nuclear energy has a bright future, and that its attributes as reliable, affordable, and sustainable reflect its strong ESG performance that is akin to and complementary of renewable energy. With nuclear declared green through the EU Taxonomy and eligible for billions of dollars in future green bond issuances, and amid renewed private capital investments, public sector financial incentives, growing political support, and significant technological advances, nuclear energy is ripe as an investible asset, including from an ESG perspective. If given its due as an investible ESG asset, nuclear can receive the investment it needs to fulfill its promise.

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[37] *See* "Green Bond Issuance Crosses $2trn Milestone," Environmental Finance, *accessible* at https://www.environmental-finance.com/content/news/green-bond-issuance-crosses-$2trn-milestone.html.

[38] *See* "Is the Westinghouse $7 Billion Acquisition a Sign of Nuclear's Revival?," Power Engineering International, October 13, 2022, *accessible at* https://www.power-eng.com/nuclear/is-the-westinghouse-7-billion-acquisition-a-sign-of-nuclears-revival/#gref.

[39] *See* "Nuclear Giant Westinghouse Acquired by Renewable Power Company and Uranium Fuel Supplier," by Aaron Larson, POWER Magazine, October 12, 2022, *accessible at* https://www.powermag.com/nuclear-giant-westinghouse-acquired-by-renewable-power-company-and-uranium-fuel-supplier/.

[40] *See* "Is the Westinghouse $7 Billion Acquisition a Sign of Nuclear's Revival?," Power Engineering International, October 13, 2022, *accessible at* https://www.power-eng.com/nuclear/is-the-westinghouse-7-billion-acquisition-a-sign-of-nuclears-revival/#gref.

The following sections of this report describe how the U.S. nuclear energy industry performs against various environmental, social, and governance categories and how there is no pathway to global net zero emissions without nuclear energy. Additionally, the report will examine how green market mechanisms could provide a significant portion of the financing nuclear energy will need to play its needed role in the energy transition, how ESG investors, financiers, and rating agencies have overlooked and undervalued ESG, the steps needed to ensure an evaluation better reflective of the industry's actual performance, and how the industry's ESG performance does and should enhance its value.

III. U.S. Nuclear Industry's ESG Performance

Multiple frameworks exist from which to measure industry and company performance across a range of environmental, social, and governance metrics. Disclosure frameworks commonly used by U.S. companies include the Sustainability Accounting Standards Board, Global Reporting Initiative, and Task Force on Climate-Related Financial Disclosures. The United Nations Sustainable Development Goals provide an additional framework from which operations can be evaluated for alignment with sustainability objectives.

This report assesses the U.S. nuclear industry's performance against the eighteen topics highlighted in Figure 2. These topics were determined based on relevance to the nuclear industry, importance to the financial community, and disclosure trends.

Figure 2. Topics for Evaluation of U.S. Nuclear Industry ESG Performance.

ENVIRONMENTAL	SOCIAL	GOVERNANCE
Climate & Greenhouse Gas Emissions	Grid Resiliency	Risk Management & Opportunity Oversight
Air Quality	Energy Affordability	Ethics & Transparency
Biodiversity	Nuclear Safety & Emergency Mgmt.	Supplier Engagement
Waste	Workforce Health & Safety	
Water Management	Economic Impacts	
	Employee Management	
	Human Rights	
	Diversity & Inclusion	
	Community Relations & Social Investment	

In assessing the industry's performance, the report includes a focus on power generation, while in some cases also addressing other aspects of the industry including nuclear fuels, technology providers, and suppliers. Additionally, for most topics, the report compares performance with other sectors, and for all topics, the report outlines example metrics associated with major disclosure frameworks and the Sustainable Development Goals.

In sum, while specific performance will vary by company and project and opportunities exist to maintain and further enhance performance through continued technological advances and policy support, the evaluation findings align with the conclusion of a 2021 report prepared for the United Nations Economic Commission for Europe:

> *"Nuclear energy is an indispensable tool for achieving the global sustainable development agenda. It has a crucial role in decarbonizing the energy sector, as well as eliminating poverty, achieving zero hunger, providing clean water, affordable energy, economic growth, and industry innovation. Improved government policy and public perception along with ongoing innovation will enable nuclear energy to overcome traditional barriers to deployment and expand into new markets."*[41]

A. Environmental

1. *Climate & Greenhouse Gas Emissions*

A global movement to address climate issues took formal shape in 1992 upon adoption of the United Nations Framework Convention on Climate Change (Convention).[42] There are currently 197 signatory nations, including the United States, which became a party to the Convention in 1992. Under the Convention, all signatories commit to take climate considerations into account in their policies and actions, with signatories including the United States also specifically committing to adopt policies to limit greenhouse gas emissions.[43]

More recently, through the Paris Agreement, nearly all Convention signatory nations including the United States have committed to submit detailed plans known as Nationally Determined Contributions in support of a goal to limit the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. As part of the effort, signatory nations aim to reach "global peaking" of greenhouse gas emissions as soon as possible, and to subsequently undertake rapid reductions.[44]

Citing the Intergovernmental Panel on Climate Change, the U.S. Environmental Protection Agency has noted that greenhouse gases from human activities "are the most significant driver of observed climate change since the mid-20th century."[45] According to EPA, in 2020, carbon dioxide comprised 79% of U.S. greenhouse gas emissions, followed by methane (11%), nitrous oxide (7%), and fluorinated gasses (3%).[46]

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[41] *See* Application of the United Nations Framework Classification for Resources and the United Nations Resource Management System: Use of Nuclear Fuel Resources for Sustainable Development – Entry Pathways, Prepared by the Expert Group on Resource Management, United Nations Economic Commission for Europe, 2021, *accessible at* https://unece.org/sites/default/files/2021-03/UNFC%20%26amp%3B%20UNRMS%20NuclearEntryPathwaysRevised.pdf.

[42] *See* Chapter XXVII, Environment, United Nations Framework Convention on Climate Change, United Nations Treaty Collection, *accessible at* https://treaties.un.org/Pages/ViewDetailsIII.aspx?src=IND&mtdsg_no=XXVII-7&chapter=27&Temp=mtdsg3&clang=_en.

[43] *See* United Nations Framework Convention on Climate Change, New York, May 9, 1992, *accessible at* https://treaties.un.org/doc/Treaties/1994/03/19940321%2004-56%20AM/Ch_XXVII_07p.pdf.

[44] *See* Chapter XXVII, Environment, Paris Agreement, United Nations Treaty Collection, *accessible at* https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en#5; and Paris Agreement, United Nations, 2015, *accessible at* https://treaties.un.org/doc/Treaties/2016/02/20160215%2006-03%20PM/Ch_XXVII-7-d.pdf.

[45] *See* Climate Change Indicators: Greenhouse Gases, U.S. Environmental Protection Agency, *accessible at* https://www.epa.gov/climate-indicators/greenhouse-gases.

[46] *See* Overview of Greenhouse Gases, U.S. Environmental Protection Agency, *accessible at* https://www.epa.gov/ghgemissions/overview-greenhouse-gases.

To meet its climate goals and obligations under the Paris Agreement, the United States has specifically announced a target to reduce greenhouse gas emissions 50-52% from 2005 levels by 2030, create a carbon-free electricity sector by 2035, and achieve net zero greenhouse gas emissions across the economy by 2050. In doing so, the U.S. government has explicitly recognized the role of nuclear energy in reaching those goals.[47]

In addition to Congress approving new financial incentives in 2022 that are designed in part to reduce greenhouse gas emissions, federal agencies have also been directed to assess and manage climate-related risks to financial stability,[48] and the Securities and Exchange Commission has proposed requiring climate-related disclosures including greenhouse gas emissions data in registration statements and periodic reports.[49]

Meanwhile, states have enacted their own policies, including electricity portfolio standards and emissions cap and trade programs.[50]

Amid these developments, companies are being driven to address climate change by a variety of factors. One survey of more than 2,000 C-suite executives in 21 countries including the United States was conducted in 2021 and found that pressures to act include regulators/government (77%), Board members/management (75%), consumers/clients (75%), civil society (72%), shareholders/investors (71%), competitors/peers (66%), employees (65%), and banks/lenders (55%).[51]

Additionally, the survey found that 97% of respondents said their companies have already been negatively impacted by climate change, with the top climate issues affecting them comprised of operational impacts (48%), regulatory/political uncertainty (47%), pressure from civil society (42%), the need to modify industrial processes (40%), and climate change mitigation costs (40%).

Given those findings, it is not surprising that a number of climate and greenhouse gas-related metrics exist, many of which are listed below in Figure 3.

Figure 3. Example Climate & GHG Emissions-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Disclose the organization's governance around climate-related risks and opportunities, including the role of the board and in overseeing climate related issues and the role of management in assessing and managing climate-related risks and opportunities	TCFD (Governance)
Actual/potential impacts of climate-related risk on the business, strategy and financial planning where such information is material, including: (1) climate-	TCFD (Strategy)

[47] *See* "Fact Sheet: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies," The White House, April 22, 2021, *accessible at* https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/.
[48] *See* Public Law No. 117-169, Inflation Reduction Act of 2022, *accessible at* https://www.congress.gov/bill/117th-congress/house-bill/5376/text; and Executive Order on Climate-Related Financial Risk, May 20, 2021, *accessible at* https://www.whitehouse.gov/briefing-room/presidential-actions/2021/05/20/executive-order-on-climate-related-financial-risk/.
[49] *See* SEC Proposes Rules to Enhance and Standardize Climate-Related Disclosures for Investors, U.S. Securities and Exchange Commission, March 21, 2022, *accessible at* https://www.sec.gov/news/press-release/2022-46.
[50] *See* U.S. Climate Change Policy, Congressional Research Service, October 28, 2021, *accessible at* https://crsreports.congress.gov/product/pdf/R/R46947.
[51] *See* Deloitte 2022 CxO Sustainability Report, *accessible at* https://www2.deloitte.com/content/dam/Deloitte/global/Documents/2022-deloitte-global-cxo-sustainability-report.pdf.

related risks and opportunities the organization has identified over the short, medium, and long term; (2) impact of climate-related risks and opportunities on the organization's businesses, strategy and financial planning; and (3) resilience of the organization's strategy, taking into consideration different climate-related scenarios including a 2˚C or lower scenario	
Disclose how the organization identifies, assesses, and manages climate-related risks, including identification of processes for doing so and how those processes are integrated into the organization's overall risk management	TCFD (Risk)
Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material, including Scope 1 and 2, and if appropriate, Scope 3 GHG emissions and related risks	TCFD (Metrics & Targets)
(1) Gross global Scope 1 emissions, percentage covered under (2) emissions-limiting regulations, and (3) emissions-reporting regulations	SASB IF-EU-110a.1
Greenhouse gas (GHG) emissions associated with power deliveries	SASB IF-EU-110a.2
Discussion of long-term and short-term strategy or plan to manage Scope 1 emissions, emissions reduction targets, and an analysis of performance against those targets	SASB IF-EU-110a.3
Direct (Scope 1) GHG emissions	GRI 305-1
Energy indirect (Scope 2) GHG emissions	GRI 305-2
Other indirect (Scope 3) GHG emissions	GRI 305-3
GHG emissions intensity	GRI 305-4
Reduction of GHG emissions	GRI 305-5
Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	SDG 3
Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable and modern energy for all	SDG 7
Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable	SDG 11
Responsible Consumption and Production: Ensure sustainable consumption and production patterns	SDG 12
Climate Action: Take urgent action to combat climate change and its impact	SDG 13
Life Below Water: Conserve and sustainably use the oceans, sea and marine resources for sustainable development	SDG 14
Life on Land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	SDG 15

Industry Performance

While federal rules limiting GHG emissions in the electricity sector are not in place, climate change is considered in federal decision-making. In furtherance of such consideration, the U.S. Nuclear Regulatory Commission (NRC) developed guidance for staff to evaluate greenhouse gas emissions and climate change impacts when conducting environmental reviews for new reactors, including indirect emissions associated with the nuclear fuel cycle.[52]

Even in the absence of federal rules limiting GHG emissions in the U.S. electricity sector, the sector's emissions fell 33% between 2005 and 2019. A federal report noted that the overall decrease in U.S. greenhouse gas emissions during that period was "largely related" to the electricity sector declines, highlighted the "key role" of the "evolving electricity generation portfolio" to the electricity sector decline, and noted that sources including nuclear power "emit no GHG emissions at the point of power generation."[53]

More broadly, in stating that nuclear power and hydropower "form the backbone of low-carbon electricity generation," the International Energy Agency in 2019 noted that they contribute 75% of the world's low-carbon electricity, and that nuclear in particular has reduced CO_2 emissions by more than 60 gigatons.[54] In addition, in expressing high confidence that multiple energy supply options exist to reduce emissions over the next ten years, a Working Group report approved by the Intergovernmental Panel on Climate Change member governments among other things cited nuclear as an "already established" technology that can be deployed.[55]

The operation of U.S. nuclear power plants in 2021 avoided over 476 million metric tons of carbon dioxide emissions.[56] For perspective, that equates to ~8% of the total gross U.S. greenhouse gas emissions in 2020.[57]

As highlighted below in Figure 4, an assessment of the lifecycle greenhouse gas emissions associated with various electricity generation technologies across twelve global regions found nuclear power to be the least impactful technology. According to the study, nuclear power contributes 5.1-6.4 grams of CO_2 equivalent per kilowatt hour of output, with "front end" processes covering the mining to fuel fabrication phase being the primary contributor. The study found that lifecycle emissions associated with a small modular design would be 4.6 grams of CO_2 equivalent per kilowatt hour of output.[58]

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[52] *See* Staff Guidance for Greenhouse Gas and Climate Change Impacts for New Reactor Environmental Impact Statements, COL/ESP-ISG-026, *accessible at* https://www.nrc.gov/docs/ML1410/ML14100A157.pdf.

[53] *See* U.S. Climate Change Policy, Congressional Research Service, October 28, 2021, *accessible at* https://crsreports.congress.gov/product/pdf/R/R46947. Emissions can still occur through other processes, including those related to the fuel supply chain and waste management. See below for more information on lifecycle emissions.

[54] *See* "Nuclear Power in a Clean Energy System," International Energy Agency, May 2019, *accessible at* https://iea.blob.core.windows.net/assets/ad5a93ce-3a7f-461d-a441-8a05b7601887/Nuclear_Power_in_a_Clean_Energy_System.pdf.

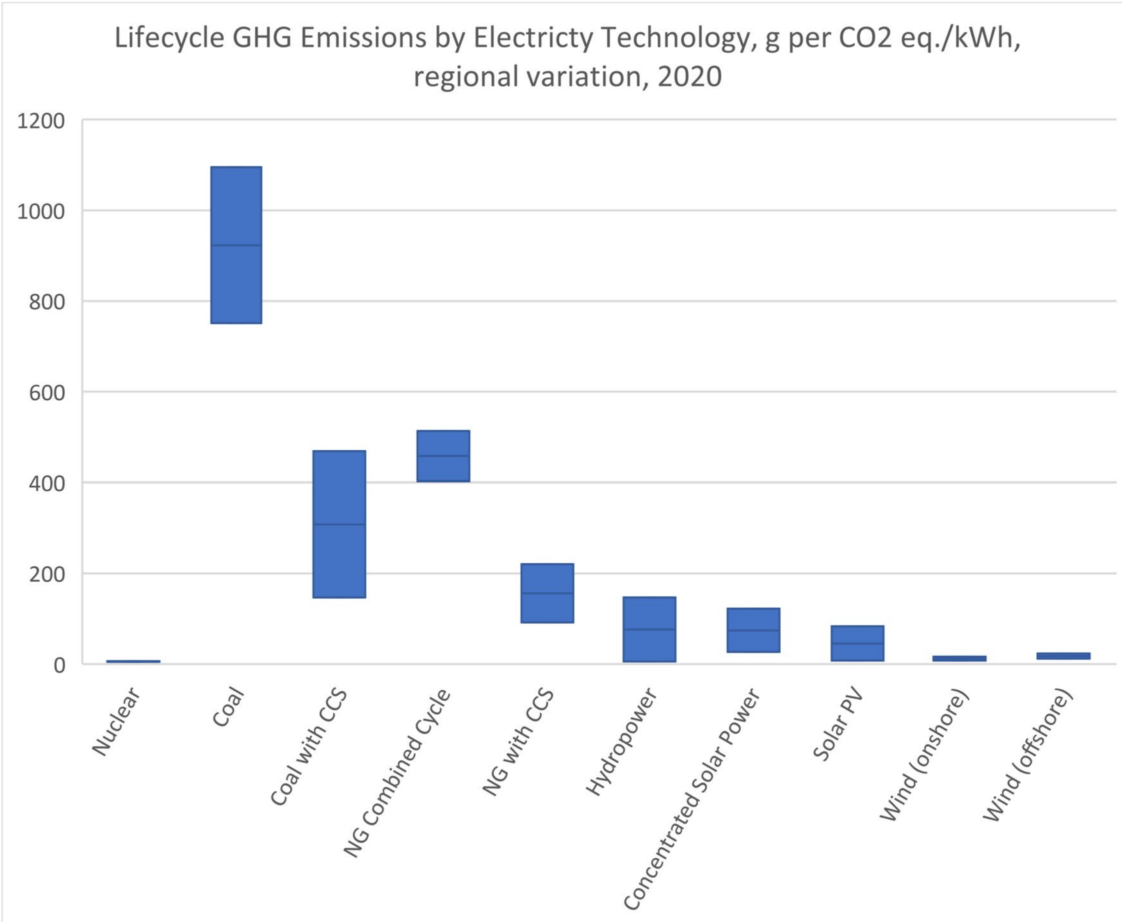
[55] *See* Climate Change 2022: Mitigation of Climate Change, Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, *accessible at* https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Full_Report.pdf.

[56] *See* Greenhouse Gas Emissions Avoided by U.S. Nuclear Power Plants in 2021, Nuclear Energy Institute, *accessible at* https://www.nei.org/resources/statistics/emissions-avoided-by-us-nuclear-industry-by-state.

[57] *See* Data Highlights, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, U.S. Environmental Protection Agency, *accessible at* https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-1990-2020-data-highlights.pdf.

[58] *See* Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources, United Nations Economic Commission for Europe, 2022, *accessible at* https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf. The following regions were assessed: Canada, Australia, and New Zealand; China; European Union; Japan; Latin America; Non-EU member states; Other Asia; Reforming Countries; Sub Saharan Africa; and United States.

Figure 4. Lifecycle GHG Emissions by Electricity Technology.



Source: Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources, United Nations Economic Commission for Europe, 2022. https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf.

In terms of risk, a Moody's Investors Service report in 2020 assessed credit risk implications associated with the vulnerability of U.S. nuclear power plants to climate change, finding that decisions on mitigation investments will ultimately determine any credit impacts. While noting that nuclear plants "are among the most hardened infrastructure assets," the report also cited their nearness to water bodies and associated vulnerability to climate risks. The report further identified ~48 gigawatts of nuclear capacity that had "elevated exposure" to rising temperatures and water stress, and found that regulated plants would be better positioned in terms of credit impacts given their access to rate recovery tools in the event of physical damage.[59]

A report conducted for the NRC in 2012 also examined the implications of climate change on geologic disposal of high-level radioactive waste (generally, not site-specific) in the United States. In noting the importance of climate adaptation strategies that consider the impact of future climate conditions affecting geological disposal sites on human and environmental health and safety, the report cited

[59] *See* Moody's – Nuclear Operators Face Increasing Climate Risks, but Resiliency Investments Mitigate Impact, August 18, 2020, *accessible at* https://www.moodys.com/research/Moodys-Nuclear-operators-face-increasing-climate-risks-but-resiliency-investments--PBC_1241730.

potential effects from flooding and other weather events, as well as water-related conditions such as sea-level rise.[60]

As to climate-related risks, while impacts can occur, recent events have underscored the resiliency of nuclear plants, particularly with regard to major weather events. For example, during the 2014 Polar Vortex, U.S. nuclear power facilities operated at an average 95% capacity factor, with only two-weather related shutdowns.[61] Similarly, when Hurricane Harvey made landfall in Texas in 2017 and wreaked devastation across the state, the South Texas Project ~90 miles southwest of Houston remained operational throughout.[62]

Moreover, as noted below in the discussion on water management, some U.S. nuclear plants rely on seawater for cooling, relieving pressure on freshwater resources, while one nuclear plant site relies on wastewater.[63]

Importantly, as the U.S. Energy Department has pointed out, technological advances are also paving the way for small modular nuclear reactors that are less vulnerable and more resilient to both natural and manmade events.[64] These reactors, some of which include non-light water design optionality that negates the need for access to a nearby water body, could add a significant source of stable and reliable electricity for communities that are not currently within range of existing nuclear power plant facilities. For example, one small modular reactor nuclear project being developed in Idaho will substitute air for cooling towers dependent on water, reducing water use by over 90%.[65]

Additionally, the U.S. government has recognized the role that nuclear power and small modular reactors could play in addressing water scarcity by providing zero-carbon electricity to desalination plants,[66] and a June 2022 study found that with the addition of over 300 gigawatts of new nuclear generation, nuclear could comprise over 40% of all U.S. electricity supply in 2050 and "play an important role in decarbonizing the electricity sector."[67]

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[60] *See* Regulatory Perspectives on Climate Change and Adaptation for Geologic Disposal of High-Level Radioactive Waste, Prepared for U.S. Nuclear Regulatory Commission, Prepared by O. Osidele, B. Werling, and R. Fedors, April 2012, *accessible at* https://www.nrc.gov/docs/ML1210/ML12103A006.pdf.

[61] *See* History of U.S. Nuclear Plants' Responses to Unusual Natural Events, October 10, 2018, *accessible at* https://www.nei.org/resources/fact-sheets/history-us-nuclear-plants-response-events.

[62] *See* "As Harvey Raged, Workers Remained at Nuclear Plant's Controls," by Mark Chediak, Bloomberg, August 31, 2017, *accessible at* https://www.norwichbulletin.com/story/news/disaster/2017/08/31/as-harvey-raged-workers-remained/18953693007/.

[63] *See* Technical assessment of nuclear energy with respect to the 'do no significant harm' criteria of Regulation (EU) 2020/852 ('Taxonomy Regulation'), European Commission Joint Research Centre, Petten, 2021, JRC124193, *accessible at* https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/210329-jrc-report-nuclear-energy-assessment_en.pdf; Water, PG&E, *accessible at* https://www.pgecorp.com/corp_responsibility/reports/2018/en04_water.html; The Palo Verde Water Cycle Model (PVWCM) – Development of an Integrated Multi-Physics and Economics Model for Effective Water Management, by Bobby D. Middleton, Patrick V. Brady, Jeffrey A. Brown, and Serafina T. Lawles, Proceedings of the ASME 2021 Power Conference, 2021, *accessible at* https://www.osti.gov/servlets/purl/1866034; Seabrook Nuclear Power Plant, New Hampshire, The Center for Land Use Interpretation, *accessible at* https://clui.org/ludb/site/seabrook-nuclear-power-plant; and St. Lucie, FPL, *accessible at* https://www.fpl.com/clean-energy/pdf/st-lucie-factsheet.pdf.

[64] *See* 5 Key Resilient Features of Small Modular Reactors, Office of Nuclear Energy, U.S. Department of Energy, July 3, 2018, *accessible at* https://www.energy.gov/ne/articles/5-key-resilient-features-small-modular-reactors.

[65] *See* Carbon Free Power Project, NuScale Power, *accessible at* https://www.nuscalepower.com/projects/carbon-free-power-project.

[66] *See* 3 Surprising Ways to Use Nuclear Energy, Office of Nuclear Energy, U.S. Department of Energy, March 16, 2022, *accessible at* https://www.energy.gov/ne/articles/3-surprising-ways-use-nuclear-energy.

[67] *See* Role of Electricity Produced by Advanced Nuclear Technologies in Decarbonizing the U.S. Energy System, Prepared by Vibrant Clean Energy, LLC, Christopher T M Clack, Aditya Choukulkar, Brianna Coté, and Sarah A McKee, June 17, 2022, *accessible at* https://www.vibrantcleanenergy.com/wp-content/uploads/2022/06/VCE-NEI-17June2022.pdf.

2. *Air Quality*

Air pollution accounts for 6.5 million deaths around the world every year,[68] with exposure to substances including noxious gases, particulate matter, and volatile organic compounds contributing to a multitude of public health impacts. Research has established linkages between air pollution and health conditions including cancer, heart disease, respiratory illness, low birth weight, and premature births.[69]

Air quality has significantly improved in the United States in recent decades. For example, emissions associated with nitrogen oxides have fallen 72% between 1980 and 2021, with sulfur dioxide emissions and volatile organic compound emissions respectively dropping 93% and 61% over that same period. Between 1990 and 2021, direct emissions from PM_{10} and $PM_{2.5}$ have respectively decreased 33% and 40%.[70]

At the same time, underscoring the opportunity for further improvement, a study published in 2019 found that air pollution from outdoor $PM_{2.5}$ exposure alone cost the United States $790 billion in 2014,[71] and research published in 2020 found that exposure to air pollution still leads to 100,000-200,000 deaths each year.[72] Examples of air quality-related ESG metrics are included in Figure 5 below.

Figure 5. Example Air Quality-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Air emissions of the following pollutants: (1) NOx (excluding N2O), (2) SOx, (3) particulate matter (PM10), (4) lead (Pb), and (5) mercury (Hg); percentage of each in or near areas of dense population	SASB IF-EU-120a.1
Nitrogen oxides (NOx), sulfur oxides (SOx), and other significant air emissions	GRI 305-7
Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	SDG 3
Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable, and modern energy for all	SDG 7
Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient, and sustainable	SDG 11
Responsible Consumption and Production: Ensure sustainable consumption and production patterns	SDG 12

[68] *See* Pollution and Health: A Progress Update, by Richard Fuller, BEng, Philip J. Landrigan, MD, Kalpana Balakrishnan, PhD, Glynda Bathan, LLB, Stephan Bose-O'Reilly, MD, and Prof. Michael Brauser, ScD, et al., The Lancet, Volume 6, Issue 6, E535-547, June 1, 2022, *accessible at* https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(22)00090-0/fulltext.

[69] *See e.g.,* Air Pollution and Your Health, National Institute of Environmental Services, *accessible at* https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm#:~:text=Air%20pollution%20can%20affect%20lung,are%20linked%20to%20chronic%20bronchitis..

[70] *See* Air Quality – National Summary, U.S. Environmental Protection Agency, *accessible at* https://www.epa.gov/air-trends/air-quality-national-summary.

[71] *See* Fine Particulate Matter Damages and Value Added in the US Economy, by Peter Tschofen, Inês L. Azevedo, and Nicholas Z. Muller, Proceedings of the National Academy of Sciences of the United States of America, September 9, 2019, *accessible at* https://www.pnas.org/doi/10.1073/pnas.1905030116.

[72] Reducing Mortality from Air Pollution in the United States by Targeting Specific Emission Sources, by Sumil K. Thakrar, Srinidhi Balasubramanian, Peter J. Adams, Inês M. L. Azevedo, Nicholas Z. Muller, Spyros N. Pandis, Stephen Polasky, C. Arden Pope III, Allen L. Robinson, Joshua S. Apte, Christopher W. Tessum, Julian D. Marshall, and Jason D. Hill, Environmental Science & Technology Letters, July 15, 2020, *accessible at* https://pubs.acs.org/doi/10.1021/acs.estlett.0c00424.

Industry Performance

Nuclear power generation brings significant benefits to air quality, as plant generation does not create air pollution.[73]

Although there are air quality impacts when accounting for the full lifecycle, as illustrated below in Figure 6, nuclear performs particularly well when compared to fossil fuel energy power generation technologies, and is generally competitive across technologies.

Figure 6. Ranges of Electric Power Technology Emissions.

Power Generation Technology	NOx (mg/kWh)	SO_2 (mg/kWh)	PM (mg/kWh)
Nuclear	9-240	11-157	~0-7
Natural Gas Combined Cycle	100-1,400	1-324	18-133
Natural Gas Steam Turbine	340-1020	~0-5,830	Insufficient Data
Hard Coal	540-4,230	530-7,680	17-9,780
Lignite Coal	790-2,130	425-27,250	113-947
Hydropower - Reservoir	3-13	9-60	0.1-25
Hydropower – River	4-6	1-6	0.1-25
Solar PV	16-340	73-540	6-610
Concentrated Solar	54-160	35-48	7-26
Wind	10-75	3-88	1-14
Geothermal	~0-50	~0-160	1.3-50
Ocean	49	64-200	15-36
Bioenergy	290-820	40-940	29-79

Source: Table 3. Ranges of Electric Power Technology Emissions and Resource-Use Factors (per unit generation). Life-Cycle Assessment of Electric Power Systems, by Eric Masanet, Yuan Chang, Anand R. Gopal, Peter Larsen, William R. Morrow III, Roger Sathre, Arman Shehabi, and Pei Zhai, Annual Review of Environment and Resources, 2013, 38:1, 107-136. Note that the ranges reflect the results of a literature review examining multiple studies on the lifecycle analysis of air pollutant emissions. https://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-010710-100408.

[73] *See e.g.,* Nuclear Explained: Nuclear Power and the Environment, U.S. Energy Information Administration, *accessible at* https://www.eia.gov/energyexplained/nuclear/nuclear-power-and-the-environment.php#:~:text=Unlike%20fossil%20fuel%2Dfired%20power,or%20carbon%20dioxide%20while%20operating.

Underscoring the air quality benefits associated with nuclear energy, research has shown that in 2021, the operation of nuclear power plants in the United States avoided more than 217,000 short tons of nitrogen oxide emissions and over 262,000 short tons of sulfur dioxide emissions.[74]

Other research has underscored the benefits of nuclear energy for air quality. For example, studies have found that the continued operation of two nuclear power plants in New Jersey could annually avoid 6,367 metric tons of NOx emissions, 4,331 metric tons of SO2 emissions, 9,537 tons of PM10 emissions, and 7,778 tons of PM2.5 emissions across the Eastern Interconnection region.[75]

Similar benefits were estimated in association with keeping nuclear plants operational in Pennsylvania (5), Ohio (2), and Illinois (2), with average estimated avoided emissions of 11,503 metric tons (PA), 4,080 metric tons (OH), and 8,786 metrics tons (IL) of NOx, 8,479 metric tons (PA), 3,408 metric tons (OH), and 3,815 metric tons (IL) of SO2, 16,630 metric tons (PA), 4,011 metric tons (OH), and 6,103 metric tons (IL) of PM10, and 13,534 metric tons (PA), 3,238 metric tons (OH), and 4,877 metric tons (IL) of PM2.5.[76]

A separate study examined the air quality impacts of potential closures of three nuclear power generation facilities in Pennsylvania and Ohio, and found that their retirement could result in an additional annual 126 deaths and $812 million in related economic damages.[77]

More broadly, one recent study found that eliminating emissions of primary $PM_{2.5}$, SO_2, and NO_x from the U.S. electric power, transportation, building, and industrial sectors could annually prevent 53,200 premature deaths and 3.68 million days of work lost due to illness, as well as generate $608 billion in health benefits.[78]

3. Biodiversity

Biodiversity has been defined as "the variety of life on Earth and the natural patterns it forms."[79] An assessment in 2019 found that almost 1 million of the world's estimated 8 million animal and plant species are threatened with extinction, with more than 500,000 terrestrial species having habitat that is

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[74] *See* Emissions Avoided by U.S. Nuclear Industry by State, *accessible at* https://www.nei.org/resources/statistics/emissions-avoided-by-us-nuclear-industry-by-state.

[75] *See* Salem and Hope Creek Nuclear Power Plants' Contribution to the New Jersey Economy, by Mark Berkman and Dean Murphy, The Brattle Group, November 2017, *accessible at* https://www.brattle.com/wp-content/uploads/2021/05/13065_11755_salem_and_hope_creek_nuclear_power_plants_contribution_to_the_new_jersey_economy1.pdf.

[76] *See* Pennsylvania Nuclear Power Plants' Contribution to the State Economy, by Mark Berman and Dean Murphy, The Brattle Group, December 2016, *accessible at* https://www.brattle.com/wp-content/uploads/2017/10/5732_pennsylvania_nuclear_power_plants_contribution_to_the_state_economy.pdf; Ohio Nuclear Power Plants' Contribution to the State Economy, by Mark Berkman and Dean Murphy, April 2017, The Brattle Group, *accessible at* https://d3n8a8pro7vhmx.cloudfront.net/nuclearmatters/pages/211/attachments/original/1494337829/Ohio-Nuclear-Report-Brattle-21April2017_%281%29.pdf?1494337829; and Electricity Cost and Environmental Effects of Retiring the Quad Cities and Clinton Nuclear Plants, by Mark Berkman and Dean Murphy, The Brattle Group, October 2016, *accessible at* https://www.brattle.com/wp-content/uploads/2017/10/5735_quadcitiesclintonnuclear-brattle-oct2016.pdf.

[77] *See* Air Quality and Health Impacts of Potential Nuclear Electricity Generator Closures in Pennsylvania and Ohio, by Christopher W. Tessum, Research Scientist, Civil and Environmental Engineering, University of Washington, Seattle WA, and Julian D. Marshall, John R. Kiely Endowed Professor, Civil and Environmental Engineering, University of Washington, Seattle, WA, April 16, 2019, *accessible at* https://depts.washington.edu/airqual/reports/Nuclear%20Replacement%20Air%20Quality.pdf.

[78] *See* "Nationwide and Regional PM2.5-related Air Quality Health Benefits from the Removal of Energy-related Emissions in the United States," by Mailloux, N. A., Abel, D. W., Holloway, T., & Patz, J. A., GeoHealth, May 16, 2022, *accessible at* https://doi.org/10.1029/2022GH000603.

[79] *See* UNEP and Biodiversity, UN Environment Programme, *accessible at* https://www.unep.org/unep-and-biodiversity#:~:text=Biological%20diversity%E2%80%94or%20biodiversity%E2%80%94is,of%20human%20influence%20as%20well.

insufficient for long-term survival in the absence of habitat restoration. It also found a 30% reduction in global terrestrial habitat integrity.[80]

Another study in 2020 found that $44 trillion of economic value generation is vulnerable to risks from nature loss,[81] with recent reports estimating economic losses resulting from biodiversity loss that range from ~$1.9 trillion to $2.7 trillion annually.[82]

Amid these trends, biodiversity has become an increasing area of focus in private sector sustainability efforts. In 2018, one study found that 49 of the Fortune 100 companies were already mentioning biodiversity in their sustainability reports, including 31 that made clear commitments.[83]

Additionally, governments are seeking to develop new goals for global action to address biodiversity loss,[84] and efforts are underway to develop a risk management and reporting framework for companies to make disclosures on nature-related risks and guide decision-making.[85] As the new reporting framework is being developed, examples of existing biodiversity-related standards and metrics are illustrated in Figure 7 below.

Figure 7. Example Biodiversity-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Operational sites owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas	GRI 304-1
Significant impacts of activities, products and services on biodiversity	GRI 304-2
Habitats protected or restored	GRI 304-3
IUCN Red List species and national conservation list species with habitats in areas affected by operations	GRI 304-4
Climate Action: Take urgent action to combat climate change and its impact	SDG 13
Life Below Water: Conserve and sustainably use the oceans, sea, and marine resources for sustainable development	SDG 14
Life on Land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	SDG 15

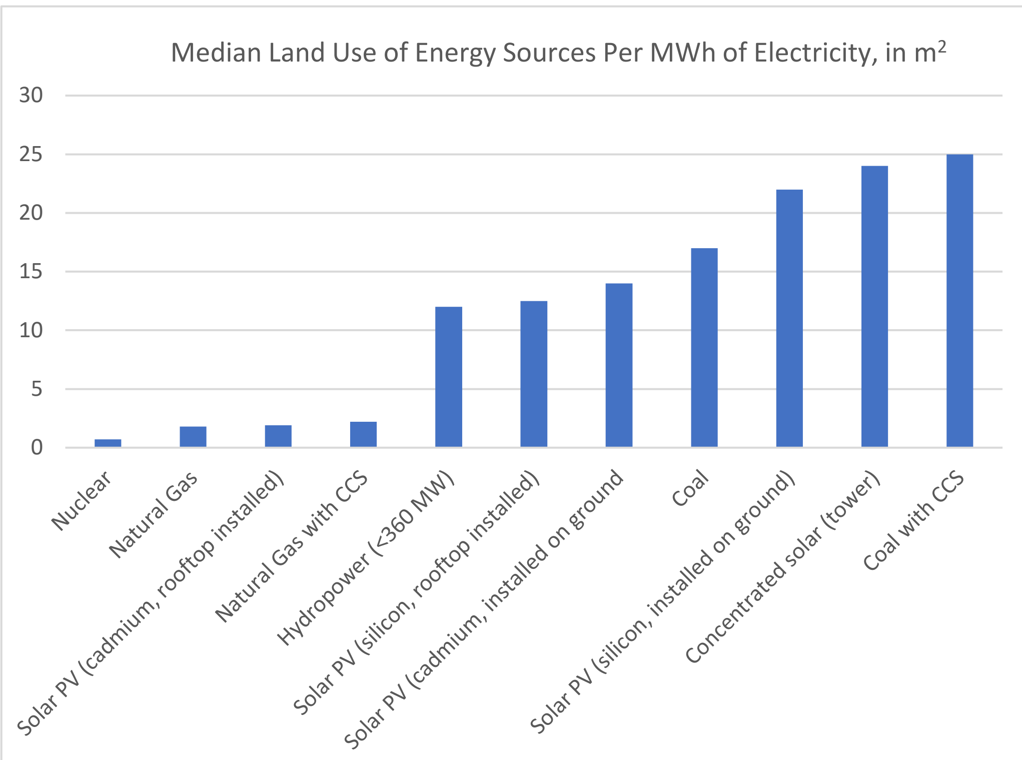
[80] *See* Nature's Dangerous Decline 'Unprecedented' Species Extinction Rates 'Accelerating,' Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, May 5, 2019, *accessible at* https://ipbes.net/news/Media-Release-Global-Assessment.
[81] *See* "Half of World's GDP Moderately or Highly Dependent on Nature, Says New Report, World Economic Forum, January 19, 2020, *accessible at* https://www.weforum.org/press/2020/01/half-of-world-s-gdp-moderately-or-highly-dependent-on-nature-says-new-report/.
[82] *See e.g.,* "Moody's Has a $1.9 Trillion Warning Over Biodiversity," by Tim Quinson, Bloomberg, September 28, 2022, *accessible at* https://www.bloomberg.com/news/articles/2022-09-28/moody-s-1-9-trillion-warning-over-biodiversity-green-insight; and "Protecting Nature Could Avert Global Economic Losses of $2.7 Trillion Per Year," World Bank, July 1, 2021, *accessible at* https://www.worldbank.org/en/news/press-release/2021/07/01/protecting-nature-could-avert-global-economic-losses-of-usd2-7-trillion-per-year.
[83] *See* Addison, P.F.E., Bull, J.W. and Milner-Gulland, E.J. (2019), Using conservation science to advance corporate biodiversity accountability. Conservation Biology, 33: 307-318. https://doi.org/10.1111/cobi.13190.
[84] *See* UN Biodiversity Conference (COP 15), UN Environment Programme, *accessible at* https://www.unep.org/events/conference/un-biodiversity-conference-cop-15.
[85] *See* Taskforce on Nature-related Financial Disclosures, *accessible at* https://tnfd.global/.

Industry Performance

Land use has been cited as a major driver of biodiversity loss,[86] with the Organisation for Economic Co-Operation and Development (OECD) stating that land use changes and land degradation globally between 1997 and 2011 respectively resulted in the loss of $4-20 trillion and $6-11 trillion annually.[87]

Beyond operations at the plant, biodiversity can be impacted by other activities throughout the supply chain, such as the mining and extraction of minerals that are necessary to generate electricity. In that regard, in June 2022 the World Economic Forum produced analysis that incorporated the full lifecycle analysis associated with land use for a multitude of electricity generation technologies. Nuclear performed best-in-class at 0.7 m^2 per MWh, as shown below in Figure 8.

Figure 8. Median Land Use of Energy Sources.



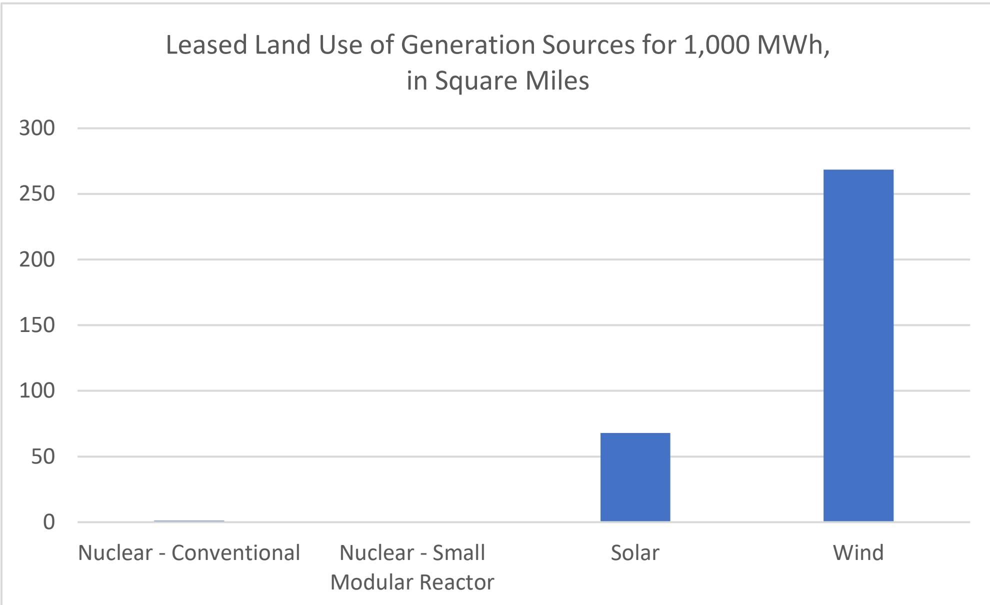
Source: "Energy: Which Electricity Source Uses the Most Land?," Hannah Ritchie, World Economic Forum, June 30, 2022 (citing United Nations Economic Commission for Europe's Lifecycle Assessment of Electricity Generation Options (2021) for all data except wind). In addition to accounting for capacity factors, the lifecycle analysis accounts for variables including the mining of minerals, fuel inputs, decommissioning, and waste handling. For wind, the author calculated the project site area land use for onshore wind to range between 8.4 m^2 and 247 m^2 (including the area between wind turbines that can be used for other purposes), with the impact of the excavation and insertion of turbines estimated to be 0.8 m^2. https://www.weforum.org/agenda/2022/06/energy-electricity-sources-land/.

