The Role of Small Modular Reactors in Decentralizing Energy Production: Assessing Economic Viability, Safety, and Environmental Impact in Underdeveloped Regions

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Abstract

Small modular reactors (SMRs) have shown great promise in decentralizing energy production, particularly in developing countries where energy access remains a significant barrier. This paper argues that SMRs represent a strategic and feasible energy option for developing nations through an analysis of their technological viability, economic impact, and policy considerations. Analysing safety features, deployment strategies, and financial models of SMRs can effectively provide insight into how they may be used to fill the global energy gap and promote a more equitable and sustainable energy future. Environmental evaluations also take into account disasters related to conventional systems, efficiency, and overall carbon emissions. Research results indicate that, in spite of obstacles, including SMRs into distributed energy systems could be essential for addressing world energy inequalities and accelerating the shift to a low-carbon future.

Keywords: Small Modular Reactors, Renewable Energy, Nuclear Safety, Economic Development, Decentralized Energy Production

1. Introduction

The World Bank notes that developing countries often pay more for electricity, lack access to clean energy projects, and continue to rely on fossil fuels, consequently suffering a triple disadvantage in the transition to clean energy. There are numerous difficulties in the global energy environment, especially in balancing growing energy needs with sustainable energy solutions. Low-income nations undoubtedly demonstrate these difficulties; poverty, inadequate technology, and environmental problems limit access to consistent, clean energy. These issues permeate the risk of exacerbating world inequality and increasing the effects of climate change in the absence of prompt and practical solutions (World Bank, 2023).

1.1 Potential Role of SMRs

Amid these challenges, SMRs prove to be a viable solution through their modular design, passive safety approach, and reduced infrastructure, making them particularly suited for regions with limited energy capabilities.

1.2 Research Objective and Scope

This paper explores the economic viability, safety, and environmental impact of SMRs in underdeveloped regions. It argues that SMRs offer a strategic and feasible energy solution for decentralizing energy production in the developing world.

2. Discussion

2.1 What is an SMR

Small Modular Reactors represent a newer category of factory-produced, compact nuclear reactors designed for modularity and deployment. Unlike traditional large-scale reactors, which require significant infrastructure and a considerable upfront capital cost, SMRs can be implemented incrementally to meet specific local energy requirements. Because of their modular construction, which allows for faster assembly on-site, easier transport, and faster manufacturing, they form a very attractive alternative to both developed and, primarily, developing areas. A physical representation of SMRs can be seen in Figure 1, where leading SMR organization NuScale Power introduces its power module alongside its components.

