SUMMARY OF STUDY ON

SMR TECHNOLOGY AND ITS IMPACT FOR INDIANA

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STUDY HIGHLIGHTS

In partnership with a team of experts, Purdue University was selected by the Indiana Office of Energy Development (IOED) to perform a comprehensive study that analyzes small modular reactor (SMR) technology applications and their impacts for the state of Indiana.

CONCLUSION: SMRs present a viable opportunity for Indiana to transition to a cleaner, resilient and diversified energy future. Successful deployment of SMR technology requires a careful balance of economic, regulatory and social considerations along with development of the technology.

KEY RECOMMENDATIONS: The state of Indiana, as well as Indiana energy stakeholders, should proceed with feasibility studies, build partnerships for SMR development and prioritize stakeholder engagement to ensure SMRs are integrated smoothly and beneficially into the state's energy portfolio. More specific recommendations include:

- Develop educational resources for differing audiences to build on publicly understood benefits of nuclear energy while educating on perceived safety and environmental concerns.
- Review existing state requirements, investigate incentives and lead in technology standardization with a goal of de-risking SMR construction within the state, especially at existing or retired coal plants.
- Take advantage of existing supply chain resources within the state to ensure Indiana's economy benefits from SMR construction anywhere in the nation.

CONTENTS

SUMMARY OF STUDY ON SMR TECHNOLOGY AND ITS IMPACT FOR INDIANA

While Indiana invests in a diverse energy supply including natural gas, coal, wind, and solar, no nuclear power plants exist in the state with the benefit of producing zero carbon emissions. In view of this, Purdue University, in partnership with a carefully selected team of experts, was selected by the Indiana Office of Energy Development (IOED) to perform a comprehensive study that analyzes small modular reactor (SMR) technology applications and their impacts for the state of Indiana, including an assessment of SMR costs and benefits.

The broad focus areas of the study included gathering quantitative and qualitative data on the current state of SMR technology, projected safety of the proposed technology, potential regional and national economic impact, community engagement, and opportunities for workforce development. The present study not only leverages the findings from the recent year-long SMR feasibility study by Purdue University, but it is also a natural next step toward diversifying and modernizing the state's energy portfolio, bringing reliable, affordable, and sustainable energy to the people of Indiana, enabling a workforce that is nuclear technology ready, and developing a potential model for implementation for the state as well as the nation.

The key objective of the proposed study is to provide the information needed to better understand SMR technology as a resource for electricity generation and assist IOED in the development of a comprehensive energy plan and policies to enable a diverse and balanced portfolio of energy resources that benefit all Hoosiers. The project team, in coordination with IOED, included the School of Nuclear Engineering at Purdue University, Purdue Administrative Operations, Purdue Polytechnic Institute (Polytechnic), Purdue Extension Community Development (CDExt), Purdue Center for Regional Development (PCRD), Ivy Tech Community College of Indiana (Ivy Tech), the Energy Systems Network (ESN), and Argonne National Laboratory (ANL). The organizational chart of the project team and the distribution of tasks are shown in Figure 1.

Although Indiana currently has no electricity-generating nuclear power plants within its borders, the study showed that SMRs could present substantial

OPPORTUNITIES FOR INDIANA

- Coal-to-nuclear transition
- 24/7 dispatchable source of carbon free electricity with capacity factor of more than 92%
- Creation of high-paying jobs during construction and operation
- Increase of the tax base
- Increase employment by supply chain providers

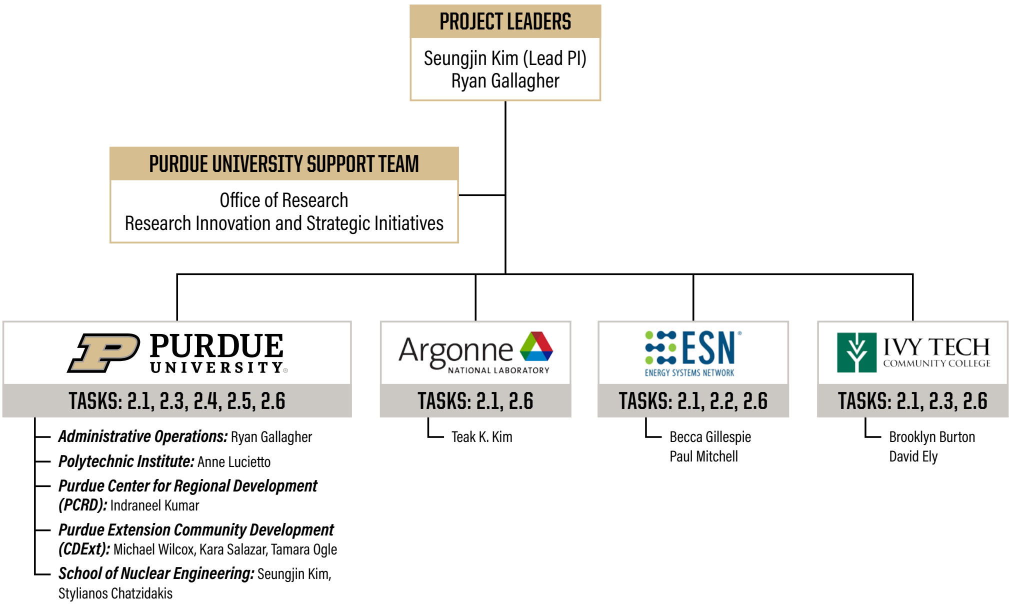

Figure 1. SMR Study Team Organizational Chart

opportunities for the state of Indiana, including significant coal-to-nuclear opportunities, a 24/7 dispatchable source of carbon free electricity to meet the expected load growth of 1.5-3% from 2022 to 2030 (a big change compared to the 0.2% annual growth rate over the prior decade), the creation of high paying jobs during both the construction and operation of the facility, increase of the tax base in the state, as well as the potential to increase employment throughout the state by various supply chain providers, including the nuclear manufacturing.

SMRs are compact nuclear reactors with electric generating capacity typically less than 500 megawatts of electrical power (MWe) and designed to offer scalable energy solutions with enhanced safety features compared to traditional nuclear plants.

While SMRs could present significant opportunities for Indiana's energy future, their deployment requires careful planning and a balanced approach. Comprehensive feasibility studies, regulatory alignment, workforce development, and robust community engagement are some of the necessary components to ensure that SMRs can be safely and successfully integrated into Indiana's energy portfolio. By addressing the financial, regulatory, and technological challenges, Indiana can position itself as a leader in adopting this emerging technology while creating economic opportunities and ensuring energy security .

The study found that, while SMRs show promise and can add value to Indiana, their deployment is not without challenges. Construction costs remain high, especially for first-of-a-kind (FOAK) units, which have unique challenges and higher upfront costs. The study highlighted that subsequent "n^{th}-of-a-kind" (NOAK) units are expected to be significantly cheaper as experience and efficiencies improve. Supply chain stability is one of the major challenges; high-cost components such as reactor vessels and turbines require reliable supply networks, which may necessitate multi-state or multi-company orders to maintain cost-effectiveness. Additionally, navigating federal and state regulatory frameworks will require careful planning, as each SMR installation must meet stringent safety and environmental standards.