[86] *See e.g.,* "Why Businesses Must Care About Sustainable Land Use – and Actions They Can Take to Protect It," World Economic Forum, May 12, 2022, *accessible at* https://www.weforum.org/agenda/2022/05/businesses-sustainable-land-use-actions-protect/.

[87] *See* OECD (2019), Biodiversity: Finance and the Economic and Business Case for Action, report prepared for the G7 Environment Ministers' Meeting, 5-6 May 2019, *accessible at* https://www.oecd.org/environment/resources/biodiversity/Executive-Summary-and-Synthesis-Biodiversity-Finance-and-the-Economic-and-Business-Case-for-Action.pdf.

Additional research published in 2021 compared leased land use requirements for existing and future nuclear technologies with clean energy technologies, and found similar results in terms of environmental footprint as shown below in Figure 9.

Figure 9. Leased Land Use by Generation Source.



Source: Gone with the Steam: How New Nuclear Power Plants Can Re-Energize Communities When Coal Plants Close, ScottMadden, October 2021 (citing NREL and NuScale Power – Environmental Footprint). https://www.scottmadden.com/content/uploads/2021/10/ScottMadden_Gone_With_The_Steam_WhitePaper_final4.pdf.

As discussed elsewhere in this report, with a 92.7% capacity factor, nuclear energy also performs best-in-class when it comes to the electrical output produced over a given period of time in comparison with the total amount that could be generated at continuous full power.[88] Nuclear's efficiency with regard to both land use requirements for generation and production output underscore the benefits that can accrue to nature by increasing its contribution to the grid.

4. Waste

In addition to complying with regulatory requirements, more and more companies are taking actions to reduce their waste footprint in order to achieve economic and operational efficiencies and maintain their license to operate.

Even so, in a 2021 survey, just 46% of 225 respondents working across a variety of industries said their company is measuring waste reduction and recycling performance, with electronic waste and packaging material and waste respectively measured by 37% and 36% of respondents.[89]

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[88] *See* U.S. Energy Information Administration, Electric Power Monthly, Table 6.07.A. Capacity Factors for Utility Scale Generators Primarily Using Fossil Fuels, and Table 6.07.B. Capacity Factors for Utility Scale Generators Primarily Using Non-Fossil Fuels. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_07_a and https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_07_b.

[89] *See* ESG Survey: Environmental Performance and the Stakes for Your Business. Crowell, December 2021, *accessible at* https://www.crowell.com/files/ESG-Survey_Publication.pdf.

A 2016 study of 5,589 of the United States' largest publicly traded companies found that they sent over 342 million metric tons of waste to landfills and incinerators in 2014, with a total weighted average cost to those companies of $31-58 billion and an estimated $90-170 billion cost to society. The study noted that waste reduction presents the opportunity to enhance profitability and brand reputation and reduce regulatory risks.[90] Examples of ESG metrics related to waste are highlighted in Figure 10.

Figure 10. Example Waste-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Discussion of waste generation and significant waste-related impacts	GRI 306-1
Management of significant waste-related impacts	GRI 306-2
Waste generated	GRI 306-3
Waste diverted from disposal	GRI 306-4
Waste directed to disposal	GRI 306-5
Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	SDG 3
Clean Water and Sanitation: Ensure availability and sustainable management of water and sanitation for all	SDG 6
Responsible Consumption and Production: Ensure sustainable consumption and production patterns	SDG 12
Life Below Water: Conserve and sustainably use the oceans, sea and marine resources for sustainable development	SDG 14
Life on Land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	SDG 15

Industry Performance

The need to manage waste extends across all energy technologies. It has been noted that all energy production produces waste that has to be managed, and that waste from electricity production other than nuclear "either goes directly into the environment (e.g., GHG emissions) or into landfills for the materials that are not recycled."[91]

Underscoring that point, the U.S. Environmental Protection Agency has stated that increased investment in renewable energy systems "will create new kinds and new volumes of waste," with such systems producing materials that require "careful end-of-life management to avoid creating unexpected burdens on individuals and communities and the risk of causing new Superfund sites and wasting of scarce and valuable resources."[92]

In the case of commercial nuclear power generation, the NRC categorizes waste as either high-level (spent fuel) or low-level (e.g., personal protective equipment, clothing, and materials that have been

[90] *See* Trash to Treasure: Changing Waste Streams to Profit Streams, U.S. Chamber of Commerce Foundation, *accessible at* https://www.uschamberfoundation.org/sites/default/files/Trash%20To%20Treasure_FINAL.pdf.
[91] *See* Characteristics of U.S. Energy Production Using Nuclear Fission, by Curtis Smith, Kurt Vedros, S. Andrew Orrell, Jason Christensen, Robert Youngblood, and Bruce Hallbert, Idaho National Laboratory, May 2022, *accessible at* https://inldigitallibrary.inl.gov/sites/sti/sti/Sort_54709.pdf.
[92] *See* EPA Releases Briefing Paper on Renewable Energy Waste Management, Press Release, U.S. Environmental Protection Agency, January 6, 2021, *accessible at* https://www.epa.gov/newsreleases/epa-releases-briefing-paper-renewable-energy-waste-management.

exposed to radiation). Low-level waste is generally stored onsite and ultimately either disposed of as ordinary trash or shipped in U.S. Department of Transportation-approved containers to low-level waste disposal sites in South Carolina, Texas, Utah, and Washington.[93]

The U.S. Department of Energy has cited the "minimal waste" associated with nuclear energy production, noting that the density of nuclear energy is ~1 million times greater than traditional energy and thus generates less used fuel than many might assume.[94] It has been estimated that all the waste generated by the U.S. nuclear industry since the 1950s would only require the space of one football field 10 yards deep, and that one coal plant produces as much waste by volume in one hour as nuclear power has in all of its history.[95]

Even so, used fuel is a significant byproduct of nuclear generation. When nuclear fuel loses its efficiency for generating electricity, it is initially stored and cooled in water pools, generally for at least five years or until it has reached a temperature low enough for transfer to dry cask storage.[96] After the need for alternative storage options emerged in the late 1970s and early 1980s, dry cask storage was evaluated as an option and was first licensed in the United States in 1986 at a plant in Virginia.[97]

As of the end of 2021, over 88,000 metric tons of uranium fuel generated by commercial nuclear power reactors have been stored in the United States.[98] One estimate suggests that the amount of spent nuclear fuel could grow to more than 140,000 metric tons over the remaining lifetime of existing nuclear plants.[99]

Despite congressional direction by the Nuclear Waste Policy Act (NWPA) of 1982 for the U.S. Department of Energy (DOE) to investigate sites for the permanent geologic storage of spent nuclear fuel and for the collection of fees from nuclear power reactor owners for the development of permanent storage sites, as well as subsequent direction in 1987 for DOE to specifically and exclusively focus permanent storage efforts on Yucca Mountain in Nevada, DOE in 2009 ended its efforts to site a facility at Yucca Mountain.[100] The NRC subsequently found that the project would comply with safety and regulatory requirements, and that any potential environmental impacts on groundwater and the ground surface would be "small."[101]

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[93] *See* High-Level Waste, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/waste/high-level-waste.html; Low-Level Waste, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/waste/llw-disposal.html; and Locations of Low-Level Waste Disposal Facilities, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/waste/llw-disposal/licensing/locations.html.

[94] *See* 3 Reasons Why Nuclear Is Clean and Sustainable, Office of Nuclear Energy, U.S. Department of Energy, March 31, 2021, *accessible at* https://www.energy.gov/ne/articles/3-reasons-why-nuclear-clean-and-sustainable#:~:text=Nuclear%20energy%20produces%20minimal%20waste,big%20as%20you%20might%20think..

[95] *See* What Happens to Nuclear Waste in the U.S., by Hannah Hickman, Nuclear Energy Institute, November 19, 2019, *accessible at* https://www.nei.org/news/2019/what-happens-nuclear-waste-us#:~:text=In%20fact%2C%20the%20entire%20amount,way%20to%20think%20about%20it.

[96] *See* Commercial Spent Nuclear Fuel: Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution, U.S. Government Accountability Office, GAO-21-603, September 2021, *accessible at* https://www.gao.gov/assets/gao-21-603.pdf.

[97] *See* Dry Cask Storage, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/waste/spent-fuel-storage/dry-cask-storage.html.

[98] *See* Used Fuel Storage and Nuclear Waste Fund Payments by State, Nuclear Energy Institute (citing U.S. Department of Energy and Gutherman Technical Services), updated August 2022, *accessible* at https://www.nei.org/resources/statistics/used-fuel-storage-and-nuclear-waste-fund-payments; and Nuclear Waste Fund (NWF).

[99] *See* Commercial Spent Nuclear Fuel: Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution, U.S. Government Accountability Office, GAO-21-603, September 2021, *accessible at* https://www.gao.gov/assets/gao-21-603.pdf.

[100] *See* Commercial Spent Nuclear Fuel: Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution, U.S. Government Accountability Office, GAO-21-603, September 2021, *accessible at* https://www.gao.gov/assets/gao-21-603.pdf.

[101] *See* Legal Developments Relating to Nuclear Waste Storage and Disposal and the Yucca Mountain Repository Site, Congressional Research Service, August 29, 2016, *accessible at* https://www.everycrsreport.com/files/20160829_R44151_80f02db008ea1e1dfc79056aae50182f4112404c.pdf.

Meanwhile, as of the end of FY 2021, contributions to the NWPA fund dedicated to the development of a permanent storage site have boosted the balance to more than $44 billion.[102] Payments to the fund have been suspended since 2014 following a ruling by the U.S. Circuit Court of Appeals for the District of Columbia which found that further fee collections were unwarranted so long as licensing for permanent storage at Yucca Mountain remains suspended and in the absence of an alternative management plan for spent fuel disposal.[103]

Amid these developments, in December 2020, Congress provided DOE with funding for nuclear waste disposal activities, including for interim storage, and following a recommendation by the Blue Ribbon Commission on America's Nuclear Future, DOE is currently engaged in a public proceeding on the use of consent-based siting to identify interim storage sites for spent nuclear fuel.[104]

While the NRC has issued a license for the construction and operation of a temporary storage site for spent fuel in Texas, and has recommended issuance of a license for such a facility in New Mexico, both projects are being challenged in court and leadership in both states are opposed to the projects.[105]

As a result, spent fuel today is currently stored onsite at nuclear reactor facilities. The NRC has determined that spent fuel can continue to be safely and temporarily stored in pools and dry casks until a solution for a permanent storage site is secured, citing the importance of a strong regulatory framework featuring oversight and licensee compliance for safe storage and "well-developed" storage-related regulatory guidance, standards, and processes that are already in place.[106]

Spent fuel is also often shipped between facilities owned by the same entity for storage, or to research facilities for further study. The NRC noted that thousands of shipments of spent fuel have occurred over the last four decades without any radiological incident or public harm. Such shipments are subject to federal safety and security requirements, certifications, inspections, and monitoring.[107] More broadly, ~15 million packages of radioactive material are annually transported around the world, with no incidence of a release resulting in harm to people, property, or the environment.[108]

[102] *See* Annual Financial Report Summary, FY2021 and Cumulative, ($'s in millions), *accessible at* https://www.energy.gov/sites/default/files/2021-12/FY21%20-%20NWF%20Annual%20Financial%20Report%20Summary.pdf.

[103] *See* Commercial Spent Nuclear Fuel: Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution, U.S. Government Accountability Office, GAO-21-603, September 2021, *accessible at* https://www.gao.gov/assets/gao-21-603.pdf.

[104] *See* Commercial Spent Nuclear Fuel: Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution, U.S. Government Accountability Office, GAO-21-603, September 2021, *accessible at* https://www.gao.gov/assets/gao-21-603.pdf; Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy, January 2012, *accessible at* https://www.energy.gov/sites/default/files/2013/04/f0/brc_finalreport_jan2012.pdf; and Consent-Based Siting, Office of Nuclear Energy, U.S. Department of Energy, *accessible at* https://www.energy.gov/ne/consent-based-siting#:~:text=Consent%2Dbased%20siting%20is%20an,(as%20the%20implementing%20organization)..

[105] *See* "Nuclear Waste Storage Facility at Texas-New Mexico Border Granted Federal License," by Adrian Hedden, Carlsbad Current-Argus, September 14, 2021, *accessible at* https://www.currentargus.com/story/news/local/2021/09/14/nuke-waste-facility-texas-new-mexico-border-granted-federal-license/8331255002/; "Western States Join New Mexico in Resisting Nuclear Waste Storage Without State Consent," by Adrian Hedden, Carlsbad Current-Argus, July 29, 2022, *accessible at* https://www.currentargus.com/story/news/2022/07/29/western-states-new-mexico-resisting-nuclear-waste-storage-texas-radiation-federal-fuel-energy-holtec/65382940007/; Governor Abbott Petitions Fifth Circuit to Keep Spent Nuclear Fuel Out of the Permian Basin, Press Release, Office of the Texas Governor, February 8, 2022, *accessible at* https://gov.texas.gov/news/post/governor-abbott-petitions-fifth-circuit-to-keep-spent-nuclear-fuel-out-of-the-permian-basin; and "New Mexico's Challenge to Nuclear Waste Storage License Tossed," by Maya Earls, Bloomberg Law, March 11, 2022, *accessible at* https://news.bloomberglaw.com/litigation/new-mexicos-challenge-to-nuclear-waste-storage-license-tossed.

[106] *See* Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel, Final Report, Volume 1, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/docs/ML1419/ML14196A105.pdf.

[107] *See* Transportation of Spent Nuclear Fuel, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/waste/spent-fuel-transp.html.

[108] *See* Radioactive Waste – Myths and Realities, World Nuclear Association, updated January 2022, *accessible at* https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-wastes-myths-and-realities.aspx.

While efforts to secure a permanent storage solution have not yet borne fruit in the United States, nations around the world like Finland, Sweden, and Switzerland have recently taken steps to move forward with the development of the world's first permanent, deep geologic storage sites for nuclear waste.[109] Similarly, beyond storage, other nations are utilizing mechanisms to treat spent nuclear fuel such as reprocessing, with estimates that ~96% of nuclear fuel used for power generation or research purposes is recyclable.[110]

According to the World Nuclear Association, in addition to a lower level of radioactivity in waste from reprocessed fuel, reprocessing spent fuel can save up to 30% of the uranium that would otherwise be needed for new fuel and reduce the amount of material for disposal as high-level waste to roughly one-fifth. Although three civil reprocessing plants have been built in the United States, none are currently operational and global commercial reprocessing capacity today is currently focused outside the United States.[111]

Although the U.S. government initiated the Global Nuclear Energy Partnership (GNEP) in 2006 to work toward the establishment of domestic reprocessing capacity, and the NRC commenced development of a regulation for reprocessing, the GNEP effort floundered, and in 2021 the NRC determined that a continued rulemaking was not justified given limited expressed or expected interest in the near-term use of reprocessed spent fuel.[112]

Even so, the Pacific Northwest National Laboratory (PNNL) has underscored the potential for recycling of spent nuclear fuel for additional use rather than storage. Specifically, through microfluidics technology in combination with real-time monitoring, PNNL noted that its researchers have developed a way to quickly separate, monitor, and control uranium and plutonium ratios in a cost-effective and safe manner. PNNL chemist Amanda Lines said the approach that has been developed "enables incredible opportunities to develop and advance recycling approaches."[113]

Additionally, major nuclear fuel suppliers in the United States have been collaborating with the U.S. government to test accident tolerant fuels for potential commercial use as soon as 2026. The U.S. Department of Energy has noted that these fuels are anticipated to be longer-lasting, possibly extending the time between refueling and reducing the number of nuclear fuel assemblies needed for reactor operation, thereby resulting in less waste as well as reduced fuel costs.[114]

In 2021, the U.S. Department of Energy and counterparts from the United Kingdom and Canada also committed to a collaborative partnership focused in part on sharing experiences and approaches to efficiently, safely, and sustainably managing legacy nuclear sites, including by minimizing waste.[115]

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[109] *See e.g.,* Switzerland Picks Site Near German Border for Nuclear Waste Storage, Agence France-Presse, September 11, 2022, *accessible at* https://www.theguardian.com/world/2022/sep/11/switzerland-picks-site-near-german-border-for-nuclear-waste-storage.

[110] *See* All About Used Fuel Processing and Recycling, Orano, *accessible at* https://www.orano.group/en/unpacking-nuclear/all-about-used-fuel-processing-and-recycling.

[111] *See* Processing of Nuclear Fuel, World Nuclear Association, updated December 2020, *accessible at* https://world-nuclear.org/information-library/nuclear-fuel-cycle/fuel-recycling/processing-of-used-nuclear-fuel.aspx.

[112] *See* Reprocessing, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/materials/reprocessing.html.

[113] *See* Recycling Gives New Purpose to Spent Nuclear Fuel, by Kelsey Adkisson, Pacific Northwest National Laboratory, May 14, 2021, *accessible at* https://www.pnnl.gov/news-media/recycling-gives-new-purpose-spent-nuclear-fuel.

[114] *See* These Accident Tolerant Fuels Could Boost the Performance of Today's Reactors, Office of Nuclear Energy, U.S. Department of Energy, January 28, 2020, *accessible at* https://www.energy.gov/ne/articles/these-accident-tolerant-fuels-could-boost-performance-todays-reactors.

[115] *See* Trilateral Commitment to Sustainability in the Decommissioning of Legacy Nuclear Sites, November 2, 2021, *accessible at* https://www.energy.gov/sites/default/files/2021-11/Trilateral-Sustainability-Statement.pdf.

To ensure that U.S. nuclear power plant sites are restored to a state in which the property can safely be put to other uses following its closure, regulations obligate operators to plan for decommissioning as soon as facility operations first commence. Specifically, licensees must establish or obtain a financing mechanism to provide an assurance of their ability to pay for decommissioning, with decommissioning funding updates provided every two years.[116] Over $50 billion has been allocated to decommissioning, and new business models are reducing the decommissioning timelines from as many as sixty years to as few as eight or less, providing benefits to taxpayers, communities, and operators alike.[117]

Notably, the World Nuclear Association has observed that 99% of radioactivity associated with nuclear plants is associated with fuel removed after a permanent shutdown, with most parts of the plant never becoming radioactive (or only at very low levels) and most of the metal recyclable.[118] Additionally, it has elsewhere been noted that of the material decommissioned from a plant, 90% is recoverable or recyclable and 5% is disposed of as conventional waste, with only 5% of the decommissioned material being radioactive.[119]

Underscored by a recent U.S. poll which found that, of those opposed to nuclear power, 64% expressed concerns about nuclear waste,[120] awareness initiatives, technological advances, and enhanced reprocessing capabilities that reduce the need for storage would all be useful tools to address current public perceptions of nuclear waste.

Beyond the management of spent fuel, companies operating within the U.S. nuclear industry mitigate waste through initiatives including recycling programs, waste reduction initiatives, engagement with suppliers on their waste generation performance, and restrictions on product use.[121]

5. Water Management

According to the United Nations, 2.3 billion people live in water-stressed countries, where at least 25% of renewable freshwater resources are being withdrawn, with severe water stress affecting river basins

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[116] *See* Backgrounder on Decommissioning Nuclear Power Plants, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/decommissioning.html.

[117] *See* Decommissioning Nuclear Power Plants, Fact Sheet, Nuclear Energy Institute, *accessible at* https://www.nei.org/resources/fact-sheets/decommissioning-nuclear-power-plants#:~:text=Decommissioning%20is%20the%20process%20by,the%20U.S.%20Nuclear%20Regulatory%20Commission.; and Decommissioning, Nuclear Energy Institute, *accessible at* https://www.nei.org/advocacy/make-regulations-smarter/decommissioning.

[118] *See* Decommissioning Nuclear Facilities, World Nuclear Association, Updated May 2022, *accessible at* https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/decommissioning-nuclear-facilities.aspx.

[119] *See* "The World's Nuclear Fleet Is Aging – How Do You Recycle A Nuclear Power Plant?," by Giorgia Marino, GreenBiz, May 13, 2021, *accessible at* https://www.greenbiz.com/article/worlds-nuclear-fleet-aging-how-do-you-recycle-nuclear-power-plant#:~:text=Only%205%25%20of%20the%20material,disposed%20of%20as%20conventional%20waste.

[120] *See* Americans Split on Nuclear Energy as Safety Worries Linger – Reuters/Ipsos Poll, by Timothy Gardner, June 6, 2022, *accessible at* https://www.reuters.com/business/energy/americans-split-nuclear-energy-safety-worries-linger-2022-06-06/.

[121] *See e.g.,* Economic Impacts of the Columbia Generating Station, Nuclear Energy Institute, January 2018, *accessible at* https://www.energy-northwest.com/energyprojects/Columbia/Documents/NEI_EconomicImpacts-ColumbiaGeneratingStation-010918.pdf; 2022 Sustainability Report, Constellation Energy, *accessible at* https://www.constellationenergy.com/content/dam/constellationenergy/pdfs/Constellation-2022-Sustainability-Report.pdf; 2022 Corporate Sustainability Report, American Electric Power, *accessible at* http://www.aepsustainability.com/performance/report/docs/2022_AEP-Sustainability-Report.pdf; 2020 Sustainability and Corporate Responsibility Report, Dominion Energy, *accessible at* https://sustainability.dominionenergy.com/assets/pdf/2020-Sustainability-Report.pdf; 2021 ESG Report, Duke Energy Corporation, *accessible at* https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/esg/2021-esg-report-full.pdf?la=en&rev=19532a880c3a47ee868fb43cb087c369; 2022 Environmental, Social, and Governance Report, NextEra Energy, *accessible at* https://www.nexteraenergy.com/content/dam/nee/us/en/pdf/2022_NEE_ESG_Report_Final.pdf; 2022 Corporate Sustainability Report, PG&E, *accessible at* https://www.pgecorp.com/corp_responsibility/reports/2022/assets/PGE_CSR_2022.pdf; 2021 Sustainability Report, Vistra Corp., *accessible at* https://vistracorp.com/wp-content/uploads/2022/05/VST-sustainability-report-2021.pdf; and 2021 Sustainability Report, Xcel Energy, *accessible at* https://s25.q4cdn.com/680186029/files/doc_downloads/2022/06/2021-Sustainability-Report-Full.pdf;

in regions including the Americas, Asia, and Africa.[122] Although the United States is identified as a low water stress nation, areas within the country can and have experienced medium to extremely high water stress, in some cases leading to legal disputes between states over water rights, and nearly 1/3 of Americans were affected by drought conditions in August 2022.[123]

At the same time, less than half of all countries home to more than three billion people actually monitor and report on ambient water quality,[124] and in 2019 the World Bank identified regions including in the United States that are at high water quality risk when accounting for biological oxygen demand, nitrogen, and salinity. The World Bank found that the range of water pollutants "tends to expand with prosperity," with the United States annually receiving notices for the annual release of over 1,000 new chemicals into the environment.[125]

With one recent study forecasting that U.S. water use could range from an 8% decrease to a 235% increase under various climate scenarios,[126] companies are increasingly focused on reducing water needs and maximizing water use efficiency, as well as minimizing impacts on water quality. In a 2019 survey of 86 companies with revenues of at least $1 billion, although 44% said they had no plan in place to achieve water goals, 74% of respondents said water was an increasing priority, 59% called it a growing business risk, and 88% reported that they would take active steps to manage water use over the next three years.[127] Examples of water management-related ESG metrics are included below in Figure 11.

Figure 11. Example Water Management-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Total water withdrawn, (2) total water consumed, percentage of each in regions with High or Extremely High Baseline Water Stress	SASB IF-EU-140a.1
Number of incidents of non-compliance associated with water quantity and/or quality permits, standards, and regulations	SASB IF-EU-140a.2
Description of water management risks and discussion of strategies and practices to mitigate those risks	SASB IF-EU-140a.3
Interactions with water as a shared resource	GRI 303-1
Management of water discharge-related impacts	GRI 303-2

[122] *See* Summary Progress Update 2021: SDG 6 – Water and Sanitation for All, UN-Water, July 2021, *accessible at* https://www.unwater.org/sites/default/files/app/uploads/2021/12/SDG-6-Summary-Progress-Update-2021_Version-July-2021a.pdf.

[123] *See* Freshwater Scarcity Poses Growing Risk in U.S., Federal Reserve Bank of St. Louis, March 14, 2022, *accessible at* https://www.stlouisfed.org/on-the-economy/2022/mar/freshwater-scarcity-poses-growing-risk-us; Texas, New Mexico Dispute Over Rio Grande Heads to Trial, by Scott Wyland, Santa Fe New Mexican, September 28, 2022, *accessible at* https://www.santafenewmexican.com/news/local_news/texas-new-mexico-dispute-over-rio-grande-heads-to-trial/article_5b758fa4-3f4a-11ed-a307-a3f179be5163.html; and Drought Affected Nearly a Third of Americans in August, by Chris Gilligan, U.S. News & World Report, August 29, 2022, *accessible at* https://www.usnews.com/news/health-news/articles/2022-08-29/august-droughts-affected-over-30-of-americans.

[124] *See* Summary Progress Update 2021: SDG 6 – Water and Sanitation for All, UN-Water, July 2021, *accessible at* https://www.unwater.org/sites/default/files/app/uploads/2021/12/SDG-6-Summary-Progress-Update-2021_Version-July-2021a.pdf.

[125] *See* Quality Unknown: The Invisible Water Crisis, by Richard Damania, Sébastien Desbureaux, Aude-Sophie Rodella, Jason Russ, and Esha Zaveri, World Bank Group, 2019, *accessible at* https://openknowledge.worldbank.org/bitstream/handle/10986/32245/9781464814594.pdf?sequence=8&isAllowed=y.

[126] *See* Warziniack, T., Arabi, M., Brown, T. C., Froemke, P., Ghosh, R., Rasmussen, S., & Swartzentruber, R. (2022). Projections of freshwater use in the United States under climate change. Earth's Future, 10, e2021EF002222, *accessible at* https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2021EF002222.

[127] *See* Ecolab-GreenBiz Survey Finds Corporations Still Struggle to Translate Water Goals into Action on the Ground, Press Release, Ecolab, March 21, 2019, *accessible at* https://www.ecolab.com/news/2019/03/ecolabgreenbiz-survey-finds-corporations-still-struggle-to-translate-water-goals-into-action-on-the.

Water withdrawal	GRI 303-3
Water discharge	GRI 303-4
Water consumption	GRI 303-5
Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	SDG 3
Clean Water and Sanitation: Ensure availability and sustainable management of water and sanitation for all	SDG 6
Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable and modern energy for all	SDG 7
Responsible Consumption and Production: Ensure sustainable consumption and production patterns	SDG 12
Climate Action: Take urgent action to combat climate change and its impact	SDG 13
Life Below Water: Conserve and sustainably use the oceans, sea and marine resources for sustainable development	SDG 14
Life on Land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	SDG 15

Industry Performance

At varying degrees, all energy technologies have needs for water resources and impact them, and with projections that over 40% of freshwater-cooled thermal and nuclear power plants will be in areas at high-risk of exposure to water stress by 2040,[128] the capacity to adapt and operate and maintain resilient infrastructure will be important.

In its review considering the environmental effects of the nuclear energy lifecycle, the Joint Research Centre (JRC) for the European Commission in 2021 found that “there is no evidence that nuclear energy does more harm to the sustainable use and protection of water and marine resources” than other energy technologies included in the European Union’s classification system (“Taxonomy”) for environmentally sustainable economic activities.[129]

The JRC noted that while significant quantities of water may be withdrawn for power plants based on energy like nuclear, most may be returned to the watercourse and very little ultimately consumed, depending on the cooling technology employed. Additionally, as seen in the United States, some nuclear plants rely on seawater for cooling, relieving pressure on freshwater resources, while one nuclear plant site relies on wastewater.[130] Moreover, some advanced technologies developed for small

[128] *See* World Energy Outlook 2021, International Energy Agency, *accessible at* https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf.

[129] *See* Technical assessment of nuclear energy with respect to the ‘do no significant harm’ criteria of Regulation (EU) 2020/852 (‘Taxonomy Regulation’), European Commission Joint Research Centre, Petten, 2021, JRC124193, *accessible at* https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/210329-jrc-report-nuclear-energy-assessment_en.pdf.

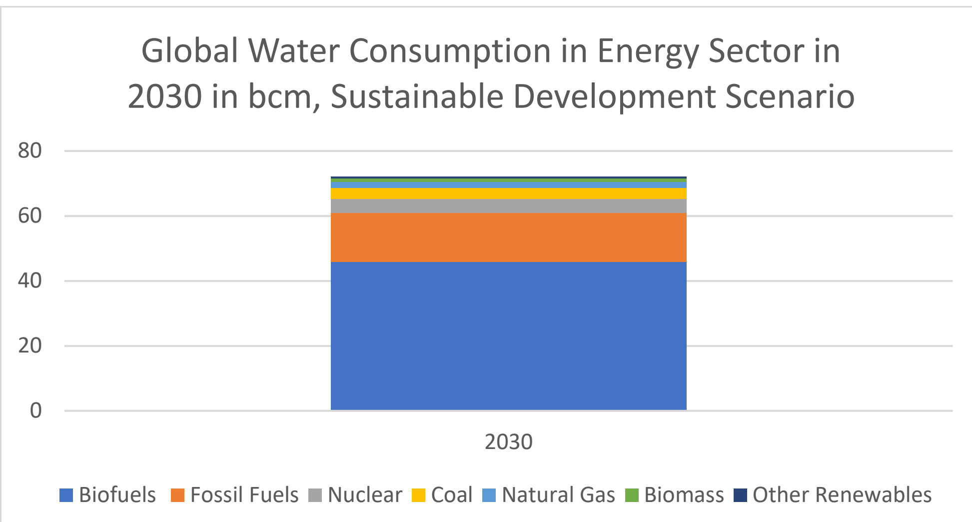
[130] *See* Technical assessment of nuclear energy with respect to the ‘do no significant harm’ criteria of Regulation (EU) 2020/852 (‘Taxonomy Regulation’), European Commission Joint Research Centre, Petten, 2021, JRC124193, *accessible at* https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/210329-jrc-report-nuclear-energy-assessment_en.pdf; Water, PG&E, *accessible at* https://www.pgecorp.com/corp_responsibility/reports/2018/en04_water.html; The Palo Verde Water Cycle Model (PVWCM) – Development of an Integrated Multi-Physics and Economics Model for Effective Water Management, by Bobby D. Middleton, Patrick V. Brady, Jeffrey A. Brown, and Serafina T. Lawles, Proceedings of the ASME 2021 Power Conference, 2021, *accessible at*

modular reactors provide the option for air-cooled designs in locations with water scarcity that can limit water consumption to as low as 1.1 gallons/MWh, and include water recycling design features that prevent liquid discharge.[131]

In terms of water consumption generally across various electricity generation sources and cooling technologies, in summarizing available literature, the JRC found that nuclear consumes significantly more water as compared to other technologies including solar photovoltaic and wind, but performs similarly to or better than other technologies like hydropower, biomass, and concentrating solar power.[132]

Other recent analysis provides perspective on water consumption associated with nuclear energy. For example, in the International Energy Agency's sustainable development scenario, nuclear power generation in 2030 comprises ~6% of the energy sector's water consumption,[133] yet would be projected to generate 3,395 TWh, or ~10%, of the world's electricity.[134] The water consumption finding is reflected below in Figure 12.

Figure 12. Global Water Consumption in Energy Sector.



Source: Global Water Consumption in the Energy Sector by Fuel Type in the Sustainable Development Scenario, 2016-2030. Notes: Biofuels and Fossil Fuels water consumption reflects primary energy use, while nuclear, coal, natural gas, biomass, and other renewables reflects water consumption from power generation. Other renewables include wind, solar PV, concentrated solar power, and geothermal, and excludes hydropower. https://www.iea.org/data-and-statistics/charts/global-water-consumption-in-the-energy-sector-by-fuel-type-in-the-sustainable-development-scenario-2016-2030.

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https://www.osti.gov/servlets/purl/1866034; Seabrook Nuclear Power Plant, New Hampshire, The Center for Land Use Interpretation, *accessible at* https://clui.org/ludb/site/seabrook-nuclear-power-plant; and St. Lucie, FPL, *accessible at* https://www.fpl.com/clean-energy/pdf/st-lucie-factsheet.pdf.

131 *See e.g.,* Water Efficiency Technology, NuScale Power, *accessible at* https://www.nuscalepower.com/benefits/reduced-water-consumption.

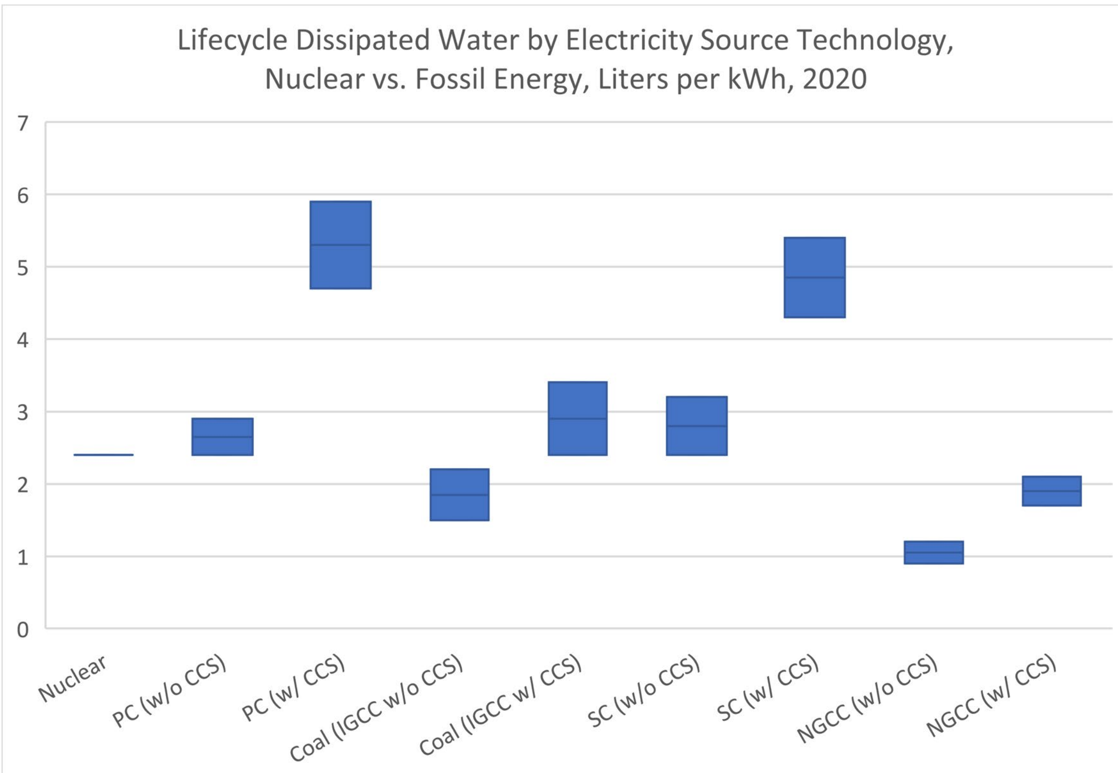
132 *See* Technical assessment of nuclear energy with respect to the 'do no significant harm' criteria of Regulation (EU) 2020/852 ('Taxonomy Regulation'), European Commission Joint Research Centre, Petten, 2021, JRC124193, *accessible at* https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/210329-jrc-report-nuclear-energy-assessment_en.pdf.

133 *See* IEA, Global water consumption in the energy sector by fuel type in the Sustainable Development Scenario, 2016-2030, IEA, Paris, *accessible at* https://www.iea.org/data-and-statistics/charts/global-water-consumption-in-the-energy-sector-by-fuel-type-in-the-sustainable-development-scenario-2016-2030. IEA's calculation excluded hydropower.

134 *See* Table A.3c, World Electricity Sector, World Energy Outlook 2021, International Energy Agency, *accessible at* https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf.

In a 2021 report assessing the lifecycle environmental impacts of electricity generation sources, the United Nations Economic Commission for Europe (UNECE) examined the lifecycle water footprint associated with electricity generation. Specifically, UNECE analyzed the amount of water that is used by the various generation technologies and not immediately returned to the environment ("dissipated water"). With an average requirement for dissipated water of 2.4 liters per kWh, while lagging hydropower and renewables, nuclear performs well against most fossil generation technologies as illustrated below in Figure 13.[135]

Figure 13. Lifecycle Dissipated Water by Electricity Source Technology.



Source: Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources, United Nations Economic Commission for Europe, 2022. PV = Pulverized Coal, CCS = Carbon (Dioxide) Capture and Storage, IGCC = Integrated Gasification Combined Cycle, SC = Supercritical Coal, NGCC = Natural Gas Combined Cycle. https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf.

With regard to impacts on water ecosystems as a result of emissions from toxic substances, the JRC reported that in one study, nuclear achieved the lowest freshwater ecotoxicity level as compared to coal/oil, natural gas, wind, and solar (with another study finding similar performance), while other research showed natural gas to be the top performer. Most of the impact of nuclear was found to result from metals associated with uranium mill tailings. As to impacts on marine ecosystems, the literature surveyed by the JRC similarly found that nuclear was a top or second-best performer.[136]

[135] *See* Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources, United Nations Economic Commission for Europe, 2022, *accessible at* https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf. The following regions were assessed: Canada, Australia, and New Zealand; China; European Union; Japan; Latin America; Non-EU member states; Other Asia; Reforming Countries; Sub Saharan Africa; and United States.

[136] *See* Technical assessment of nuclear energy with respect to the 'do no significant harm' criteria of Regulation (EU) 2020/852 ('Taxonomy Regulation'), European Commission Joint Research Centre, Petten, 2021, JRC124193, *accessible at*

The JRC also noted the limited availability of information on the effect of thermal pollution associated with nuclear energy's lifecycle on water bodies. Although concerns have been addressed about the impact of nuclear power plants in the United States on marine ecosystems as a result of seawater intake and water discharges,[137] others have noted that strict regulations encompassing intake and discharge are in place to protect marine life and noted the role that nuclear power plants could play in addressing climate challenges by powering desalination operations that produce freshwater.[138]

B. Social

1. *Grid Resiliency*

Access to reliable electricity is vital to society's ability to effectively function, with recent events demonstrating the full range of major consequences that can occur when the flow of electricity comes to a halt.

For example, when over 11 million people in Texas lost power during Winter Storm Uri in February 2021, nearly 250 lives were lost, including 161 to extreme cold exposure, in addition to an estimated $80-130 billion in losses for the state's economy.[139] Illustrating how blackouts can affect daily life, in a post-storm poll, 71% reported having lost Internet service, 49% said they lost running water, 47% experienced disruptions in cell phone service, and 31% reporting having experienced water damage to their homes.[140]

Underscoring the significance of access to reliable electricity to daily life and the physical and economic harm that a loss of power can cause, grid resiliency is a significant metric utilized by ESG standard-setting frameworks (see Figure 14 below for specific metrics of relevance). Long-term forecasts of slow but steady growth in U.S. average electricity consumption through 2050,[141] the emergence of other risks associated with human-caused incidents including cyberattacks,[142] and the effects of recent blackout

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https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/210329-jrc-report-nuclear-energy-assessment_en.pdf.

[137] *See e.g.,* The Divide Over Diablo, by Jonathan Thompson, High Country News, September 13, 2022, *accessible at* https://www.hcn.org/articles/nuclear-energy-the-divide-over-diablo.

[138] *See* Q&A: Options for the Diablo Canyon Nuclear Plant, by David Chandler, News Office, Massachusetts Institute of Technology, November 8, 2021 (comments by MIT Professor John Lienhard), *accessible at* https://news.mit.edu/2021/diablo-canyon-nuclear-plant-1108; and An Assessment of the Diablo Canyon Nuclear Plant for Zero-Carbon Electricity, Desalination, and Hydrogen Production, by Justin Abron (LucidCatalyst, LLC), Ejeong Baik (Stanford University), Sally Benson (Stanford University), Andrew T. Bouma (Massachusetts Institute of Technology), Jacopo Buongiorno (Massachusetts Institute of Technology), John H. Lienhard, V (Massachusetts Institute of Technology), John Parsons (Massachusetts Institute of Technology), and Quantum J. Wei (Massachusetts Institute of Technology), November 2021, *accessible at* https://energy.stanford.edu/sites/g/files/sbiybj9971/f/diablocanyonnuclearplant_report_11.19.21.pdf.