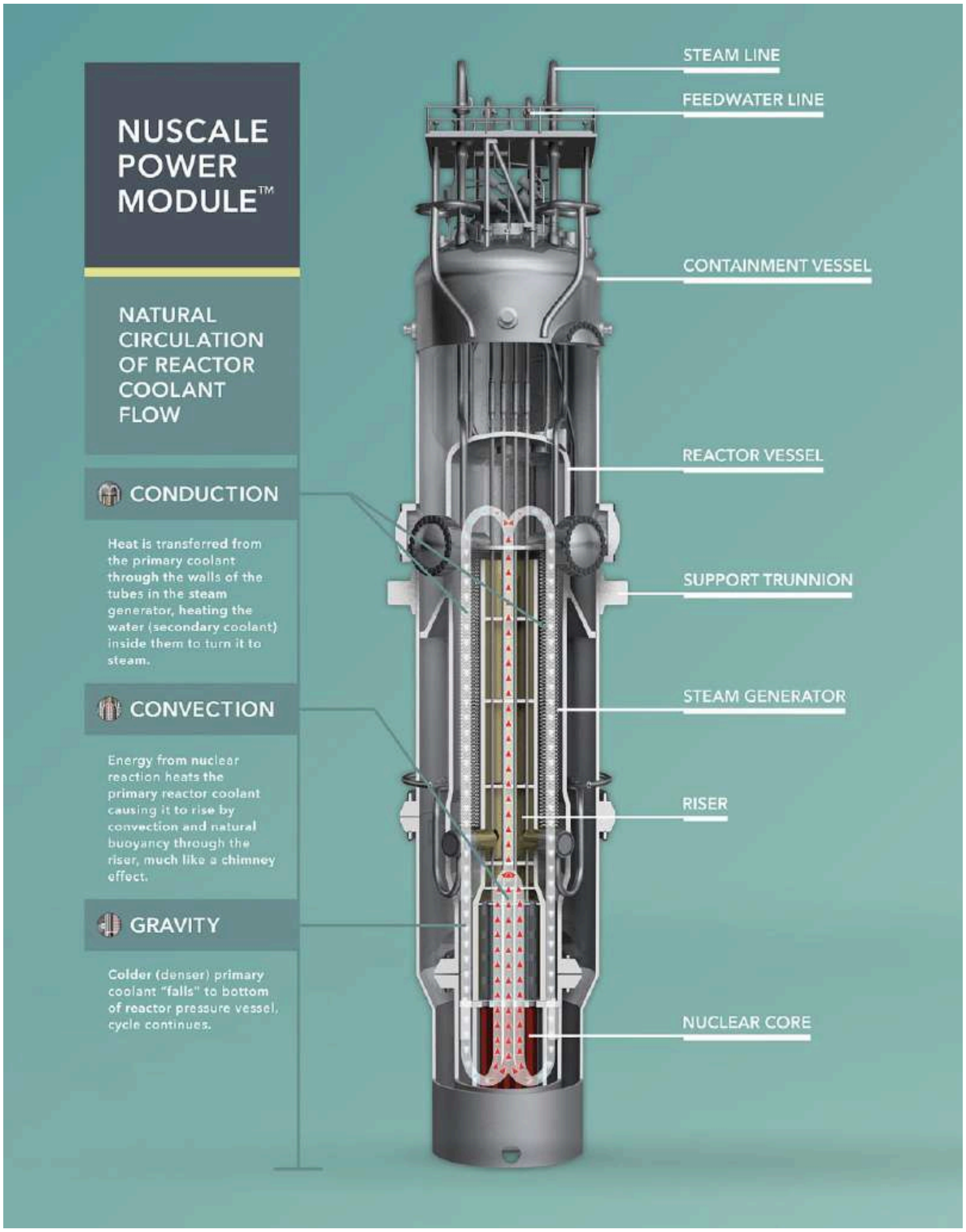

Figure 1. NuScale (A leading SMR producer) power module with an outline of components and purpose (Nuscale Power, 2025)

2.2 Types of SMRs

SMRs come in a variety of designs, some of which are in the conceptual or early stages of development and others of which are operational or under construction. The four primary SMR categories under pursuit include the following (World Nuclear Association, 2024):

2.2.1. Light water reactors, or LWRs, pose the least technological risk as they resemble traditional nuclear reactors. They slow down the neutrons released during fission by using water as a moderator and coolant. Because they function at comparatively lower temperatures than other designs, their efficiency is moderate. Low-enriched uranium (LEU) is their fuel; it is readily available but needs to be enriched from natural uranium.

2.2.2. Fast neutron reactors, or FNRs, differentiate in the respect that they do not require a moderator and offer advantages like longer operating times between refuelings, reduced nuclear waste, and improved fuel efficiency. They can operate at high temperatures because they usually use liquid helium, lead, or sodium as a coolant. Their high efficiency is a result of better fuel and neutron economy. They make better use of the enormous uranium-238 reserves, which make up more than 99% of natural uranium, by using natural uranium, depleted uranium, plutonium, or mixed oxide (MOX) fuel.

2.2.3. High-temperature reactors, or HTRs, utilize graphite as a moderator and, as the name suggests, operate at temperatures significantly higher than those of conventional reactors; these can achieve high levels of thermal efficiency (up to 50%). They can operate steadily and safely because they are frequently cooled by CO2 or helium.

2.2.4. Lastly, the molten salt reactor. MSRs offer increased safety and efficiency (up to 45–50%) by using liquid molten salt as a coolant and a fuel carrier. While some thermal-spectrum MSRs use graphite as a moderator, fast-spectrum designs do not require one. LEU, which is three to four times more abundant than uranium, can be used in MSRs.