While there are financial risks to being an early adopter of SMRs, the benefits of moving early present the opportunity to have a leadership role in developing the SMR supply chain ecosystem. SMRs are a new technology, and as such, there are opportunities for Indiana to establish itself throughout the supply chain. Early adopters may be able to explicitly negotiate with a technology vendor to site factories and other facilities within their borders, or a state may be able to craft the workforce development and supply chain programs in concert with the project to incentivize the new high-value and sustainable business opportunities to locate within the state. As SMR's market share grows, suppliers of specialized equipment, components, materials, or services that have been established during early projects may be called upon in later projects.

In building a new SMR, many categories of expenditures are nearly all expended locally, including buildings, structures, sitework, and field supervision. The largest element of the construction economic impact is the reactor plant equipment, which represents around 50% of the total costs. Reactor plant equipment is also the most novel element of the SMR design, therefore representing the biggest opportunity for early movers. Should Indiana position itself as an early mover in adopting SMRs, the state and Indiana's energy stakeholders should seek opportunities to leverage their position to maximize the sustainable business opportunities in the reactor plant equipment category of costs, as either

INDIANA CAN POSITION *itself as a leader in adopting this emerging technology while creating economic opportunities and ensuring energy security.*

a supplier to those providers or a manufacturing site for assemblies and/or sub-assemblies of that equipment, as well as reactor components, which currently is non-existent in the U.S. for commercial nuclear power reactors.

It is noted that there is already one major nuclear manufacturing facility in Indiana, namely, BWXT, located in Mount Vernon, IN. BWXT makes the large components of naval nuclear reactors including the reactor vessels and parts of the steam generator. They also complete the final assembly of the naval nuclear reactors on site and ship them out to the customer. BWXT recently conducted a study to determine the feasibility of manufacturing the GE-Hitachi BWRX-300 SMR reactor vessels in their Indiana plant. They determined that manufacturing reactor vessels of that size would require them to build an entirely new 120,000 ft^2 facility due to the large size of the BWRX-300 vessels. The new facility would still benefit from much of the existing infrastructure, human resources, supply chain, and transportation facilities at their existing plant. They roughly estimated the cost of that facility at $80 million. To justify such a facility, however, they would need to have several orders on hand and a clear line of sight to 6-8 orders per year over the long term. They would also need orders with at least three years of lead time since building the facility and securing the supplies could take two years. While this study was specific to the final assembly of the GE-Hitachi BWRX-300 SMR, they speculate that a reactor vessel manufacturing facility of this size would be capable of making reactor vessels for other SMR designs as well, if the other designs were known upfront and the facility could be designed accordingly.

To secure some of this economic impact and the possibility of Indiana becoming home to the go-to manufacturers for new SMR designs, the state may be able to create a broad-based program or incentive that drives nuclear component manufacturing in-state where possible and when the opportunity is significant and justified. This will require deep engagement with the technology provider, or a short-list of possible technology providers, as the project takes shape.

The second largest non-local opportunity is the turbine plant equipment, which represents approximately 10% of the total costs. Indiana holds a significant advantage when it comes to established manufacturing industries. Indiana has the fourth largest manufacturing output of any state at $289.5 billion, representing roughly 4.5% of all manufacturing. While Indiana may not be able to leverage their status as an early mover to negotiate new business opportunities in the turbine equipment side, the build will likely have an outsized in-state effect due to Indiana's critical role in U.S. manufacturing overall.

PUBLIC ACCEPTANCE *of nuclear technology hinges on transparent communication about the benefits and safety measures associated with SMRs.*

Indiana also offers several additional advantages, including the resources already available within the state, e.g., high quality coal power plant workers. As a result, Indiana can prepare the landscape on workforce development by funding educational programs to de-risk and re-train coal power plant workers and help those who want to build SMR to regain their investment.

Public acceptance of nuclear technology hinges on transparent communication about the benefits and safety measures associated with SMRs . The study outlined methods for outreach, including surveys, focus groups, and informational sessions to address public concerns. Workforce development was found to be critical, requiring collaboration with local institutions such as Purdue University, Ivy Tech Community College, and specialized training programs to prepare a skilled workforce. This preparation is essential, as SMR technology demands expertise in areas such as nuclear engineering, safety protocols, and reactor operations, which will also create new, high-paying job opportunities for Indiana residents.

A brief summary of each topic covered in the chapters of the report is provided in the following pages.

FEATURES OF SMR CONSTRUCTION

- → Compact and scalable
- → Outputs of less than 500MWe
- → Modular construction
- → Usable at smaller sites
- → Integrated with existing energy infrastructure
- → Advanced safety technology

SMR TECHNOLOGY OVERVIEW

The current landscape on SMR technology development is outlined in Chapter 2 of the report, including the potential advantages of SMRs over traditional nuclear power plants. SMRs are designed to be compact, scalable reactors with outputs of typically less than 500 MWe, and they employ modular construction techniques, which could enable shorter build times and reduced costs. SMRs are adaptable, can be built at smaller sites, and capable of being integrated with existing energy infrastructure. Advances in safety technology, such as passive safety systems that operate without active controls or human intervention, further enhance SMR appeal for Indiana's energy needs. This adaptability, combined with low carbon emissions, positions SMRs as a strong candidate for Indiana's future energy portfolio, which seeks to diversify beyond natural gas, coal, and renewable sources.

There are many variations in SMR designs and technology. Some SMRs are designed as smaller versions of traditional power plants, utilizing low-enriched uranium (LEU) fuel and a light water coolant. Other designs implement newer fuel options, such as fuel pebbles. LEU has a U-235 enrichment percentage of 5% or less. High-Assay LEU, or HALEU, on the other hand, has a higher U-235 enrichment percentage of between 5 and 20%. All currently operating commercial nuclear power plants in the United States use LEU. These reactors are classified as Generation II to III+ reactors, with the latest one built being the 1 GWe-rated AP1000 at the Vogtle Power Plant in Georgia. Various coolant types besides light water, including high-temperature gas or liquid metal, have also been proposed. SMR designs typically range from low-power units of roughly 70 MWe, allowing the choice to operate several units at a single site, to designs producing roughly 450 MWe from a single reactor.

The report reviewed seventeen U.S.-based SMR designs and two international SMR designs, with further in-depth analysis of six U.S.-based designs and one international design. The review focused on design principles, features and advantages, potential issues and shortcomings, progress to deployment, and comparison to traditional nuclear technology. These designs are shown in Figure 2, categorized by the coolant type.