[139] *See e.g.,* "Cost of Texas' 2021 Deep Freeze Justifies Weatherization," by Garrett Golding, Anil Kumar, and Karel Martens, Federal Reserve Bank of Dallas, April 15, 2021, *accessible at* https://www.dallasfed.org/research/economics/2021/0415.aspx; "Winter Storm Uri Cost Texas Between $80 and $130 Billion, Report Shows," by Ariana Garcia, Houston Chronicle, November 2, 2021, *accessible at* https://www.chron.com/politics/article/Texas-winter-storm-freeze-deaths-financial-cost-16585329.php (citing University of Houston, Hobby School of Public Affairs "The Winter Storm of 2021" survey); and February 2021 Winter Storm-related Deaths – Texas, Texas Department of State Health Services, December 31, 2021, *accessible at* https://www.dshs.texas.gov/news/updates/SMOC_FebWinterStorm_MortalitySurvReport_12-30-21.pdf.

[140] *See* Fiscal Notes, Jess Donald, Office of the Texas Comptroller of Public Accounts, October 2021, *accessible at* https://comptroller.texas.gov/economy/fiscal-notes/2021/oct/winter-storm-impact.php.

[141] *See* Annual Energy Outlook 2022, Electricity Demand Grows Slowly Across the Projection Period, Which Increases Competition Among Fuels, U.S. Energy Information Administration, March 3, 2022, *accessible at* https://www.eia.gov/outlooks/aeo/narrative/electricity/sub-topic-01.php.

[142] *See e.g.,* "Lessons Learned: Risks Posed by Firewall Firmware Vulnerabilities," North American Electric Reliability Corporation, September 4, 2019, *accessible at* https://www.nerc.com/pa/rrm/ea/Lessons%20Learned%20Document%20Library/20190901_Risks_Posed_by_Firewall_Firmware_Vulnerabilities.pdf.

events still top of mind for millions of Americans all reinforce the prominence of grid resiliency as a continued area of focus for industry and government alike.

Figure 14. Example Grid Resiliency-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Number of incidents of non-compliance with physical and/or cybersecurity standards or regulations	SASB IF-EU-550a.1
(1) System Average Interruption Duration Index (SAIDI), (2) System Average Interruption Frequency Index (SAIFI), and (3) Customer Average Interruption Duration Index (CAIDI), inclusive of major event days	SASB IF-EU-550a.2
Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	SDG 3
Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable and modern energy for all	SDG 7
Decent Work and Economic Growth: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	SDG 8
Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable	SDG 11

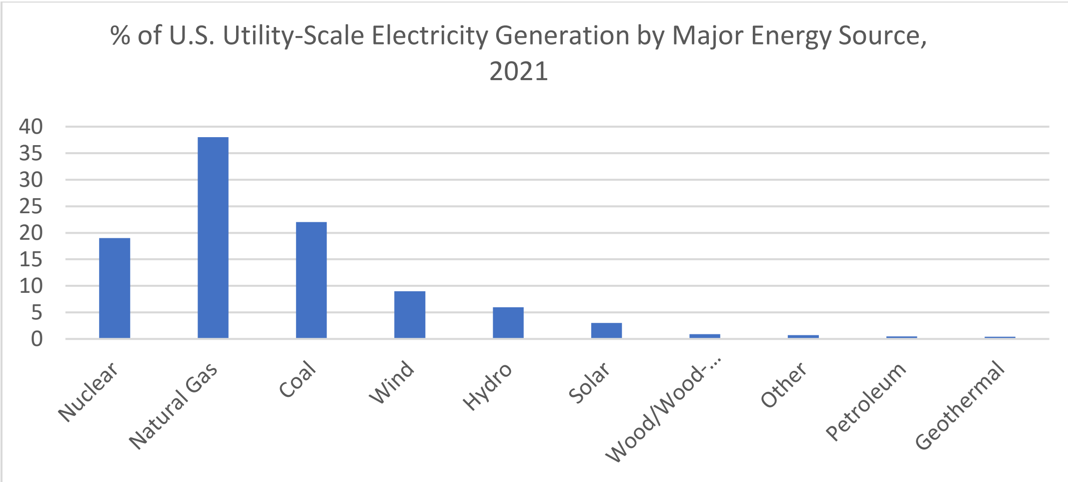
Industry Performance

The U.S. Energy Information Administration reported that in 2020, U.S. electricity customers experienced an average of more than 8 hours of lost power, the highest level recorded since EIA began tracking reliability data in 2013.[143] Additionally, the System Average Interruption Frequency Index (SAIFI) for 2020 showed that the average U.S. electricity customer experienced 1.44 interruptions.[144] For each interruption, the Customer Average Interruption Duration Index (CAIDI) demonstrated that it took an average of ~5 hours and 42 minutes to restore non-momentary electric interruptions.[145]

The significant role of nuclear energy in meeting U.S. electricity needs is highlighted below in Figure 15.

[143] *See* "U.S. Electricity Customers Experienced Eight Hours of Power Interruptions in 2020," U.S. Energy Information Administration, November 10, 2021, *accessible at* https://www.eia.gov/todayinenergy/detail.php?id=50316. *See also* Table 11.4 SAIDI (System Average Interruption Duration Index) Values (Minutes Per Year) of U.S. Distribution System by State, 2013-2020, Any Method, All Events (With Major Event Days), U.S. Energy Information Administration, *accessible at* https://www.eia.gov/electricity/annual/html/epa_11_04.html (showing that the average customer experience 491.9 minutes of non-momentary electric interruptions in 2020).
[144] *See* Table 11.5 SAIFI Values (Times Per Year) of U.S. Distribution System by State, 2013-2020, Any Method, All Events (With Major Event Days), U.S. Energy Information Administration, *accessible at* https://www.eia.gov/electricity/annual/html/epa_11_05.html.
[145] *See* Table 11.6 CAIDI Values (Minutes Per Interruption) of U.S. Distribution System by State, 2013-2020, Any Method, All Events (With Major Event Days), *accessible at* https://www.eia.gov/electricity/annual/html/epa_11_06.html.

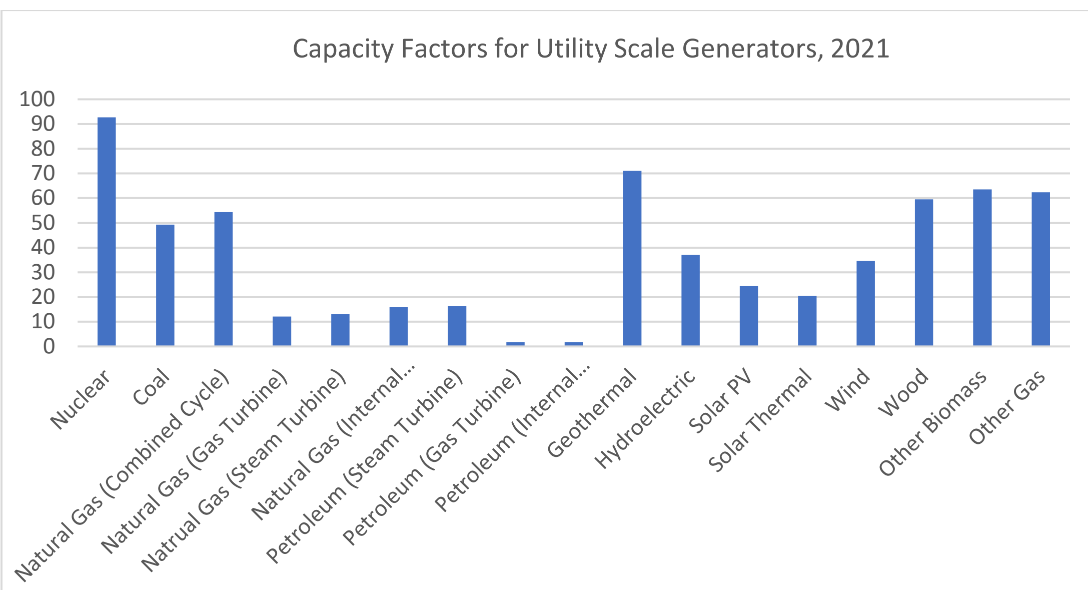
Figure 15. % of U.S. Utility-Scale Electricity Generation by Major Energy Source.



Source: U.S. Energy Information Administration, Electric Power Monthly, Table 1.1. Net Generation by Energy Source: Total (All Sectors), 2012-July 2022, and Table 1.1.A. Net Generation from Renewable Sources: Total (All Sectors), 2012-July 2022. Preliminary Data. Other = Landfill Gas, Biogenic Municipal Solid Waste, Other Waste Biomass, Non-Biogenic Municipal Solid Waste, Batteries, Hydrogen, Purchased Steam, Sulfur, Tire-Derived Fuel, and other Miscellaneous Energy Sources. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_1_01 and https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_1_01_a.

One way to measure reliability is by evaluating a power generation technology's capacity factor, which is the ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period.[146] Figure 16 below illustrates nuclear' s best-in-class performance by this measure, with an industry-leading 92.7% capacity factor.

Figure 16. Capacity Factors for Utility Scale Generators.



Source: U.S. Energy Information Administration, Electric Power Monthly, Table 6.07.A. Capacity Factors for Utility Scale Generators Primarily Using Fossil Fuels, and Table 6.07.B. Capacity Factors for Utility Scale Generators Primarily Using Non-Fossil Fuels.

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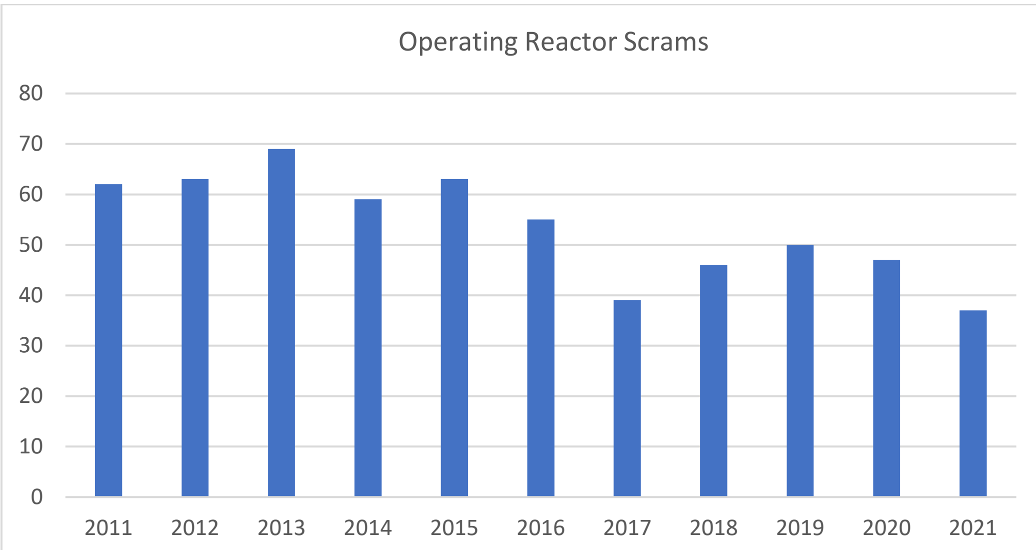
[146] *See* Glossary, U.S. Energy Information Administration, *accessible at* https://www.eia.gov/tools/glossary/index.php?id=C.

https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_07_a and https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_07_b.

At an operational level, and as illustrated in Figure 17 below, nuclear power generators have seen a generally declining trend in the number of sudden shutdowns in recent years (otherwise known as “scrams” or “reactor trips”).

Figure 17. Operating Reactor Scrams.



Source: U.S. Nuclear Regulatory Commission, Operating Reactor Scram Trending. https://www.nrc.gov/reactors/operating/ops-experience/scrams.html#dashboard.

During Winter Storm Uri, 3 of Texas’ 4 nuclear power reactors were unaffected and remained operational throughout, with one forced offline due to failure of a feedwater pressure sensing line caused by a false signal, with an Argonne National Laboratory report noting that nuclear power plants “are not susceptible to sudden fuel supply interruptions” and that additional nuclear capacity “would reduce these system-wide risks.”[147]

More broadly, as recently noted in a report by the Electric Power Research Institute:

> *“Operating experience and high capacity factors show that nuclear plants also have operational resilience to extreme events. It is rare that extreme weather events have a significant direct impact on nuclear plant generation, with most major loss of production events due to grid-wide challenges. In fact, during the studied [2011-2020] time period, weather-related events have only caused less than a 0.1% average loss of capacity factor at U.S. nuclear plants.”*[148]

[147] *See* “February 2021 Electricity Blackouts and Natural Gas Shortages in Texas,” Preliminary Analysis of Texas 2021 Power Outages, Energy Systems Division, Nuclear Science and Engineering Division, Argonne National Laboratory, *accessible at* https://publications.anl.gov/anlpubs/2021/07/169454.pdf.

[148] *See* “Nuclear Plant Resilience to Weather-Related Events Between 2011 To 2020,” Electric Power Research Institute, September 2022, *accessible at* https://www.epri.com/research/products/000000003002025519.

As to planned outages for refueling, which are generally scheduled every 18-24 months during times of lower demand and include opportunities for needed maintenance activity, the average length of downtime fell from 44 days in 2000 to 32 days in 2020.[149]

Companies in the U.S. nuclear energy industry are taking a variety of steps to manage both natural and human-caused risks, including physical security measures, cybersecurity controls and related public-private sector collaborations and partnerships, implementation of North American Electric Reliability Corporation Critical Infrastructure Protection requirements, and training and exercises.[150]

Additionally, U.S. regulations require that nuclear power reactor licensees protect digital computer and communications systems and networks from cyberattacks. Following the NRC's review and approval of a compliance plan, the agency issues a Safety Evaluation Report and reviews and assesses the program through inspections on an ongoing basis. The NRC and Nuclear Energy Institute have both published guidance for compliance that have been approved as acceptable for licensee use.[151]

While nuclear power plant operations are not immune from the effects of external events, as seen in Texas in 2021 and in Iowa in 2020 following a derecho,[152] risk mitigation measures are in place and nuclear energy is a critical and reliable contributor to the nation's baseload electricity. The increased deployment of intermittent electricity sources to the grid and the vulnerability to supply issues that other electricity technologies entail underscore the crucial role that nuclear energy can play as a reliable, low-emissions generator of power.

2. *Energy Affordability*

In August 2022, the Bureau of Labor Statistics reported that the price index for U.S. electricity rose 15.8%, representing the index's largest annual increase since 1981.[153] Between July 2021 and July 2022, the average retail price of electricity in the United States similarly rose 15%, from 11.54 cents/kilowatt hour to 13.28 cents/kilowatt hour.[154] As reflected in Figure 18 below, price increases have affected both residential and non-residential customers alike.

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[149] *See* "Capacity Outages at U.S. Nuclear Power Plants Averaged 3.1 Gigawatts This Summer," U.S. Energy Information Administration, *accessible at* https://www.eia.gov/todayinenergy/detail.php?id=49796.

[150] *See e.g.,* 2021 ESG Report, Duke Energy Corporation, *accessible at* https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/esg/2021-esg-report-full.pdf?la=en&rev=19532a880c3a47ee868fb43cb087c369; 2020 Sustainability and Corporate Responsibility Report, Dominion Energy *accessible at* https://sustainability.dominionenergy.com/assets/pdf/2020-Sustainability-Report.pdf, FY 2021 Sustainability Report, Tennessee Valley Authority, *accessible at* https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/tva-sustainability-report-fy2021a8f8ec86-6e31-4b28-a071-12a9c9498c19.pdf?sfvrsn=f59561f2_3; 2022 Sustainability Report, Constellation Energy, *accessible at* https://www.constellationenergy.com/content/dam/constellationenergy/pdfs/Constellation-2022-Sustainability-Report.pdf; "Southern Nuclear Plant Vogtle Recognized for Advancements in Cybersecurity," Southern Nuclear, March 13, 2020, *accessible at* https://www.southernnuclear.com/news-center/innovation/epriaward-200316.html; and Entergy's Cybersecurity Management Overview, Entergy Corporation, *accessible at* https://cdn.entergy.com/userfiles/content/sustainability/Cybersecurity_Management.pdf.

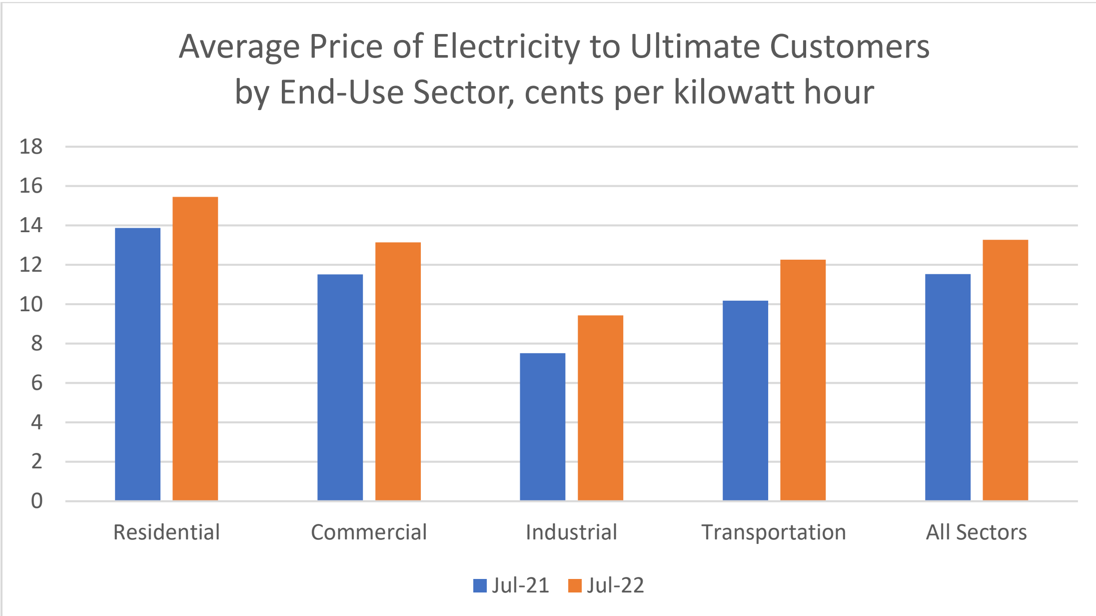
[151] *See* Backgrounder on Cyber Security, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/cyber-security-bg.html; and Regulatory Guide 5.71, Cyber Security Programs for Nuclear Facilities, U.S. Nuclear Regulatory Commission, January 2010, *accessible at* https://www.nrc.gov/docs/ML0903/ML090340159.pdf.

[152] *See* "Duane Arnold Nuclear Plant Decommissioning Early After Damage from the Derecho," by Rebecca Kopelman, KGAN CBS 2, August 24, 2020, *accessible at* https://cbs2iowa.com/news/local/duane-arnold-nuclear-plant-decommissioning-early-after-damage-from-derecho.

[153] *See* Consumer Price Index Summary, U.S. Bureau of Labor Statistics, *accessible at* https://www.bls.gov/news.release/cpi.nr0.htm#:~:text=The%20energy%20index%20increased%2023.8,the%20period%20ending%20May%201979.

[154] *See* Electric Power Monthly, Average Price of Electricity to Ultimate Customers by End-Use Sector, U.S. Energy Information Administration, *accessible at* https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a.

Figure 18. Average Price of Electricity to Ultimate Customers.



Source: Electric Power Monthly, U.S. Energy Information Administration. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a.

Notably, burdens associated with high energy prices disproportionately impact those who can least afford it. According to the U.S. Department of Energy, 44% of all American households are low-income, with low-income households experiencing a national average energy burden (8.6%) that is nearly three times higher than that of non-low-income households (3%).[155]

Given the importance of energy prices to both society and the economy, as shown in Figure 19 below, ESG metrics for affordable energy have been developed by leading ESG reporting frameworks, and a Sustainable Development Goal specific to affordable energy has been established.

Figure 19. Example Energy Affordability-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Average retail electric rate for (1) residential, (2) commercial, and (3) industrial customers	SASB IF-EU-240a.1
Typical monthly electric bill for residential customers for (1) 500 kWh and (2) 1,000 kWh of electricity delivered per month	SASB IF-EU-240a.2
Number of residential customer electric disconnections for non-payment, percentage reconnected within 30 days	SASB IF-EU-240a.3
Discussion of impact of external factors on customer affordability of electricity, including the economic conditions of the service territory	SASB IF-EU-240a.4
Affordable and Clean Energy	SDG 7

[155] *See* Low-Income Community Energy Solutions, State and Local Solution Center, U.S. Department of Energy, *accessible at* https://www.energy.gov/eere/slsc/low-income-community-energy-solutions#:~:text=According%20to%20DOE's%20Low%2DIncome,be%20as%20high%20as%2030%25.

Industry Performance

The costs involved with generating nuclear energy in the United States have experienced a decline trend in recent years, with benefits for electricity consumers as discussed in this section. For example, a report published in 2021 noted that the average total generating cost for U.S. nuclear energy had fallen to $29.37 per megawatt hour, a 4.6% decline from 2019 levels and a 35% decline from generating costs in 2012.[156]

A recent study examined the potential impacts of the retirement of two nuclear power plants in New Jersey on electricity bills in the state, and found that consumers would pay $176 million more each year if the plants were to cease operations ($69 million for residential customers and $107 million for commercial/industrial customers). The study also found that the price savings associated with continued operation of the two plants would support over 1,200 jobs in the state.[157]

Similar research in Illinois concluded that without continued operation of four of the state's six nuclear power plants, consumers in Illinois would pay $483 million more annually for electricity ($149 million for residential customers, $179 million for commercial customers, and $155 million for industrial customers).[158] Following the passage of legislation designed to keep the state's nuclear plants open, the Illinois Commerce Commission reported that ComEd customers would receive a monthly credit of ~$19.71, or over $236 annually as a result of the plants' continued operation.[159]

Recent developments highlight how the absence of nuclear power can impact electricity prices. For example, following the closure of the Indian Point Energy Center plant in Buchanan, New York in April 2021,[160] the New York Independent System Operator (NYISO) in 2022 noted that the average wholesale price of electricity rose from $25.70/megawatt hour in 2020 to $47.59 in 2021, with prices having generally risen due to the plant closure.[161]

In addition to environmental and reliability benefits, another study found that maintaining the operation of the Diablo Canyon nuclear power plant in California would save $2.6 billion in power system costs

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[156] *See* Nuclear Costs in Context, Nuclear Energy Institute, November 2021, *accessible at* https://www.nei.org/CorporateSite/media/filefolder/resources/reports-and-briefs/Nuclear-Costs-in-Context-2021.pdf.

[157] *See* Salem and Hope Creek Nuclear Power Plants' Contribution to the New Jersey and Local Economies, by Mark Berkman and Dean Murphy, The Brattle Group, December 2020, *accessible at* https://www.brattle.com/wp-content/uploads/2021/05/20628_salem_and_hope_creek_nuclear_power_plants_contribution_to_the_new_jersey_and_local_economies.pdf.

[158] *See* The Impacts of Illinois Nuclear Power Plants on the Economy and the Environment, by Dean Murphy and Mark Berkman, The Brattle Group, December 2020, *accessible at* https://www.brattle.com/wp-content/uploads/2021/06/20732_the_impacts_of_illinois_nuclear_power_plants_on_the_economy_and_the_environment_-_re-issued_december_2020.pdf.

[159] *See* "A Billion Reasons Why Nuclear Plant Negotiations Turned Out Well for ComEd Customers," Chicago Sun Times, May 10, 2022, *accessible at* https://chicago.suntimes.com/2022/5/10/23062706/nuclear-plant-credit-illinois-commerce-commission-commonwealth-edison-power-bills-editorial.

[160] *See* New York's Indian Point Nuclear Power Plant Closes After 59 Years of Operation, U.S. Energy Information Administration, April 30, 2021, *accessible at* https://www.eia.gov/todayinenergy/detail.php?id=47776.

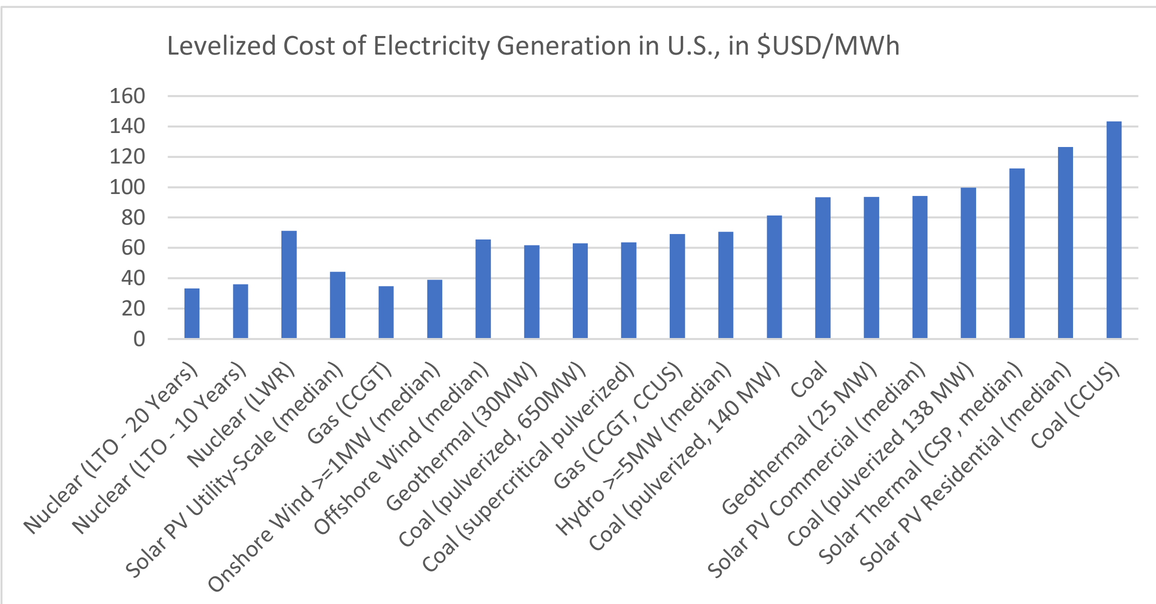
[161] *See* The Path to a Reliable, Greener Grid for New York, The New York ISO Annual Grid & Markets Report, Power Trends 2022, *accessible at* https://www.nyiso.com/documents/20142/2223020/2022-Power-Trends-Report.pdf/d1f9eca5-b278-c445-2f3f-edd959611903?t=1654689893527 (with reference to 2021 State of the Market Report for the New York ISO Markets, Potomac Economics, May 2022, *accessible at* https://www.nyiso.com/documents/20142/2223763/NYISO-2021-SOM-Full-Report-5-11-2022-final.pdf/5307870c-9b62-1720-1708-6b9c157211bb).

between 2025 and 2035.[162] In early September, California Governor Gavin Newsom signed legislation that could keep the plant open past its currently expected closure in 2025.[163]

As illustrated in Figure 20 below, the levelized cost of electricity generation associated with the continued operation of existing nuclear energy plants is superior to most other alternatives. Importantly, the estimates do not account for transmission and distribution costs, which for some generation technologies could be significant.[164] A 2019 study also found that system costs related to electricity generated by variable renewable energy could range from near $10/megawatt hour in a scenario with 10% wind and solar, to over $50/megawatt hour in the case of a 75% wind/solar share.[165]

Although the cost of associated with a new-build 1,100 MW light water nuclear reactor is estimated to be substantially higher than the costs associated with the continuation of operations at existing sites, as discussed elsewhere in this paper, new technologies are being developed that would provide for smaller scale facilities and in turn reduce the cost associated with providing reliable and dispatchable nuclear energy.

Figure 20. Levelized Cost of Electricity Generation in U.S.



Source: Levelized Cost of Electricity Calculator, International Energy Agency (2020), Paris. (last updated Sept. 22, 2022). Assumes 7% discount rate. https://www.iea.org/data-and-statistics/data-tools/levelised-cost-of-electricity-calculator.

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[162] *See* An Assessment of the Diablo Canyon Nuclear Plant for Zero-Carbon Electricity, Desalination, and Hydrogen Production, by Justin Abron (LucidCatalyst, LLC), Ejeong Baik (Stanford University), Sally Benson (Stanford University), Andrew T. Bouma (Massachusetts Institute of Technology), Jacopo Buongiorno (Massachusetts Institute of Technology), John H. Lienhard, V (Massachusetts Institute of Technology), John Parsons (Massachusetts Institute of Technology), and Quantum J. Wei (Massachusetts Institute of Technology), November 2021, *accessible at* https://energy.stanford.edu/sites/g/files/sbiybj9971/f/diablocanyonnuclearplant_report_11.19.21.pdf.

[163] *See* California Legislative Information, SB-846, *accessible at* https://leginfo.legislature.ca.gov/faces/billVotesClient.xhtml?bill_id=202120220SB846.

[164] *See* Projected Costs of Generating Electricity, International Energy Agency and Nuclear Energy Agency, 2020 Edition, *accessible at* https://iea.blob.core.windows.net/assets/ae17da3d-e8a5-4163-a3ec-2e6fb0b5677d/Projected-Costs-of-Generating-Electricity-2020.pdf.

[165] *See* The Costs of Decarbonisation: System Costs with High Shares of Nuclear and Renewables, Nuclear Energy Agency, Organisation for Economic Co-Operation and Development, 2019, *accessible at* https://www.oecd-nea.org/upload/docs/application/pdf/2019-12/7299-system-costs.pdf.

Importantly, these calculations were also determined prior to the natural gas spike that began in 2021 and has continued into 2022. Since fuel only accounts for ~20 percent of nuclear power plant generating costs,[166] nuclear power plants are significantly less susceptible to volatility in commodity markets than other major generation technologies.

As states and regions seek to meet emission goals, recent research has found that nuclear could play an important role in ensuring more affordable as well as reliable energy. For example, one study released in 2020 found that small modular reactors could help reduce the cost associated with securing a 100% GHG emissions-free electricity sector in the Pacific Northwest by ~$8 billion annually.[167]

3. *Nuclear Safety & Emergency Management*

Companies across all economic sectors operate networks of assets that face risks of accidents. Any emergency situation could have wide-ranging impacts on the environment, employees, and local communities.

Nuclear safety and emergency management are particularly top of mind for the nuclear industry and the communities in which they operate. Although infrequent, incidents have the potential to cause significant impacts and can affect public confidence in the ability of nuclear power to safely deliver energy. In one recent poll which found that more Americans support nuclear power than oppose it, of those opposed, 69% cited concerns about the risk of a nuclear meltdown.[168]

As described below, the U.S. nuclear industry and regulators have taken a series of actions to promote effective nuclear safety and emergency measurement. An example of ESG metrics related to nuclear safety and emergency management is shown in Figure 21.

Figure 21. Example Nuclear Safety & Emergency Management-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Total number of nuclear power units, broken down by U.S. Nuclear Regulatory Commission Action Matrix Column	SASB IF-EU-540a.1
Description of efforts to manage nuclear safety and emergency preparedness	SASB IF-EU-540a.2
Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	SDG 3
Clean Water and Sanitation: Ensure availability and sustainable management of water and sanitation for all	SDG 6
Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable and modern energy for all	SDG 7
Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable	SDG 11

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[166] *See* Nuclear Costs in Context, Nuclear Energy Institute, November 2021, *accessible at* https://www.nei.org/CorporateSite/media/filefolder/resources/reports-and-briefs/Nuclear-Costs-in-Context-2021.pdf.

[167] *See* Pacific Northwest Zero-Emitting Resources Study, Executive Summary, Energy and Environmental Economics, Inc., January 29, 2020, *accessible at* https://www.ethree.com/wp-content/uploads/2020/02/E3-Pacific-Northwest-Zero-Emitting-Resources-Study-Executive-Summary-Jan-2020.pdf.

[168] *See* Americans Split on Nuclear Energy as Safety Worries Linger – Reuters/Ipsos Poll, by Timothy Gardner, June 6, 2022, *accessible at* https://www.reuters.com/business/energy/americans-split-nuclear-energy-safety-worries-linger-2022-06-06/.

Responsible Consumption and Production: Ensure sustainable consumption and production patterns	SDG 12

Industry Performance

The U.S. nuclear industry currently includes 92 operating nuclear reactors at 54 nuclear power plants.[169] In addition to voluntary measures taken by industry, the sector is subject to strong oversight and regulation by the NRC that together has helped ensure operational safety and effective emergency management.

For example, U.S. nuclear power plants are subject to NRC regulations and guidance related to emergency preparedness. Initial operating licenses for a new nuclear power reactor will not be issued absent a finding that there is reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency, including through an assessment of emergency plans.[170] Nuclear power reactor operating licensees are also subject to a number of conditions related to safety, including maintenance of a compliant emergency plan.[171]

Additionally, structures, systems, and components of nuclear power plants that are important to safety must be designed to withstand the effects of events like earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their safety functions.[172]

NRC has also issued and endorsed guidance to nuclear power plant operators regarding acceptable methods for implementing emergency preparedness regulations,[173] and emergency planning requirements are separately provided for other licenses, including those involving the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste, and those seeking to possess and use special nuclear material in a plutonium processing or fuel fabrication plant or for a uranium enrichment facility.[174]

To ensure sufficient emergency preparedness at nuclear power plants, the NRC conducts inspections of emergency plans, tracks performance indicators and measures them against risk-informed thresholds, conducts full-scale exercises at least once every two years to evaluate plant staff's ability to successfully implement their emergency plans (with participation from the Federal Emergency Management Agency), and evaluates drills conducted by plants.[175] Nuclear power plant inspections also generally

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[169] *See* Nuclear Explained, U.S. Energy Information Administration, *accessible at* https://www.eia.gov/energyexplained/nuclear/nuclear-power-plants.php#:~:text=As%20of%20July%201%2C%202022,the%20U.S.%20nuclear%20energy%20industry..

[170] *See* 10 CFR § 50.47, Emergency Plans, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0047.html. *See* Section IV or Appendix E to 10 CFR Part 50 for further guidance on information needs for demonstrating compliance with emergency plan requirements, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-appe.html.

[171] *See* 10 CFR § 50.54, Conditions of Licenses, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0054.html.

[172] *See* Appendix A to Part 50 – General Design Criteria for Nuclear Power Plants, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/full-text.html.

[173] *See* Regulations, Guidance, and Generic Communications, NRC-Generated Guidance Documents and NRC-Endorsed Guidance Documents, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/about-nrc/emerg-preparedness/regs-guidance-comm.html#regs.

[174] *See e.g.,* 10 CFR Part 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/cfr/part072/index.html; and 10 CFR Part 70, Domestic Licensing of Special Nuclear Material, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/cfr/part070/index.html.

[175] *See* About Emergency Preparedness, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/about-nrc/emerg-preparedness/protect-public.html.

include verifications of organizational structure, operator qualifications, design, maintenance, fuel handling, and environmental and radiation protection programs.[176]

Through "resident inspectors" located at each operating U.S. nuclear power plant and fuel cycle facility, NRC also carries out inspections on a day-to-day basis. NRC additionally conducts inspections of licensed radioactive materials activities and operations other than those carried out at power plants and fuel cycle facilities. According to NRC, the agency annually conducts ~1,000 inspections of nuclear material licensees.[177]

In addition to NRC inspections, industry partners with the Institute of Nuclear Power Operations to conduct onsite, multi-week safety inspections at every U.S. nuclear power plant every two years, with post-inspection briefings that include the company's chief executive officer.[178]

In addition to emergency preparedness, NRC licensees are also subject to measures intended to promote the common defense and security and public health and safety, including through the regulation of accounting systems for special nuclear and source materials and security programs and contingencies.[179]

To protect against theft, diversion of nuclear material for nefarious purposes, protection of information from unauthorized disclosure, and sabotage, NRC licensees as well as staff are subject to regulatory requirements and license conditions related to physical protection, materials control and accounting, information security, protection of digital computer and communication systems from cyberattacks, radioactive material security, required reporting for national security clearance holders, criminal history records and firearms background checks, and insider threats.[180]

As to international safeguards, the NRC provides support for U.S. compliance with various treaties including the Treaty on Non-Proliferation of Nuclear Weapons, the U.S. – International Atomic Energy Agency Safeguards Agreement and its related Additional Protocol, and the U.S. – International Atomic Energy Agency Caribbean Territories Safeguards Agreement and its modified Small Quantities Protocol. Regulatory requirements for NRC licensees under these treaties include provision of information on nuclear facilities, fuel cycle-related activities, nuclear material inventories, and shipments and receipts, as well as access to nuclear fuel cycle locations for information verification purposes.[181]

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[176] *See* Inspection, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/about-nrc/regulatory/safety-oversight.html.
[177] *See* Inspection, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/about-nrc/regulatory/safety-oversight.html.
[178] *See* Safety: The Nuclear Energy Industry's Highest Priority, Nuclear Energy Institute, *accessible at* https://nei.org/resources/fact-sheets/safety-nuclear-energy-industry-highest-priority.
[179] *See* Nuclear Security and Safeguards, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security.html.
[180] *See* Physical Protection, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/domestic/phys-protect.html; Material Control and Accounting, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/domestic/mca.html; Regulations, Guidance, and Communications, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/domestic/reg-guide.html; Domestic Safeguards Licensing Requirements, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/domestic/licensing.html; Information Security, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/info-security.html; Cybersecurity, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/cybersecurity.html; Radioactive Material Security, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/byproduct.html; Required Reporting for Clearance Holders, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/required-reporting-for-clearance-holders.html; Licensee Criminal History Records Checks & Firearms Background Check Information, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/chp.html; and Insider Threat Program for Licensees, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/security/insider-threat-program-for-licensees.html.
[181] *See* International Safeguards, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/materials/fuel-cycle-fac/international-safeguards.html.

In furtherance of its oversight, the NRC developed a Safety Culture Policy Statement (Policy Statement) that applies to the agency and those subject to its authority, including licensees, permit and authorization holders, and suppliers and vendors of safety-related equipment.[182]

The Policy Statement guides the activities of NRC staff and clearly describes the NRC's expectation that individuals and organizations engaged in or overseeing regulated activities involving nuclear material "establish and maintain a positive safety culture commensurate with the safety and security significance of their activities and the nature and complexity of their organizations and functions." The Policy Statement specifically directs individuals and organizations to "take the necessary steps to promote a positive safety culture" by fostering the following traits as they apply to their organizational environments:

- *Leadership Safety Values and Actions*: Leaders demonstrate a commitment to safety in their decisions and behaviors;
- *Problem Identification and Resolution*: Issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance;
- *Personal Accountability*: All individuals take personal responsibility for safety;
- *Work Processes*: The process of planning and controlling work activities is implemented so that safety is maintained;
- *Continuous Learning*: Opportunities to learn about ways to ensure safety are sought out and implemented;
- *Environment for Raising Concerns*: A safety conscious work environment is maintained where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination;
- *Effective Safety Communication*: Communications maintain a focus on safety;
- *Respectful Work Environment*: Trust and respect permeate the organization; and
- *Questioning Attitude*: Individuals avoid complacency and continuously challenge existing conditions and activities in order to identify discrepancies that might result in error or inappropriate action

Additionally, the Policy Statement notes organizations' responsibility to monitor and trend individual and operational performance in part to help identify possible safety culture-related areas for improvement, and the need for integration and balance to achieve both safety and security in the activities of personnel involved in those areas.

Although not binding or enforceable, in expressing its preference for a Policy Statement as a more effective way to engage stakeholders, the NRC underscored that "the option to consider rulemaking exists."

Within NRC, the Offices of Enforcement, Nuclear Reactor Regulation, New Reactors, Nuclear Material Safety and Safeguards, Nuclear Regulatory Research, and Nuclear Security and Incident Response all have roles and responsibilities related to implementation of the Policy Statement.[183]

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[182] *See* Final Safety Culture Policy Statement, U.S. Nuclear Regulatory Commission, 76 FR 34773, June 14, 2011, *accessible at* https://www.govinfo.gov/content/pkg/FR-2011-06-14/pdf/2011-14656.pdf.
[183] *See* Safety Culture Policy Statement Implementation Plan Update, U.S. Nuclear Regulatory Commission, June 2015, *accessible at* https://www.nrc.gov/docs/ML1518/ML15180A150.pdf.

The NRC has noted that its regulated nuclear facilities "among the most secure of the nation's critical infrastructure," and "among the best-protected private sector facilities in the Nation."[184] A significant reason for that is because, alongside events affecting nuclear facilities in recent decades, U.S. regulators and industry have undertaken comprehensive reviews, applied lessons learned, and exercised continued diligence to ensure that the U.S. nuclear industry remains a top performer.

For example, a partial meltdown occurred at a Three Mile Island commercial nuclear power reactor in 1979, leading to a small radioactive release that constituted the country's most serious nuclear power plant incident to date. Following the incident, although it had no detectable employee or public health effects, the NRC required nuclear power plants and fuel fabrication facilities to have emergency plans in place.[185]

In 1986, a nuclear power station in Chernobyl was destroyed following a sudden power surge, releasing a significant amount of radiation into the environment. While the NRC determined that U.S. reactors are protected against many of the causes of the Chernobyl incident, including through plant design, shutdown capabilities, and sound structures, it undertook a major review to ascertain the facts of the event and determine the implications for the regulation of U.S. nuclear power plants, and conducted long-term studies. Although immediate regulatory changes were found not to be warranted, the NRC continues to study the event for lessons regarding structure and land decontamination and the return of people to areas that were formerly contaminated.[186]

Following a significant release of uranium hexafluoride at a U.S. conversion facility in 1986, the NRC determined that follow-up action was necessary, and required that emergency plans for fuel facilities account for hazardous chemical releases.[187]

Although U.S. nuclear facilities were unaffected, following the September 11, 2001 terrorist attacks on the United States, the NRC shortly thereafter required all U.S. plants to take measures including facility design reviews, the addition of security personnel, improved physical protection measures, enhanced emergency plans, and additional training, and created the Office of Nuclear Security and Incident Response. Federal, state, and local governments and industry worked quickly to implement the requirements and participated together in joint drills and exercises. In 2011, the NRC required that Hostile Action Based Emergency Preparedness Drills be conducted at all U.S. nuclear power plants at least once every 8 years, and the NRC today conducts enhanced force-on-force inspections every three years.[188]

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[184] *See* Backgrounder on Nuclear Security, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/security-enhancements.html; and Radiation and National Security, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/about-nrc/radiation/rad-nat-security.html.