Table 1: Comparison Chart between Energy Sources (McHugh, 2023)

	Small Modular Reactors (SMRs)	**Traditional Nuclear Reactors**	**Renewable Energy (Solar/Wind)**
Scalability	High – 50 MW to 300 MW per unit	Low – fixed large-scale projects, typically 700 MW to 1600 MW per plant	High – can be installed incrementally; 1 MW to 500 MW
Construction Time	Shorter, estimated 3 to 5 years per unit (factory-built, assembled on-site)	Longer, typically 7-10 years (complex on-site construction)	Short, 1 - 3 years, but subject to permitting and land use
Upfront Cost	Medium/High 50M $ - 3B $	High 6B $ - 9B $	Low

Grid Requirements	Suitable for smaller, decentralized grids	Requires a large, stable grid	Flexible but needs storage solutions
Carbon Emissions	Near zero, estimated 6 g of carbon per kWh	Near zero, estimated 12 g of carbon per kWh	Zero during operation
Waste Management	Requires nuclear waste handling	Requires nuclear waste handling	No nuclear waste
Reliability/ Capacity Factor	High – operates 90% of the time	High – operates 92-95% of the time	Intermittent – solar (25%) and wind (35%), depending on weather conditions

2.3 Economic Viability/Startup Costs

The upfront cost of SMRs represents a great advantage in nuclear power. By offering a more cost-effective alternative to traditional nuclear reactors, SMRs present themselves as a far more viable energy option, as seen in Table 1 above. This advantage stems from their modular design and production assembly. The average full-scale nuclear reactor will cost approximately 6-9 billion for an 1100MW energy reactor. “Costs for SMRs vary, but estimates suggest that, depending on the size, smaller reactors can cost between $50M for microreactors to $3B for larger units (Gilani, 2023). Although SMR’s energy output is not proportional to its price relative to a full-sized reactor, when accounting for economies of scale through mass production, the total cost will be lower. As mentioned previously, SMRs are not required to be specifically tailored to a location, they rather adopt a more standardized model that can be factory-produced and shipped off. This approach allows SMRs to be manufactured in bulk and potentially benefit from economies of scale, which drive down per-unit costs. The straightforward comparison between a full-scale, modular, and microreactor can be seen in Figure 2, where costs of implementation, capacity, and cost per MW can be found.

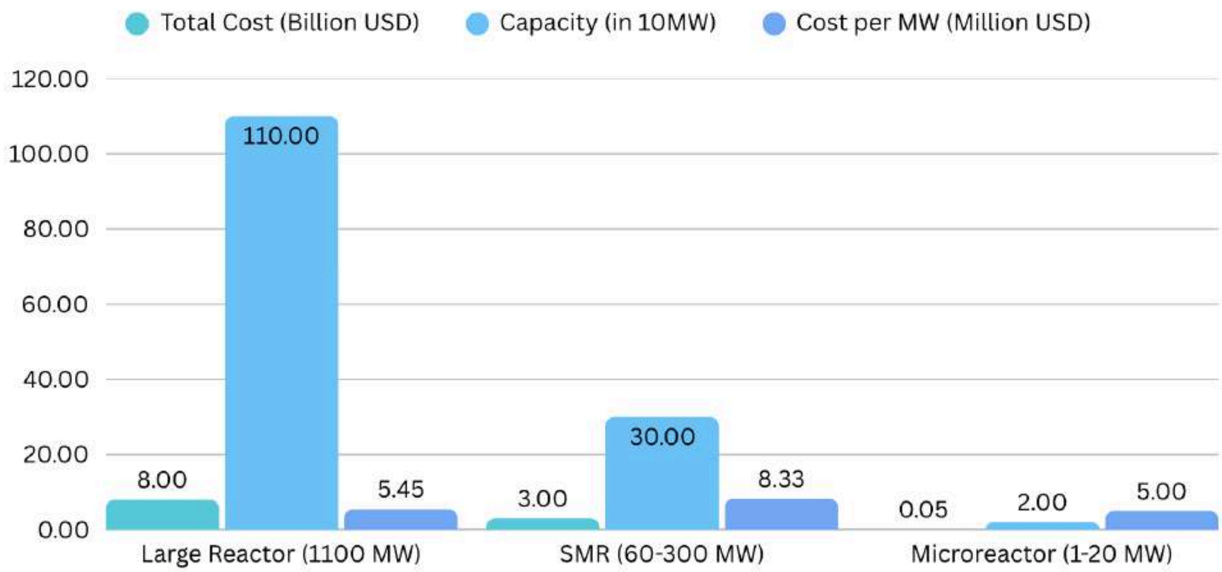

Figure 2. Comparison chart of full-scale reactor, SMR, and microreactor

The possibility of mass production in SMRs makes it an attractive option in underdeveloped regions. As global production increases, manufacturing efficiency and the potential lowering of costs could enable widespread adoption in underdeveloped regions, leapfrogging the challenges associated with constructing a large custom reactor.