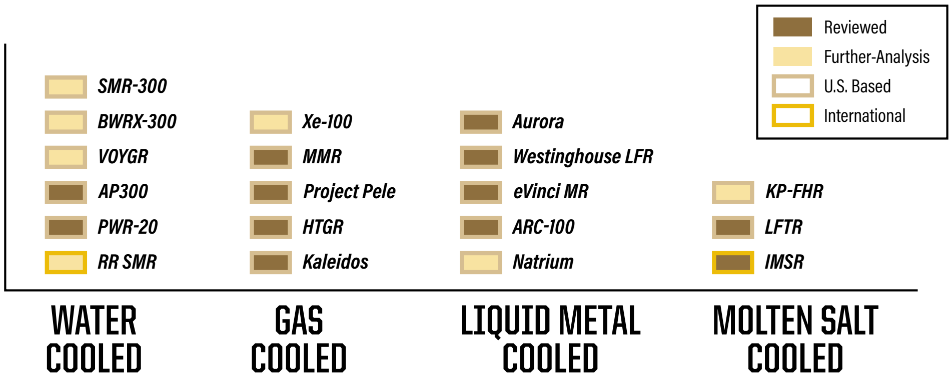

Figure 2. Reactors reviewed in this study, sorted by coolant type

U.S. electricity demand is growing for the first time in over a decade. This is spurred by data centers, the electrification of vehicles, other residential electrification, industrial process electrification, and manufacturing reshoring. It is estimated that electric load will grow by 2.4% in the U.S. from 2022 to 2030 as shown in Figure 3. According to MISO, energy consumption will grow by 1.7% per year from 2023 through 2030, a big change compared to the 0.2% annual growth rate over the prior decade. MISO analysis predicts that energy consumption will increase even further, to 3.9% per year between 2030 and 2040.

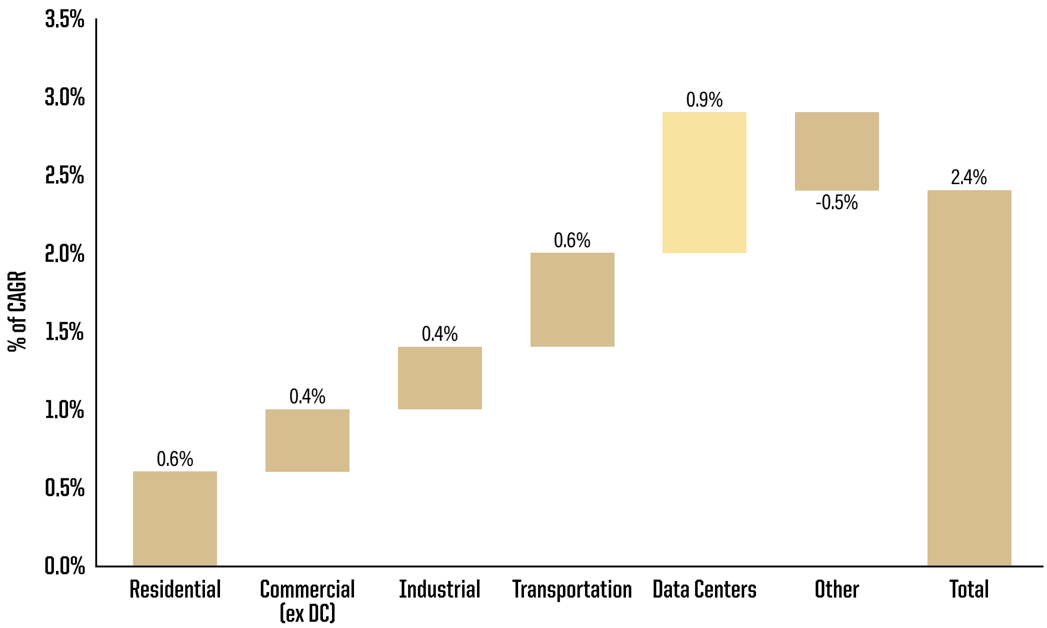

Figure 3. Factors Contributing to Expected U.S. Energy Consumption Growth from 2022 to 2030

On the supply side, nationwide power capacity additions are hitting record highs; however, they are largely dominated by intermittent renewable additions. Existing power plants, dominated by coal plants, are retiring, offsetting the effects of the new additions. MISO anticipates 7 GW of coal to retire over the coming 3 years, which, according to MISO, will keep their reserve margins tight in coming years. Similarly, Indiana's electricity generation mix has altered significantly over the past decade as a result of the changing generation resources in the state. In 2023, intermittent renewables (wind and solar) made up 13% of Indiana's generation mix, whereas 10 years before in 2013, only 3% of the electricity generated in Indiana came from intermittent renewables. Overall, the amount of electricity generated within Indiana has fallen by 26% over the past two decades although electricity consumption has stayed relatively steady, only decreasing by 3% over the same time period (Figure 4). The remaining electricity has been imported; in 2023, about 14% of all electricity consumed in the state was imported from out-of-state generators.

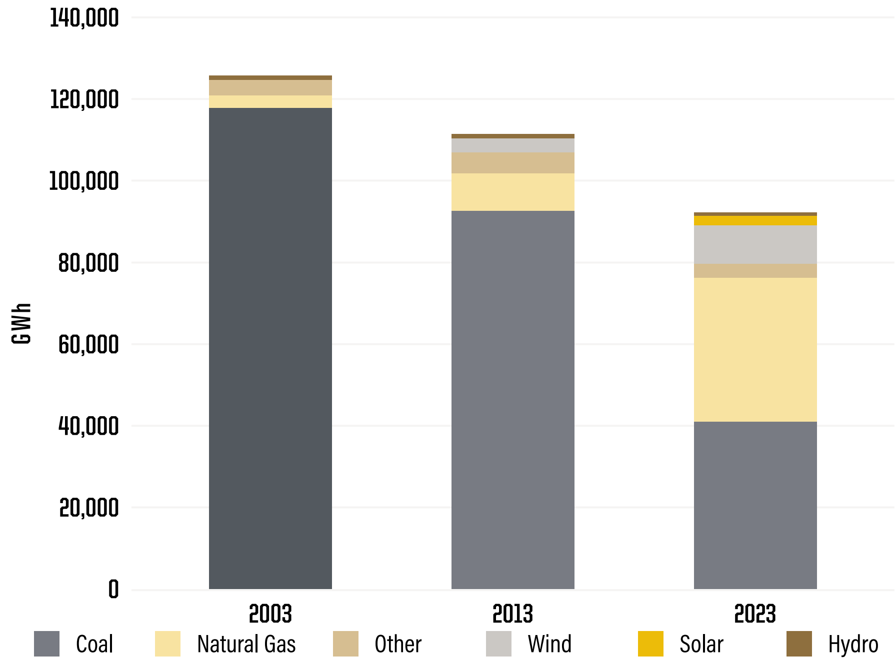

Figure 4. Electricity Generation by Fuel Type in Indiana

The first Department of Energy (DOE) Coal-to-Nuclear (C2N) report published in 2022, found that Indiana has the second most coal plants that are suitable for conversion to nuclear power plants. Indiana was found to have 8 to 10 coal plants suitable for the development of nuclear plants according to the screening tool used by the DOE, the Oak Ridge Siting Analysis tool for Power Generation Expansion (OR-SAGE). Only Texas has more suitable coal power plant sites with 14 to 15 sites. The report also evaluated recently retired coal sites, where Indiana had 9 sites suitable for a nuclear power plant according to the OR-SAGE screening tool, among the top handful of states with Pennsylvania having the most, 11 sites, Michigan and Ohio each having 10 sites, and Indiana and Kentucky, each with 9 sites.