[185] *See* Backgrounder on the Three Mile Island Accident, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html; and Backgrounder on Emergency Planning and Preparedness for Nuclear Fuel Facilities, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/emerg-plan-prep-nuc-fac-fs.html.

[186] *See* Backgrounder on Chernobyl Nuclear Power Plant Accident, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/chernobyl-bg.html.

[187] *See* Backgrounder on Emergency Planning and Preparedness for Nuclear Fuel Facilities, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/emerg-plan-prep-nuc-fac-fs.html.

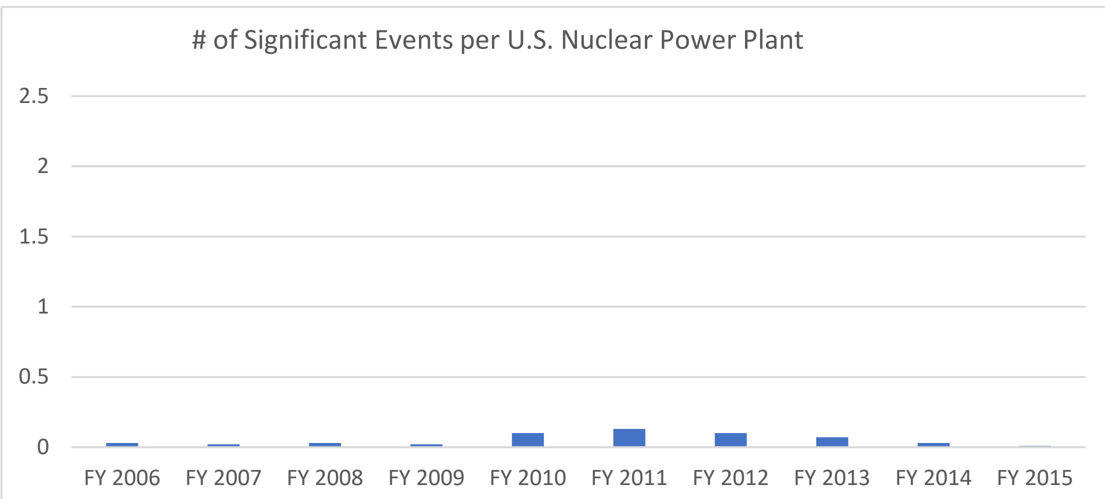
[188] *See* Emergency Preparedness in Response to Terrorism, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/response-terrorism.html; and Backgrounder on Force-on-Force Security Inspections, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/force-on-force-bg.html.

More recently, following the damage to Japan's nuclear power reactors at the Fukushima Dai-ichi facility caused by an earthquake and subsequent tsunami, the NRC required U.S. nuclear power plants to undergo several enhancements. Requirements included new capabilities for maintaining essential plant safety functions post-natural disaster, updated evaluations of the potential impacts of seismic and flooding events, new equipment for better managing potential reactor core damage events, and enhanced emergency preparedness capabilities.[189]

With that as context, the U.S. nuclear industry has performed well from a safety and emergency management perspective.

For example, in addition to the overall decline in sudden reactor shutdowns discussed in the Grid Resiliency section above, the NRC in 2018 noted that the number of significant U.S. reactor events (*e.g.*, degradation of safety equipment, sudden reactor shutdown with complications, or unexpected response to sudden degradation of fuel or pressure boundaries) fell from 2.5 events per nuclear power plant in 1985 to 0.01 in FY 2015.[190] A review of trends between FY 2006 and FY 2015 is illustrated in Figure 22.

Figure 22. Number of Significant Events per U.S. Nuclear Power Plant.

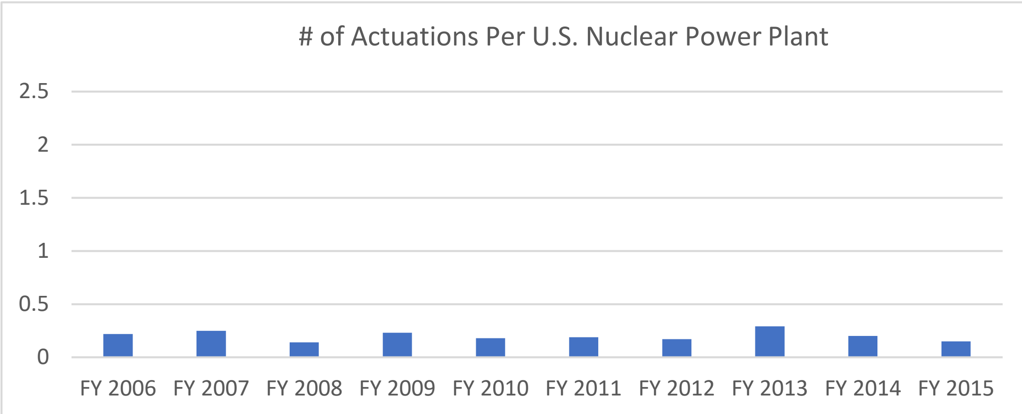


Source: Improved Plant Safety Performance, Backgrounder, U.S. Nuclear Regulatory Commission, March 2018. https://www.nrc.gov/docs/ML1807/ML18075A296.pdf.

Similarly, as shown in Figure 23, the number of safety system actuations per plant, or the number of times when a manual or automatic signal starts emergency core cooling systems or emergency power systems, has been similarly low, with far less than one per plant between FY 2006 and FY 2015.

[189] *See* Safety Enhancements After Fukushima, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/docs/ML1835/ML18355A806.pdf.
[190] *See* Improved Plant Safety Performance, Backgrounder, U.S. Nuclear Regulatory Commission, March 2018, *accessible at* https://www.nrc.gov/docs/ML1807/ML18075A296.pdf.

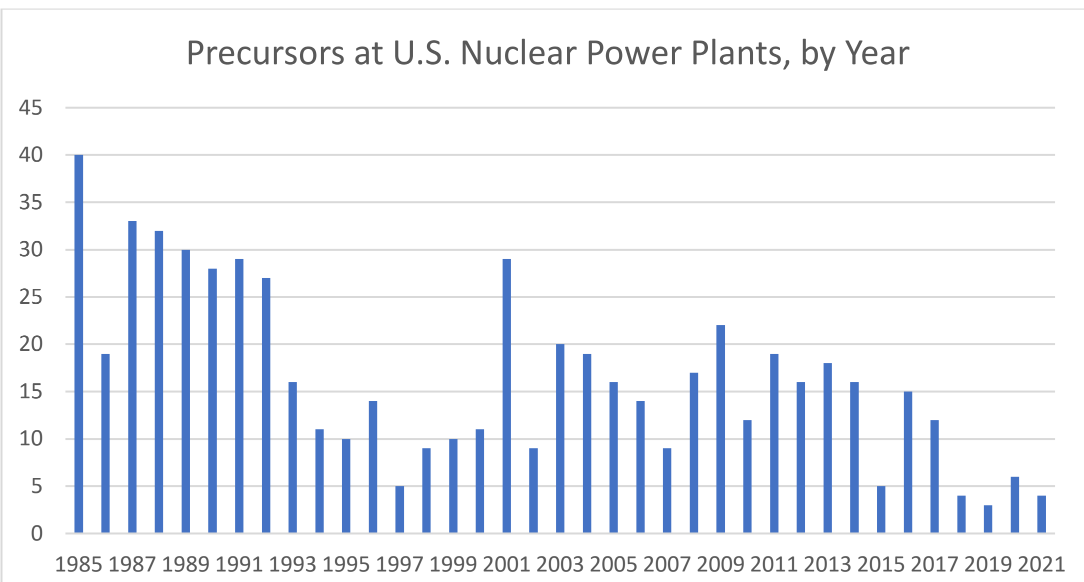
Figure 23. Number of Actuations Per U.S. Nuclear Power Plant.



Source: Improved Plant Safety Performance, Backgrounder, U.S. Nuclear Regulatory Commission, March 2018. https://www.nrc.gov/docs/ML1807/ML18075A296.pdf.

NRC staff reviews operational events at U.S. nuclear power plants to identify "precursors," defined as events that could result in a plant condition involving inadequate core cooling and severe reactor core damage.[191] The NRC's latest assessment concludes that the overall number of licensee event reports and potential precursors "continues a decrease to historical lows," with Figure 24 illustrating the downward trend in identified precursors in recent decades.[192]

Figure 24. Number of Precursors at U.S. Nuclear Power Plants.



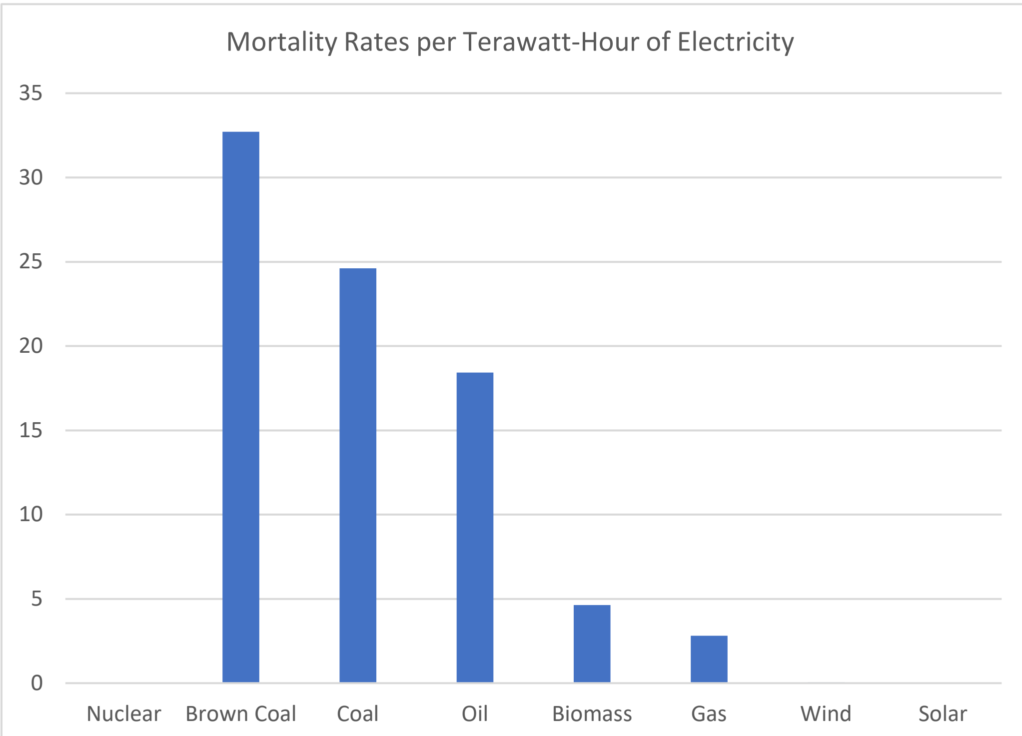
Source: Accident Precursor Program Dashboard, U.S. Nuclear Regulatory Commission. https://app.powerbigov.us/view?r=eyJrIjoiNmU2NjJiYjktOTQyYS00OGRhLTk0MGItMmUxNDdlOGI5NTgzIiwidCI6ImU4ZDAxNDc1LWMzYjUtNDM2YS1hMDY1LTVkZWY0YzY0ZjUyZSJ9.

[191] *See* Accident Sequence Precursor (ASP) Program, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/about-nrc/regulatory/research/asp.html; and United States Nuclear Regulatory Commission Accident Sequence Precursor (ASP) Program Summary Description, November 2008, *accessible at* https://www.nrc.gov/docs/ML1319/ML13192A106.pdf.

[192] *See* U.S. Nuclear Regulatory Commission Accident Sequence Precursor (ASP) Program 2021 Annual Report, June 2022, *accessible at* https://www.nrc.gov/docs/ML2215/ML22151A163.pdf.

Additionally, as shown in Figure 25, research comparing the performance of the nuclear power generation sector versus other power generation technologies finds that it is among the very safest when accounting for deaths from accidents and air pollution.

Figure 25. Mortality Rates by Energy Production Source.



Source: Our World in Data (citing Markandya, A., & Wilkinson, P. (2007), Sovacool et al. (2016), and UNSCEAR (2008 and 2018). Death rates represent deaths from accidents and air pollution. https://ourworldindata.org/grapher/death-rates-from-energy-production-per-twh.

The NRC is currently considering the application of performance-based emergency preparedness requirements tailored for small modular reactors and other new technologies like non-light-water reactors and certain non-power production or utilization facilities.[193] In March 2022, the NRC also proposed amendments to existing regulations that would apply a graded approach to emergency preparedness with regard to the decommissioning of production and utilization facilities.[194]

4. *Workforce Health & Safety*

While certain industries may be more vulnerable than others, workforce health and safety is critical to the operation of any business. In addition to protecting lives, workforce health and safety also helps to ensure productivity, reduce costs, and maintain a social license to operate. Examples of ESG metrics related to workplace health and safety are included below in Figure 26.

[193] *See* Emergency Preparedness for Small Modular Reactors and Other New Technologies, 85 FR 28436, May 12, 2020, *accessible at* https://www.govinfo.gov/content/pkg/FR-2020-05-12/pdf/2020-09666.pdf.
[194] *See* Regulatory Improvements for Production and Utilization Facilities Transitioning to Decommissioning, 87 FR 12254, March 3, 2022, *accessible at* https://www.govinfo.gov/content/pkg/FR-2022-03-03/pdf/2022-03131.pdf.

A recent study of more than 2,000 U.S. workers found that 97% of employees view safety as an important factor when considering where they work, with employers' genuine care about safety ranked just behind competitive compensation when it comes to the top reason for staying with an employer over the long-term. While 90% of respondents said that employers have a duty of care to protect workers from harm when working or on work travel, just 54% felt that safety was extremely important to their employer.[195]

Figure 26. Example Workforce Health & Safety-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
1) Total recordable incident rate (TRIR), (2) fatality rate, and (3) near miss frequency rate (NMFR)	IF-EU-320a.1
Operational Health and Safety Management System	GRI 403-1
Hazard Identification, Risk Assessment, and Incident Investigation	GRI 403-2
Occupational Health Services	GRI 403-3
Worker Participation, Consultation, and Communication on Occupational Health and Safety	GRI 403-4
Worker Training on Occupational Health and Safety	GRI 403-5
Prevention and Mitigation of Occupational Health and Safety Impacts Directly Linked by Business Relationships	GRI 403-7
Workers Covered by an Occupational Health and Safety Management System	GRI 403-8
Work-related Injury Data	GRI 403-9
Work-related Ill Health Data	GRI 403-10
Good Health and Well-Being	SDG 3
Decent Work and Economic Growth	SDG 8

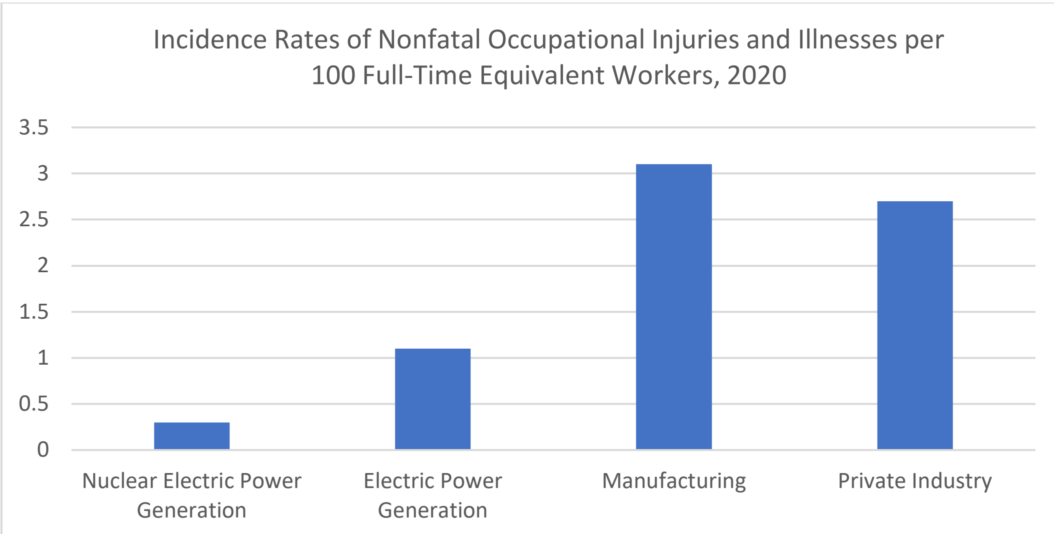
Industry Performance

The NRC and U.S. Occupational Safety and Health Administration have identified four primary hazards that can be associated with NRC-licensed facilities: facility conditions resulting in occupational hazards unrelated to radioactive materials (industrial safety and health hazards), radiation hazards produced by radioactive materials, chemical hazards produced by radioactive materials, and facility conditions affecting the safety of radioactive materials and presenting an increased radiation risk to workers.[196]

[195] *See* The State of Employee Safety in 2022, AlertMedia, *accessible at* https://www.alertmedia.com/employee-safety-report/?utm_source=popup.
[196] *See* Memorandum of Understanding between the U.S. Nuclear Regulatory Commission and the Occupational Safety and Health Administration, September 6, 2013, *accessible at* https://www.osha.gov/laws-regs/mou/2013-09-06.

In 2020, as illustrated in Figure 27 below, the U.S. nuclear electric power generation sector achieved a nonfatal injury/illness incidence rate that was lower than that of electric power generation, electric utilities, manufacturing, and private industry overall.

Figure 27. Incidence Rates of Nonfatal Occupational Injuries and Illnesses.



Source: U.S. Bureau of Labor Statistics Incidence rates of nonfatal occupational injuries and illnesses by injury and case types, 2020. https://www.bls.gov/web/osh/summ1_00.htm#soii_n17_as_t1.f.1.

Additionally, INPO calculates a safety accident rate for the U.S. nuclear industry, which reflects the number of accidents resulting in lost work, restricted work, or fatalities per 200,000 worker hours. In 2020, the U.S. nuclear industry achieved a 0.00 safety accident rate.[197]

Furthermore, the NRC requires its licensees to limit occupational exposure to radiation to 5,000 mrem annually,[198] and to date there have been zero instances of radiation-related health impacts associated with U.S. commercial nuclear energy.[199]

NRC licensees - which include commercial nuclear power reactors and test reactor facilities, industrial radiographers, fuel processors, fabricators, and reprocessors, manufacturers and distributors of byproduct material, and independent spent fuel storage installations – are required to annually report on individual exposure to radiation. In April 2022, the NRC published data on occupational radiation exposure at commercial nuclear power reactors and other facilities in 2019, finding that the average annual total effective dose equivalent was 50 mrem across all licensees, and 120 mrem when accounting for the average annual measurable total effective dose equivalent.

0.00

U.S. Nuclear Industry Safety Accident Rate in 2020

0

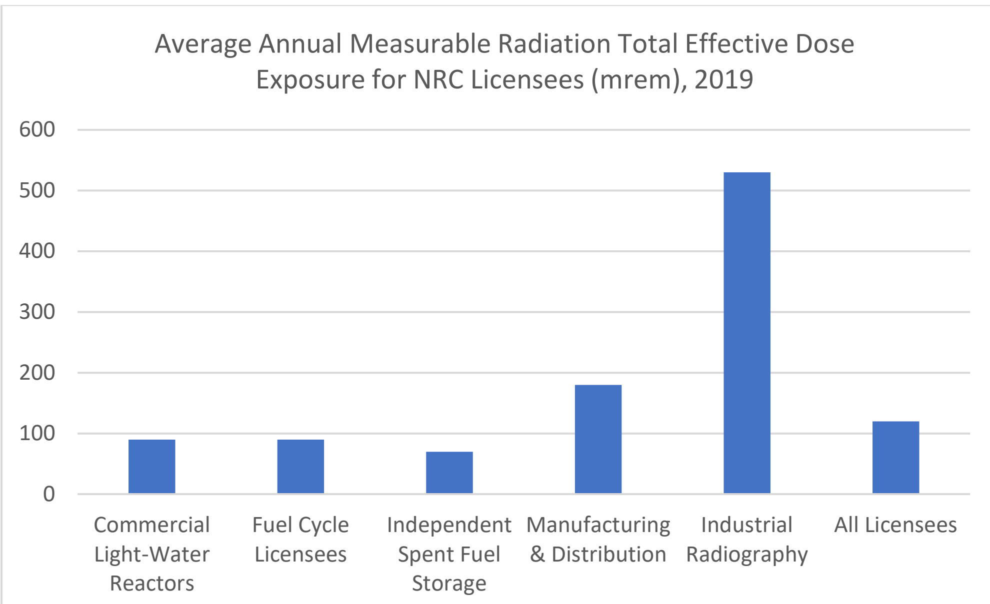
Incidents of Radiation-related Health Impacts from U.S. Commercial Nuclear Energy

[197] *See* U.S. Nuclear Industry Safety Accident Rate, One-year Industry Values, Nuclear Energy Institute (citing Institute of Nuclear Power Operators), *accessible at* https://www.nei.org/resources/statistics/us-nuclear-industrial-safety-accident-rate.
[198] *See* Occupational Dose, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reading-rm/basic-ref/glossary/occupational-dose.html. Federal regulations require licensees to monitor exposures to radiation and radioactive materials at levels sufficient to demonstrate compliance with occupational dose limits. *See* 10 CFR § 20.1502.
[199] *See* Operational Safety, Nuclear Energy Institute, *accessible at* https://www.nei.org/fundamentals/safety/operational-safety.

Figure 28 below illustrates the average annual measurable total effective dose equivalent by licensee category. For perspective, the annual average individual radiation exposure is ~620 mrem. In its latest report that assesses the four-year cycle covering 2010-2014, the United Nations Scientific Committee on the Effects of Atomic Radiation estimates that the worldwide level of annual occupational exposure across the entire commercial nuclear fuel cycle is 60 mrem, a 25% drop from the level assessed for the 2005-2009 time period.[200]

When accounting only for commercial light-water reactors, the average annual total effective dose equivalent and average measurable annual total effective dose equivalent were respectively 40 mrem and 90 rem.[201]

Figure 28. Average Annual Measurable Radiation Total Effective Dose.



Source: NRC, Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2019. https://www.nrc.gov/docs/ML2211/ML22111A013.pdf.

In the United States, in addition to Fitness-for-Duty Programs required by NRC regulations,[202] company-level worker health and safety efforts that have enabled strong performance include training initiatives and drills, hazard detection and mitigation programs, safety committees and peer groups, root cause analyses of significant safety incidents, and alert bulletins sharing best practices and learnings.[203]

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[200] *See* "Sources, Effects and Risks of Ionizing Radiation," United Nations Scientific Committee on the Effects of Atomic Radiation, Volume IV, Scientific Annex D, 2022, *accessible at* https://www.unscear.org/unscear/uploads/documents/publications/UNSCEAR_2020_21_Annex-D.pdf.

[201] *See* U.S. Nuclear Regulatory Commission, Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2019, published April 2022, *accessible at* https://www.nrc.gov/docs/ML2211/ML22111A013.pdf

[202] *See* Fitness-for-Duty Programs, U.S. Nuclear Regulatory Commission, *accessible at* https://www.nrc.gov/reactors/operating/ops-experience/fitness-for-duty.html.

[203] *See e.g.,* 2021 ESG Report, Duke Energy Corporation, *accessible at* https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/esg/2021-esg-report-full.pdf?la=en&rev=19532a880c3a47ee868fb43cb087c369; 2022 Sustainability Report, Constellation Energy, *accessible at* https://www.constellationenergy.com/content/dam/constellationenergy/pdfs/Constellation-2022-Sustainability-Report.pdf; 2020 Sustainability and Corporate Responsibility Report, Dominion Energy, *accessible at* https://sustainability.dominionenergy.com/assets/pdf/2020-Sustainability-Report.pdf; and 2019/2020 Corporate Responsibility Executive Summary, Southern Company, *accessible at* https://www.southerncompany.com/content/dam/southerncompany/pdfs/about/governance/reports/Southern_Company_2019-2020_Corporate_Responsibility_Executive_Summary.pdf.

5. *Economic Impacts*

Beyond the goods and services provided, companies can make a significant local, regional, national, and global impact depending on the size and scale of their operations.

In an assessment of OECD countries, a study released by the McKinsey Global Institute in 2021 found that businesses contribute 72% of Gross Domestic Product in OECD nations, with economic value moving to households through labor income, capital income, taxes, investment in capital assets, payments to suppliers, consumer surplus, environmental impact, and total factor productivity growth. The study found that in the United States, the contribution of businesses to real GDP per capita grew from $13,000 in 1960 (2018$) to $40,000 per person in 2018.[204]

In the United States, the importance of a strong local workforce and economy has been underscored by governmental efforts to promote local jobs and economic growth and reduce reliance on overseas supply chains through laws that incentivize local hiring, the domestic manufacturing of goods, and U.S. energy production.[205] Examples of ESG metrics related to economic considerations are identified below in Figure 29.

Figure 29. Example Economic Impact-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Direct economic value generated and distributed	GRI 201-1
Financial implications and other risks and opportunities due to climate change	GRI 201-2
Defined benefit plan obligations and other retirement plans	GRI 201-3
Financial assistance received from government	GRI 201-4
Infrastructure investments and services supported	GRI 203-1
Significant indirect economic impacts	GRI 203-2
Ratios of standard entry level wage by gender compared to local minimum wage	GRI 202-1
Proportion of senior management hired from the local community	GRI 202-2
Proportion of spending on local suppliers	GRI 204-1
No Poverty: End poverty in all its forms everywhere	SDG 1
Zero Hunger: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	SDG 2
Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	SDG 3

[204] *See* Companies in the 21st Century: A New Look At How Corporations Impact the Economy and Households, Discussion Paper, by James Manyika, Michael Birshan, Sven Smit, Jonathan Woetzel, Kevin Russell, Lindsay Purcell, and Sree Ramaswamy, McKinsey Global Institute, June 2021, *accessible at* https://www.mckinsey.com/~/media/mckinsey/business%20functions/strategy%20and%20corporate%20finance/our%20insights/a%20new%20look%20at%20how%20corporations%20impact%20the%20economy%20and%20households/a-new-look-at-how-corporations-impact-the-economy-and%20households-vf.pdf?shouldIndex=false.

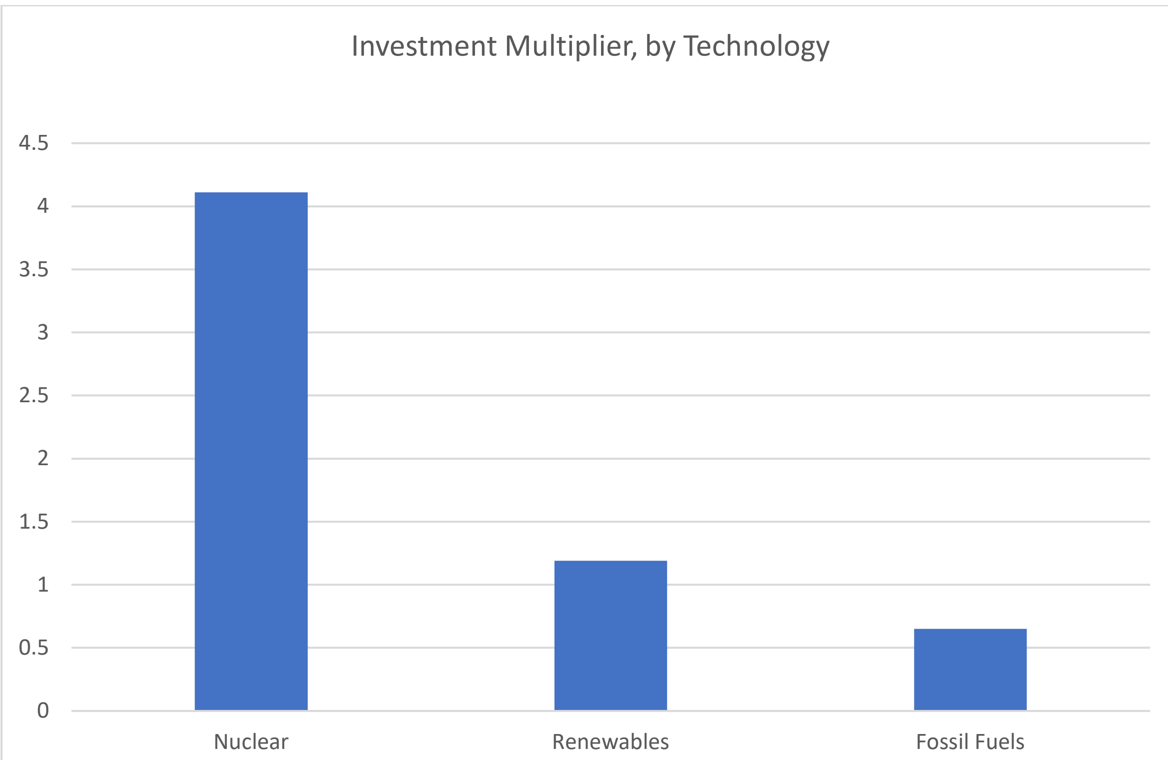
[205] *See e.g.,* Bipartisan Infrastructure Law – Section 25019(a) "Local Hiring Preference for Construction Jobs, Questions and Answers, U.S. Federal Highway Administration, Updated June 8, 2022, *accessible at* https://www.fhwa.dot.gov/construction/hiringpreferences/qanda060822/; Congress Expands Buy America Requirements in the Infrastructure Investments and Jobs Act (P.L. 117-58), Congressional Research Service, December 7, 2021, *accessible at* https://crsreports.congress.gov/product/pdf/IF/IF11989; and Inflation Reduction Act of 2022 (IRA): Provisions Related to Climate Change, Congressional Research Service, October 3, 2022, *accessible at* https://crsreports.congress.gov/product/pdf/R/R47262.

Decent Work and Economic Growth: Promote sustained and sustainable economic growth, full and productive employment and decent work for all	SDG 8
Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable	SDG 11

Industry Performance

The U.S. nuclear industry supports almost 500,000 jobs and annually produces an estimated $60 billion in U.S. Gross Domestic Product and spends ~$11 billion on labor.[206] As shown in Figure 30, one study has found that the economic multiplier effect associated with investments in nuclear energy is significantly higher than that associated with other energy technologies.[207]

Figure 30. Investment Multiplier by Technology.



Source: IMF Working Paper, Building Back Better: How Big Are Green Spending Multipliers?, March 2021. Using multipliers with credible intervals, delimited by the 16th and the 84th percentiles, that exclude zero. IMF noted that "[t]he data on nuclear energy spending cover a smaller set of countries and a larger number of years, therefore they are not strictly comparable." https://www.imf.org/-/media/Files/Publications/WP/2021/English/wpiea2021087-print-pdf.ashx.

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[206] *See* Advantages and Challenges of Nuclear Energy, Office of Nuclear Energy, U.S. Department of Energy, March 29, 2021, *accessible at* https://www.energy.gov/ne/articles/advantages-and-challenges-nuclear-energy#:~:text=The%20nuclear%20industry%20supports%20nearly,gross%20domestic%20product%20each%20year; and Jobs, Nuclear Energy Institute, *accessible at* https://www.nei.org/advantages/jobs.

[207] *See* IMF Working Paper, Building Back Better: How Big Are Green Spending Multipliers?, Prepared By Nicoletta Batini, Mario Di Serio, Matteo Fragetta, Giovanni Melina, and Anthony Waldron, March 2021, *accessible at* https://www.imf.org/-/media/Files/Publications/WP/2021/English/wpiea2021087-print-pdf.ashx.

According to a 2022 U.S. Department of Energy study, the nuclear power generation and fuels industries in 2021 directly employed nearly 65,000 workers.[208] Another DOE study found that jobs in the nuclear power and fuels sectors in 2019 provided a $39.19 median hourly wage that surpassed natural gas, coal, hydropower, oil, wind, solar, energy efficiency, and storage, and exceeded the average national median hourly wage by nearly 105%.[209]

At the facility level, nuclear power plants generate significant economic benefits. For example, one plant in Florida annually supports $630 million in local economic activity and 2,700 direct and indirect jobs throughout the state.[210] In New Jersey, it is estimated that between 2021 and 2030, continued operation of two nuclear power plants will annually generate $1.2 billion in net Gross Domestic Product for the state (24% of county GDP), 4,530 in-state direct and secondary jobs, $76 million in local spending, and $54 million in state taxes and $146 million in federal taxes.[211]

Another study found that between 2020 and 2029, the continued operation of four nuclear plants in Illinois would generate over $3.4 billion in annual Gross Domestic Product for the state, $149 million in state tax revenue, and over 28,000 in-state direct and secondary jobs.[212]

In addition to state incentives and prior to the passage of new federal incentives in 2022,[213] one study in 2019 found that the U.S. nuclear energy industry received $300 million in federal tax incentives in 2017.[214]

Recent developments involving closures of previously operational nuclear power plants underscore their value to local communities. For example, following the closure of a facility in New York, local media recently reported that the village in which the facility was sited is faced with the loss of ~$3.5 million annually in property taxes.[215] In addition to the loss of hundreds of plant workers, prior to the closure, a local town supervisor said that $32 million in annual revenue was at stake, of which $24 million was allocated to the local school district.[216]

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[208] *See* United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022, *accessible at* https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

[209] *See* Supplement to the 2020 United States Energy & Employment Report, *accessible at* https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/606d1178a0ee8f1a53e66206/1617760641036/Wage+Report.pdf

[210] *See* St. Lucie Nuclear Power Plant, Florida Power & Light Company, *accessible at* https://www.fpl.com/content/dam/fplgp/us/en/clean-energy/pdf/st-lucie-nuclear-operations.pdf.

[211] *See* Salem and Hope Creek Nuclear Power Plants' Contribution to the New Jersey and Local Economies, Prepared for PSEG, Prepared by Mark Berkman and Dean Murphy, The Brattle Group, December 2020, *accessible at* https://www.brattle.com/wp-content/uploads/2021/05/20628_salem_and_hope_creek_nuclear_power_plants_contribution_to_the_new_jersey_and_local_economies.pdf.

[212] *See* Re-Issue: The Impacts of Illinois Nuclear Power Plants on the Economy and the Environment, Prepared for Illinois IBEW State Council and Illinois AFL-CIO, Prepared by Dean Murphy, Ph.D. and Mark Berkman, Ph.D., The Brattle Group, *accessible at* https://www.brattle.com/wp-content/uploads/2021/06/20732_the_impacts_of_illinois_nuclear_power_plants_on_the_economy_and_the_environment_-_re-issued_december_2020.pdf.

[213] *See* Inflation Reduction Act of 2022 (IRA): Provisions Related to Climate Change, Congressional Research Service, October 3, 2022, *accessible at* https://crsreports.congress.gov/product/pdf/R/R47262.

[214] *See* The Value of Energy Tax Incentives for Different Types of Energy Resources, Congressional Research Service, Updated March 19, 2019, *accessible at* https://crsreports.congress.gov/product/pdf/R/R44852.

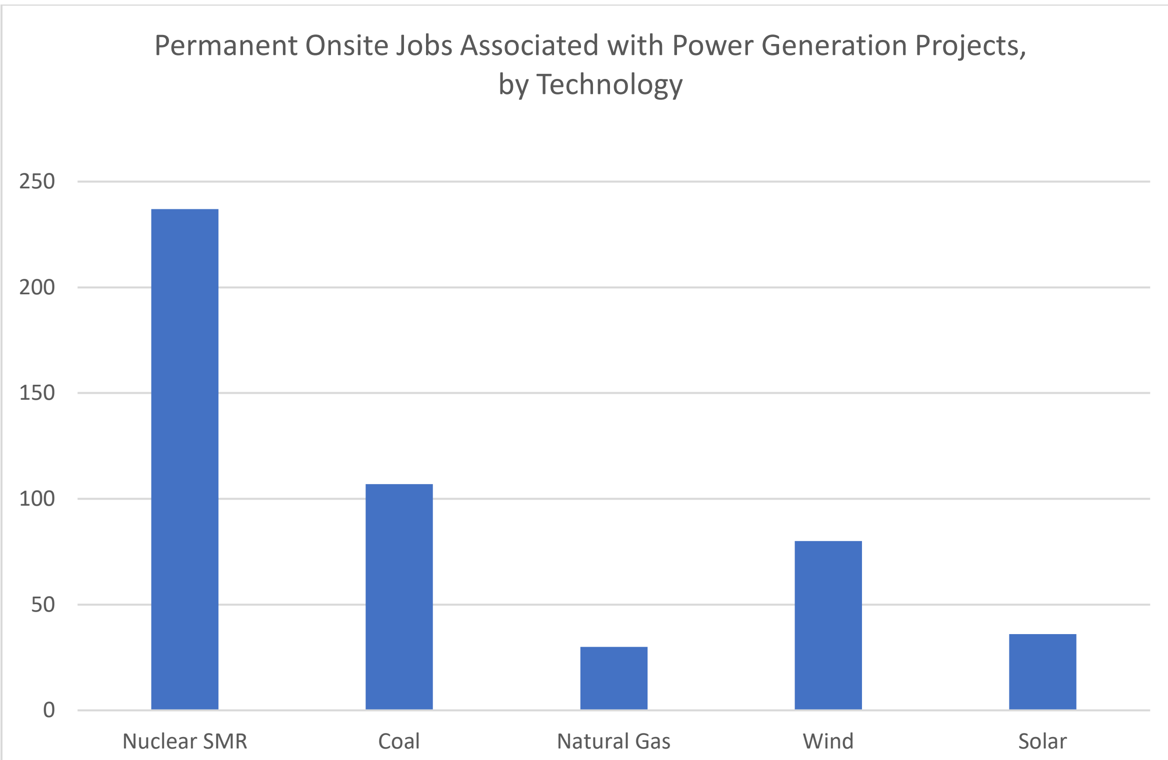
[215] *See* NY's Fossil Fuel Use Soared After Indian Point Plant Closure. Officials Sound the Alarm," by Thomas C. Zambito July 22, 2022, lohud.com, *accessible at* https://www.lohud.com/story/news/2022/07/22/new-york-fossil-fuels-increase-after-indian-point-nuclear-plant-shutdown/65379172007/.

[216] *See* "Indian Point is Shutting Down. That Means More Fossil Fuel," by Patrick McGeehan, The New York Times, April 12, 2021, *accessible at* https://www.nytimes.com/2021/04/12/nyregion/indian-point-power-plant-closing.html.

With existing nuclear power facilities having a capacity to operate for at least 80 years,[217] these economic benefits are generally sustained over a significant period of time.

In terms of benefits associated with new technology that are specific to local communities, one recent report examined the potential employment effects of new-build small modular nuclear reactor projects as compared to other power generation projects producing an annual electricity output equivalent to ~1,000 megawatts. In addition to an estimated 1,600 construction jobs, the report found that the number of permanent onsite jobs associated with SMRs would dwarf those of the other energy projects.[218] The findings from the study are highlighted below in Figure 31

Figure 31. Permanent Onsite Jobs Associated with Power Generation Projects.



Source: Gone with the Steam: How New Nuclear Power Plants Can Re-Energize Communities When Coal Plants Close, ScottMadden, October 2021. https://www.scottmadden.com/content/uploads/2021/10/ScottMadden_Gone_With_The_Steam_WhitePaper_final4.pdf.

Boise State University's Idaho Policy Institute concluded that in addition to annually generating 667 regional jobs through *indirect and induced* effects over the facility's 40-60 year lifecycle, one particular small modular reactor project being planned in Idaho would produce ~$48 million in additional regional labor income, $81.15 million in economic output, and ~$14 million in local and state ($2.97 million) and federal ($10.86 million) taxes.[219]

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[217] *See e.g.,* Light Water Reactor Sustainability (LWRS) Program, Office of Nuclear Energy, U.S. Department of Energy, *accessible at* https://www.energy.gov/ne/nuclear-reactor-technologies/light-water-reactor-sustainability-lwrs-program.

[218] *See* Gone with the Steam: How New Nuclear Power Plants Can Re-Energize Communities When Coal Plants Close, ScottMadden, October 2021.
https://www.scottmadden.com/content/uploads/2021/10/ScottMadden_Gone_With_The_Steam_WhitePaper_final4.pdf

[219] *See* Economic Impact Report, Construction and Operation of a Small Modular Reactor Electric Power Generation Facility at the Idaho National Laboratory Site, Butte County, Idaho, Prepared for Regional Economic Development for East Idaho, Prepared by Dr. Geoffrey Black,

In addition to increasing the amount of baseload nuclear electricity from 95 to over 250 gigawatts, a new U.S. government study found that converting a coal power plant site to a site hosting a nuclear reactor could reduce overnight costs of capital by 15-35% as compared to a greenfield project, generate up to $275 million in annual regional economic activity, and add 650 permanent jobs that produce $102 million in labor income.[220]

6. *Employee Management*

The COVID-19 pandemic has underscored the critical role that maintaining a stable and satisfied workforce plays in ensuring companies' ability to operate and meet customer needs.

According to Gallup, 65% of U.S. workers are not engaged, with highly engaged business units performing better on absenteeism, productivity, and profitability, among other things.[221] To further illustrate the implications associated with a disengaged workforce, 74% of actively disengaged workers are looking for a new job or keeping an eye on openings, compared to 55% of not engaged employees and 30% of engaged employees that are doing the same.[222] Equally important, nearly 4.2 million Americans quit their jobs in July 2022, with the 2.7% quit rate still hovering near a record high, with those changing jobs seeing an average 6.7% annual wage growth rate compared to 4.9% for those remaining with their current employer.[223]

Areas of relevance to effective employee management include initiatives related to workforce training and development, competitive compensation and benefits, talent recruitment, succession planning, and a culture of engagement, teamwork, and working conditions that promote good health and overall employee satisfaction. Examples of specific metrics tied to existing ESG reporting frameworks are included below in Figure 32.