3. Advantages of SMRs

3.1 Economic Benefits for Local Communities

Economically, small modular reactors offer financial benefits to the local communities through various means. Among the most significant outcomes is the increase in employment, which is vital for encouraging development in the economies of underdeveloped nations. A typical 100-megawatt SMR will cost approximately $500 million per unit and could create up to 7,000 jobs. SMRs require regular maintenance and environmental management and have an operational lifespan of 40 to 60 years, providing disadvantaged communities with consistent job opportunities in the following decades (US Department of Energy, 2020). In developing nations, creating jobs has a revolutionary impact that raises household incomes and lowers unemployment rates. While the growth of a skilled labor force promotes long-term economic resilience, this income infusion raises local economies through higher consumer spending. SMR project-related training initiatives can also improve the skill sets of the local workforce by giving them knowledge of advanced manufacturing, engineering, and nuclear operations that they can use in other sectors of the economy.

By promoting domestic manufacturing, SMRs not only directly create jobs but also stimulate secondary economic growth. Local industries produce more when parts like steel and specialized machinery needed for SMRs are produced. It is anticipated that each SMR unit will produce roughly $1.3 billion in sales, $404 million in payroll income, and $35 million in indirect business taxes (US Department of Energy, 2020). These earnings have a ripple effect that helps both governments and businesses in the area, thereby accelerating economic expansion, and a visual representation of these effects can be seen in Figure 3 below.

Figure 3. Expected economic revenue through SMR implementation within a region

3.2 Scalability and Modularity

Another distinctive characteristic of small modular reactors (SMRs) is their scalability and growth potential. Usually producing between 50 and 100 MW per unit, SMR designs are naturally modular and comprise individual units. This permits a region to start with a 100 MW SMR and then increase capacity in 100 MW increments, reaching 200 MW and 300 MW without the necessity of building an entirely new large-scale reactor. Underdeveloped areas suffering slow industrial and economic progress significantly benefit from this scalability. The ability to grow energy systems in control and cost-effectiveness guarantees that the energy supply can satisfy growing needs, promoting sustainable development. NuScale Power's investment in an SMR project in Romania shows the beneficial implementation of modularity. Romania substituted old coal-fired power plants with modular SMR technology in cooperation with the US government and international organizations. Six 77-megawatt modules will first be installed in a decommissioned coal plant under the project. As energy demand rises, extra modules will be added (Nuscale Power, 2023).

3.3 Construction Speed

The modular design of SMRs enables faster deployment compared to traditional large reactors. Prefabricated components are manufactured in factories under controlled conditions and assembled on-site, reducing construction timelines and minimizing delays. Production of conventional nuclear reactors is typically measured on a timeline using decades, with delays often occurring, causing a budget overrun. The reduced construction time of these reactors means that the regions in need of energy can reach more immediate and consistent sources of energy.

The energy output will determine how long it takes to build each SMR. For instance, SMR manufacturer Last Energy's PWR-20 (Last Energy, 2023), a 20MW reactor, takes less than two years to construct, as opposed to the average of more than seven years for a conventional nuclear reactor. The Chinese reactor ACP-100, a 125MW SMR, began construction in 2021 and is planning to be completed in 2026, a 5-year construction period, even when accounting for the obstruction of the pandemic.

3.4 Safety and Risk Mitigation

SMRs can offer several inherent safety advantages over traditional reactors, largely due to their passive safety feature and lower energy. The design and core functionality of SMRs mitigate many of the risks associated with nuclear energy, with safety remaining a priority throughout the lifespan.

One of the primary advancements of SMRs is their reliance on passive safety systems. SMRs use the natural processes of the reactor, unlike conventional reactors that mostly rely on human intervention or external security features. This dependence on passive systems instead of human intervention greatly lowers the accident risk.

The SMR is found in a sealed capsule while it stays submerged in cold water. Equivalent to how a stove heats water in a kettle, the heat from the overheating core causes the water within the capsule to absorb energy and start boiling. During boiling, steam is generated and rises into the outer layer of the capsule. The capsule is submerged in cool water, thus, the steam meets the cold outside, where it condenses back into liquid water. Once the cooled water returns to the bottom and passes once more into the capsule, an ongoing cycle of heat removal is then finished (IAEA, 2016).