Key benefits cited by the DOE for C2N included the following:

- Mitigate the economic impacts of closing a coal plant, instead turning it into an opportunity
- Need for carbon-free baseload power throughout the country
- Existing site, minimizing environmental impacts of new site
- Existing workforce with some relevant skill sets
- Existing infrastructure: roads, water, grid interconnection equipment, and ancillary site improvements such as office buildings, fencing, and security.
- Possible reuse of plant components such as the heat sink and the electric plant equipment.

Additionally, when a coal plant is replaced with nuclear, it is replacing a baseload power resource directly and can serve the same load as the coal plant served previously. Furthermore, most coal plant sites are located in energy communities, as designated by the DOE, and this designation allows nuclear plants in that zone to earn an extra 10% on their Investment Tax Credit (ITC).

ECONOMIC IMPACT

The economic benefits of deploying SMRs in Indiana are considerable as outlined in Chapter 3 of the report. Based on the present study, it is estimated that building a 500 MWe SMR could create approximately 2,000 direct jobs during a four-year construction phase, injecting over $500 million annually into the state's economy. Once operational, a 500 MWe SMR plant could employ about 140 full-time workers, who, on average, earn 18% more than those in equivalent coal plants. The report also notes that the long-term economic impact of an operating SMR—estimated at around $352 million annually—doubles that of a coal plant of the same size. Additionally, SMR deployment could stimulate job growth in related industries, including those in supply chains for nuclear manufacturing, skilled trades, and maintenance.

ECONOMIC BENEFITS OF 500MWe SMR

→ Four year construction phase could create approximately **2,000 direct jobs** and inject **$500M+ annually** into the state's economy

→ Operational phase could employ **140 full-time workers** earning 18% more on average than those in coal plants with an estimated economic impact of **$352M annually**, double that of a similarly sized coal plant

The total cost of nuclear energy includes capital costs (CapEx), operational costs (OpEx) and financing costs. Putting together the CapEx, OpEx, incentives, and financing costs, then dividing the total by the energy that the plant is expected to produce allows us to estimate the levelized cost of energy (LCOE) for new nuclear power plants. LCOE is a useful, but not perfect, metric to compare energy costs between different power plant types. The CapEx for SMRs in the U.S. are not widely agreed upon, as none have been constructed in the U.S. to date, and only a few in the world have been completed. Many studies use a normalized cost of building the Vogtle Reactors, a pair of large Westinghouse AP-1000 reactors built in Georgia at an existing nuclear site that came online in mid-2023 (Vogtle 3) and early 2024 (Vogtle 4). These reactors were the FOAK in the U.S.,

Figure 5. Global Cost of New Nuclear Construction, Since 2000

meaning it was the first time a Westinghouse AP-1000 was built in the U.S. The OCC for the Vogtle Plants was about $11,000/kW.

Like all technologies, the FOAK is expected to be the costliest deployment, with costs lowering over time according to a learning curve. One of the key drivers of this effect is that the first time a design is built, the regulators must review and provide feedback on the new design, often with licensing activities and feedback, and the ensuing redesigns are ongoing as the project is under construction. On the other hand, like all technologies, second and third implementations, or later implementations, also called NOAK, are less expensive because the design is finalized, the supply chain is secured and vetted, the engineering processes are streamlined, and the process is beginning to benefit from economies of scale.

The DOE Liftoff Report published by its Loan Program Office (LPO) examined the ways in which the costs of a "Best Practices FOAK" should be expected to be 30-40% lower than the OCC of the Vogtle Project, or $6,200/kW. Additionally, it was reported that there could be significant opportunities for savings between the FOAK and the NOAK that could reduce costs by another 40%.

THE COSTS OF OPERATING *a nuclear power plant tend to be about half of the operating costs of a gas turbine plant or coal plant of the same size.*

Even if an SMR has the same normalized cost as a large reactor, because the total cost is less, it may be easier for the project to begin. Due to their modularity, even if the financing is only available for one third of the project, it may be possible to build one third of the project until the remaining money becomes available. Because of their lower total cost, the projects may be easier to finance and quicker to deploy, and thus SMRs may reach NOAK pricing before large reactors do.

Nuclear reactors in the U.S. are required to share information publicly on the cost of operations. While all existing reactors are large reactors, and not SMRs, the data offers some general insight into the operational costs of nuclear power plants generally. The costs of operating a nuclear power plant tend to be about half of the operating costs of a gas turbine plant or coal plant of the same size. As shown in Figure 6, the operational costs of running a nuclear plant are about 75% operation & maintenance (O&M) costs and 25% fuel. Conversely, the fuel costs

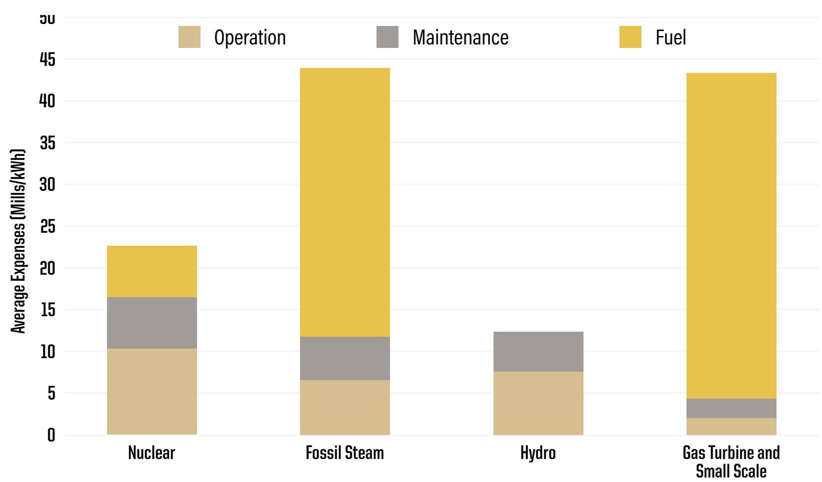

Figure 6. Operation Costs for Generators reported on Federal Energy Regulatory Commission (FERC) in 2022

are about 75% of the operating costs of a coal or gas plant, with the remaining 25% covering the O&M cost.

Overall, a nuclear plant typically creates twice the number of local jobs compared to a similarly sized coal plant with nuclear plant workers earning 18% more than coal plant workers on average. A nuclear power plant's revenue is also assumed to be about 78% higher than a coal plant because nuclear plants have a higher capacity factor. In total, the economic output of a 300-500 MWe nuclear power plant was typically two times higher than the economic output of a coal plant of the same size in communities with more than 90,000 people.