Figure 32. Example Employee Management-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
New employee hires and employee turnover	GRI 401-1
Average hours of training per employee	GRI 404-1
Programs for upgrading employee skills and transition assistance programs	GRI 404-2
% of employees receiving regular performance and career development reviews	GRI 404-3

Idaho Policy Institute, Boise State University, and Mr. Steven Peterson, McClure Center for Public Policy Research, University of Idaho, Final Copy, January 29, 2019, *accessible at* https://www.rediconnects.org/wp-content/uploads/2019/02/SMR-Economic-Impact-Report-FINAL.pdf.

[220] *See* Investigating the Benefits and Challenges of Converting Retiring Coal Plants into Nuclear Plants, Nuclear Fuel Cycle and Supply Chain, INL/RPT-22-67964, Revision 1, Prepared for U.S. Department of Energy, Systems Analysis and Integration, by J. Hansen, W. Jenson, A. Wrobel (Idaho National Laboratory) N. Stauff, K. Biegel, T. Kim (Argonne National Laboratory) R. Belles, F. Omitaomu (Oak Ridge National Laboratory), September 13, 2022, *accessible at* https://fuelcycleoptions.inl.gov/SiteAssets/SitePages/Home/C2N2022Report.pdf.

[221] *See* Employee Engagement vs. Employee Satisfaction and Organizational Culture, Gallup, April 12, 2017, Updated August 13, 2022, *accessible at* https://www.gallup.com/workplace/236366/right-culture-not-employee-satisfaction.aspx.

[222] *See* U.S. Employee Engagement Data Hold Steady in First Half of 2021, Gallup, July 29, 2021, Updated April 8, 2022, *accessible at* https://www.gallup.com/workplace/352949/employee-engagement-holds-steady-first-half-2021.aspx.

[223] *See* "Job openings, quits rate stay near record highs despite recession fear," The Hill, August 30, 2022, *accessible at* https://thehill.com/policy/finance/3620879-job-openings-quits-rate-stay-near-record-highs-despite-recession-fears/, and "Job openings top 11.2 million in July, well above estimate and nearly double the available workers," CNBC, Aug. 30, 2022, *accessible at* https://www.cnbc.com/2022/08/30/jolts-july-2022.html.

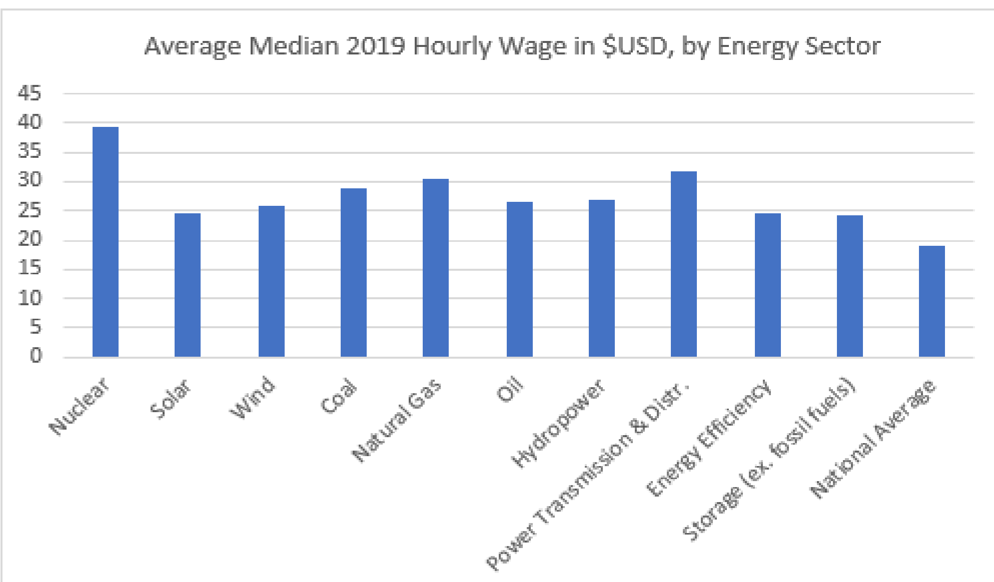
Benefits provided to full-time employees that are not provided to temporary or part-time employees	GRI 401-2
Parental Leave	GRI 401-3
Promotion of Worker Health	GRI 403-6
Average hourly earnings of female and male employees	SDG 8 (Decent Work and Economic Growth)

Industry Performance

A recent global survey found that being fairly rewarded financially to be the most important factor for employees when considering a change in work environment, followed by finding their job fulfilling, feeling they can truly be their self, feeling that their team cares about their well-being, the ability to be creative and innovative in their work, the ability to exceed expectations in a new job role, and the ability to choose when and where to work.[224]

As to compensation, those involved in nuclear power generation and nuclear fuel production and distribution earn significantly more than the national average and outperform other measured energy sectors as well, as highlighted in Figure 33 below. This measure of the U.S. nuclear industry accounts for utility workers, construction and maintenance employees, those engaged in related mining, manufacturing, and production, and those providing financial, legal, and other support to those operations.

Figure 33. Average Median 2019 Hourly Wage by Energy Sector.

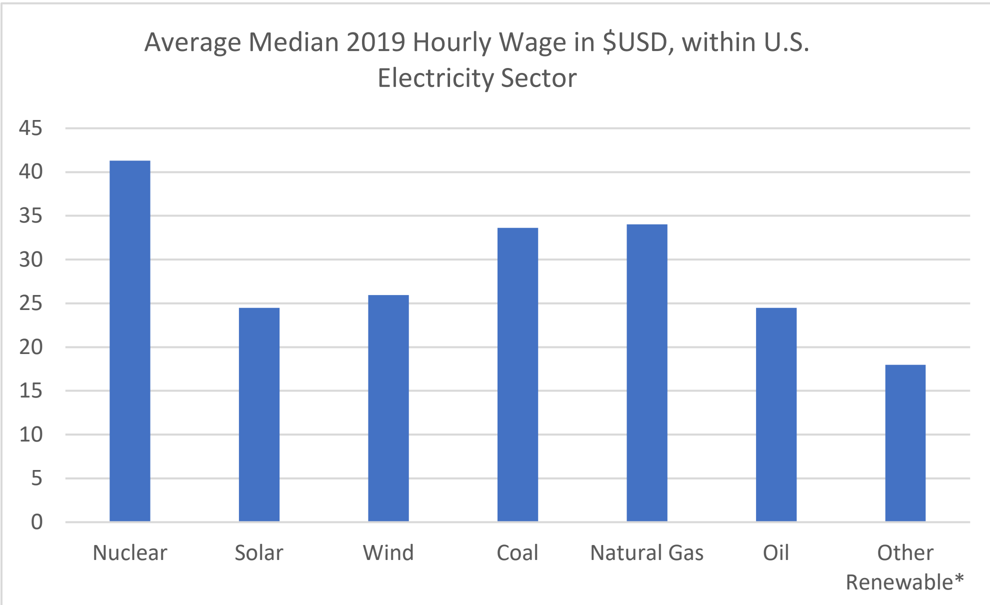


Source: Wages, Benefits, and Change: A Supplemental Report to the Annual U.S. Energy & Employment Report, by BW Research Partnership, The National Association of State Energy Officials, and The Energy Futures Initiative, *accessible at* https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/606d1178a0ee8f1a53e66206/1617760641036/Wage+Report.pdf.

[224] *See* "What 52,000 people think about work today," PwC Global Workforce Hopes and Fears Survey 2022, May 24, 2022, *accessible at* https://www.pwc.com/gx/en/issues/workforce/hopes-and-fears-2022.html?WT.mc_id=CT1-PL52-DM2-TR2-LS4-ND30-TTA3-CN_Hopes-and-Fears-Survey-2022-tw#retention-strategies.

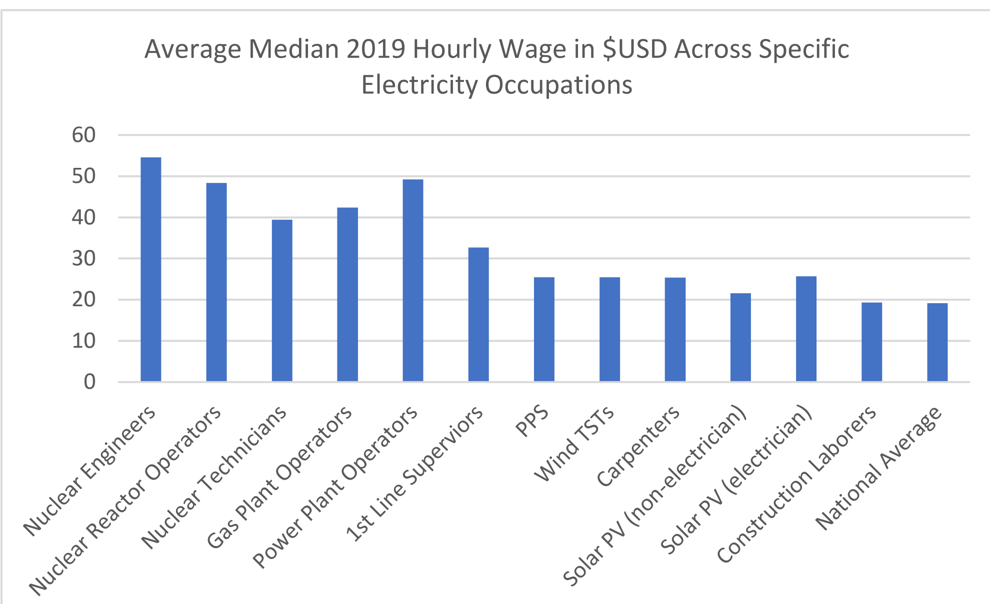
Among power generation and fuel technologies in particular, as shown below in Figures 34 through 37, nuclear also outperforms other subsectors in terms of compensation, and performs well among specific occupations within the electricity sector.

Figure 34. Average Median 2019 Hourly Wage Within U.S. Electricity Sector.



*Other Renewable includes geothermal, low-impact and traditional hydropower, bioenergy, and combined heat and power.
Source: Wages, Benefits, and Change: A Supplemental Report to the Annual U.S. Energy & Employment Report, by BW Research Partnership, The National Association of State Energy Officials, and The Energy Futures Initiative.
https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/606d1178a0ee8f1a53e66206/1617760641036/Wage+Report.pdf.

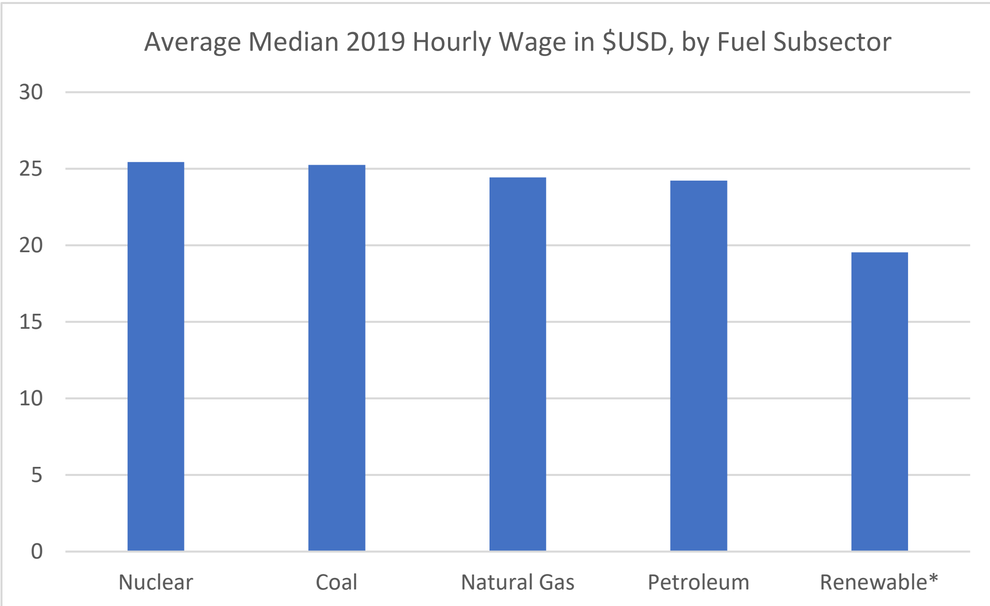
Figure 35. Average Median 2019 Hourly Wage Across Electricity Occupations.



Source: Wages, Benefits, and Change: A Supplemental Report to the Annual U.S. Energy & Employment Report, by BW Research Partnership, The National Association of State Energy Officials, and The Energy Futures Initiative. 1st Line Supervisors = 1st Line Supervisors of Construction Trades and Extraction Workers, PPS = Plumbers, Pipefitters, Steamfitters, Wind TSTs = Wind Turbine Service Technicians, and Solar PV non-

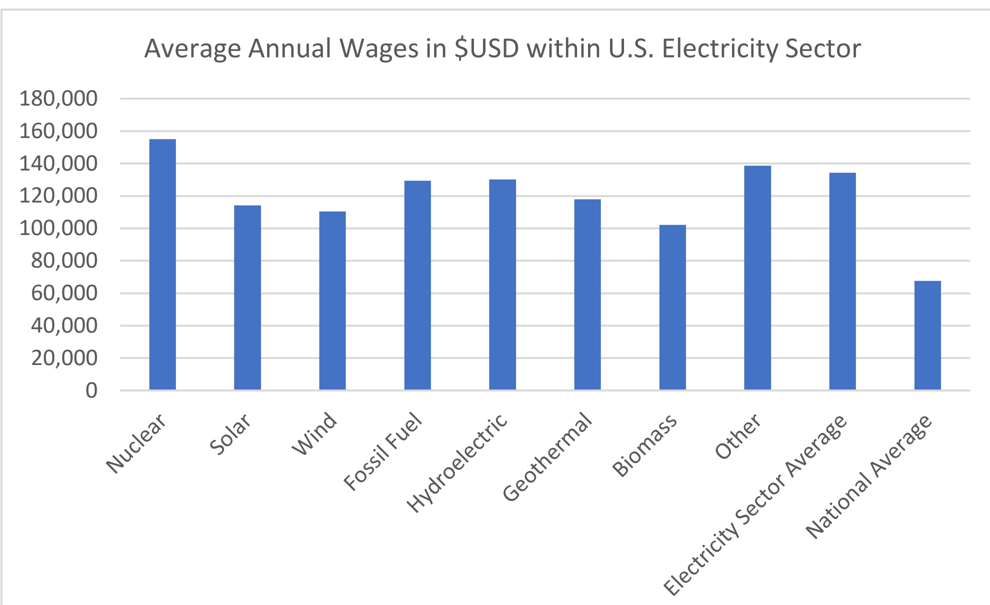
electrician and electrician refers to Solar PV installers (non-electrician) and Solar PV installers (electrician).
https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/606d1178a0ee8f1a53e66206/1617760641036/Wage+Report.pdf.

Figure 36. Average Median 2019 Hourly Wage by Fuel Subsector.



*Renewable includes corn ethanol, woody biomass, and non-woody biomass like straw, manure, vegetable oil, and animal fats.
Source: Wages, Benefits, and Change: A Supplemental Report to the Annual U.S. Energy & Employment Report, by BW Research Partnership, The National Association of State Energy Officials, and The Energy Futures Initiative.
https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/606d1178a0ee8f1a53e66206/1617760641036/Wage+Report.pdf.

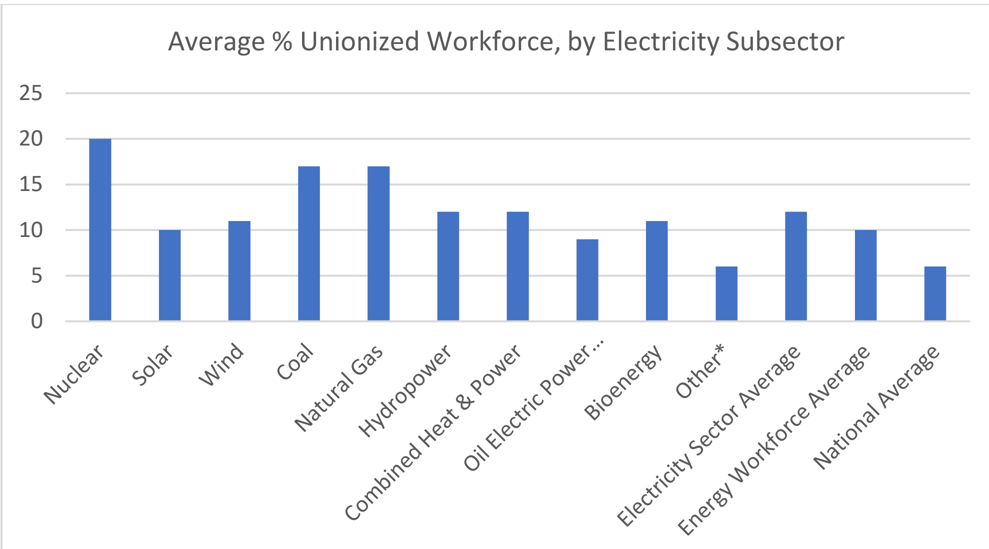
Figure 37. Average Annual Wage within U.S. Electricity Subsector.



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages, Employment and Wages Data Viewer.
https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables.

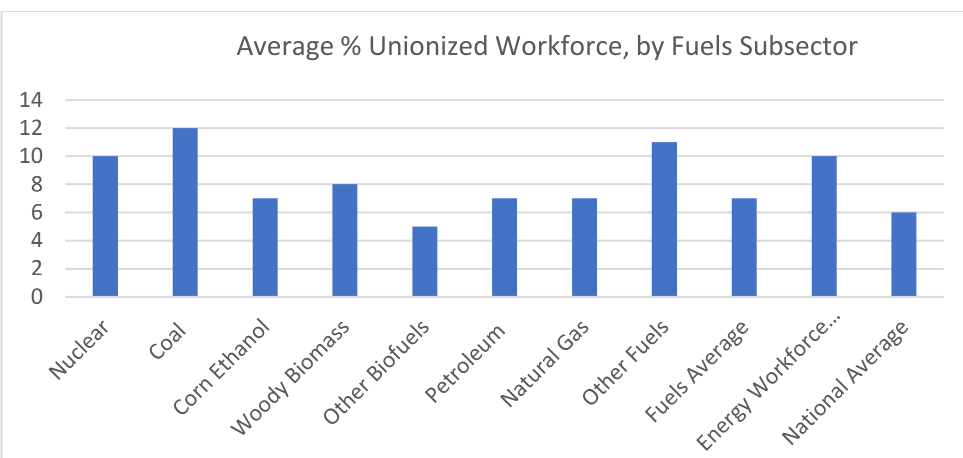
Recent research also suggests that U.S. union workers are more satisfied with their jobs than those who are not members of a union.[225] As reflected in Figure 38 below, the nuclear power generation subsector outperforms all peers and overall sector, energy workforce, and national averages regarding the percentage of workers that are represented by unions and/or collective bargaining agreements, and/or are subject to project labor agreements ("unionized"). Additionally, as shown below in Figure 39, the nuclear fuels subsector outperforms all but two subsector peers and meets or exceeds overall sector, energy workforce, and national averages for workforce unionization.

Figure 38. Average % Unionized Workforce by Electricity Subsector.



*Includes generation from incineration of "other fuels" *e.g.*, waste. Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

Figure 39. Average % Unionized Workforce by Fuels Subsector.



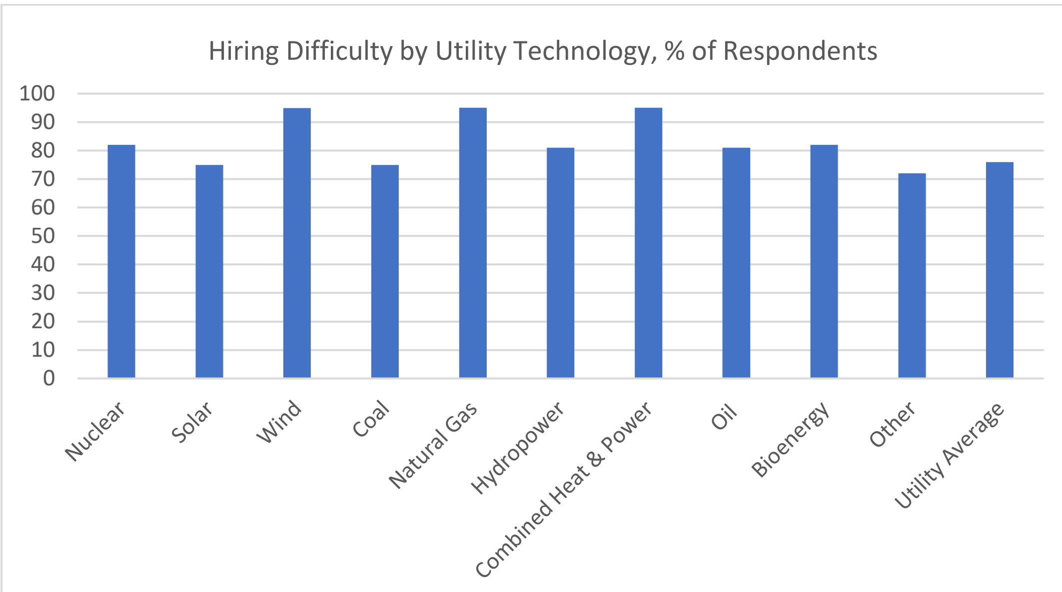
Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

[225] *See* "Unions Increase Job Satisfaction in the United States," by Benjamin Artz, David G. Blanchflower, and Alex Bryson, National Bureau of Economic Research, April 2020, *accessible at* https://www.nber.org/system/files/working_papers/w28717/w28717.pdf.

Within the U.S. nuclear power generation sector, the utilities industry accounts for the largest share of workers. As shown in Figure 40 below, the nuclear utility sector experiences less hiring difficulty than several other utility sectors, and greater hiring difficulty than others.

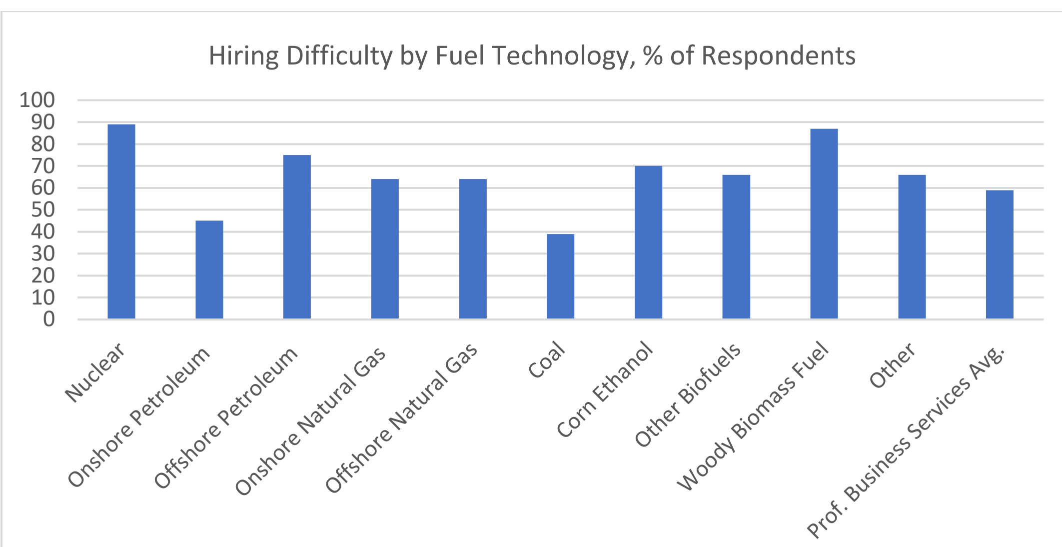
Additionally, within the U.S. nuclear fuel sector, professional business services contribute the biggest share of employment. As illustrated below in Figure 41, the nuclear fuel professional services industry experiences greater hiring difficulty than all other assessed fuel-related professional services industries other than offshore petroleum, as well as the fuel-related professional services average overall.

Figure 40. Hiring Difficulty by Utility Technology.



Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022, *accessible at* https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf

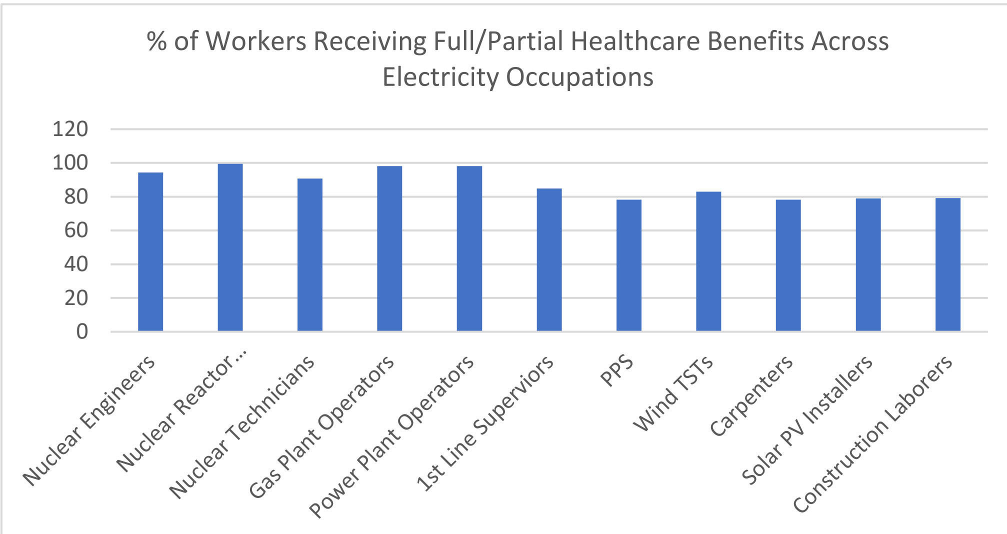
Figure 41. Hiring Difficulty by Fuel Technology.



Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022, *accessible at* https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf

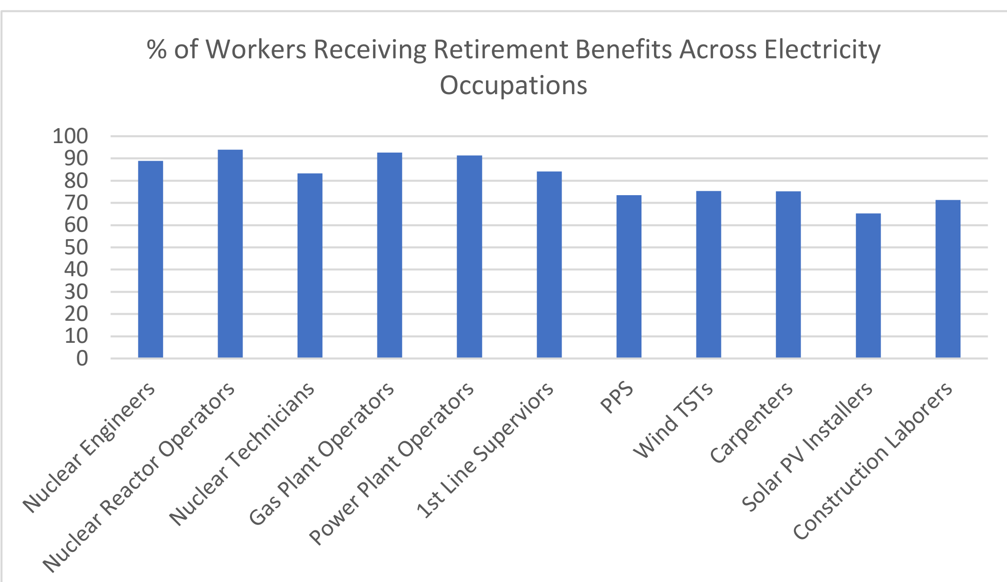
Also of note, as illustrated in Figures 42 and 43 below, when evaluating specific occupations within the U.S. electricity industry, nuclear-related occupations are shown to be competitive in terms of healthcare and retirement benefit coverage.

Figure 42. % of Workers Receiving Full/Partial Healthcare Benefits Across Electricity Occupations.



Source: Wages, Benefits, and Change: A Supplemental Report to the Annual U.S. Energy & Employment Report, by BW Research Partnership, The National Association of State Energy Officials, and The Energy Futures Initiative. 1st Line Supervisors = 1st Line Supervisors of Construction Trades and Extraction Workers, PPS = Plumbers, Pipefitters, Steamfitters, and Wind TSTs = Wind Turbine Service Technicians. https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/606d1178a0ee8f1a53e66206/1617760641036/Wage+Report.pdf.

Figure 43. % of Workers Receiving Retirements Benefits Across Electricity Occupations.



Source: Wages, Benefits, and Change: A Supplemental Report to the Annual U.S. Energy & Employment Report, by BW Research Partnership, The National Association of State Energy Officials, and The Energy Futures Initiative. 1st Line Supervisors = 1st Line Supervisors of Construction Trades and Extraction Workers, PPS = Plumbers, Pipefitters, Steamfitters, and Wind TSTs = Wind Turbine Service Technicians. https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/606d1178a0ee8f1a53e66206/1617760641036/Wage+Report.pdf.

The U.S. nuclear industry is taking a variety of steps to address future workforce needs. Initiatives include internships, recruitment at universities, employee training and development programs, employee engagement surveys, paid leave and tuition reimbursement policies, health and wellness programs, and participation in collective bargaining.[226]

In addition to private sector programs, the U.S. government in April 2022 underscored its commitment to supporting an effective domestic nuclear energy workforce by announcing the availability of over $5 million for nearly 90 scholarships and fellowships for students at 32 colleges and universities in 23 states who are pursuing degrees in nuclear energy and engineering.[227]

7. *Human Rights*

Companies are increasingly taking steps to ensure and formalize their recognition of basic rights and freedoms based on factors including respect, dignity, and equality. Examples of these efforts, many of which have long been practiced in the United States, include explicit prohibitions on harassment and discrimination toward employees, contractors, and people in surrounding communities, and the establishment of policies and/or training that provide instructions on how to report suspected violations in the workplace.

A survey of American adults conducted for the Workplace Bullying Institute in 2021 found that 49% of respondents had direct experience with (30%) or witnessed (19%) abusive conduct at work, with 48% saying that retaliation for filing a complaint (16%), management's history of responding to complaints (21%), and HR's response to complaints (11%) contribute to a toxic and abusive workplace. Only 37% of respondents said that employers take positive steps like acknowledging it (13%), eliminating it (11%), or condemning it (13%).[228]

According to a Gallup survey conducted in 2020, 18% of U.S. employees say they have felt discriminated against at work, including 24% of Black employees, 24% of Hispanic employees, and 15% of White employees. Of those who felt discriminated against, 52% said they felt discriminated against because of their race and/or ethnicity, including 75% of Black employees, 61% of Hispanic employees, and 42% of White employees.[229]

In addition to compliance with legal requirements and societal norms, human rights abuses can affect worker productivity and a company's bottom line, including through staff turnover and reputational

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[226] *See e.g.* 2022 Sustainability Report, Constellation Energy, *accessible at* https://www.constellationenergy.com/content/dam/constellationenergy/pdfs/Constellation-2022-Sustainability-Report.pdf; Duke Energy Corporation 2021 ESG Report, *accessible at* https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/esg/2021-esg-report-full.pdf?la=en&rev=19532a880c3a47ee868fb43cb087c369; Careers, Tennessee Valley Authority, *accessible at* https://www.tva.com/careers; Attracting Talent and Developing & Retaining Talent, Dominion Energy, *accessible at* https://sustainability.dominionenergy.com/attracting-talent/ and https://sustainability.dominionenergy.com/developing-retaining-talent/; Connect With Your Future, Westinghouse, *accessible at* https://www.westinghousenuclear.com/careers/students-new-graduates; and Internships and Employee Benefits, NuScale Power, *accessible at* https://www.nuscalepower.com/careers/internships and https://www.nuscalepower.com/careers/benefits.

[227] *See* "U.S. Department of Energy Awards $5 Million to Future Nuclear Scientists and Engineers," U.S. Department of Energy, Office of Nuclear Energy, April 12, 2022, *accessible at* https://www.energy.gov/ne/articles/us-department-energy-awards-5-million-future-nuclear-scientists-and-engineers.

[228] *See* U.S. Workplace Bullying Survey, 2021, Workplace Bullying Institute, *accessible at* https://workplacebullying.org/wp-content/uploads/2021/04/2021-Full-Report.pdf.

[229] *See* One in Four Black Voters Report Discrimination at Work, by Camille Lloyd, Gallup, January 12, 2021, *accessible at* https://news.gallup.com/poll/328394/one-four-black-workers-report-discrimination-work.aspx.

harm.[230] As a result, human rights-related metrics such as those highlighted below in Figure 44 have become widely prevalent in ESG reporting in recent years.

Figure 44. Example Human Rights-related Example ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Incidents of discrimination and corrective actions taken	GRI 406-1
Operations and suppliers in which the right to freedom of association or collective bargaining may be violated or at significant risk and measures taken to support rights to exercise freedom of association and collective bargaining	GRI 407-1
Operations and suppliers at significant risk for incidents of child labor and measures taken to effectively abolish it	GRI 408-1
Operations and suppliers at significant risk for incidents of forced or compulsory labor	GRI 409-1
Security personnel trained in human rights policies or procedures, and applicability to 3rd party security providers	GRI 410-1
Incidents of violations involving rights of indigenous peoples	GRI 411-1
Gender Equality	SDG 5
Decent Work and Economic Growth	SDG 8
Reduced Inequalities	SDG 10
Sustainable Cities and Communities	SDG 11
Responsible Consumption and Production	SDG 12
Peace, Justice, and Strong Institutions	SDG 16

Industry Performance

Mining associated with the nuclear industry has generated some criticism and opposition by indigenous groups, as evidenced by a recent complaint filed by Eastern Navajo Diné Against Uranium Mining filed with the Inter-American Commission on Human Rights. In the filing, the group alleged that the U.S. government violated their human rights by issuing licenses for uranium mines.[231]

Initiatives by companies in the U.S. nuclear industry to mitigate the risk of human rights abuses in the workplace include mandatory annual training that addresses areas including workplace conduct and harassment prevention, whistleblower protections such as anti-retaliation policies, 24-hour phone and online helplines with options for anonymous reporting, human rights policies, duties to report, and formal guidance on human rights and employment practices through codes of ethics.[232]

[230] *See e.g.,* Workplace Sexual Harassment: Experts Suggest Expanding Data Collection to Improve Understanding of Prevalence and Costs, U.S. Government Accountability Office, September 2020, *accessible at* https://www.gao.gov/assets/gao-20-564.pdf.

[231] *See* "'Ignored for 70 Years': Human Rights Group to Investigate Uranium Contamination on Navajo Nation," by Cody Nelson, The Guardian, October 27, 2021, *accessible at* https://www.theguardian.com/environment/2021/oct/27/human-rights-group-uranium-contamination-navajo-nation.

[232] *See e.g.,* 2021 ESG Report, Duke Energy Corporation, *accessible at* https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/esg/2021-esg-report-full.pdf?la=en&rev=19532a880c3a47ee868fb43cb087c369; 2020 Sustainability and Corporate Responsibility Report, Dominion Energy, *accessible at* https://sustainability.dominionenergy.com/assets/pdf/2020-Sustainability-Report.pdf; Global Ethics Code, Westinghouse, October 2021, *accessible at* https://www.westinghousenuclear.com/Portals/0/about-2020/ethics/26909_Global_Ethics_Code_Book-English2021_Final.pdf?ver=1YFF4OPb1jXFaTQrE0dBxQ%3d%3d; and Code of Business Ethics Program, NuScale Power, *accessible at* https://s29.q4cdn.com/251742275/files/doc_downloads/gov-docs/code-of-business-ethics.pdf.

With regard to freedom of association and collective bargaining, as discussed elsewhere in this report, the nuclear power generation subsector outperforms all peers and overall sector, energy workforce, and national averages regarding the percentage of workers that are represented by unions and/or collective bargaining agreements, and/or are subject to project labor agreements ("unionized"). Additionally, as discussed elsewhere in this report, the nuclear fuels subsector outperforms all but two subsector peers and meets or exceeds overall sector, energy workforce, and national averages for workforce unionization.

Although prohibited by U.S. law, the provision of goods and services from other countries to companies operating inside the United States can increase the risk that child labor and/or forced labor have been involved in the supply chain. Recent headlines have highlighted how these dynamics can impact the U.S. energy sector and underscore the need for companies to exercise significant diligence in selecting suppliers and business partners.[233]

Efforts by U.S. companies in the nuclear energy sector to uphold human rights throughout the entire supply chain include Supplier Codes of Conduct that address labor and employment practices and standards for suppliers, contractors, and agents, and specific requests of suppliers for evidence that products were not developed in regions using forced labor.[234]

8. *Diversity & Inclusion*

Diversity and inclusion has emerged as a key component of both corporate and ESG performance. One assessment of more than 1,000 companies around the world found that companies in the top 25% for gender and ethnic diversity were 12% more likely to outperform the other companies evaluated in terms of profitability, while those in the bottom 25% for gender and ethnic diversity were 27% more likely to underperform. Additionally, the assessment found that companies with boards in the top 25% for gender diversity were 28% more likely to financially outperform their peers, while companies in the top 25% for executive team gender diversity were 25% more likely to outperform.[235]

Diversity and inclusion has also been shown to be an important factor for workforce retention and recruitment. For example, one recent study found that 68% of U.S. workers were prepared to consider a new job if their current employer lacked a diversity and inclusion policy, with 70% saying the same if

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[233] *See e.g.,* "U.S. Blocks Some Solar Materials Made in Xinjiang Region," Bloomberg, June 23, 2021, *accessible at* https://www.bloomberg.com/news/articles/2021-06-23/u-s-to-block-some-solar-goods-made-in-china-s-xinjiang-region?leadSource=uverify%20wall; and China's Electric Vehicle Battery Supply Chain Shows Signs of Forced Labor, Report Says," CNBC, June 21, 2022, *accessible at* https://www.cnbc.com/2022/06/22/signs-of-forced-labor-found-in-chinas-ev-battery-supply-chain-report.html.

[234] *See e.g.,* Duke Energy Human Rights Policy, *accessible at* https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/190797-human-rights-policy.pdf?la=en&rev=a6d0a0211c3d41e4b703c3c9df1ef8e4; 2021 ESG Report, Duke Energy Corporation, *accessible at* https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/esg/2021-esg-report-full.pdf?la=en&rev=19532a880c3a47ee868fb43cb087c369; 2020 Sustainability and Corporate Responsibility Report, Dominion Energy, *accessible at* https://sustainability.dominionenergy.com/assets/pdf/2020-Sustainability-Report.pdf; Supplier Code of Conduct, Westinghouse, *accessible at* https://www.westinghousenuclear.com/Portals/0/about/mission%20vision%20values/WEC_SupplierCodeofConduct_Book-English_FIN.pdf?ver=2019-11-04-155047-297; and Supplier Code of Conduct, Constellation Energy, *accessible at* https://www.constellationenergy.com/content/dam/constellationenergy/pdfs/Supplier-Code-of-Conduct-2022.pdf.

[235] *See* "Diversity wins: How inclusion matters," by McKinsey & Company, May 2020, *accessible at* https://www.mckinsey.com/~/media/mckinsey/featured%20insights/diversity%20and%20inclusion/diversity%20wins%20how%20inclusion%20matters/diversity-wins-how-inclusion-matters-vf.pdf?shouldIndex=false.

their company had an unfair gender pay gap.[236] Another survey found that 47% of millennials say that diversity and inclusion would be an important factor in a job search.[237]

Underscoring diversity and inclusion trends from an ESG perspective, the UN Principles for Responsible Investment, which currently has over 3,800 signatories with over $121 trillion in assets under management, has identified diversity, equity, and inclusion as a priority ESG issue.[238]

As referenced in Figure 45 below, elements of diversity and inclusion including workforce , executive management, and Board composition as well as pay equity are important elements of ESG reporting frameworks as well as the UN Sustainable Development Goals.

Figure 45. Example Diversity & Inclusion-related ESG Metrics of Relevance.

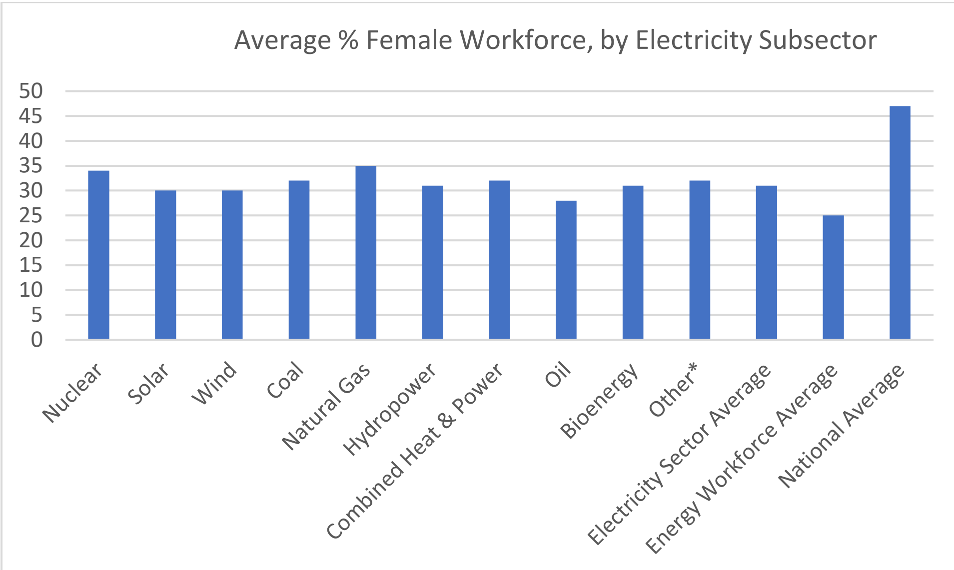
Example ESG Metrics of Relevance	Source
Workforce composition data, with discussion of workforce composition, including for governance bodies and as percentage of employees per employee category (by gender, age group, and other indicators where relevant e.g., minority or vulnerable groups)	GRI 405-1
Ratio of basic salary and remuneration of women to men for each employee category, by significant locations of operation	GRI 405-2
Proportion of women in managerial positions	SDG 5 (Gender Equality)
Average hourly earnings of female and male employees, by occupation, age and persons with disabilities	SDG 8 (Decent Work and Economic Growth)

Industry Performance

The U.S. nuclear industry has shown itself to be a strong performer within the domestic power generation and fuels sectors with regard to workforce diversity characteristics tied to gender, race, and age, outperforming the energy workforce overall and most peer subsectors as illustrated in Figures 46-51 below. At the same time, the results also highlight areas for improvement such as gender diversity, where nuclear and all other electricity and fuels subsectors currently trail the national average.

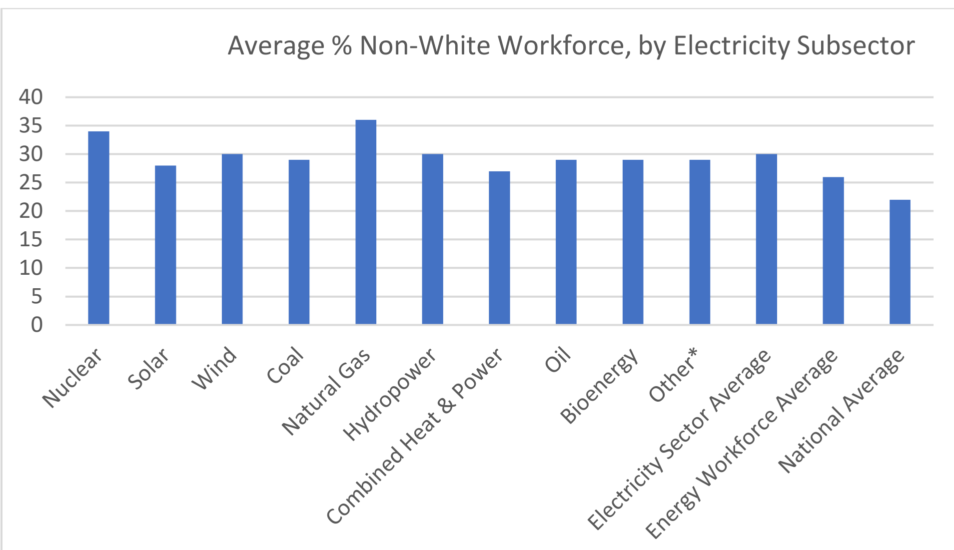
[236] *See* "People at Work 2022: A Global Workforce View," ADP Research Institute, by Nela Richardson, Ph.D. and Marie Antonello, *accessible at* https://www.adpri.org/wp-content/uploads/2022/04/PaW_Global_2022_GLB_US-310322_MA.pdf.
[237] *See* "Millennials at Work: Perspectives on Diversity & Inclusion, Weber Shandwick, June 12, 2016, *accessible at* https://www.webershandwick.com/news/millennials-at-work-perspectives-on-diversity-inclusion/.
[238] *See* Annual Report 2021, Principles for Responsible Investment, *accessible at* https://dwtyzx6upklss.cloudfront.net/Uploads/s/u/b/pri_annualreport_2021_15698.pdf. The Principles for Responsible Investment is an investor initiative in partnership with the UN Environment Programme Finance Initiative and UN Global Impact.

Figure 46. Average % Female Workforce, by Electricity Subsector.



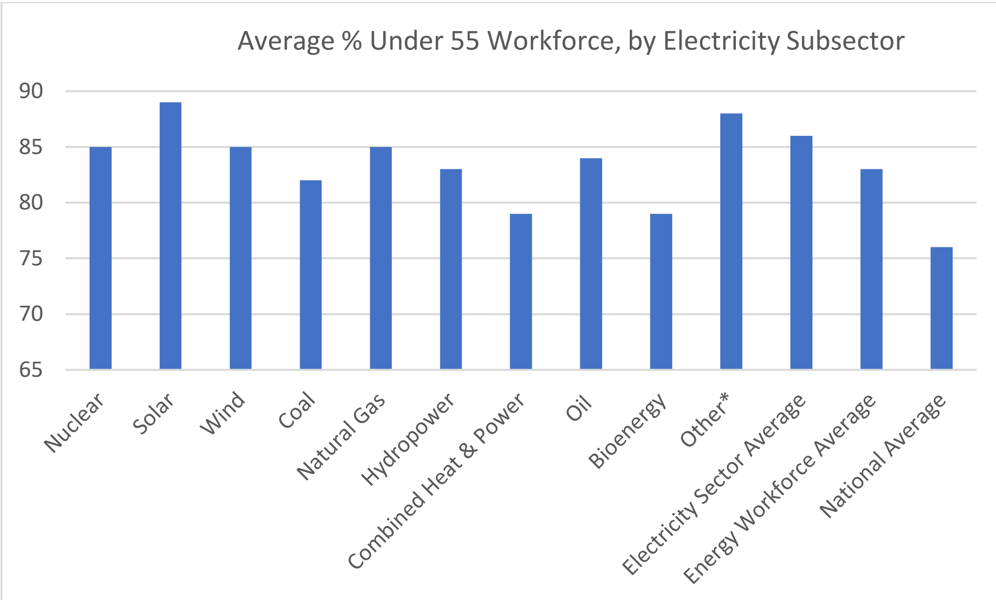
*Includes generation from incineration of "other fuels" *e.g.*, waste. Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

Figure 47. Average % Non-White Workforce by Electricity Subsector.



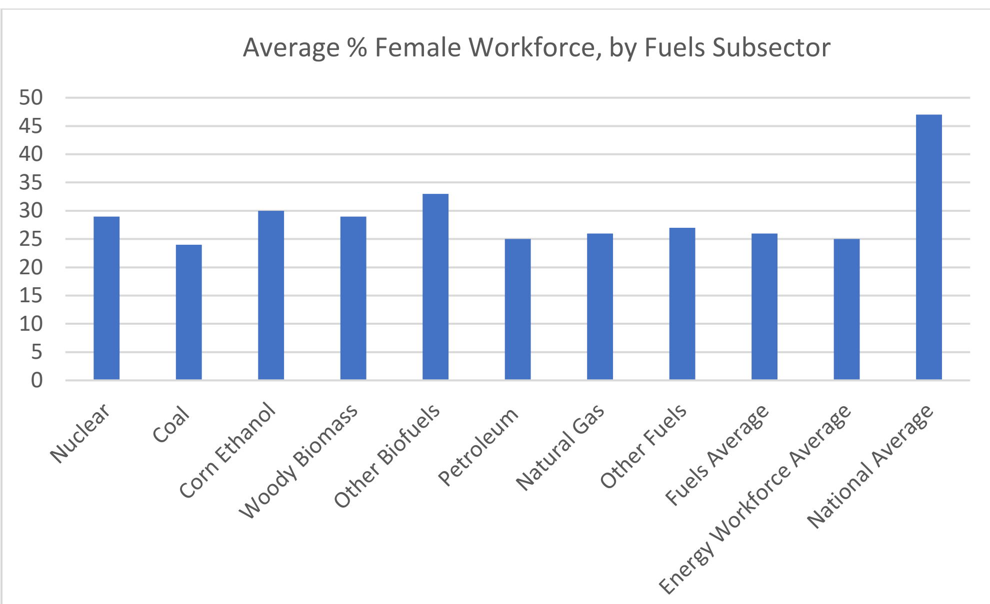
*Includes generation from incineration of "other fuels" *e.g.*, waste. Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

Figure 48. Average % Under 55 Workforce by Electricity Subsector.



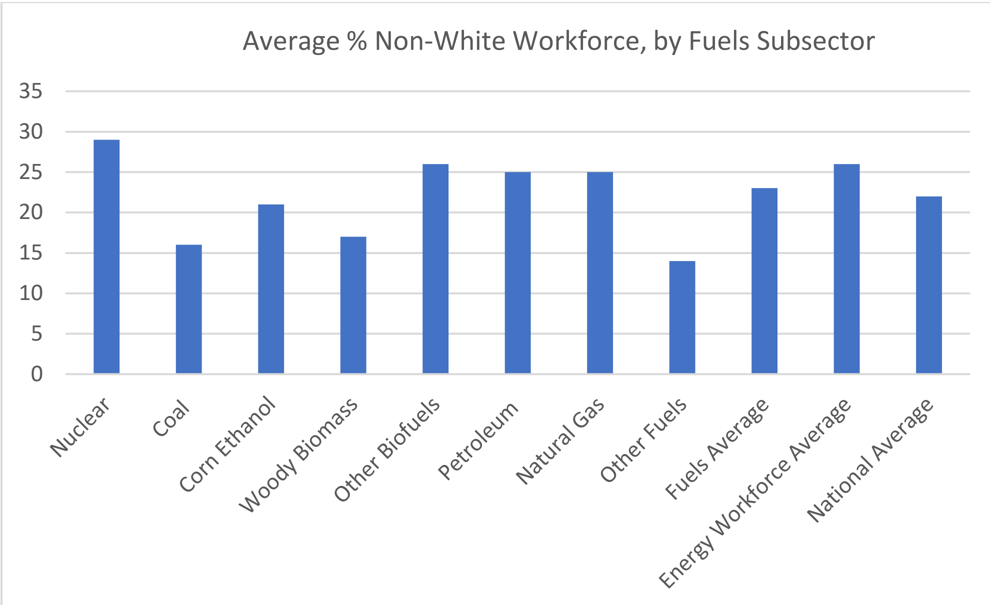
*Includes generation from incineration of "other fuels" *e.g.*, waste. Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

Figure 49. Average % Female Workforce by Fuels Subsector.



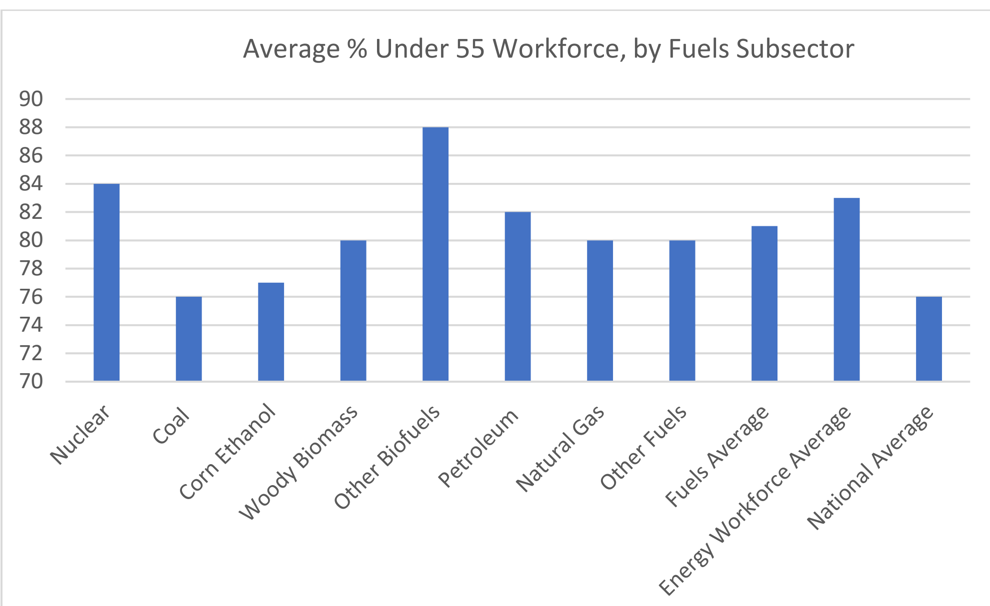
Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022.
https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

Figure 50. Average % Non-White Workforce by Fuels Subsector.



Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

Figure 51. Average % Under 55 Workforce by Fuels Subsector.



Source: United States Energy & Employment Report 2022, U.S. Department of Energy, June 2022. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

While the nuclear industry has made strides in diversity and inclusion, industry and company-level initiatives are underway to further improve its performance. For example, U.S. Women in Nuclear (WIN) established the Nuclear Executives of Tomorrow immersive leadership program to provide executive-level training to females positioned for career advancement, with ~60% of participants having received a promotion within 12 months of completing the program.[239] WIN's Professional Development Committee also launched the Growth, Relationships, and Opportunities through WIN (GROW) Mentoring Program in 2021 to help women in the nuclear energy and technology fields achieve career and personal goals, with 18 women participating in the program's first year.[240]

Actions taken by individual companies within the U.S. nuclear sector include joining the Equal by 30 campaign and committing to equal pay, equal leadership, and equal opportunities for women in the clean energy industry, including commitments to increase the percent of women in corporate leadership and the workforce overall.[241]

Other efforts intended to foster diverse and inclusive organizations within the nuclear sector include the creation of D&I-focused management positions and cross-functional councils, Employee Resource Groups, inclusive talent recruitment and retention strategies, and actions to instill a more inclusive culture within the organization, including through training.[242]

9. ***Community Relations & Social Investment***

Companies may be involved in projects in a region that can have a wide range of community impacts. Since community rights and interests may be affected, support is frequently needed from local communities to ensure that strong, positive relationships prevail and company objectives are achieved throughout a project's entire lifecycle.

In addition, developing a strong commitment to the communities in which companies operate and where employees live and work through social investments can be critical to sustainable operations. Activities such as volunteering, corporate matching gifts, and charitable spend strategies can help demonstrate that commitment while achieving important societal objectives in local communities.

According to a recent study, corporate giving to U.S. charities rose ~24% to reach over $21 billion in 2021, including through cash and in-kind contributions as well as grants and gifts by company foundations.[243]

Another report evaluating corporate giving trends of 230 companies found that median total community investments was $27.5 million in 2020, with 22% of employees on average participating in a matching gift program in 2020. Additionally, amid effects of the pandemic, the average employee volunteer participation rate in 2020 was 17%, down considerably from the typical ~30% rate, and the median

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[239] *See* Nuclear Executives of Tomorrow, U.S. Women in Nuclear, *accessible at* https://www.winus.org/about-us/next/.
[240] *See* GROW Mentoring Program, U.S. Women in Nuclear, *accessible at* https://www.winus.org/about-us/mentoring-program/.
[241] *See e.g.,* Equal by 30, *accessible at* https://www.equalby30.org/en; Building a Strong, Equitable Workforce, Equal by 30, NuScale Power, *accessible at* https://www.nuscalepower.com/newsletter/nucleus-winter-2019/building-a-strong-equitable-workforce; and "Westinghouse Joins Equal by 30 Campaign," Mar. 31, 2022, *accessible at* https://info.westinghousenuclear.com/news/westinghouse-joins-equal-by-30.
[242] *See e.g.*, FY 2021 Diversity, Equity, Inclusion and Accessibility Report, Tennessee Valley Authority, *accessible at* https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/careers/diversity-inclusion/diversity-equity-inclusion-accessibility-report-fy-2021.pdf?sfvrsn=33eaea35_9; Inclusion makes us stronger, Duke Energy, *accessible at* https://www.duke-energy.com/our-company/about-us/diversity; Diversity, Equity & Inclusion (DE&I), Dominion Energy, *accessible at* https://www.dominionenergy.com/our-company/employee-experience/diversity-and-inclusion.
[243] *See* "Giving USA: Total U.S. charitable giving remained strong in 2021, reaching $484.85 billion," Lilly School of Philanthropy, Indiana University, *accessible at* https://philanthropy.iupui.edu/news-events/news-item/giving-usa:--total-u.s.-charitable-giving-remained-strong-in-2021,-reaching-$484.85-billion.html?id=392 (citing data from "Giving USA 2022: The Annual Report on Philanthropy for the Year 2021).

volunteered hour per employee rate fell 50% between 2018 and 2020. Notably, virtual volunteering opportunities rose from 38% of companies in 2018 to 87% in 2020.[244]

Demonstrating the varied beneficial outcomes that result from corporate giving, a recent survey found that corporate social investment programs increase employee engagement and workforce development, with 55% of companies citing employee engagement as the most important employee benefit, and ~20% saying that it leads to better potential job candidates.[245] Other research found that corporate volunteer programs were effective tools for professional growth and leadership development, with 92% of respondents in one survey saying that volunteering improves professional skill sets and improves leadership skills.[246]

Examples of ESG metrics related to community relations and social investment are highlighted in Figure 52 below.

Figure 52. Example Community Relations & Social Investment-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Operations with local community engagement, impact assessments, local community development programs, and consultation committees, councils, and processes	GRI 413-1
Operations with significant actual and potential negative impacts on local communities	GRI 413-2
Direct economic value generated and distributed, including community investments	GRI 201-1
No Poverty	SDG 1
Zero Hunger	SDG 2
Quality Education	SDG 4
Sustainable Cities and Communities	SDG 11

Industry Performance

Community relations are particularly significant for companies seeking to develop energy projects. A recent paper examining opposition to U.S. renewable energy projects found "substantial barriers" to moving forward and the need to "pay closer attention to the full range of socially-oriented sources of opposition to new facilities." The study identified 53-utility scale U.S. wind, solar, and geothermal energy projects representing ~10,000 megawatts of potential generating capacity that were opposed and delayed or blocked over the 2008-2021 timeframe, finding that 34% of the projects had significant delays and permitting difficulties, 49% were canceled, and 26% resumed following stoppages lasting months or years.[247]

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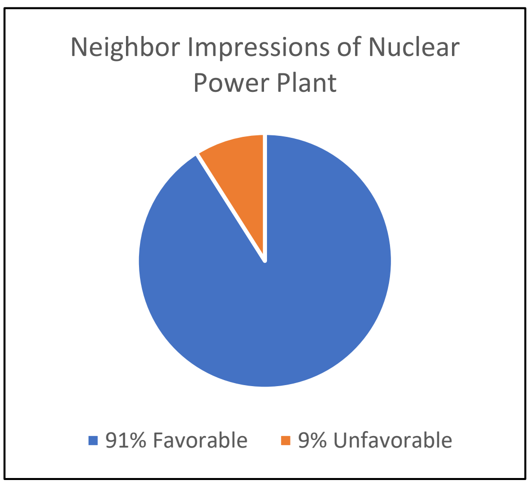
[244] *See* "Giving In Numbers," 2021 Edition, Chief Executives for Corporate Purpose, *accessible at* https://cecp.co/wp-content/uploads/2021/10/GIN2021-FINAL-WEB.pdf?redirect=no.
[245] *See* "Giving In Numbers," 2021 Edition, Chief Executives for Corporate Purpose, *accessible at* https://cecp.co/wp-content/uploads/2021/10/GIN2021-FINAL-WEB.pdf?redirect=no.
[246] *See* 2016 Deloitte Impact Survey, "Building leadership skills through volunteerism," *accessible at* https://www2.deloitte.com/content/dam/Deloitte/us/Documents/us-deloitte-impact-survey.pdf.
[247] *See* Sources of Opposition to Renewable Energy Projects in the United States, Energy Policy, Volume 165, 2022, 112922, ISSN 0301-4215, by Lawrence Susskind, Jungwoo Chun, Alexander Gant, Chelsea Hodgkins, Jessica Cohen, Sarah Lohmar, https://doi.org/10.1016/j.enpol.2022.112922; *accessible at* https://www.sciencedirect.com/science/article/pii/S0301421522001471.

The International Atomic Energy Agency (IAEA) has noted the importance of effective engagement and communication with stakeholders, noting that "[i]nvolving a wide range of interested parties in the decision-making on nuclear power programmes can enhance public awareness, understanding and confidence."

IAEA further acknowledged that effective communication with stakeholders is often cited as "one of the biggest challenges when initiating a nuclear power programme or undertaking related activities," stating that increased awareness and understanding among various constituencies including local communities "is essential to build mutual trust related to nuclear science and technology."[248]

U.S. nuclear industry efforts to enhance community relations and mitigate community risks include community outreach programs and environmental monitoring and management systems, and studies suggest that these initiatives have generated positive results in terms of community acceptance.[249]

For example, recent research of 910 full-time residents living within 10 miles of nearly all U.S. nuclear power plants reflect a positive view of the plants and the nuclear industry generally. Specifically, 91% of nuclear plant neighbors said they have a favorable impression of the plant, with 88% holding a favorable view of nuclear energy, and vast majorities accepting of a license renewal for the plant (95%), placement of a new reactor (78%) or Small Modular Reactor (86%) at the site, and construction of a new plant (74%).[250]



Additionally, vast majorities expressed agreement that the plant is a good neighbor to the community (88%), that the plant helps the economy (91%), and that there are good jobs for local people at the plant and in local businesses that provide services to the plant (92%).[251]

The survey also found that neighbors' favorability of nuclear energy grows stronger the more informed they become about it, with those not at all informed favoring nuclear by 55% and those who are very well-informed favoring it by 95%. With just 28% saying they are very well informed, the findings suggest the potential for further upward movement in neighbors' positive viewpoints toward nuclear energy.[252]

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[248] *See* "Social and ethical aspects of decision-making in radiological risk situations," RICOMET 2017, *accessible at* https://www.researchgate.net/profile/Liudmila-Liutsko/publication/318345925_Liutsko_L_Ohba_T_Tanigawa_K_Cardis_E_June_2017_Individual_and_historico-societal_factors_influencing_decision-making_processes_related_to_RP_behavior_in_post-accidental_period_RICOMET_Austria_Wien_pos/links/5964cc5f0f7e9bfb63cb9a14/Liutsko-L-Ohba-T-Tanigawa-K-Cardis-E-June-2017-Individual-and-historico-societal-factors-influencing-decision-making-processes-related-to-RP-behavior-in-post-accidental-period-RICOMET-Austria-W.pdf.

[249] *See e.g.,* "The Economic Benefits of Texas' Nuclear Power Plants," Nuclear Energy Institute, December 2015, *accessible at* https://www.nei.org/CorporateSite/media/filefolder/resources/reports-and-briefs/economic-benefits-texas-nuclear-plants-201512.pdf, "Economic Impacts of the Cooper Nuclear Station," Nuclear Energy Institute, February 2018, *accessible at* https://www.nei.org/CorporateSite/media/filefolder/resources/reports-and-briefs/economic-impacts-cooper-nuclear-station-201802.pdf, "Economic Impacts of the Columbia Generating Station," Nuclear Energy Institute, January 2018, *accessible at* https://www.energy-northwest.com/energyprojects/Columbia/Documents/NEI_EconomicImpacts-ColumbiaGeneratingStation-010918.pdf

[250] *See* "Reverse NIMBY: Nuclear Power Plant Neighbors Say "Yes.," by Ann S. Bisconti, PhD, Bisconti Research, Inc., June 2022, *accessible at* https://www.bisconti.com/blog/9th-national-survey-of-nuclear-power-plant-neighbors.

[251] *See id*.

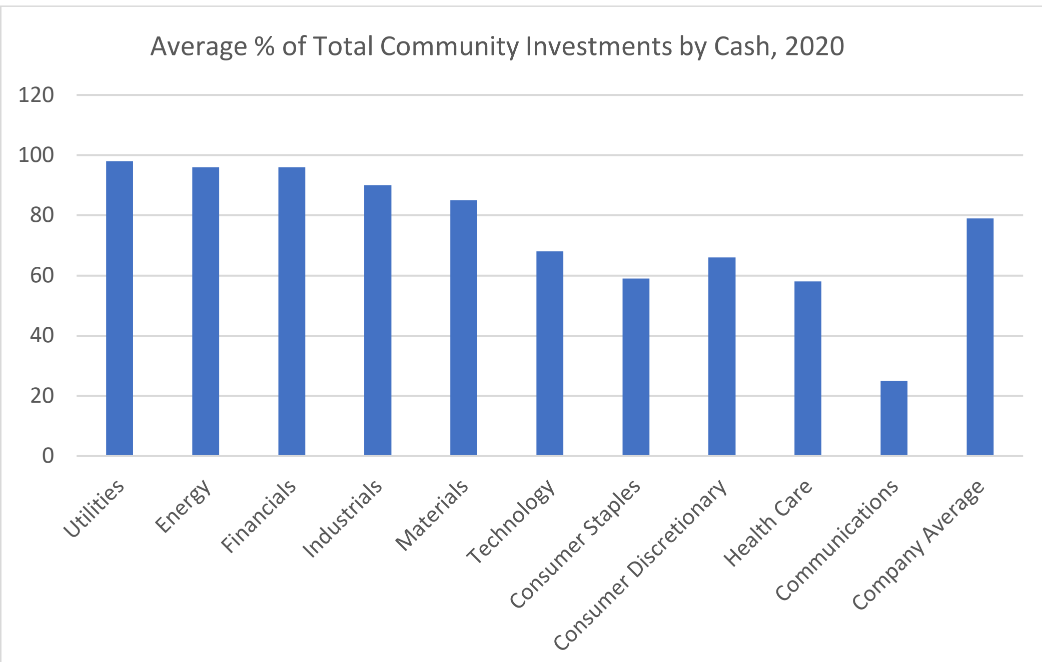
[252] *See id*.

Corporate giving initiatives are an important component of community relations, and recent research on U.S. social investment trends illustrates related activity undertaken by the domestic utility industry, including several nuclear power generators.

The findings show that the utility industry exceeds its peers and the overall average regarding the percent of total community investments made through cash contributions. Additionally, health and social services was the top program area for the sampled utility companies, with community and economic development and disaster relief rounding out the top three areas of giving.

As to matching gifts, the utility industry was found to provide an average of 2.3 matching gift programs, in line with the overall average while trailing the energy and health care sectors. In 2020, the sampled utilities were found to have provided median matching gifts of $960,000.[253] The results are highlighted in Figures 53 through 56 below.

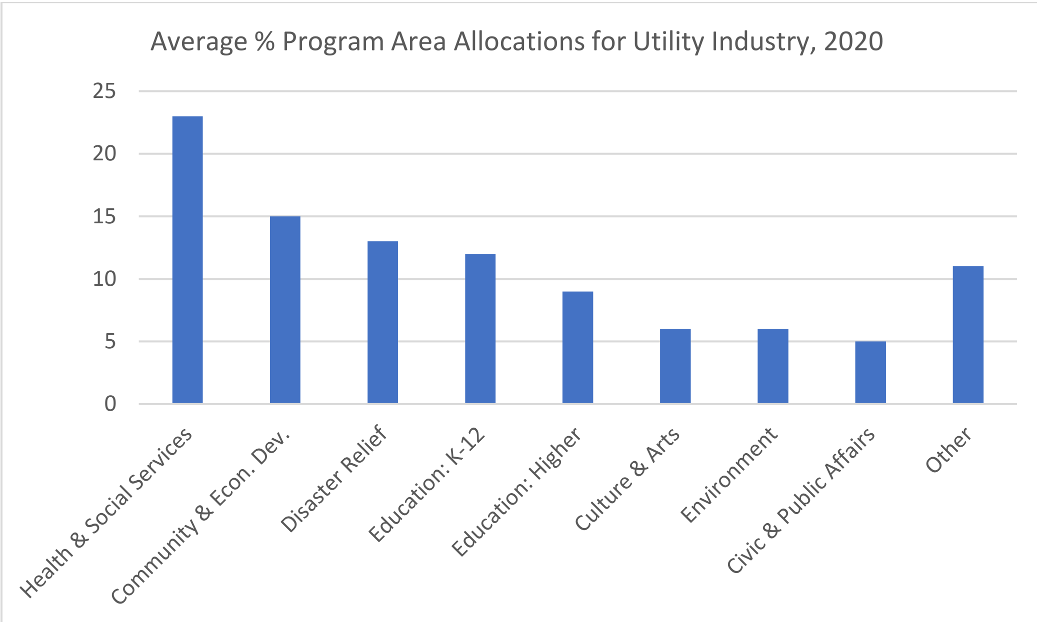
Figure 53. Average % of Total Community Investments by Cash.



Utilities sampled include nuclear power generators. Source: "Giving In Numbers," 2021 Edition, Chief Executives for Corporate Purpose https://cecp.co/wp-content/uploads/2021/10/GIN2021-FINAL-WEB.pdf?redirect=no.

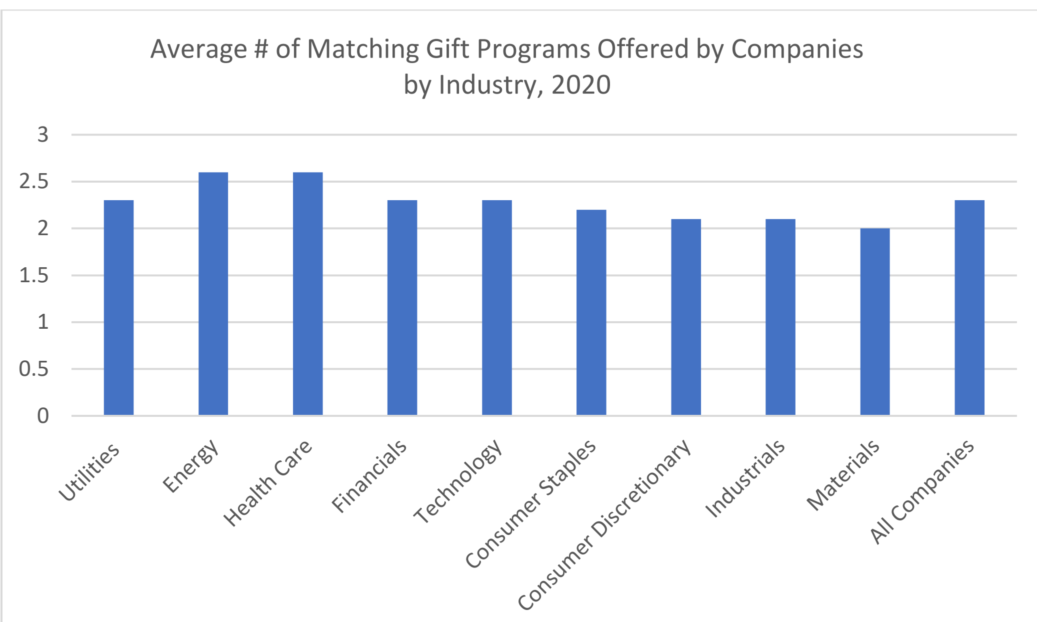
[253] *See* "Giving In Numbers," 2021 Edition, Chief Executives for Corporate Purpose, *accessible at* https://cecp.co/wp-content/uploads/2021/10/GIN2021-FINAL-WEB.pdf?redirect=no.

Figure 54. Average % Program Area Allocations for Utility Industry.



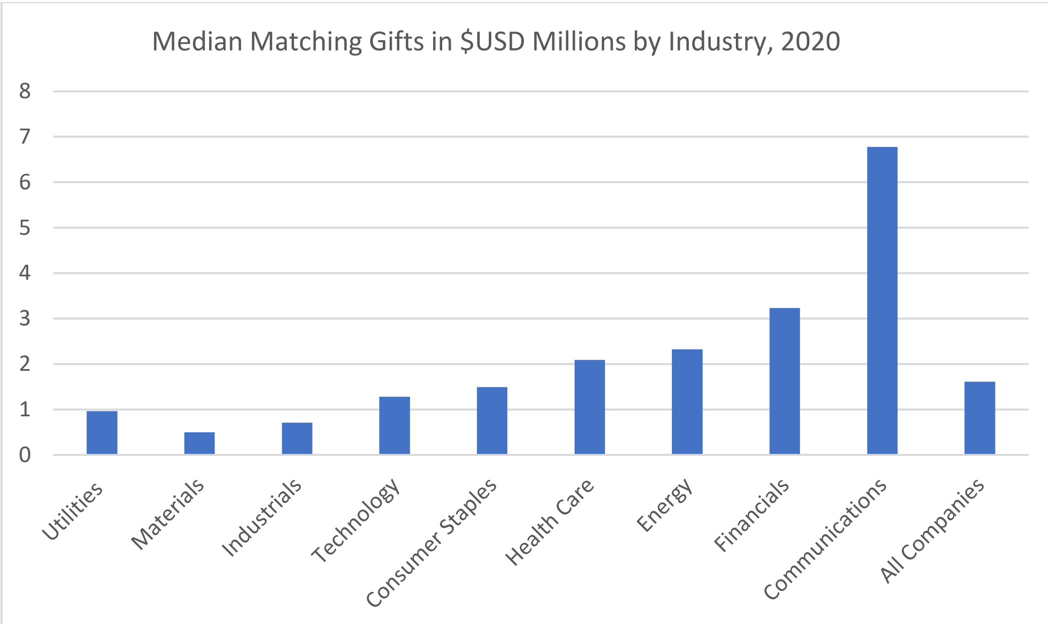
Utility industry sampled companies include nuclear power generators. Source: "Giving In Numbers," 2021 Edition, Chief Executives for Corporate Purpose. https://cecp.co/wp-content/uploads/2021/10/GIN2021-FINAL-WEB.pdf?redirect=no.

Figure 55. Average # of Matching Gift Programs Offered by Companies, by Industry.



Utility industry sampled companies include nuclear power generators. Source: "Giving In Numbers," 2021 Edition, Chief Executives for Corporate Purpose. https://cecp.co/wp-content/uploads/2021/10/GIN2021-FINAL-WEB.pdf?redirect=no.

Figure 56. Median Matching Gifts by Industry.



Utility industry sampled companies include nuclear power generators. Source: "Giving In Numbers," 2021 Edition, Chief Executives for Corporate Purpose. https://cecp.co/wp-content/uploads/2021/10/GIN2021-FINAL-WEB.pdf?redirect=no.

Within the U.S. nuclear industry, individual company efforts include employee donations to local non-profits and participation in initiatives such as United Way, March of Dimes, Nuclear Science Week, Kids Engineering Day, Day of Service, Community Pride Day, and Community Champions, among others.[254] In 2021, one leading generator contributed $10 million through philanthropic and employee donations, with employees volunteering 64,800 hours in their respective communities.[255]

Notably, recent research shows that those who live in the vicinity of nuclear power plants are aware of the community services that the plant's employees are engaging in, with 75% of respondents expressing awareness of those services.[256]

As with all ESG metrics, community relations and social investment performance within the nuclear industry is ultimately company-specific. However, existing research and reports illustrate the degree to which major components of the U.S. nuclear industry are effectively engaging local communities and mitigating related risks.

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[254] *See e.g.,* https://www.fpl.com/clean-energy/nuclear/economic-benefits.html; https://www.fpl.com/content/dam/fplgp/us/en/clean-energy/pdf/st-lucie-nuclear-operations.pdf; https://www.fpl.com/content/dam/fplgp/us/en/clean-energy/pdf/turkey-point-nuclear-operations.pdf; https://www.energy-northwest.com/whoweare/CommunityEngagement/Pages/default.aspx; https://tx.my.xcelenergy.com/s/community/volunteerism; https://www.stpnoc.com/community-information; https://www.constellationenergy.com/sustainability/community/community-champions.html; https://www.nexteraenergyresources.com/content/dam/neer/us/en/pdf/seabrook-infographic.pdf; https://nuclear.gepower.com/company-info/ge-in-the-community, and https://www.southernnuclear.com/about-us/community-partnership.html.

[255] *See* 2022 Constellation Sustainability Report, *accessible at* https://www.constellationenergy.com/content/dam/constellationenergy/pdfs/Constellation-2022-Sustainability-Report.pdf.

[256] *See* "Reverse NIMBY: Nuclear Power Plant Neighbors Say "Yes.," by Ann S. Bisconti, PhD, Bisconti Research, Inc., June 2022, *accessible at* https://www.bisconti.com/blog/9th-national-survey-of-nuclear-power-plant-neighbors.

C. Governance

1. *Risk Management & Opportunity Oversight*

Corporate governance plays a critical role in achieving and maintaining superior operational performance, with management of risk a key component of effective oversight.

In a 2021 EY survey of over 500 board members from around the world, 79% of respondents said that improved risk management will be critical to enabling their companies to protect and build value over the next five years. However, only 13% said their organization is highly effective at embedding risk and compliance activities. In the energy and resources sector, board respondents cited climate change and natural resource constraints and changes in the regulatory environment as the most significant risk to their organization.[257]

A separate EY survey of 305 chief executives of Forbes Global 2000 companies found similar sentiment about the importance of risk management from the CEO perspective, with risk management most cited as the area of the enterprise where respondents expect to make the most changes over the next three years.[258]

Example metrics related to risk and opportunity oversight are highlighted below in Figure 57.

Figure 57. Example Risk Management & Opportunity Oversight-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Governance structure and composition	GRI 2-9
Role of the highest governance body in overseeing the management of impacts	GRI 2-12
Delegation of responsibility for managing impacts	GRI 2-13
Statement on sustainable development strategy	GRI 2-22
Policy commitments	GRI 2-23
Embedding policy commitments	GRI 2-24
Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	SDG 3
Clean Water and Sanitation: Ensure availability and sustainable management of water and sanitation for all	SDG 6
Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable and modern energy for all	SDG 7
Decent Work and Economic Growth: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	SDG 8
Industry, Innovation and Infrastructure: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	SDG 9

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[257] *See* The Board Imperative: Is Now the Time to Reframe Risk as Opportunity?, EY Global Board Risk Survey 2021, Executive Summary, *accessible at* https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/board-matters/ey-global-board-risk-survey-executive-summary.pdf?download.

[258] *See* The CEO Imperative: How Has Adversity Become a Springboard to Growth?, by John de Yonge, Director Global Insights, Research Institute, Global Markets – EY Knowledge, March 8, 2021, *accessible at* https://www.ey.com/en_us/ceo/the-ceo-imperative-how-has-adversity-become-a-springboard-to-growth.

Reduced Inequalities: Reduce inequality within and among countries	SDG 10
Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable	SDG 11
Responsible Consumption and Production: Ensure sustainable consumption and production patterns	SDG 12
Climate Action: Take urgent action to combat climate change and its impact	SDG 13
Life Below Water: Conserve and sustainably use the oceans, sea and marine resources for sustainable development	SDG 14
Life on Land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	SDG 15
Peace, Justice and Strong Institutions: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	SDG 16
Partnerships for the Goals: Strengthen the means of implementation and revitalize the global partnership for sustainable development	SDG 17

Industry Performance

Risk and opportunity management and oversight is key for companies across the U.S. energy sector, and the nuclear industry is no exception. Companies with nuclear power operations undertake rigorous steps to manage risk and leverage opportunities, including through internal governance processes designed to ensure compliance with regulatory requirements and best practices and maintain optimal performance.

As one example, following the 2011 earthquake and tsunami at the Fukushima Dai-ichi nuclear plant, the NRC conducted a comprehensive review of existing regulations and processes and implemented new requirements for nuclear power reactor license holders and applicants to mitigate beyond-design-basis events, including through (1) the use of installed equipment and resources to maintain or restore core cooling, containment, and spent fuel pool cooling; (2) provision of sufficient, portable, onsite equipment and consumables to maintain or restore such functions until they can be accomplished with resources brought onsite; and (3) obtaining sufficient offsite resources to sustain those functions indefinitely.[259]

The NRC subsequently adopted with clarifications an industry-developed Diverse and Flexible Coping Strategies (FLEX) Implementation Guide as an acceptable approach for compliance.[260] This process highlights how strong corporate governance within the U.S. nuclear industry has produced prompt and effective actions to manage and mitigate risk.

Within organizations, specific company measures include the following:

- Board risk and strategy oversight, including on ESG matters
- Independent members of Boards of Directors, including some with nuclear expertise

[259] See "Issuance of Order to Modify Licenses With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," EA-12-049, U.S. Nuclear Regulatory Commission, March 12, 2012, accessible at https://www.nrc.gov/docs/ML1205/ML12054A735.pdf.
[260] *See* "Compliance with Order EA-12-049, Order Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," JLD-ISG-2012-01, Interim Staff Guidance, Revision 0, Japan Lessons-Learned Project Directorate, U.S. Nuclear Regulatory Commission, August 29, 2012, *accessible at* https://www.nrc.gov/docs/ML1222/ML12229A174.pdf.

- Committees dedicated to governance, risk, nuclear operations, safety, strategic planning, and sustainability
- Enterprise risk management processes and environmental management systems
- Integration of sustainability into risk management frameworks
- Designation of chief sustainability officers and chief risk officers, and steering committees, councils, and work groups focused on sustainability
- Incentive compensation linked with ESG performance[261]

Additionally, companies with nuclear power operations engage externally to mitigate risk and pursue operational excellence. For example, the U.S.-based INPO was created in 1979 to promote excellence in nuclear power plant operational safety and reliability. INPO utilizes performance monitoring, evaluations, member support missions, peer reviews, and training program accreditation to support member companies, and serves as a conduit for timely information exchange.[262] In addition, the Chief Nuclear Officer position reports to the CEO, and CEOs of companies with nuclear power operations are held accountable for the results of the plant reviews.