The expected economic impacts for a 300 MWe and 500 MWe nuclear power plant in a community of 200,000 people or more is shown in Table 1. Although nuclear power plants are typically located in small communities to comply with federal regulations, the county size of 200,000+ is shown to approximate the economic impacts to the larger region (as opposed to just the local community), as that is more important for state considerations. It is worth considering that many of the coal sites analyzed in the site analysis are located along the Wabash or Ohio rivers that form borders with Illinois and Kentucky, respectively,

Table 1. Nuclear Power Plant Operations Annual Economic Impact for Communities of 200,000+

		Employment (Jobs)	**Labor Income** ($ Millions)	**Value Added** ($ Millions)	**Total Output** ($ Millions)
300 MWe Plant	*Direct Effect*	100	$16.1	$53.5	$136.7
	Indirect Effect	161	$15.3	$30.9	$60.0
	Induced	91	$5.1	$9.2	$15.8
	Total	**352**	**$36.5**	**$93.7**	**$212.5**
500 MWe Plant	*Direct Effect*	140	$22.6	$84.9	$227.8
	Indirect Effect	269	$25.5	$51.6	$100.0
	Induced	139	$7.9	$14.1	$24.2
	Total	**548**	**$55.9**	**$150.6**	**$352.0**

and some of the regional economic impacts for those sites may go to those neighboring states.

REPURPOSING COAL SITES TO NUCLEAR

Indiana's retired coal plants offer promising locations for SMR installation, with eight potential sites identified for further investigation. Chapter 4 of the report shows that repurposing coal sites could reduce SMR project costs by 7-26%

due to existing infrastructure, transmission lines, and available space. Such a C2N transition aligns with Indiana's goals of reducing carbon emissions and reinvigorating local economies. Furthermore, SMRs' smaller footprints and flexible siting requirements make them well-suited to fit within or near these former coal plant sites. This approach would provide a steady, dispatchable source of low-carbon energy to meet the expected statewide electricity demand increase of 1.5-3% per year through 2030.

In view of this, a site analysis was performed on coal plant sites in Indiana for the purpose of converting one to an SMR. Various factors such as population density, seismic activity, and retirement status were considered when narrowing down a potential site, and remaining sites were then prioritized to find sites hypothetically ideal for SMR development. Due to the many benefits of coal-to-nuclear, all existing coal plants and coal plants retired within the last 10 years were included in the site analysis. Three factors were used to screen out sites that are not likely to be developed because of their geography:

HIGH POPULATION: Since this work focuses on the deployment of SMRs that have smaller source terms and emergency planning zones (EPZs) than the large conventional nuclear power plants, the population density was evaluated within a 4-mile radius of the site. There should be no population centers of 25,000 or more within 4 miles of the site. There should be no 100 m by 100 m cells with greater than 500 person-per-square-miles (ppsm) within 2 miles of the site. Six sites were screened out as too populated by one or both of these measures. In reality, SMRs may have a smaller radius than 4 miles depending upon the size of each reactor and the determination of the NRC. Still, those sites are not likely to be prioritized for early development due to the nearby population centers and the regulatory uncertainty/risk.

HIGH SEISMIC: The 2002 EPRI siting guide suggests that large LWR technologies should be located on sites with a safe-shutdown earthquake (SSE) peak ground acceleration of less than 0.3g. Some SMRs are designed to withstand up to 0.5g of ground acceleration, and STAND, the DOE's publicly available Siting Tool for Advanced Nuclear Development, can be adjusted to screen accordingly. For this initial screening, the level was left at 0.3g to be conservative. Two coal plants in the southwestern part of the state were found to exceed that level and were eliminated as potential sites.

100-YR FLOODPLAIN: STAND identifies if the site is in the 100-year floodplain, which applied to three of the coal sites in this study. The NRC does not prohibit nuclear development on a 100-year floodplain though it will likely make construction and permitting more difficult. It may also make permitting with the local or state authorities more difficult.

Additionally, certain criteria make a site less likely to be prioritized for early nuclear development:

HAZARDOUS FACILITIES: STAND identifies any hazards and protected sites within a 5-mile radius of the site that might be impacted by the site or present a hazard to the nuclear plant. Any of these have the potential to make permitting difficult, but given the prevalence of such sites, they are nearly impossible to completely avoid. Nearly all sites were near at least 1-3 hazardous facilities. Sites with 4-6 nearby hazardous sites were deemed non-priorities. Only one site had more than six hazardous facilities nearby. However, that site was already screened out as a high-population area.

INVESTMENT TAX CREDIT (ITC) ADDER: Sites located in DOE designated energy communities would qualify for an additional 10% adder to their ITC. This adder has a significant economic impact and unqualified sites are unlikely to be prioritized. Nearly all of the existing and former coal sites would qualify for this adder, and those that don't qualify now would most likely qualify once the coal plant retired since that is a determining factor in designating energy communities. There is one additional energy community in north central Indiana that does not have an operating or recently retired coal plant, and a site in that region was included in the analysis. The remaining two sites in northeastern Indiana that were included for geographic diversity, are not in energy communities and, therefore, would miss out on the 10% adder for the ITC.

COAL-TO-NUCLEAR ECONOMIC BENEFITS: The sites that hosted coal plants with a small electrical capacity, e.g., less than 200 MW, would not benefit from many of the C2N economic savings. Therefore, these sites would not be as likely to be prioritized and are designated as "small." The sites selected for geographical diversity that are not coal plant sites would also not be prioritized since they would not benefit from those economic advantages either, those designated as "greenfield."

HEAT SINK AVAILABILITY: The STAND tool also identifies whether a site has suitable water resources for cooling a nuclear power plant, with 50,000 gallons per minute being the suggested streamflow for a 300 MWe SMR. The tool flags any site without sufficient streamflow within a 20-mile radius, and they are designated as "low water." This designation affected two sites: one that had been eliminated as too populated and another that had already been deprioritized as a greenfield site. Some SMR technologies would not be affected by this criterion because they depend on dry cooling.

The study identified eight coal sites to be suitable for SMR development as shown in Figure 7, including six existing coal plant sites and two recently retired coal plant sites. An additional eight sites pass the highest level of technical screening

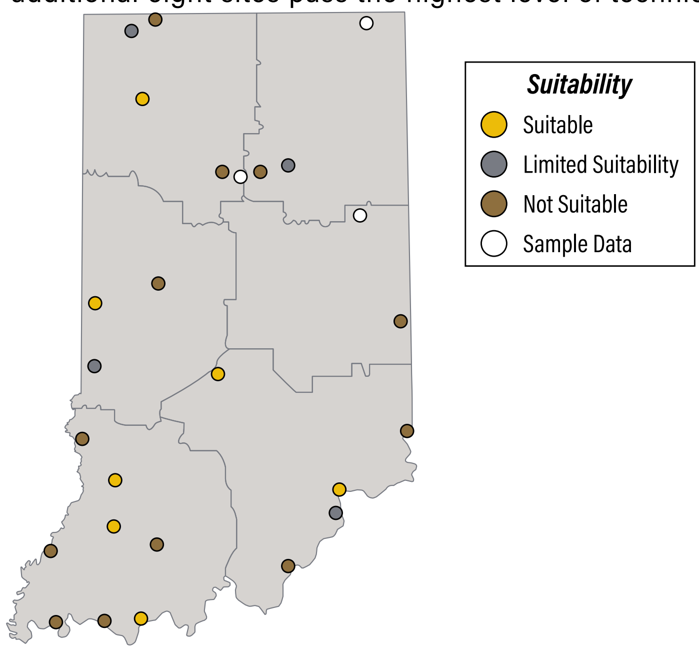

Figure 7. Sites Evaluated for Nuclear Suitability throughout Indiana. Here 'sample data' denotes greenfield sites selected for geographic diversity.

but have one or more factors that would make them unlikely to be prioritized.