Through representation by INPO, companies with operating U.S. commercial nuclear power plants are also members of the World Association of Nuclear Operators (WANO), a global organization established in 1989 to maximize nuclear plant safety and reliability through collaborative support, information exchange, and sharing of best practices.[263] Services and assistance to members in the United States is carried out by WANO's regional office in Atlanta, Georgia.[264]

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[261] *See e.g.,* Transforming For Our Future, 2022 Sustainability Report, Ameren, *accessible at* https://www.ameren.com/-/media/corporate-site/files/environment/reports/sustainability-report.ashx; 2022 Corporate Responsibility Report Overview, April 22, 2022, Pinnacle West Capital Corporation, *accessible at* https://s22.q4cdn.com/464697698/files/doc_downloads/2022/04/2022-Corporate-Responsibility-Report-Overview.pdf; 2022 Sustainability Report, Constellation Energy, *accessible at* https://www.constellationenergy.com/content/dam/constellationenergy/pdfs/Constellation-2022-Sustainability-Report.pdf; 2020 Sustainability and Corporate Responsibility Report, Dominion Energy, *accessible at* https://sustainability.dominionenergy.com/assets/pdf/2020-Sustainability-Report.pdf; Corporate Governance Committee Charter and Nuclear Review Committee Charter, DTE Energy, *accessible at* https://newlook.dteenergy.com/wps/wcm/connect/4baaae5c-d3be-4048-aaf3-94b6a3548e52/CorporateGovernanceCharter.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=4baaae5c-d3be-4048-aaf3-94b6a3548e52 and https://newlook.dteenergy.com/wps/wcm/connect/e9b75acc-b0fa-453a-8e33-34deab84750a/NuclearReviewCharter.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=e9b75acc-b0fa-453a-8e33-34deab84750a; 2021 ESG Report, Duke Energy Corporation, *accessible at* https://p-micro.duke-energy.com/esg/-/media/pdfs/our-company/esg/2021-esg-report-full.pdf; 2021 Integrated Report, The Future Is On, Entergy, *accessible at* https://integratedreport.entergy.com/; 2022 Corporate Sustainability Report, American Electric Power, *accessible at* http://www.aepsustainability.com/performance/report/docs/2022_AEP-Sustainability-Report.pdf; Our Board of Directors, Board Guidelines, Committees, Nebraska Public Power District, *accessible at* https://www.nppd.com/about-us/board-of-directors; 2022 Environmental, Social and Governance Report, NextEra Energy, *accessible at* https://www.nexteraenergy.com/content/dam/nee/us/en/pdf/2022_NEE_ESG_Report_Final.pdf; 2022 Corporate Sustainability Report, PG&E, *accessible at* https://www.pgecorp.com/corp_responsibility/reports/2022/assets/PGE_CSR_2022.pdf; ESG Performance Report, PSEG, December 2020, *accessible at* https://corporate.pseg.com/-/media/PSEG/Corporate/Documents/newsroom/2020/ESG-Performance-Report-Jan2021; 2019/2020 Corporate Responsibility Executive Summary, Southern Company, *accessible at* https://www.southerncompany.com/content/dam/southerncompany/pdfs/about/governance/reports/Southern_Company_2019-2020_Corporate_Responsibility_Executive_Summary.pdf; 2020 ESG Report, Talen Energy, *accessible at* https://2b8c7m21kpn72va5h73tnwgz-wpengine.netdna-ssl.com/wp-content/uploads/Talen-Energy-2020-ESG-Report.pdf; FY 2021 Sustainability Report, Tennessee Valley Authority, *accessible at* https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/tva-sustainability-report-fy2021a8f8ec86-6e31-4b28-a071-12a9c9498c19.pdf?sfvrsn=f59561f2_3; 2021 Sustainability Report, Evergy, *accessible at* https://greatplainsenergy.gcs-web.com/static-files/0420417a-eb13-401d-9018-6b155c83ca1d; 2021 Sustainability Report, Xcel Energy, *accessible at* https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Sustainability%20Report/2021%20SR/2021-Sustainability-Report-Full.pdf.

[262] *See* About, Institute of Nuclear Power Operations, *accessible at* https://inpo.info/#about.

[263] *See* Who Are Our Members?, World Association of Nuclear Operators, *accessible at* https://www.wano.info/members/who-are-our-members; Our Mission, World Association of Nuclear Operators, *accessible at* https://www.wano.info/about-us/our-mission; and Our History, World Association of Nuclear Operators, *accessible at* https://www.wano.info/about-us/our-history.

[264] *See* Atlanta Centre, World Association of Nuclear Operators, *accessible at* https://www.wano.info/centres/atlanta-centre.

WANO has issued nearly 30 principles and guidelines and more than 100 practices for improved plant performance and safety, conducts objective quadrennial peer reviews (with biennial follow-ups) of member companies, and provides industry learning and development opportunities though activities including workshops, seminars, training, and leadership curriculum.[265]

Additionally, members commit to the active participation of their chief executives in WANO governance, hosting and supporting peer reviews, timely action to correct performance issues identified during peer reviews, accepting assistance and improving performance where a plant, facility, or corporate organization has been recognized as needing more assistance, and providing operating experience and performance data and publishing reports on their website regarding any significant deviation from normal expected plant functioning.[266]

2. *Ethics & Transparency*

Company policies and management systems can support education, training, and awareness of ethical and transparent business practices. This includes, but is not limited to, prevention of corruption and bribery throughout the organization and in all outside engagements, as well as prevention of anti-competitive behavior that could result in collusion with potential competitors and thereby limit the effects of market competition.

The importance of a strong ethics and compliance program is underscored by the findings of a recent Ethics & Compliance Initiative survey of for-profit business employees working in the United States, which found that 21% reported experiencing strong ethical cultures, nearly double the 10% rate reported in 2000 but unchanged from the level reported in 2017. At the same time, 30% of respondents say they felt pressure to compromise workplace ethics standards, compared to just 16% in 2017 and 14% in 2000, while those who reported having observed misconduct rose from 47% of respondents in 2017 to 49% in 2020.[267]

The most commonly reported types of observed misconduct were favoritism toward certain employees, management lying to employees, conflicts of interest, improper hiring practices, abusive behavior, and health violations.

Although 86% of respondents said they reported at least one behavior they felt violated workplace ethics standards, reporting levels were significantly lower for the most common types of reported misconduct, including abusive behavior (60%) and favoritism toward certain employees (40%). Additionally, 79% reported having experienced retaliation after reporting wrongdoing, compared to 44% in 2017 and just 13% in 2007.

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[265] *See* Peer Review, World Association of Nuclear Operators, ***accessible at*** https://www.wano.info/services/peer-review; Performance Analysis, World Association of Nuclear Operators, ***accessible at*** https://www.wano.info/services/performance-analysis; Member Support, World Association of Nuclear Operators, ***accessible at*** https://www.wano.info/services/member-support; and Industry Learning and Development, World Association of Nuclear Operators, ***accessible at*** https://www.wano.info/services/training-development.

[266] *See* About WANO Membership, World Association of Nuclear Operators, ***accessible at*** https://www.wano.info/members/about-wano-membership; and Performance Analysis, World Association of Nuclear Operators, ***accessible at*** https://www.wano.info/services/performance-analysis;

[267] *See* The State of Ethics & Compliance in the Workplace: A Look at Global Trends, 2021 Global Business Ethics Survey Report, Ethics & Compliance Initiaitve, Ethics Research Center, ***accessible at*** *https://www.ethics.org/wp-content/uploads/2021-ECI-GBES-State-Ethics-Compliance-in-Workplace.pdf*.

Additionally, in its 2022 Anti-Bribery and Corruption Benchmarking Report, Kroll found that 48% of surveyed executives in the United States rated their anti-bribery and corruption programs as effective, and 54% felt that the compliance function would take on increased responsibilities in 2022.[268]

Examples of ESG metrics related to ethics and transparency are included below in Figure 58.

Figure 58. Example Ethics & Transparency-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
Operations assessed for risks related to corruption	GRI 205-1
Communication and training about anti-corruption policies and procedures	GRI 205-2
Confirmed incidents of corruption and actions taken	GRI 205-3
Legal actions for anti-competitive behavior, antitrust, and monopoly practices	GRI 206-1
Political contributions	GRI 415-1
Peace, Justice, and Strong Institutions: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	SDG 16

Industry Performance

In the U.S. nuclear energy sector, companies have enacted various programs and safeguards to minimize ethics-related risks and increase transparency. Specific efforts include the following:

- Formal ethics and compliance programs with Board and management oversight
- Codes of ethics for directors, employees, and suppliers that address areas including conflicts of interest, bribery, corruption, anti-competitive practices, trade controls and compliance, and money laundering
- Principles of conduct for nuclear power plant exports
- Annual ethics and compliance training
- Annual employee certifications of compliance obligations
- Due diligence reviews and reporting of political contribution and engagement activities
- Telephone and online ethics reporting and inquiry options (including through independent third parties)
- Prohibitions on retaliation
- Employee duties to report
- Annual compliance risk assessments
- Conflict mineral reviews
- Employee surveys on ethical culture perceptions[269]

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[268] *See* 2022 Anti-Bribery and Corruption Benchmarking Report, Kroll, June 6, 2022, *accessible at* https://www.kroll.com/en/insights/publications/compliance-risk/anti-bribery-and-corruption-report.

[269] *See e.g.,* 2021 ESG Report, Duke Energy Corporation, *accessible at* https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/esg/2021-esg-report-full.pdf?la=en&rev=19532a880c3a47ee868fb43cb087c369; 2022 Sustainability Report, Constellation Energy, *accessible at* https://www.constellationenergy.com/content/dam/constellationenergy/pdfs/Constellation-2022-Sustainability-Report.pdf; 2020 Sustainability and Corporate Responsibility Report, Dominion Energy, *accessible at* https://sustainability.dominionenergy.com/assets/pdf/2020-Sustainability-Report.pdf; FY 2021 Sustainability Report, Tennessee Valley Authority, *accessible at* https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/tva-sustainability-report-fy2021a8f8ec86-6e31-4b28-a071-12a9c9498c19.pdf?sfvrsn=f59561f2_3; Third Party Code of Conduct, NuScale Power, LLC, *accessible at* https://suppliers.nuscalepower.com/Pages/Code.aspx; and Ethics and Compliance, Westinghouse, *accessible at*

Although initiatives to promote a culture of ethics and transparency are in place, as highlighted in news headlines in recent years including a high-profile bribery case, as well as the Ethics & Compliance Initiative survey mentioned above, continued and enhanced vigilance is necessary both within the nuclear energy sector and across the broader U.S. economy.[270]

3. *Supplier Engagement*

To ensure that corporate sustainability goals are achieved throughout the lifecycle of a particular good or service, companies are increasingly engaging suppliers and contractors to facilitate alignment with policies and procedures covering areas including environmental, health and safety, emergency response, ethics, diversity and inclusion, and human rights, among others.

Through this process, which companies can undertake through both pre-engagement due diligence screening processes and reviews of existing relationships, companies can reduce the risk of reputational and societal harm that could arise from the behavior of those not under their direct management and control. Even so, one global survey conducted in early 2020 found that on average, 43% of third parties are not subject to due diligence reviews, with 60% of respondents saying they are not fully monitoring third parties for ongoing risks.[271]

Example ESG performance metrics related to supplier and contractor engagement are highlighted in Figure 59.

Figure 59. Example Supplier Engagement-related ESG Metrics of Relevance.

Example ESG Metrics of Relevance	Source
New suppliers that were screened using environmental data	GRI 308-1
Negative environmental impacts in the supply chain and actions	GRI 308-2
New suppliers that were screened using social criteria	GRI 414-1
Negative social impacts in the supply chain and actions taken	GRI 414-2
Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	SDG 3
Decent Work and Economic Growth: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	SDG 8
Reduced Inequalities: Reduce inequality within and among countries	SDG 10
Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable	SDG 11
Responsible Consumption and Production: Ensure sustainable consumption and production patterns	SDG 12

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https://www.westinghousenuclear.com/about/vision-and-values/ethics-and-compliance; and 2021 Sustainability Report, GE, *accessible at* https://www.ge.com/sites/default/files/ge2021_sustainability_report.pdf.

[270] *See e.g., "*FirstEnergy Fires CEO, VPs After 2 Plead Guilty in Nuclear Bailout Scandal," by Jennifer Edwards Baker, Fox 19 Now, October 30, 2020, *accessible at* https://www.fox19.com/2020/10/30/firstenergy-fires-ceo-vps-after-plead-guilty-nuclear-bailout-scandal/.

[271] *See* "The Real Risks: Hidden Threats Within Third-Party Relationships," Refinitiv, *accessible at* https://www.refinitiv.com/content/dam/marketing/en_us/documents/reports/hidden-threats-within-third-party-relationships-2020.pdf.

Peace, Justice, and Strong Institutions: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	SDG 16

Industry Performance

Due to factors including regulatory and permitting obstacles and domestic manufacturing constraints, many sectors within the U.S. energy industry, including technologies at the center of the energy transition, rely on supply chains that extend well beyond the nation's borders. As a result, and as noted in a recent U.S. government report, challenges include dependence on goods from countries with poor records on human rights, democracy, and safety.[272]

Companies operating in the U.S. nuclear industry have taken a series of steps to implement sustainability throughout the supply chain. While specific initiatives vary from company to company, actions to date include the following:

- Collaborative efforts to develop voluntary environmental-related standards for suppliers
- Procurement-stage and post-procurement environmental and sustainability reviews that include social impact assessments and evaluation of security and other risks
- Establishment of supplier codes of conduct and related training
- Supplier diversity programs
- Local supplier spending programs
- Contractor health and safety questionnaires
- Anti-discrimination contractual obligations
- Requests for manufacturer demonstrations that materials are not sourced from regions that use forced labor[273]

One area that is attracting extra focus amid geopolitical developments surrounding the Russia-Ukraine conflict is the U.S. nuclear industry's reliance on Russia for nuclear fuel supplies. One recent report noted that Russia today enriches over 40% of the world's uranium, and accounts for ~25% of the United States' nuclear fuel supply for electricity generation.[274]

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[272] *See* America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition, U.S. Department of Energy Response to Executive Order 14017, "America's Supply Chains," February 24, 2022, *accessible at* https://www.energy.gov/sites/default/files/2022-02/America%E2%80%99s%20Strategy%20to%20Secure%20the%20Supply%20Chain%20for%20a%20Robust%20Clean%20Energy%20Transition%20FINAL.docx_0.pdf.

[273] *See e.g.,* 2022 Sustainability Report, Constellation Energy, *accessible at* https://www.constellationenergy.com/content/dam/constellationenergy/pdfs/Constellation-2022-Sustainability-Report.pdf; Ethics and Compliance, Westinghouse, *accessible at* https://www.westinghousenuclear.com/about/vision-and-values/ethics-and-compliance; Supplier Diversity, GE Hitachi, *accessible at* https://nuclear.gepower.com/content/dam/gepower-nuclear/global/en_US/documents/suppliers/supplier-diversity-brochure-04_22-print-ready.pdf' Suppliers, TerraPower, *accessible at* https://www.terrapower.com/contact-us/suppliers/; 2020 Sustainability and Corporate Responsibility Report, Dominion Energy, *accessible at* https://sustainability.dominionenergy.com/assets/pdf/2020-Sustainability-Report.pdf; 2021 Sustainability Report, Xcel Energy, *accessible at* https://s25.q4cdn.com/680186029/files/doc_downloads/2022/06/2021-Sustainability-Report-Full.pdf; 2021 ESG Report, Duke Energy, *accessible at* https://s25.q4cdn.com/680186029/files/doc_downloads/2022/06/2021-Sustainability-Report-Full.pdf; FY 2021 Sustainability Report, Tennessee Valley Authority, *accessible* at https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/tva-sustainability-report-fy2021a8f8ec86-6e31-4b28-a071-12a9c9498c19.pdf?sfvrsn=f59561f2_3; and Suppliers, Southern Company, *accessible at* https://www.southerncompany.com/about/suppliers.html.

[274] *See* US Redoubles Efforts to End Dependence on Russian Nuclear Fuel," by Jonathan Tirone, Blomberg, September 29, 2022, *accessible at* https://www.bloomberg.com/news/articles/2022-09-29/us-redoubles-efforts-to-end-dependence-on-russian-nuclear-fuel#xj4y7vzkg.

To help address the issue, U.S. Secretary Jennifer Granholm in September 2022 said that the White House is prioritizing the United States' ability to domestically produce reactor-grade uranium, predicting congressional support and stating that "[w]e've got to make this happen for our own independence and national security." Under the initiative, Granholm said that the U.S. government would contract with domestic enrichment facilities to assist with creating the demand needed for production.[275]

Amid these developments and global geopolitical turmoil, such efforts have been welcomed by industry, with the Nuclear Energy Institute noting that the private sector and government "must work together to ensure the establishment of a secure, reliable fuel supply chain."[276]

Additionally, legislation signed into law in August 2022 provides $700 million to support the domestic development of high-assay low-enriched uranium, which the U.S. Department of Energy recognized would support the deployment of advanced nuclear reactors and reduce reliance on Russia for nuclear fuel.[277]

IV. Access to Climate Finance

A critical path for nuclear energy's recognition as an investible asset is its ability to access capital through climate finance.

The United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement all "call for financial assistance from the parties with more financial resources to those that are less endowed and more vulnerable," according to the UN. It recognizes that the contribution of countries to climate change, and their ability to prevent it and cope with its consequences, varies greatly. In other words, according to the UNFCCC, wealthier nations have a duty to assist developing countries "to mitigate climate change impacts and lead in mobilizing financial and technical capabilities."[278]

For these reasons, according to the UN, climate finance is needed for investment in projects that enable mitigation and adaptation to climate change. There is also a growing recognition that, due to the large capital expenditures needed for climate change-related projects, climate finance should be applied to projects beyond the emerging world. Climate finance is becoming a significant financing source in the developed world as well.

Climate finance refers to local, national, or transnational financing that can come from public or private sources or a combination thereof. It addresses the financing of large-scale investments in technologies and projects that result in GHG emissions reductions and is often focused on sectors with large GHG emissions. Climate finance is also used to finance adaptation, applying resources to societies and economies that allow them to adapt to the impacts of climate change. As this report demonstrates,

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[275] *See* US Redoubles Efforts to End Dependence on Russian Nuclear Fuel," by Jonathan Tirone, Blomberg, September 29, 2022, *accessible at* https://www.bloomberg.com/news/articles/2022-09-29/us-redoubles-efforts-to-end-dependence-on-russian-nuclear-fuel#xj4y7vzkg.
[276] *See* "Nuclear Energy Industry Committed to Secure Fuel Supply," Nuclear Energy Institute, June 16, 2022, *accessible at* https://www.nei.org/news/2022/nuclear-energy-industry-committed-to-fuel-supply.
[277] *See* Sec. 50173, P.L. 117-169, Inflation Reduction Act of 2022, *accessible at* https://www.congress.gov/117/bills/hr5376/BILLS-117hr5376enr.pdf; and Inflation Reduction Act Keeps Momentum Building for Nuclear Power, Office of Nuclear Energy, U.S. Department of Energy, September 8, 2022, *accessible at* https://www.energy.gov/ne/articles/inflation-reduction-act-keeps-momentum-building-nuclear-power.
[278] *See* Primer on Climate Financing: Mechanisms and Opportunities for Latin America and the Caribbean, ParlAmericas, *accessible at* https://www.parlamericas.org/uploads/documents/Primer_on_Climate_Financing_ENG.pdf.

nuclear energy projects can have a massive impact in reducing GHG emissions and should receive access to climate finance.

Climate Financing Instruments

In order to facilitate the principle of "common but differentiated responsibility" as addressed in Article 9 of the Paris Agreement,[279] the UNFCCC created the Financial Mechanism to determine climate change policies, program priorities, and eligibility for funding of projects.[280]

There are a number of climate financing mechanisms. Traditionally climate finance has been provided through public sources such as multilateral organizations, governments, aid agencies, and multilateral development banks. However, with the cost of climate change mitigation and adaptation so high, it is necessary to bring entities including private sector sources, project developers, commercial financial institutions, philanthropic organizations, NGOs, and corporations into climate finance.

More recently, to facilitate increasing demand for climate finance, "blended financing," a combination of public and private sources, has emerged to help reduce the risk of private sector investment in climate change mitigation and adaptation. Some countries have created national climate funds whereby climate revenue streams can be funneled into a centralized fund administered by a single governing body that can allocate the funds and projects across a single country. ParlAmericas and Environment and Climate Change Canada have created the following list of types of climate change finance mechanisms:[281]

- "**Climate/green bonds:** a type of loan used to finance projects that address climate change, in which the debt is to be paid back within a certain amount of time and interest.
- **Co-financing:** joint financing between two entities that work to fund a climate change activity.
- **Concessional loans:** loans given for the purpose of addressing climate change, which are characterized with longer repayment terms and lower interest rates.
- **Debt swaps:** the sale of a foreign exchange debt to an investor or forgiveness of debt by the creditor, in exchange the debt relief would have to be invested in climate change activities.
- **Equity:** the difference between the value of the assets and the value of the liabilities of something owned.
- **Grants:** a sum of money that is given for climate change activities but does not need to be repaid.
- **Guarantee:** a pledge to pay another's debt, in relation to the climate change activity, in case of default.
- **Insurance/risk management:** the creation of risk transfer mechanisms that provide resources for climate related disaster and shifts loss responsibilities to capital market investors.
- **Non-concessional loan:** loans that are provided at a market-based interest rate for climate change activities.
- **Payment for ecosystem services:** a formal financial transaction between two entities in which one pays for the eco-system services that are provided by the other entity, it entails a commitment to support ecosystem conservation and expansion to continue supporting and obtaining the benefits/services a properly functioning ecosystem provide.

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[279] *See* Paris Agreement, United Nations, 2015, *accessible at* https://unfccc.int/sites/default/files/english_paris_agreement.pdf#page=15.
[280] *See* "Introduction to Climate Finance," United Nations Framework Convention on Climate Change, *accessible at* https://unfccc.int/topics/climate-finance/the-big-picture/introduction-to-climate-finance.
[281] *See* Primer on Climate Financing: Mechanisms and Opportunities for Latin America and the Caribbean, ParlAmericas, *accessible at* https://www.parlamericas.org/uploads/documents/Primer_on_Climate_Financing_ENG.pdf

- **Results based climate finance:** funds disbursed by donor or investor after the pre-agreed results of the climate activity are achieved and verified.
- **Technical Assistance:** non-financial assistance, providing information and expertise, instruction, skills training, and consultation in relation to a climate change activity."

The UNFCCC has recently observed that significantly more climate debt finance dollars are being allocated to climate mitigation projects than to climate adaptation projects. This is largely due to the fact that returns are generally higher for mitigation projects. UNFCCC has been seeking ways to create greater balance between the two types of projects.

Additionally, it can also be argued that more climate finance dollars should be directed at the projects that can be most impactful to climate change and that climate finance mechanisms should focus their efforts on results in both climate impact reduction as well as return on investment. Green bonds are emerging as the mechanism most impactful in terms of those two criteria. Of all the climate finance mechanisms, green bonds have also emerged as the most widely used for financing energy projects.

Green Bonds

An important mechanism for the application of climate finance is the issuance of green bonds. Green bonds were created to fund projects that have positive impacts on the environment and/or climate goals. They are defined by the International Capital Market Association (ICMA) as "any type of bond instrument where the proceeds or an equivalent amount will be exclusively applied to finance or refinance, in part or full, and/or existing eligible green projects and are which are aligned with the Green Bond Principles."[282]

The Green Bond Principles (GBPs) are a collection of voluntary frameworks that focus on "promoting the role that global debt capital markets can play in financing progress toward environmental and social sustainability." They contain best practices for issuing bonds with social and environmental goals and provide recommendations for transparency and disclosure. GBPs seeks to support bond issuers that finance projects that support net-zero goals.[283]

It is important to note that other ESG financing mechanisms exist that have their own guidelines and principles, including social bonds,[284] "use of proceeds bonds that raise funds for new and existing projects that achieve positive social outcomes," and sustainability-linked bonds, or bonds where "proceeds will be provided to finance or re-finance a combination of both green and social projects."[285]

GBPs recommend a set of processes, procedures, and disclosures to inform investors and financial institutions when considering the issuance of such bonds. They stress that transparency, integrity, and accuracy of data is needed to make such issuances legitimate.

Four core components of their issuance are:

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[282] *See* "Green Bond Principles (GBP)," International Capital Market Association, *accessible at* https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/

[283] *See* "Green Bond Principles (GBP)," International Capital Market Association, *accessible at* https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/

[284] *See* "Social Bond Principles (SBP)," International Capital Market Association, *accessible at* https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/social-bond-principles-sbp/

[285] *See* "Sustainability Bond Guidelines (SBG)," International Capital Market Association, *accessible at* https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/sustainability-bond-guidelines-sbg/

- Use of proceeds
- Process for evaluation and selection
- Management of proceeds
- Reporting

Use of proceeds refers to how issuers determine projects that are eligible for green bonds and the clear environmental benefits and indicators that determine eligibility. Projects should demonstrate contributions to environmental objectives, including climate change mitigation, climate change adaptation, natural resource conservation, biodiversity conservation, and pollution prevention and control.

The GBPs lay out a set of high-level categories under which qualifying projects may fall. Eligible projects include, but are not limited to:

- Renewable Energy
- Energy Efficiency
- Pollution Prevention and Control
- Environmentally Sustainable Management of Living Natural Resources and Land Use
- Terrestrial and Aquatic Biodiversity
- Clean Transportation
- Sustainable Water and Wastewater Management
- Climate Change Adaptation
- Circular Economy Adapted Products, Production, Technologies and Processes
- Green Buildings

A challenge for the nuclear energy has been that under these categories, there is no clear category for which nuclear power generation would fit. However, it is clear that nuclear energy would make contributions and be of benefit to all GBP categories. For instance, nuclear power's clean baseload generation characteristics enable renewable energy projects by offsetting their intermittent nature. Nuclear power is itself, with a 92 percent capacity factor, the most efficient and reliable source of power.[286]

It also has a strong performance record in terms of environmental and sustainable management of resources. For example, in terms of pollution prevention and control, nuclear energy has superior performance in terms of NOx, SOx, particulate matter and other criteria pollutants, compared to fossil energy technologies and, in some cases outperforms renewable energy technologies.[287] As discussed elsewhere in this report, nuclear energy also has a small land use footprint that benefits biodiversity, and is also a strong performer with regard to water management.

Nuclear energy contributes to clean transportation by providing low carbon electricity for electric vehicle charging and as a source of clean, pink hydrogen. It is also a clean, low GHG emissions source of reliable power, has a critical role to play in enabling climate change adaptation and in enabling the

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[286] *See* "Nuclear Power is the Most Reliable Energy Source and It's Not Even Close," Office of Nuclear Energy, Department of Energy, March 24, 2021, *accessible at* https://www.energy.gov/ne/articles/nuclear-power-most-reliable-energy-source-and-its-not-even-close.

[287] *See* Nuclear Energy: An ESG Investable Asset Class, Generation IV International Forum, *accessible at* https://www.gen-4.org/gif/jcms/c_179256/gif-final-esg-010921.

sustainable development of circular economy adapted products, production, technologies and processes, as well as the low carbon, clean energy construction and maintenance of green buildings.

The GBPs lay out a process for evaluation and selection of green bond projects that requires the issuer to clearly communicate the environmental sustainability objectives of the eligible projects, the process by which the issuers determine its eligibility, and the information used by the issuer to identify and manage perceived social and environmental risks associated with the project. The GBPs also recommend that issuers align projects with market-based taxonomy and other criteria, standards, certifications, or exclusion criteria.[288]

GBPs require that net proceeds of the green bond be credited to a sub-account or other account that can be tracked by the issuer, tracked, and managed with rigor, and that a high level of transparency be applied to the management of proceeds.

Canadian Breakthrough: Bruce Power Green Bond Issuance

In November 2021, Canada's Bruce Power, LP successfully issued a green bond for $392 million to fund a Life Extension Program, including a Major Component Replacement (MCR) and Asset Management Plan, to refurbish six of its eight units at a nuclear power generation facility, adding approximately 30-35 years to its operational life.

The successful issuance of the bond represents the first-of-its-kind product for green financing in the nuclear industry. The issuance was quite successful, with demand outstripping supply by about six times. It not only demonstrated that a green bond can be issued for nuclear energy generation, but that the issuance is attractive to investors. The seven-year bond, issued by BMO Capital Markets, HSBC, and TD Securities as lead agencies and book runners, was acquired by up to 60 investors across Canada.[289]

Bruce Power, Canada's only private sector nuclear generator, produces approximately 30 percent of Ontario's power for about 30 percent lower than the average cost of residential power generation in the province. It is a Canadian partnership, with indirect owners in TC Energy, Ontario Municipal Employees Retirement System, the Power Workers' Union, The Society of United Professionals, and the Bruce Power Employee Investment Trust.[290]

The green bond issuance will enable Bruce Power to provide a reliable, virtually carbon free source of affordable energy to Ontario consumers through 2064 via the refurbishment life-extension of six producing units. Bruce Power, through this financing, will also enable Canada to continue to maintain its position as a world leader in the production of radioactive isotopes that benefit health care in Canada and globally.

Bruce Power has a history of clean energy production. It refurbished four reactor units between 2003 and 2012, bringing on 30,000 MW of clean, low-cost power that provided 70 percent of the power needed to

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[288] *See* "Sustainability Bond Guidelines (SBG)," International Capital Market Association, *accessible at* https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/sustainability-bond-guidelines-sbg/.

[289] *See* "Bruce Power Bond Success Good News for Nuclear," Reuters Events, December 7, 2021, *accessible at* https://www.reutersevents.com/nuclear/bruce-power-bond-success-good-news-nuclear; and "A Global First: BMO Supports Bruce Power with World's First Nuclear Green Financing Framework," Bank of Montreal, November 22, 2021, *accessible at* https://newsroom.bmo.com/2021-11-22-A-Global-First-BMO-Supports-Bruce-Power-with-Worlds-First-Nuclear-Green-Financing-Framework.

[290] *See* Green Financing Framework, Bruce Power, June 2021, *accessible at* https://www.brucepower.com/wp-content/uploads/2021/11/Bruce-Power-Green-Financing-Framework-Final.pdf.

phase out coal in Ontario. Prior to its commitment to generate a green bond, it had already taken steps that allowed it to meet GBPs. It made commitments to ensure it could minimize and offset emissions, reaching net zero by 2027. It created an Environmental Protection Program that focused on understanding impacts, verifying protection, and continuous improvement through research and innovation. It also maintained a strong safety-first culture. Three ESG areas where Bruce Power has excelled are in waste management, developing and maintaining a responsible supply chain, and in managing its water usage.

In order to qualify for the issuance of a green bond, Bruce Power developed The Green Financing Framework, which established guidelines that determined the activities covered by the green bond are in accordance with the GBPs. It also aligned itself with the Green Loan Principals, which are issued by the Loan Markets Association and the Loan Syndications and Trading Association.[291]

In terms of addressing GBP "Use of Proceeds," Bruce Power determined that it qualified for the eligible category of "Clean Energy" and "Pollution Prevention and Control" and ensured that all of the eligible funds would be applied to its nuclear assets. Examples of funding uses include "component replacement, refurbishment and maintenance with the purpose of increasing operation life span while maintaining or improving the level of operational safety." Bruce Power also aligned the investment with two UN SDG categories: Affordable and Clean Energy (SDG 7) and Climate Action (SDG 13). In doing so, Bruce Power determined that near-zero GHG emissions from nuclear meets the renewable and affordable and clean energy qualifications in the GBPs and UN SDGs, a decision that is aligned with the EU's recent designation of nuclear energy as "green" under its taxonomy for green investments.

To address the GBP core principle of "Project Evaluation and Selection," Bruce Power established a Sustainability Committee to review and make recommendations on funds under which their assets could qualify as eligible for a bond issuance. The Committee aligns its recommendations with sustainability objectives, The Green Financing Framework, and the GBPs, and ensures compliance with regional and national laws and regulations.

In terms of "Management of Proceeds," Bruce Power's finance department created a process for appropriately allocating net proceeds, depositing them in general funding accounts, and tracking the use and allocation of funds for eligible investments. It also established a "Reporting" process to annually summarize green financings and activities including project updates.[292]

An important aspect of Bruce Energy's green bond issuance has been the external review it established through a second-party opinion to confirm the transparency and robustness of The Green Financing Framework. Cicero Shades of Green AS (Cicero), a Norway-based independent and research-based provider of second opinions on green bonds, analyzed and rated Bruce Energy's The Green Financing Framework and conclusions as in alignment with GBPs.[293]

Cicero stated that "life extension of nuclear reactors is a climate friendly power source with a low land use footprint that will make it easier to achieve the Paris agreement target of limiting global warming to

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[291] *See* "Sustainable Lending," Loan Market Association, *accessible at* https://www.lma.eu.com/sustainable-lending; and "GREEN LOAN PRINCIPLES," Loan Syndications and Trading Association, February 2021, *accessible at* https://www.lsta.org/content/green-loan-principles/.
[292] *See* Green Financing Framework, Bruce Power, June 2021, *accessible at* https://www.brucepower.com/wp-content/uploads/2021/11/Bruce-Power-Green-Financing-Framework-Final.pdf.
[293] *See* "CICERO Shades of Green with Second Opinion for a Nuclear Power Company," CICERO November 18, 2021, *accessible at* https://cicero.green/latestnews/2021/11/18/cicero-shades-of-green-with-second-opinion-for-a-nuclear-power-company.

well below 2°C," while acknowledging that such life extensions for nuclear power may be considered controversial by some. "Refurbishing nuclear reactors is a good way to provide low carbon electricity, in part due to the avoidance of decommissioning emissions," it reported. Cicero provided a rigorous review, description, and assessment of Bruce Power's financing framework and related policies, noting that it had strong performance in many ESG categories and GBPs including GHG emissions, pollution control, water management, land use, transparency, and governance.[294]

The report expressed concerns about overall nuclear-related issues such as final waste disposal and the potential for nuclear proliferation and accidental radiation, but noted that Bruce Power had strong policies and procedures in place to address those concerns. It also noted an overall concern about the lack of a Deep Geological Repository for long-term storage of waste, and recommended that Bruce Power report its indirect (Scope 3) GHG emissions, especially those related to uranium mining.

In the report, Cicero noted the inclusion of nuclear in the EU Taxonomy, and that to be included in the Taxonomy the applicable activity must "substantially contribute" to an EU environmental objective(s) while not doing significant harm to the other five objectives. The EU Joint Research Centre, which recommended the inclusion of nuclear in the EU Taxonomy, observed that "all potentially harmful impacts of the various nuclear energy lifecycle phases on human health and the environment can be duly prevented or avoided. The nuclear energy-based electricity production and the associated activities in the whole nuclear fuel cycle (e.g., uranium mining, nuclear fuel fabrication, etc.) do not represent significant harm to any of the TEG (Technical Expert Group on Sustainable Finance) objectives, provided that all specific industrial activities involved fulfil the related Technical Screening Criteria."

With the Canadian government having issued a Green Bond Framework applicable to bonds financing government expenditures that explicitly exclude expenditures supporting nuclear energy,[295] this development, Cicero's assessment, and the EU Taxonomy developments provide a powerful case for nuclear energy's access to climate financing mechanisms, including green bonds.

EU Nuclear Green Designation

The EU's Sustainable Finance Strategy contains three major components designed to encourage investment in activities deemed to be aligned with ESG principles.

First, the Sustainable Finance Disclosure Regulation provides a set of rules that mandate disclosure from asset managers, pension funds, and insurers as to how they consider ESG risks in their investment decisions. It is designed to prevent greenwashing and establish a common set of rules on sustainability risks. Second, the Corporate Sustainability Reporting Directive contains rules that outline sustainability reporting requirements for large corporate entities. Third, the EU Taxonomy classifies economic activities determined to be sustainable and aligned with the EU's transition to climate neutrality.

The Taxonomy is essentially a dictionary that defines what is sustainable and what is not,[296] including criteria that an activity must meet to be constituted as green. While it does not prohibit investment in

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[294] *See* Bruce Power L.P. Green Finance Second Opinion, CICERO, July 16, 2021, *accessible at* https://www.brucepower.com/wp-content/uploads/2021/11/Second-Opinion-Bruce-Power-16July2021final.pdf.

[295] *See* Canada's Green Bond Program, Government of Canada, April 12, 2022, *accessible at* https://www.canada.ca/en/department-finance/programs/financial-sector-policy/securities/debt-program/canadas-green-bond-program.html.

[296] *See* "What the Inclusion of Gas and Nuclear in the EU Taxonomy Could Mean for Investors and Asset Managers," by Jennifer Laidlaw, S&P Global, February 22, 2022, *accessible at* https://www.spglobal.com/esg/insights/what-the-inclusion-of-gas-and-nuclear-in-the-eu-taxonomy-could-mean-for-investors-and-asset-managers.

activities not constituted as green, it does place a limit on what investors and companies can claim as climate friendly. It also attempts to eliminate "greenwashing" or exaggerated claims by institutions to investors regarding environmental performance.[297]

The EU Taxonomy recognizes three types of green investments: (1) those that directly contribute to green energy goals, such as renewable energy generation; (2) those that support or enable other green resources, such as battery storage for renewables; and (3) and those that are not considered to be fully sustainable, but which have lower GHG emissions and support the transition to green energy.

In April 2021, the European Commission (EC), the EU's politically independent executive arm, published its rules regarding which economic entities could be considered green under the Taxonomy. At the time, it delayed making a decision on the designation for nuclear and natural gas. The delay was due to the fact that the energy mix of its member nations is quite diverse, and the EC did not want to isolate its members. Several months later, energy prices began to soar in Europe following the Russian invasion of Ukraine and threats by Russia to shut off shipments to Europe from its Nord Stream 1 pipeline.

In July 2022, the European Parliament voted to allow nuclear to be included in the Taxonomy.[298] While nuclear was determined to be an activity that has lower GHG emissions and supports the transition to green energy, it could be argued that nuclear also addresses the first and second eligibility categories as well because it contributes to green energy goals and enables broader use of renewables by addressing their intermittency without increasing greenhouse gas emissions.

Some countries, such as Austria and Luxemburg, opposed the labelling and have threatened to challenge it in court. Most European nations expressed relief over the development, as it helps ensure reliability of electricity in the future.

In order to render its decision, the EC needed to ensure that the addition of nuclear energy would "do no significant harm" to any of its six environmental principles. While it was easy to make the case for nuclear in the case of climate change adaptation and mitigation, it was more challenging to make the case on pollution prevention, as some argued that nuclear waste is unavoidable. It was ultimately decided that permits in the EU could only be issued for nuclear plants if the countries where they were being built could safely dispose of the waste, and included a qualification that encourages continued advancements of safety standards and waste management. The EC also recognized that technology and innovation will continue to make nuclear safer and more environmentally sound.

The EU Parliament vote constitutes a recognition that nuclear energy has an important transitional role in helping Europe meet its goal of being climate neutral by 2050 and reducing GHG emissions by at least 55% from 1990 levels by 2030. "As the Commission believes there is a role for private investment in gas and nuclear activities in the green transition, it has proposed the classification of certain fossil gas and nuclear energy activities as transitional activities contributing to climate change mitigation," the EU said in a statement.

The vote also recognized nuclear as a reliable energy source at a time when reliability of supply is anything but certain in Europe. The EU classification of nuclear as green in its taxonomy opens up the

[297] *See* "Explainer: What is the EU's sustainable finance taxonomy?," by Kate Abnett and Simon Jessop, Reuters, July 6, 2022, *accessible at* https://www.reuters.com/business/sustainable-business/what-is-eus-sustainable-finance-taxonomy-2022-02-03/.
[298] *See* "EU Lawmakers Remove Last Hurdle to Label Gas, Nuclear as Green," by John Ainger, Bloomberg, July 6, 2022, *accessible at* https://www.bloomberg.com/news/articles/2022-07-06/eu-lawmakers-remove-last-hurdle-for-gas-nuclear-as-green.

way for green financing of nuclear projects in the future that will help provide reliability to an energy system that has been turned upside down by recent economic and geopolitical events. South Korea's recent announcement that it would include nuclear energy in its taxonomy is a sign that the EU's decision will be impactful on a global scale.[299] The Bruce Power green bond financing, along with the EU designation, provide strong momentum for green financing of nuclear that can be repeated in the United States and elsewhere around the world.

The need for nuclear's access to climate finance is further underscored by the IPCC's latest report, which identified requirements for over $100 billion in annual investments in nuclear through 2050 to meet global climate targets.[300] Nuclear's ability to access green financing will be key to its success in addressing the energy trilemma of reliability, affordability, and sustainability.

V. The Need for Improved Assessments of the Nuclear Industry's Positive ESG Performance

In an effort to assess the current state of how the financial community and investors in general view nuclear energy as an investible asset, we interviewed numerous representatives from financial institutions including banks, private equity firms, insurance companies, and ESG rating agencies for their perspectives on nuclear energy-focused investments.

While a large swath of the investment community has typically had a reluctance to invest in nuclear due to perceived risks and slow returns, the interviews highlighted how attitudes toward investing are changing due to climate and ESG factors and technological innovation and how nuclear presents a solution to addressing the energy trilemma challenges of affordability, reliability, and sustainability.

In a society that seeks instant gratification and rewards immediate returns, investments in highly capital-intensive long-term projects like conventional nuclear power have fallen out of favor. There is fierce competition for investment dollars, and the investment community and corporate management are seeking opportunities that bear fruit in the next quarterly earnings report and stock price boosts that receive airtime on the morning financial shows.

Securing tens of billions of dollars for a project that could take a decade to produce any single return is challenging, regardless of the technology deployed. Climate change adds an extra layer of risk and complexity for investors to consider. It is especially difficult when policymakers and financiers lack an accurate understanding of actual risk and benefits regarding nuclear energy. The overly reactive approach to nuclear that policymakers and regulators have often taken have sent negative signals to investors given their consequences in the form of increased costs, cost overruns, and project delays.