WORKFORCE NEEDS

To ensure successful integration of SMRs, Chapter 5 outlines the need for development of a skilled workforce. Workforce development is critical, requiring collaboration with local institutions such as Purdue University, Ivy Tech Community College, and specialized training programs to prepare a skilled workforce. This preparation is essential, as SMR technology demands expertise in areas such as nuclear engineering, safety protocols, and reactor operations, which will also create new, high-paying job opportunities for Indiana residents.

As SMR technology is adopted more widely, the demand for skilled professionals in the nuclear energy sector is anticipated to rise due to the unique operational and regulatory requirements associated with SMRs. Specialized construction and liaising with the state regulatory bodies will require training. Consequently, states like Indiana, that are actively considering the implementation of SMR technology, are poised to become leaders in nuclear training and education. This positioning could enhance Indiana's role in shaping the future workforce for the nuclear industry, thereby contributing toward both local and national energy goals.

SMR TECHNOLOGY DEMANDS *expertise in areas such as nuclear engineering, safety protocols, and reactor operations, which will also create new, high-paying job opportunities for Indiana residents.*

As the energy sector shifts from fossil fuel-based power generation to nuclear energy, it is essential to recognize that workers trained in various fields will require reskilling and retraining to adapt to the new employment environment. This is particularly true for workers with experience in power generation facilities utilizing alternative heat sources. This transition to nuclear energy necessitates a comprehensive evaluation of existing educational programs to identify relevant opportunities for workforce development. In this context, programs at Ivy Tech Community College of Indiana (in the future referred to as Ivy Tech Community College or Ivy Tech) and Purdue University have been assessed to serve as examples. This evaluation has led to identifying specific training initiatives and educational pathways that can effectively support workforce reskilling, ensuring that individuals are equipped with the necessary knowledge and skills to thrive in nuclear energy facilities. By focusing on developing targeted training programs, these institutions can play a pivotal role in facilitating the transition of workers from fossil fuel environments to the nuclear sector, thereby contributing to a sustainable energy future for Indiana.

The planned synergy between and within Ivy Tech Community College, Purdue Polytechnic Institute, and Purdue Nuclear Engineering as well as other related disciplines are designed to deliver comprehensive nuclear training for Indiana's workforce across all levels.

Collectively, these institutions create a robust ecosystem that prepares students for immediate employment in the nuclear sector and fosters continuous professional development. Students could get certificates to cover first-year engineering requirements for nuclear engineering or associate with specialized skills training before transferring into the nuclear engineering technology (NET) program. The NET program then would foster skills within the chosen discipline of nuclear science, operator training, or continuous technician skills. Operator training would heavily emphasize simulator training, which is core to the role, with 5 weeks of on- and off-simulator training required in current nuclear power

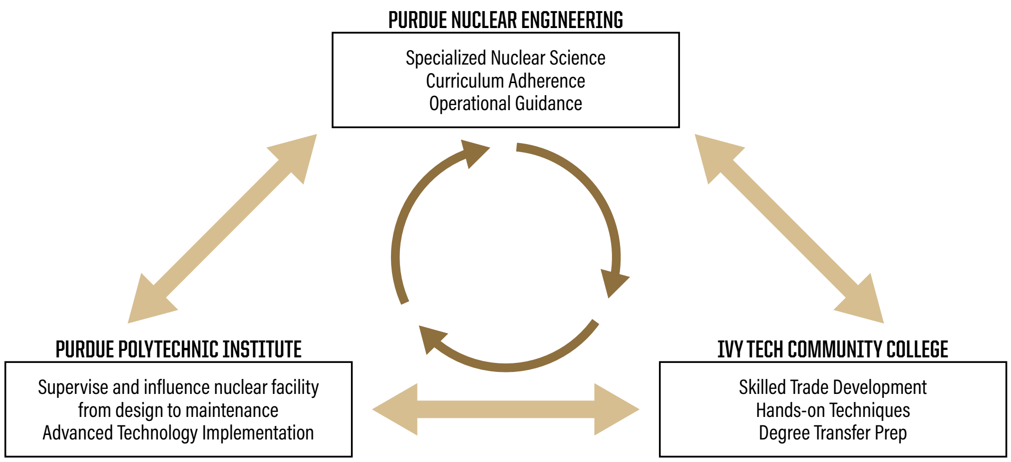

Figure 8. Collaboration Plan

plants per NRC regulations. This effectively addresses the evolving needs of the workforce and bolsters the state's economic growth in the nuclear energy field. To ensure the long-term success of these efforts, it is essential to consider how to develop the nuclear energy talent pipeline.

ENVIRONMENTAL AND SAFETY CONSIDERATIONS

Chapter 6 of the study underscored the importance of thorough environmental and safety assessments for SMR projects. SMRs have smaller emergency planning zones (EPZs) and use advanced safety features that limit the risk of severe accidents compared to traditional nuclear reactors. Nonetheless, comprehensive environmental reviews and community-centered safety plans are essential to address concerns related to radiation, nuclear waste management, and ecosystem impact. These assessments must comply with federal and state regulations, and the report recommends further studies on seismic stability, proximity to population centers, transportation safety, and infrastructure needs at potential SMR sites. Additionally, repurposing coal sites for SMR deployment can help mitigate the environmental impacts associated with coal plant operations and reduce Indiana's carbon footprint.

SMRs HAVE SMALLER EMERGENCY PLANNING ZONES *and use advanced safety features that limit the risk of severe accidents compared to traditional nuclear reactors.*

Best practices and safety features in SMRs include inherent safety features, advanced control systems, modularity, redundancy, and resilience as summarized below:

INHERENT SAFETY FEATURES: SMRs rely on natural circulation systems, air-cooling systems, and passive shutdown systems to eliminate the need for active pumps or other machinery to shut down the reactor and remove the decay heat. In addition, inherent safety systems reduce maintenance and operation costs, allowing for a simpler design without the need for complex piping layouts and configurations.

ADVANCED CONTROL SYSTEMS: The advanced control systems in SMRs represent a significant evolution in instrumentation and control (I&C) technology, aimed at enhancing safety, security, and operational flexibility.

MODULARITY, REDUNDANCY, AND RESILIENCE: The three main consistent economic savings measures due to modularization include ease of transport, standardization, and shorter build schedules. The reduced size and weight of SMRs allow for transportation on existing roads and bridges. This dramatically decreases logistical difficulty and allows 80% of the plant to be built off-site. Standardization allows for plants to be built on an assembly line-style format, which will dramatically decrease fabrication costs as supply chains and expertise can be localized.

Furthermore, selecting a suitable site for SMR deployment requires careful evaluation of multiple environmental and regulatory factors to ensure operational safety and long-term viability. Key criteria for site selection include seismic and geological stability, proximity to existing infrastructure, and environmental impact considerations, all of which are essential to meeting regulatory requirements and supporting safe, efficient operations. Before a nuclear plant can be licensed, an EPZ must be developed. The EPZ is broadly defined to be the area in which any type of emergency planning would be necessary in the case of a major event. EPZs are broken down into several overlapping zones that represent areas where particular actions may be necessary. Current regulation for a traditional reactor requires a ten-mile EPZ for plume exposure and a fifty-mile EPZ for ingestion exposure. However, due to their smaller size and additional safety features, EPZs for SMRs are expected to be smaller than those of traditional nuclear power plants and may not be required to extend beyond the plant's site boundary.

KEY CRITERIA *for site selection include seismic and geological stability, proximity to existing infrastructure, and environmental impact considerations.*

COMMUNITY ENGAGEMENT

Public acceptance of nuclear technology hinges on transparent communication about the benefits and safety measures associated with SMRs. Chapter 7 of the report discusses the importance of community engagement in Indiana's SMR deployment process. Recognizing that public perception, trust, and understanding are essential for successful SMR integration, the chapter explores community feedback and outlines engagement strategies based on insights from focus groups and a statewide survey. Some of the key components include:

COMMUNITY ATTITUDES AND CONCERNS: The report reveals diverse opinions among Indiana residents on nuclear energy and SMR technology. Participants expressed a general concern for safety, transparency, and potential environmental impact, referencing historical nuclear events like Chernobyl and Fukushima. The feedback highlights the need to address both real and perceived risks associated with SMRs, emphasizing that many residents are unfamiliar with advanced nuclear technologies and may have knowledge gaps.

THE FEEDBACK HIGHLIGHTS *the need to address both real and perceived risks associated with SMRs, emphasizing that many residents are unfamiliar with advanced nuclear technologies and may have knowledge gaps.*

ENGAGEMENT METHODS: The chapter discusses the use of focus groups and surveys to gather input. Focus groups involved local government officials, economic developers, utility representatives, and emergency managers, while the survey targeted Indiana residents to understand broader public perceptions. Topics included attitudes toward nuclear energy, siting preferences, and knowledge of SMRs. The methods aimed to provide a structured dialogue with residents, gathering insights to inform communication and education strategies. The survey was limited to Indiana full-time residents above the age of 18 years. The quotas for gender were 48% male, 52% female, and non-binary, natural fallout. The quotas for age ranges were 30% for 18-34 years, 32% for 35-54 years, and 38% for ages 55+. The quotas for residential locations were 60% urban, 20% suburban, and 20% rural, with a population breakdown of metropolitan, 78.4%, micropolitan, 14.9%, and noncore, 6.6%. The additional consideration that small modular reactor technology may likely be installed in rural areas due to potential restrictions in zoning in micropolitan and metropolitan regions necessitated an oversampling of rural respondents.

SURVEY FINDINGS: The survey findings indicate that while there is some support for nuclear technology as a clean energy option, concerns remain about siting, safety, and environmental impacts. Participants who supported SMRs highlighted potential benefits, including energy reliability and economic growth, particularly if repurposed coal plants were used as SMR sites.

Perceptions of safety and adequate emergency response were two predominant themes of concern in all focus group discussions. Specifically, in discussions with local government officials, economic development, planners, and emergency responders, the concern about the lack of knowledge and the ability of local government and emergency responders to be able to adequately address nuclear considerations, especially in counties that are underfunded for emergency responses and have limited or no hospital and medical access.

Each focus group mentioned the advantages of nuclear energy, such as being more efficient in operation and land use, more reliable, and a cleaner energy source than natural gas. Nuclear power was also compared as an alternative to solar power, with the advantage of a smaller footprint. All focus groups additionally mentioned economic development and job creation as advantages of nuclear.

Trusted sources of information mentioned in all focus groups included universities with expertise in nuclear energy and land use, such as Purdue and Purdue Extension as a technical assistance provider, federal government offices and laboratories researching nuclear energy, the U.S. military through its long history with nuclear energy, and nuclear industry experts. Focus group participants also discussed general locations for SMRs. Both local economic developers and elected officials mentioned repurposing coal fire plants that have retired or are retiring.

All four focus groups discussed community engagement in siting SMRs. A theme that emerged was the importance of informing and educating participants, citing the newness of SMR technology and the lack of conventional nuclear energy production in Indiana as primary reasons. Participants listed the general public, decision-makers, and youth as three distinct audiences for education.

Other considerations for electricity generation that the focus groups addressed included adding nuclear to long-term plans of 20 years or more, especially considering SMRs are a new technology and development and construction require long timelines. All groups also mentioned the need for a balanced approach of multiple energy sources, including nuclear.

Only 6.3%, or 64 out of 1,012 respondents, felt that they were well informed about nuclear energy used to produce electricity. Slightly more than sixty percent (61.3% or 620 out of 1,012 respondents) of respondents mentioned that they had not heard about the advanced-design nuclear power plants and SMRs.

On the opposite end of the spectrum, 46% of respondents (465 out of 1,012 respondents) either favor or strongly favor the idea of using SMR technology as one of the ways to produce electricity in the U.S., with nearly 13% (12.7%) of all respondents strongly in favor.

Respondents were asked to select their three greatest concerns about the SMR nuclear technology from a given set of concerns. Risk of accident (63.4%) and production of radioactive water (55.7%) were the greatest concerns as both concerned more than half of all respondents. Onsite waste storage (41.3%) was a concern of about two-fifths of the respondents. Cost of nuclear power (24.1%) and lack of understanding of the technology (23.1%) concerned almost a quarter of respondents. Respondents were least concerned with lack of transparency in regulatory or development process (17.8%), time it takes to build a power plant (11.8%), competition with investment in renewable energy (9.5%), and fuel reliance from foreign adversaries (9.3%). Approximately one in ten respondents (10.5%) responded that "I do not have concerns about nuclear power."

Respondents were asked to select three strongest arguments for using the SMR nuclear technology. The top three arguments for SMR nuclear technology were low cost of electricity (48.1%), energy independence (40.7%), and reduction of greenhouse gases (38.2%), followed by preservation of natural resources (35.8%), good paying jobs (28.5%), reliability of electricity (28.1%) and safety of nuclear facilities (17.1%). The least strong argument for SMR was the battery storage capability for other energy production, with only 7.6% of respondents citing it as one of their top three. Meanwhile, nearly one in six (15.4%) respondents indicated that they do not have a strong argument for nuclear power.