As the climate crisis and other environmental factors have taken on a greater role in the U.S. regulatory structure, exposure to climate, environmental, and regulatory risks have become increasingly influential in investment decisions. In general, financial institutions assess a company's environmental footprint

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[299] *See* ""South Korea Follows EU's Lead on Classifying Gas and Nuclear as Green," by Simon Mundy, Financial Times, October 17, 2022, *accessible at* https://www.ft.com/content/d09c2e67-a25d-4874-9bd3-9d5aa35966b0.

[300] *See* Climate Change 2022: Mitigation of Climate Change, Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, *accessible at* https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Full_Report.pdf.

utilizing five primary factors: greenhouse gas emissions, water use, waste and pollution, land use, and biodiversity.

The assessment of a company's environmental profile has gone from a "nice to have" to being a key driver of investment decision-making. With climatic events such as hurricanes, floods, heatwaves, and wildfires expected to increase in frequency and intensity, an extra layer of uncertainty is being added to the multifaceted framework for measuring a company's sustainability. These climatic risks can impose significant financial hurdles, especially for those companies that fail to adequately plan for the likely impacts of climate change. For utilities looking to build new generation, this indexing is augmented to include the company's efforts to invest in new sources of energy or technologies. To date, climate change has played a role in determining a company's long-term creditworthiness due to potential losses in infrastructure and property.[301]

Additionally, a full-cycle index measurement is used to weigh potential social and governance risks to determine an entity's capacity to operate successfully, along with a preparedness assessment of its overall ability to anticipate and adapt to a variety of long-term environmental disruptions, ultimately determining a unique ESG score. This score is used to sort and rank projects and determine the investibility of a project.

The primary external factors contributing to the historical support, or lack thereof, for nuclear projects from the viewpoint of the financial sector include:

- A lack of public acceptance
- A history of project cost overruns
- Failure to adhere to project completion timelines
- Lack of ongoing support from government regulators
- Absence of recognition of nuclear's role as a clean energy source
- The extended period of time needed to achieve returns on investment

The government has a significant role to play in terms of creating new energy policies that place all low-carbon or zero-carbon energy technologies on a level playing field, and as discussed elsewhere in this report, the U.S. and state governments have increasingly acknowledged nuclear as an important clean energy source. Additionally, reducing hurdles to permanent spent nuclear fuel disposal and support for the development and deployment of new nuclear technology could make new nuclear more attractive. More than a few investment professionals noted historical lack of support and recognition for nuclear as a clean energy resource, and said that nuclear should be able to access the same types of policy incentives as renewables.

As we have seen recently, climate impacts through weather events are increasingly threatening the reliability of energy supplies. As the most efficient and reliable source of generation, nuclear energy is critical to the reliability of the grid in North America, Europe, and the emerging world. That point was emphasized repeatedly by representatives of the financial services sector that were interviewed for this report. Reliable energy is critical to our economy, to people's lives and health, and to the future prosperity of the world, yet despite its importance as a social metric, it has not been adequately

[301] *See* "Credit FAQ: How Does Royal Dutch Shell's Commitment to the Energy Transition Affects Its Credit Quality," S&P Global Ratings, September 24, 2019, *accessible at* https://www.spglobal.com/ratings/en/research/articles/190924-credit-faq-how-does-royal-dutch-shell-s-commitment-to-the-energy-transition-affect-its-credit-quality-11160336.

accounted for in terms of ESG performance. ESG rating agencies, banks, and investment funds need to better recognize reliability as a critical ESG metric and the role that nuclear can and should continue to play in ensuring reliability.

Recent weather patterns, events, and their impacts emphasize the importance of weather and climate forecasting in long-term, focus-based financing. In general, the impacts derived by climatological variances are both short and long-term factors that have real consequences both for demand outlooks and supply chain dynamics. These operational issues need processes in place to mitigate risks associated with climate shifts, which necessitate the use of accurate seasonal forecasts.

Power demand is critically driven by short-term meteorological phenomena such as frontal boundaries and seasonal changes. These events can shift power output away from anticipated levels and result in an unanticipated increase in costs. In long-term investment decisions, the use of skill-based seasonal forecasts with climate-based inputs are critically important to successful outcomes. These tools, along with reliable energy supply provided by nuclear power generation, can play a significant role in mitigating the risk to society from climate-related events.

Nuclear energy's reliability is important to investors because of its ability to meet society's demands for baseload electricity and its resiliency to climate-driven weather-related events. In addition to the reliability benefits of nuclear, research shows that companies that embed environmental goals in their growth strategies suffer no statistically significant performance disadvantage at individual and portfolio levels, and may actually outperform their peers.[302]

The S&P 500 ESG Index, launched in April 2019, introduced ESG criteria to the S&P 500 by periodically ranking companies within industries and excluding those that have been deemed to underperform. This index was designed in alignment with the S&P 500's risk and return profile, and accounts for environmental risks by providing greater exposure to companies that limit the scope of their greenhouse gas emissions, set targets for reduction, and include performance and report on their ESG materiality analysis.

Importantly, the S&P 500 ESG Index has not significantly out- or underperformed the S&P 500 Index. In fact, choosing a sustainable investing strategy does not hurt returns. The S&P 500 and green-minded S&P 500 ESG Indexes have consistently tracked at virtually the same rate of momentum, with the S&P 500 ESG Index offering similar or better financial performance alongside the benefits of strong ESG performance.[303]

Sustainability is increasingly a strategic imperative for forward-looking firms, with the assessment of a corporations' environmental footprint having moved from a simple measure of corporate responsibility to an investment proposition.[304]

When considering power generation, nuclear energy is arguably one of the cleanest and most efficient sources of energy and has the potential to contribute significantly towards providing a sustainable,

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[302] *See* "Companies with Serious Climate Goals Are Beating the Market," by Tim McDonnell, Quartz, December 10, 2020 (last updated July 20, 2022), *accessible at* https://qz.com/1943426/companies-with-serious-climate-goals-are-beating-the-market/.

[303] *See* "ESG: Why Not? Insignificant Alpha Observed Between the S&P 500 ESG Index and the S&P 500," by Ben Leale-Green, S&P Global, October 23, 2019, *accessible at* https://www.spglobal.com/en/research-insights/articles/esg-why-not-insignificant-alpha-observed-between-the-sp-500-esg-index-and-the-sp-500.

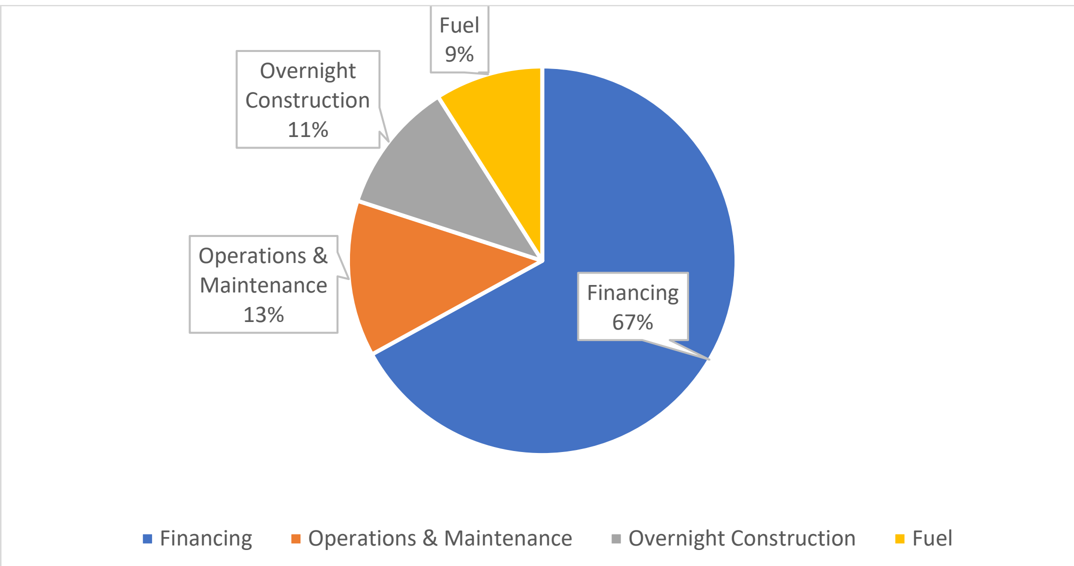
[304] *See* Quantifying Climate Risk, An S&P Global Perspective, S&P Global, *accessible at* https://www.spglobal.com/en/research-insights/featured/quantifying-climate-risk.

scalable, and relatively economical option to meet the growing global energy demand. However, when considering alternative energy sources and ESG investments such as wind and solar, nuclear energy has seldomly been included in such decisions.

For example, when investment management firm BlackRock raised $5.1 billion in 2020 for its Global Energy & Power Infrastructure Fund, it assured investors it would move away from coal and invest in businesses predominantly connected with green energy technologies. However, none of the promotional material referenced nuclear. With this backdrop, financing new nuclear power projects can be prohibitively expensive, and investors will continue to demand high premiums if the technology is viewed negatively by the general public and, by extension, legislators.

As shown below in Figure 60, the cost of financing can be as much as 67% of nuclear power's levelized cost of electricity (47% return of capital and 20% interest during construction), assuming a discount rate of 9% and overnight construction costs of $4,500/kWe.[305]

Figure 60. Cost Breakdown for Nuclear Power Levelized Cost of Electricity.



Source: Unlocking Reductions in the Construction of Nuclear: A Practical Guide for Stakeholders," Nuclear Technology Development and Economics, Nuclear Energy Agency, Organisation for Economic Co-Operation and Development, 2020. Note that the calculations also assume an 85% load factor, 60-year lifetime, and 7-year construction time. https://www.oecd-nea.org/upload/docs/application/pdf/2020-07/7530-reducing-cost-nuclear-construction.pdf.

To accelerate any forward momentum promoting the "New Nuclear," public perception of nuclear power, which forms the political perception and ultimately impacts the financial industry's posture, must be changed. Being seen as the best and least favorite alternative in the wider application of the power grid energy transition is not conducive to long-term success.

The perception of the risks associated with nuclear power, both real and borrowed from a distorted view of the technology, is problematic for operators seeking financing at a reasonable discount rate and

[305] *See* "Unlocking Reductions in the Construction of Nuclear: A Practical Guide for Stakeholders," Nuclear Technology Development and Economics, Nuclear Energy Agency, Organisation for Economic Co-Operation and Development, 2020, *accessible at* https://www.oecd-nea.org/upload/docs/application/pdf/2020-07/7530-reducing-cost-nuclear-construction.pdf.

must be addressed. Thus, a campaign to promote New Nuclear as a necessary investment is required and faces the same path forward as natural gas did in the early 2000s. Similar to how disruptive technologies like hydraulic fracturing and horizontal drilling enabled shale gas to lower the price of natural gas and increase its market share in power generation, advanced technologies like SMRs provide similar promise for a rapid adoption of nuclear.

While ESG rating systems in many cases do give nuclear energy credit for its zero-emission performance, they also tend to offset this benefit through scoring on other factors such as waste and perceived levels of controversy that do not reflect the industry's actual performance and the rigor with which it is regulated and self-regulated. To date, nuclear energy has been excluded from being considered a necessary part of a green energy future mainly due to bias from some activists and experts. That bias, according to industry advocates, has led to some significant environmentally-focused investors blacklisting companies or funds that invest in nuclear altogether due to cited concerns over nuclear waste and potential accidents. This bias can be addressed by educating stakeholders about nuclear's strong ESG performance and focusing on the important role that nuclear can play in addressing the intermittency vulnerabilities associated with wind and solar.

Opportunities to Grow Financial Industry Support

There are plenty of signs, however, that the tune is changing for nuclear in the financial world.

Recently, as discussed elsewhere in this report, the EU decided to officially label nuclear as an environmentally sustainable economic activity, opening potential floodgates for "green bonds" — a fixed-income instrument provided to climate-friendly projects — for nuclear in Europe. This could lead to open the possibility of green bond financing for new projects in Europe and could also prompt similar action in the United States.

The Inflation Reduction Act (IRA) recently passed by the U.S. Congress also contains many provisions supportive of nuclear, including tax credits to support domestic nuclear power generation and significant funding to develop a domestic supply chain for nuclear fuel grades needed for more advanced reactors. A recent Bank of America report noted that the incentives "could be a real driver" for new nuclear projects.[306] The new incentives allow nuclear plants to receive the same credits that traditionally have been limited to wind and solar, reflecting a recognition that nuclear provides emissions benefits at a similar level. Similar to the EU's classification of nuclear as sustainable, these provisions are generating a significant response from the financial sector, which is taking a fresh look at nuclear from an investibility and sustainability perspective.

Around the world, policymakers responding to the dual pressures of grid reliability and net-zero goals have decided to forgo phasing out nuclear power, and not just temporarily. Rather, they are making the case that nuclear power will be necessary for decades. Those pronouncements, and the momentum they produce, are being aided by the potential associated with SMRs, microreactors, and other forms of advanced nuclear technology. These technologies have simpler designs intended to reduce the cost of capital challenges inherent with conventional nuclear generation projects.

Benefits include greater fuel efficiencies and location flexibility, both positives for potential investors. As mentioned earlier in this report, heightened investor interest is evidenced by developments in 2022,

[306] *See* "Why We're Ever More Positive on Nuclear: Not a Renaissance But a Clean New Day," Bank of America Securities, Sept. 8, 2022.

including TerraPower's securing of at least $750 million in an equity fundraiser this year.[307] Nuclear projects utilizing advanced technologies will likely be critical to nuclear's attractiveness to investors, with nuclear advocates saying they could significantly drive down costs by enabling an assembly line approach to construction.

Even so, nuclear energy's future still rests on its role as a clean, climate-friendly, and reliable energy source. However, new-build projects need financial support in order to begin construction in a manner that will enable a timely replacement of coal generation as a reliable baseload source of electricity. Effectively building public as well as financial support requires a concomitant educational campaign regarding nuclear energy's positive ESG attributes and the critical role it needs to play in the energy transition.

Notably, all of the financial sector professionals interviewed for this report, including ESG rating agencies, agreed that the U.S. nuclear energy industry is a strong ESG performer. In fact, there was general openness to the reevaluation of nuclear's overall ESG performance in light of its climate and reliability benefits. To enhance nuclear energy's ability to access the capital needed to provide clean and reliable energy to the world, such a reevaluation needs to occur soon. Recent events such as the energy crisis in Europe and reliability threats in the United States are reminding policymakers, investors, and the public about the importance of reliable energy amid pressures to meet sustainability and climate goals, and underscore the opportunity for nuclear to be recognized as a solution.

Recommendations

To ensure that third party accountings of the nuclear industry reflect actual ESG performance, the following actions should be taken:

- The financial community should recognize nuclear as a unique energy industry within the energy sector for purposes of measuring ESG performance, and the fact that without nuclear, there is no pathway to successfully addressing both climate and economic goals
- The financial community, including ESG rating agencies, should build on recent acknowledgments and sufficiently recognize the strong ESG performance of the nuclear industry with respect to factors including its emissions, reliability performance, and beneficial role in combatting climate change, as well as its strong social and governance attributes
- The financial community, including ESG rating agencies, should recognize the critical importance of reliability to society and reflect its significance accordingly in investment screening and scoring practices
- Launch of a concerted public awareness and education outreach initiative that highlights the above-mentioned benefits to change historical perceptions and secure public and private funding for nuclear projects over the long-term
- Launch of a similar initiative focused on key members of the financial services and investment community, as well key regulators and decision-makers

[307] *See* "TerraPower Announces $750 Million Secured in Fundraise," Press Release, TerraPower, August 15, 2022, *accessible at* https://www.terrapower.com/fundraise/.

VI. Nuclear as an Investible ESG Asset

Two elements need to be defined in order to answer the question of whether nuclear is an investible ESG asset. First, what does "investibility" mean? Second, how does Environmental, Social, and Governance (ESG) impact investibility? Inversibility is not a specifically defined term, it is rather a term of art. The best approach to determining investibility of a particular asset is to use the core risk and return concept from finance, whereby the performance of an investment made in an asset, a security, or even a portfolio as compared with an investment into a risk-free asset, like a US Treasury Bond, is the best measure of investibility. As the risk of the investment rises, its returns should also rise. Another component of investibility is the nature of the investor. Some investors seek lower risk and can accept lower returns. Others take far greater risk and seek larger potential returns.

Using data from NYU's Stern School of Business, Figure 61 provides a good illustration of returns over many years.[308] Going back to 1928, the S&P 500 returned nearly 12%. Corporate Bonds returned 7.2%, and in third place US Treasury Bonds returned 5.1%. Real Estate was 4.4%, and US T-Bills returned 3.3%. Note that the US Treasuries are risk free, in terms of principal risk.

Figure 61. Historical Returns.

Arithmetic Average Historical Returns	S&P 500 (includes dividends)	3-month T.Bill	US T. Bond	Baa Corporate Bond	Real Estate
1928-2021	11.8%	3.3%	5.1%	7.2%	4.4%
1972-2021	12.5%	4.4%	7.0%	9.3%	5.4%
2012-2021	17.0%	0.5%	2.6%	6.3%	7.4%
Geometric Average Historical Returns					
1928-2021	10.0%	3.3%	4.8%	6.9%	4.2%
1972-2021	11.1%	4.4%	6.6%	9.0%	5.3%
2012-2021	16.4%	0.5%	2.4%	6.1%	7.3%

Can nuclear be considered investible given this data? The answer is yes. While it is exceedingly difficult to isolate a "pure play" nuclear power player, regulated or merchant utilities or suppliers, Figure 62 shows an analysis of Total Shareholder Returns (TSR) for the top eight nuclear fleets in the US as measured by nuclear generation capacity.[309]

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[308] *See* Damodaran Online, *accessible at* https://pages.stern.nyu.edu/~adamodar/New_Home_Page/home.htm.

[309] *See* "Why We're Ever More Positive on Nuclear: Not a Renaissance But a Clear New Day," BofA Securities, September 8, 2022. Total Shareholder Returns based on share price data obtained from Yahoo! Finance, accessible at https://finance.yahoo.com/.

Figure 62. Total Shareholder Returns.

Total Shareholder Returns	Capacity MW	5 Year TSR	Annual TSR
Constellation Energy	18,669	N/A	165.3%
Duke Energy	10,490	52.1%	10.4%
TVA	7,833	N/A	N/A
Dominion	6,607	26.3%	5.3%
Southern	5,795	92.4%	18.5%
Public Service Enterprsie Group	5,743	72.5%	14.5%
NextEra Energy	5,494	159.7%	32.0%
Entergy	5,146	77.8%	15.6%
	Mean	**80.1%**	**37.4%**
	Median	**75.2%**	**15.6%**

This data reflects trailing twelve months, and trailing five years, depending upon the specific filing dates for each issuer. TSR is a calculation that considers share price appreciation and cash dividends, and also is adjusted for stock splits and buybacks as needed. Even if we take the lowest median return, 15.6%, it can be considered to be investible by any reasonable investment firm or individual investor, as underscored by its outperformance of the S&P 500. While it is true that these companies have diverse fuel sources for their generation fleets and combine regulated with merchant power in terms of stock performance, continued operation of nuclear power stations will be necessary well into the future. Keep in mind this is absent ESG considerations, in general, because ESG is a very new concept. If several elements from a common ESG framework are added to the mix, then nuclear power has an even more compelling argument for investibility.

Strong ESG performance can enhance companies' social license to operate and thereby increase revenue growth opportunities. Additionally, efficiencies in using resources more effectively and sustainably can lower costs and boost margins. For nuclear power players, the cost of environmental and governance failures is significant, so robust planning that reduces risk naturally falls to the bottom line. Resource efficiency can also drive value, if nuclear generators consciously source materials from the most sustainable sources.[310]

The importance of lowering regulatory issues and litigation risk cannot be understated. Billions of investment and operating dollars in the nuclear power space are directly impacted by state and federal regulations. The better the governance, the more likely that dollars can be de-risked to some degree. Profits are directly impacted by regulatory action, and strong ESG performance can reduce regulatory risks that have an actual impact on returns.

Another element involves attitudes associated with a younger workforce. Data suggests that younger workers do care about societal factors, and as the nuclear industry adds more personnel from younger

[310] *See* "Valuation: Measuring and Managing the Value of Companies," 7th Edition, Koller, Goedhart, and Wessels, McKinsey and Company, pp. 84-90, *accessible at* https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/valuation-measuring-and-managing-the-value-of-companies.

demographics, the impact will be positive as workforce needs are met in a way that will reinforce and further drive strong ESG performance.

Lastly, investment returns can be increased by optimizing assets. One way to optimize an asset is for it to be consistent with various ESG models, which further de-risks it.

While it all might make sense, how do we quantify these concepts? Work has been undertaken to isolate ESG assets as intangible assets, which opens the door to traditional valuation techniques already in use for the valuation of intangibles. For now, the easiest path is a top-down approach to adjust the cost of capital to reflect a general de-risking of a company's cash flows, which in turn raises the valuation.

Valuations Rise and Cost of Capital Falls When Cost Uncertainty Is Reduced

Valuation is predicated on three key elements. The amount, timing, and risk of cash flow drives valuation. The present value of cash flows generated into the future must be discounted by a rate that takes into account the time value of money and the specific risk and timing of the various cash flows expected into the future. This is Discounted Cash Flow analysis, or DCF.

The most common rate used for this risking and discounting is the Weighted Average Cost of Capital, or WACC. The WACC is an after-tax cost that considers all types of financing, including debt and equity. WACC is also used to assess the returns on potential investments. Logically, the returns on potential investments should exceed the WACC, or the economic value of the deal is zero or negative.

Figure 63 illustrates a sample WACC calculation using inputs from a selection of large nuclear fleet operators in the United States.[311] We are using the Capital Asset Pricing Model (CAPM) to quantify the relationship between the expected return and risk of investing in a security, in this case, securities that have substantial nuclear power exposure. It shows that the expected return is a risk-free return plus some kind of risk premium, which is based on the Beta of that stock.

Investors need to be compensated for risk above and beyond a risk-free return in the form of a risk premium. In short, the risk premium must be a rate of return greater than the risk-free rate. Investors naturally want to see a higher risk premium when taking on increasingly risky investments. Beta measures a stock's risk in comparison to the broader market as a whole. It represents a stock's sensitivity to market risk. If a company has a Beta of 1.0, then it has the exact same volatility as the overall market average.

In order to illustrate this concept, we have developed a hypothetical WACC based on some observable data taken from the largest public company power generators. Figure 63 uses the CAPM to estimate this hypothetical WACC. In short, selected data from the public companies is averaged to form a "straw man" nuclear power company CAPM.

The average effective tax rate is low, which is to be expected of companies that have high depreciation and interest expense charges that reduce their tax impact. With an average of 13.7%, we are rounding up a bit to 15%. The risk-free rate is generally a US Treasury rate, such as the 10-year Note or 20-year Bond. In this case we selected the yield on the US 30-year Treasury Bond, because the assets that these generating companies have and will build have very long useful lives. This is currently about 3.5%.

[311] *See* "Why We're Ever More Positive on Nuclear: Not a Renaissance But a Clear New Day," BofA Securities, September 8, 2022.

Figure 63. Sample Weighted Average Cost of Capital Calculation.*

Capital Asset Pricing Model (CAPM) Inputs		**AVG***
Effective Tax Rate	15.0%	**14.8%**
Risk-free Rate (Rf)	3.50%	
Equity Risk Premium (ERP)	4.95%	
Beta	0.5	**0.532**
Target Debt/Equity	125.0%	**146.6%**
Pretax Cost of Debt	3.5%	**3.3%**
Small Stock Risk Premium (SSRP)	0.0%	
Unsystematic Risk Premium (USRP)	2.5%	
Capital Asset Pricing Model (CAPM) Calculations		
Beta	0.5	
Ke = Rf + (Levered Beta x ERP) + SSRP + USRP		
CAPM Cost of Equity (Ke)	**8.5%**	
After-tax cost of debt	3.0%	
Debt/capital ratio	55.6%	
Weighted Average Cost of Capital (WACC)	**5.4%**	

*The average was calculated based on the performance of some of the United States' largest nuclear power generators, as measured by capacity, with data obtained from Yahoo! Finance and SEC filings.

The Equity Risk Premium varies, depending upon the data set used. It has been as high as 7%, but more recently has dropped to 4.95 based on NYU Stern School data.[312] The large power companies selected have low Beta's, which is common for franchised electric utilities with defined service territories. They react far more slowly to market volatility than unregulated companies.

For this illustration, we are using 0.50 for Beta. The target debt to equity ratio was simplified to be 125%, as shown, as these sample companies are highly levered. This is due to the fact that a large amount of their cash flows is regulated via rate cases, as opposed to nuclear operators in deregulated markets. The pre-tax cost of debt is very reasonable, at 3.5% based on the average of 3.4%. These players have solid, if not good, credit ratings. There is no small-stock premium, given how large these companies are. We did however add Alpha, of 2.5%. This represents added risk assuming the industry can develop the capability to beat the market. Alpha is a subjective term for excess returns, or a measure of performance that beats the broad market return over a specified period.

The hypothetical case we have built, as shown in Figure 63, yields a cost of equity of 8.5% and a WACC of 5.4%.

[312] *See* Damodaran Online, *accessible at* https://pages.stern.nyu.edu/~adamodar/New_Home_Page/home.htm. Note that the Equity Risk Premium is an assumption and can vary based upon the data set used.

As discussed, when the WACC is lowered, and the cash flows are unchanged, the current valuation rises. Therefore, the DCF impact of a lower WACC can be quantified. Cost uncertainty is a critical issue in any valuation, in combination with delays. Determinations of value rest on estimates of future economic productivity as represented by cash flows. One of the single most problematic issues in the nuclear power industry has been cost overrun problems and delays. Any and all efforts to reduce or eliminate these issues flow into value enhancement right away, and new nuclear power technologies under development represent an opportunity to reduce the cost and time associated with nuclear generation projects.

Figure 64 provides a simplified illustration of how this can work. NOPAT represents a theoretical Net Operating Profit After Tax. There is no way to properly calculate such a number if cost cannot be modeled with confidence and certainty. Risk associated with cost issues has to be captured by cutting NOPAT estimates, or by raising the WACC, or even by doing both.

The letter "g" represents how NOPAT will annually grow into perpetuity, and is 2.5% in this hypothetical example because that is the long-term US GDP growth rate over the past several decades. RONIC refers to the expected Return on New Invested Capital. 10% is a reasonable number given historical returns across the power generation industry. The 5.4% WACC was calculated in Figure 63.

If we assume a corporate NOPAT of $500,000,000, then the expected present value, or actual total valuation, would be $12.8 billion given these assumptions. Very small and incremental changes in the WACC, holding all else constant, illustrate meaningful increase in valuation. For example, a reduction in the WACC from 5.4% to 5.3% creates a valuation impact exceeding $500 million. This underscores how even a small adjustment in ESG performance could impact the cost of capital and thereby enhance valuations. Thus, if nuclear's ESG performance was better recognized by the financial community, including ESG rating agencies, the lower cost of capital that could result could have a significant and positive impact on nuclear's economic attractiveness.

Figure 64. Impact of Weighted Average Cost of Capital on Valuation.

Weighted Average Cost of Capital (WACC)	**5.4%**	5.3%	5.2%	5.1%	5.0%
NOPAT	$500,000,000	$500,000,000	$500,000,000	$500,000,000	$500,000,000
g	2.5%	2.50%	2.50%	2.50%	2.50%
RONIC	10.0%	10.00%	10.00%	10.00%	10.00%
WACC	5.4%	5.30%	5.20%	5.10%	5.00%
g/RONIC	25.0%	25.0%	25.0%	25.0%	25.0%
1-g/RONIC	75.0%	75.0%	75.0%	75.0%	75.0%
WACC-g	2.9%	2.80%	2.70%	2.60%	2.50%
Valuation	**$12,844,909,610**	**$13,392,857,143**	**$13,888,888,889**	**$14,423,076,923**	**$15,000,000,000**
	Valuation Increase	**$547,947,533**	**$1,043,979,279**	**$1,578,167,313**	**$2,155,090,390**
		4.3%	**8.1%**	**12.3%**	**16.8%**

Technological Advances in Nuclear Design and Safety De-Risk Nuclear Assets

In order to capture a basis that supports a de-risking argument for nuclear power, and by extension, an investibility narrative, we need to review technological advances in nuclear design and safety. First and foremost, the industry learns from its issues, as evidenced by the U.S. response to Chernobyl, Three Mile

Island, and Fukushima. Beyond traditional reactor designs, there is a glimpse of the future we can see right now with the emergence of Small Modular Reactor (SMR) technologies.

SMRs are highly advanced nuclear reactors with a nameplate power capacity of up to 300 MW per unit, or generally one-third of the generating capacity of standard nuclear power reactors. SMRs, which will produce a large volume of low-carbon electricity, are quite small. Representing just a fraction of the size of a conventional nuclear power reactor, they are an effective means to penetrate smaller markets such as remote areas and the developing world. Given that they are modular, the SMR's various systems and components can be factory-assembled and moved by train, barge, or trucks as a unit to ultimate installation locations.

SMRs are a game changer and represent a climate solution integral to the future of nuclear, which as discussed elsewhere in this report is a necessary component of any strategy to address climate and economic goals. SMRs can be cost effective in such a way that the volatility in cash flow modeling and WACC is reduced. For example, construction delays are often caused by high customization and "bespoke" designs that are not associated with the SMR concept. The savings in cost and construction time that SMRs create will de-risk them and drive up their valuations in real time. The fact that they can be deployed incrementally, 300 MW at a time, means that they will be developed logically to serve growing energy demand. This has unique market implications, including for the developing world.

One of the biggest problems to accelerating access to energy is infrastructure. This usually means sporadic grid coverage in rural areas and the cost of grid connections for rural electrification. It can be an issue in the developed world, and certainly is in the developing world. Throughout the world, be it a developed, developing, or emerging nation, SMRs can be installed into an existing grid or even off-grid and deliver low-carbon power for commercial and population needs.

Microreactors, a smaller version of SMRs, are designed to generate electrical power at a 10 MW capacity level and represent a solution for regions that lack clean, reliable, and affordable energy. They have tremendous implications for Asia and Africa, can provide backup power supply in emergency situations and as a replacement for diesel backup power, and can serve remote locations including islands.

All of the proposed SMR designs we see today are simpler designs than conventional nuclear power plants and incorporate best practices and lessons learned from previous operating experience. SMRs will utilize more passive systems and safety designs in the reactor, including lower power and operating pressure concepts. These systems do not require human intervention or external power for shutdowns, as passive systems rely on physics such as natural circulation, convection, gravity, and self-pressurization. These increased safety designs will eliminate or significantly lower the potential releases of radioactivity in the event of an accident. Some SMRs also have meaningfully reduced fuel requirements, only needing to be refueled every 3 to 7 years, versus 1 to 2 years for conventional plants. SMRs even have design plans to operate for up to 30 years without refueling.

Importantly, advanced reactors today have the capability for higher temperature operations, with non-light water reactors able to achieve better electricity conversion efficiencies and be used for process heat and thermochemical hydrogen production. These capabilities further enhance the economic attractiveness associated with projects utilizing such technology.

Right now, government and corporate institutions are working hard to bring SMR technology to fruition within this decade. This could have a significant positive impact on GHG emission reduction objectives. As stated above, this is the most likely "magic bullet" approach to the climate challenge.

In Russia, the world's first floating nuclear power plant began commercial operations in May 2020, and it is producing energy from two 35 MW SMRs.[313] Other SMRs are under construction or in the licensing stage in Argentina, Canada, China, Russia, South Korea, and the United States. There are more than 70 commercial SMR designs being developed around the world targeting a variety of applications, including electricity, hybrid energy systems, hydrogen production, heating, water desalination, and steam for industrial use.[314]

SMRs, and nuclear power in general, provide the efficiency, economics, and flexibility required for dispatchable energy. This means they can adjust output to meet electricity demand in a way that weather-based power, like wind and solar, cannot. SMRs can be co-located with intermittent renewable sources in a hybrid energy system and play an essential role in a clean energy transition while helping countries meet Sustainable Development Goals (SDGs).

VII. Added Value from Nuclear Energy Industry's Strong Performance

Nuclear Assets are Near-Perfect Baseload Power Generation Sources and Can Support Expanded Renewable Energy Buildouts Like Wind and Solar

Capacity factors, which represent the amount of time that a unit operates as measured against its full operational capacity, are the gold standard in describing how power generation can support economic activity with consistency. Intermittent power is problematic for a wide variety of reasons. Nuclear power plants lie at the very top of the range of capacity factors. The only thing short of a shutdown that lowers the factor is maintenance and refueling. This is the formula for capacity factor:

Total generation in MWh/((365 days)*(24 hours per day)*(nameplate capacity in MWs)

Baseload generation refers to power with a high capacity factor that is essentially always on, and can be relied upon to supply power to support human activity. There are no power sources that compare to nuclear in terms of reliable baseload generation, as illustrated by its industry-leading capacity factor performance. As discussed elsewhere in this report, with a 92.7% capacity factor, nuclear energy performs best-in-class when it comes to the electrical output produced over a given period of time in comparison with the total amount that could be generated at continuous full power.[315] This is critical for several reasons.

Highly reliable baseload nuclear power reduces the need for reliance on peaking plants, expensive battery infrastructure, and unnecessary and costly overbuild of intermittent sources. The importance of nuclear's

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[313] *See* "Russia Commissions World's First Floating Nuclear Power Plant," Power Technology, May 25, 2020, *accessible at* https://www.power-technology.com/news/russia-floating-nuclear-power-plant/.

[314] *See* "What are Small Modular Reactors (SMRs)?," by Joanne Liou, International Atomic Energy Agency, November 4, 2021, *accessible at* https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs.

[315] *See* U.S. Energy Information Administration, Electric Power Monthly, Table 6.07.A. Capacity Factors for Utility Scale Generators Primarily Using Fossil Fuels, and Table 6.07.B. Capacity Factors for Utility Scale Generators Primarily Using Non-Fossil Fuels. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_07_a and https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_07_b.

reliability and the benefits thereof is underscored by the fact that weather-based power like solar or wind rarely have capacity factors above 50%.

Electricity supply reliability, or the lack thereof, can result in substantial economic impacts. According to the U.S. Department of Energy, power outages cost the United States $150 billion annually.[316]

Electrification of cars will require a significant increase in U.S. electricity supply needs. According to the National Renewable Energy Laboratory (NREL), by 2050 the projections for electric vehicles in the United States would necessitate the doubling of U.S. generation capacity under a high electrification scenario.[317] In sum, the mass switching of transportation in the United States from internal combustion to electric vehicles will demand massive investments into new generation. Given that it will not be possible to effectively model charging demands, and in many cases vehicle charging will be done at night, reliable baseload generation will be required.

Nuclear Assets Can Support Economic Development in the Developing World, Such As In Africa and In Asia, Raising the Standard of Living and Driving "S" Scores

Energy is a critical element to economic growth and prosperity, constituting a core element of the "S" in ESG. The concept of energy poverty, developed in the 1990s, refers to the lack of modern energy supply. Energy poverty occurs when people in developing countries, and in some cases in developed countries, are impacted by a lack of physical and/or financial access to modern energy supplies. Across the globe, more than 700 million people lack consistent electricity supply, and more than 2 billion people use dangerous and polluting cooking methods.[318] In developing countries, and in particular in regions like Africa and Asia, people are often forced to rely on antiquated, unhealthy, and time-intensive practices to meet their energy needs.

SMR designs can be highly effective in reducing energy poverty in the developing world in a clean and sustainable manner. The pursuits of eliminating energy poverty and reducing GHG emissions can run counter to one another, as developing nations use high carbon-emitting sources like coal to meet demand. Nuclear power shows that these pursuits do not have to be mutually exclusive, but can instead by pursued and achieved simultaneously and provide multiple "S" benefits from an ESG perspective, including with regard to greater access to food, water, health care, education, and economic advancement.

Nuclear Assets Recognized as ESG Assets Will Improve Quality of Life While Drawing Capital Investment and Contributing to Higher Valuations

If nuclear power assets are recognized as ESG assets, sustainable financing mechanisms including green bonds and ESG funds will better enable the realization of the full range of benefits associated with nuclear energy. According to J.P. Morgan Asset Management, more than $500 billion was invested in ESG-

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[316] *See* Department of Energy Report Explores U.S. Advanced Small Modular Reactors to Boost Grid Resiliency, Office of Nuclear Energy, U.S. Department of Energy, January 25, 2018, *accessible at* https://www.energy.gov/ne/articles/department-energy-report-explores-us-advanced-small-modular-reactors-boost-grid.

[317] *See* Latest Electrification Futures Study Report Explores How U.S. Power System Could Evolve with Widespread Electrification, National Renewable Energy Laboratory, January 12, 2020, *accessible at* https://www.nrel.gov/news/program/2021/latest-electrification-futures-study-report-explores-how-the-supply-side-of-the-us-power-system-could-evolve.html.

[318] *See* Report: COVID-19 Slows Progress Toward Universal Energy Access, Press Release, World Bank, June 1, 2022, *accessible at* https://www.worldbank.org/en/news/press-release/2022/06/01/report-covid-19-slows-progress-towards-universal-energy-access.

integrated funds in 2021.[319] Without nuclear, there is no pathway to successfully addressing both climate and economic goals.

Valuations naturally escalate as capital flows toward the technological solutions that society commits to in furtherance of meeting its most pressing needs. Lowering WACC by factoring in a variety of ESG de-risking elements also drives up value. Removing regulatory and cost uncertainty and volatility creates a normalized cash flow that can be valued with more certainty. An example of how one could incorporate ESG concepts into WACC is shown below in Figure 65. As described above in Figure 64, small, defensible, and incremental adjustments to WACC can have a large impact on valuation, which naturally impacts investibility.

ESG platforms have developed frameworks to assign scoring to performance across a variety of common ESG themes. The illustration below provides an example of how nuclear's strong ESG performance across various topics could enhance valuation by reducing the cost of capital. Note that nuclear's cost of capital, and hence valuation, could be further enhanced if its actual performance were better recognized by the investment community. Additionally, the reduced cost of capital included in the example illustration below could be further reduced based on an assessment of actual performance, which could exceed that which is depicted in the presented hypothetical model.

See following page for Figure 65.

[319] *See* ESG Outlook 2022: The Future of ESG Investing, by Jennifer Wu, J.P. Morgan Asset Management, January 2, 2022, *accessible at* https://am.jpmorgan.com/dk/en/asset-management/liq/investment-themes/sustainable-investing/future-of-esg-investing/.

Figure 65. Example Illustration of How ESG Performance Could Impact WACC.

	Potential WACC Adj.
Environmental	
Emissions of Air Pollutants	-0.0500%
Emissions of Water Pollutants	0.0000%
Emissions of inorganic pollutants	0.0000%
Carbon Footprint	-0.5000%
Energy Efficiency	-0.0015%
Energy Consumption Intensity	0.0000%
Water Usage	0.0250%
Waste Production	0.0250%
Production of hazardous waste	0.2500%
Reusability/Recyclability	0.0000%
Total Environmental	**-0.2515%**
Social Factors	
Social impact of products and services	-0.0150%
Employee Relationships and Labor Standards	-0.0150%
Freedom of association and right to organise	0.0000%
Average ratio of female to male board members	0.1500%
Average ratio of females to males in total workforce	0.1500%
Equal remuneration	0.0000%
Average gender pay gap	0.0000%
Number of incidents of discrimination	0.0000%
Human capital management	0.0000%
Frequency of performance assessment per employee	0.0000%
Workplace health and safety	0.0000%
Rate of accidents	-0.0250%
Publication of information on ESG performance	-0.0250%
Human Rights	0.0000%
Povery and Famine	-0.2500%
Total Social	**-0.0300%**
Governance Factors	
Ethical Considerations	0.0000%
Accountability/rule of law	-0.0150%
Strategy and Risk Management	0.0000%
Internal controls and risk management policies and procedures	-0.0250%
Transparency	-0.0150%
Observance of disclosures, information rules and practices	-0.0150%
Total Governance	**-0.0700%**
Total De-Risking WACC	**-0.35%**

VIII. Conclusion

Nuclear energy has exceptional characteristics that make it uniquely qualified to address all three facets of the energy trilemma: affordability, sustainability, and reliability.

This report demonstrates that the U.S. nuclear industry performs well across major ESG topics addressed by the world's most recognized framework organizations. ESG rating agencies should better reflect this performance in its analyses of nuclear energy producers. Assessments to date have not accurately reflected nuclear energy's performance as a source of reliable, clean energy and its role in helping the United States and the world reach net zero emissions goals while addressing energy poverty and still growing the global economy.

Recent developments reflect a growing recognition of nuclear energy's unique attributes. The EU's classification of nuclear as a green energy source will help provide access to billions of dollars in climate finance tools including green bonds, and has been followed by a similar decision in South Korea. Following the first green bond issuance for nuclear energy in Canada, other such financings can be expected to occur as nations around the world seek to meet energy demand.

Other recent developments underscoring momentum for nuclear include government actions to delay planned closings of nuclear facilities and the passage of legislation in the United States that will provide incentives to keep existing nuclear assets generating and fund future nuclear energy generation, including advanced reactors such as SMRs and microreactors.

The financial community also increasingly recognizes the importance of nuclear energy and its positive ESG characteristics. This is critical to attracting needed investments to fund nuclear generation in the years and decades ahead. Further education regarding the importance of nuclear and its climate, reliability, and other ESG attributes should be focused on the financial community (including ESG rating agencies) as well as decision-makers and the public.

Even absent ESG considerations, nuclear is an investible asset. However, its strong ESG performance makes the case for investment even stronger. The educational and engagement initiative outlined above can help ensure that the financial community and ESG ratings better acknowledge and reflect nuclear's benefits from an environmental and reliability perspective and its contributions across the full range of relevant ESG topics. Doing so will enable nuclear to help achieve the world's climate, energy, and economic goals.

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