Respondents weighed in on the perceived trustworthiness of various sources of information on nuclear technology. The twelve options included elected

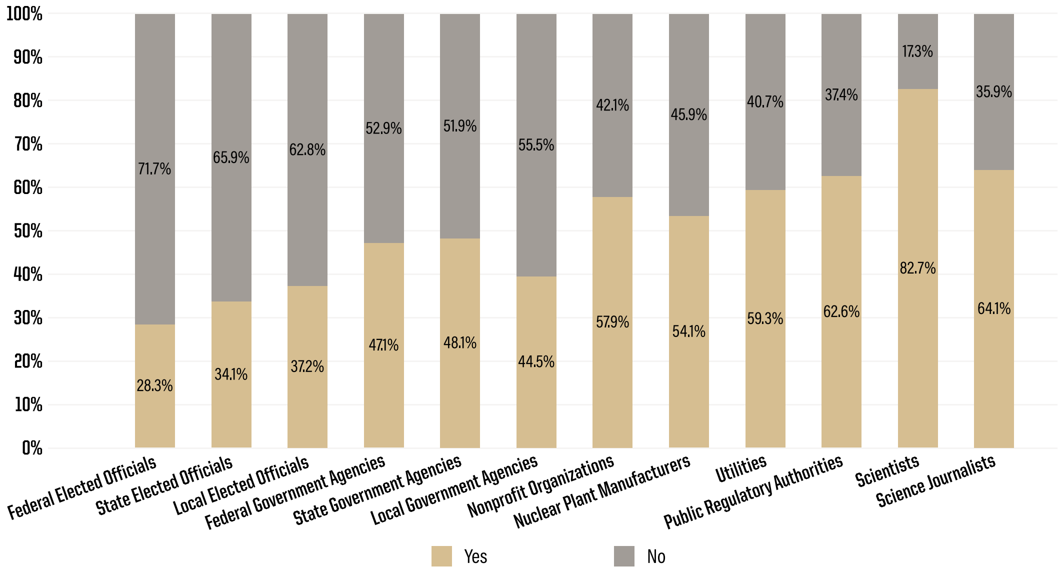

Figure 9. Which of the following do you think are trustworthy sources of information on nuclear technology?

COMMUNITY SURVEY RESPONSES

46% of respondents (465 out of 1,012) either **favor or strongly favor** the idea of using SMR technology to produce electricity in the U.S.

→ *ARGUMENTS FOR*

- Low cost of electricity, **48.1%**
- Energy independence, **40.7%**
- Reduction of greenhouse gases, **38.2%**

→ *CONCERNS WITH*

- Risk of accident, **63.4%**
- Production of radioactive water, **55.7%**

82.7% OF SURVEY RESPONDENTS *reported that they thought scientists were the most trustworthy source of information on nuclear technology.*

officials, governmental agencies, organizations, businesses, science journals and scientists. Of the 1,012 valid responses, respondents selected Federal Elected Officials as the least trustworthy amongst the twelve sources of information for nuclear technology (Yes = 28.3%), followed by State and Local elected officials (Yes = 34.1% and 37.2%, respectively). In contrast, the most trustworthy resource was Scientists (Yes = 82.7%).

While elected officials had the lowest level of trustworthiness, government agencies performed better with state government agencies being the most trustworthy sources of information amongst the three (Yes = 48.1%) and local the least (44.5%). In comparison, 62.6% and 64.1% of respondents selected public regulatory authorities and science journalists as trustworthy sources of information about nuclear technology. Meanwhile, utilities, nonprofits, and nuclear plant manufacturers received 59.3%, 57.9%, and 54.1% affirmative responses, respectively.

The gap between affirmative response between scientists, the top-ranked option, and science journalists, the second-ranked option, is almost 19 percentage points. An impressive eight in ten respondents in the Hoosier state selected scientists as trustworthy sources of information.

27% of respondents were confident that SMR nuclear power plants are very safe, and 38% were confident that SMR nuclear power plants are moderately safe. This means that 65% of respondents, or three in five respondents, considered SMR nuclear power plants as either very safe or moderately safe. Nearly one in four (23%) respondents reported that they didn't know about the safety aspects of the SMR nuclear power plants. 12% of respondents replied that the SMR nuclear power plants were not safe.

EDUCATIONAL OUTREACH NEEDS: To improve understanding, the study recommends creating accessible educational resources tailored to different audiences, including residents, policymakers, and youth. Suggested formats include Q&A

sessions, short videos, educational bulletins, and online resources. The study underscores the importance of science-based information from trusted sources, like scientists and regulatory bodies, to counter misinformation and build trust.

The community engagement study concludes with specific recommendations, emphasizing that community engagement should be an ongoing, transparent process. State agencies are encouraged to work with local leaders and trusted facilitators to develop engagement programs that foster open dialogue and collaboration. A central recommendation is the partnership between state agencies and engagement experts to develop training for local officials and to set clear expectations about the outcomes of the engagement process, focusing on trust-building at the community level.

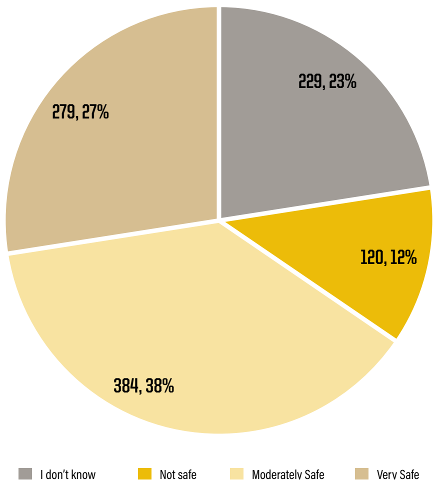

Figure 10. What is your level of confidence in the operational safety of nuclear power plants – SMR nuclear power plants.

CONCLUSION

The study concludes that SMRs present a viable opportunity for Indiana to transition to a cleaner, resilient, and diversified energy future. Successful deployment of SMR technology, however, requires a careful balance of economic, regulatory, and social considerations along with development of the technology. By addressing the outlined challenges—construction costs, supply chain constraints, regulatory compliance, workforce training, and community engagement—Indiana could position itself as a leader in next-generation nuclear technology while creating economic opportunities and ensuring energy security. The findings in the study recommends that the state as well as Indiana energy stakeholders proceed with feasibility studies, build partnerships for SMR development, and prioritize stakeholder engagement to ensure SMRs are integrated smoothly and beneficially into the state's energy portfolio.

STUDY CONCLUDES

SMRs present a **viable opportunity** for Indiana to transition to a **cleaner**, **resilient**, and **diversified** energy future.

SUCCESSFUL DEPLOYMENT REQUIRES

- Balance of **economic, regulatory**, and **social** considerations
- Development of **technology**


INDIANA