Until the reactor naturally cools down, this passive cooling mechanism will be maintained indefinitely without human involvement or outside power sources. This self-regulating safety element guarantees that the reactor stays safely cooled in case of an emergency or shutdown, substantially lowering the risk of overheating or meltdown. This process is visually illustrated in Figure 4, where natural circulation takes place.

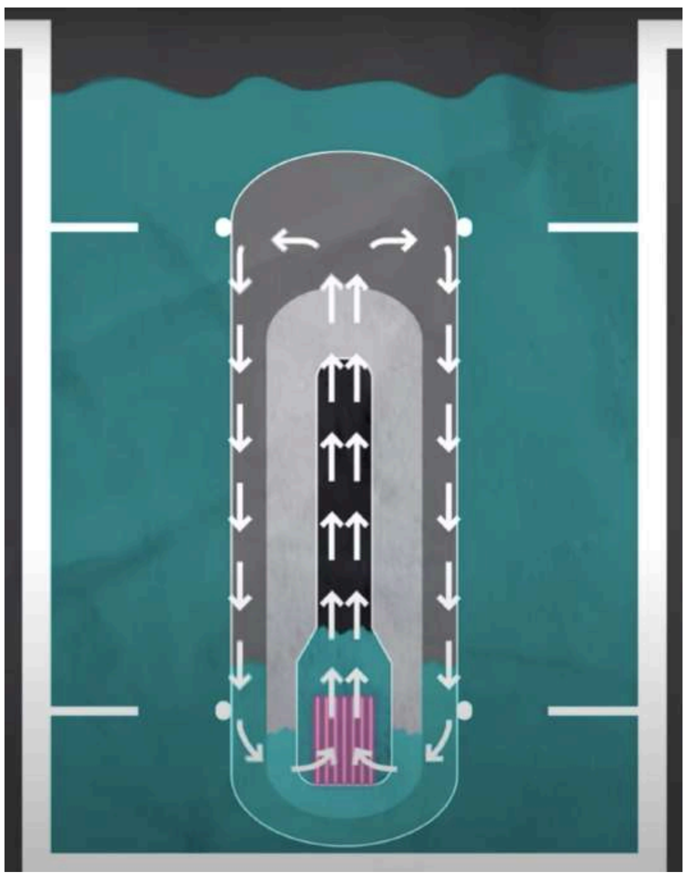

Figure 4: Process of natural circulation within SMR (DW Planet A, 2025)

3.5Energy Independence in Remote Communities

Small modular reactors can provide energy independence to remote communities primarily dependent on imported fuels and unreliable power transmission systems. By making localized low-carbon energy affordable, SMRs enable communities to reduce their reliance on foreign energy sources and lower their risk of supply chain interruptions or geopolitical conflicts.

The power disruptions felt in the Marshall Islands and Sri Lanka highlight the fundamental importance of local energy resilience. The foreign exchange crisis in Sri Lanka has worsened because international oil prices have climbed as a result of geopolitical conflicts occurring in Eastern Europe. Transportation has faced delays while power outages reach 7.5 hours each day, and essential fuels like furnace oil, diesel, and naphtha have become scarce (Francis, 2022).

Similarly, the Marshall Islands' dependence on imports and rising fuel prices are significant concerns as well. The cost of food, building materials, and transportation has increased significantly on remote islands as a result of petrol prices rising to more than $10 per gallon (Marshall Islands Journal, 2022). These price increases put a strain on public infrastructure and have a direct impact on people's livelihoods, making them more than just inconveniences. For instance, residents now have to pay outrageous prices for basic necessities like eggs and building materials, and local taxi drivers were forced to raise their fares by fifty percent.

In both cases, SMRs provide a sensible long-term solution. Local clean, consistent electricity generation lets SMRs aid isolated or resource-constrained communities to withstand supply interruptions and changing fuel prices.

3.6 Reduced Carbon Emissions and Land Efficiency

The low carbon footprint of SMRs is one of their most compelling environmental benefits. In contrast to coal plants, which emit enormous volumes of carbon dioxide and other dangerous pollutants into the atmosphere, SMRs, like all nuclear energy systems, emit very little greenhouse gas during operation.

For example, a single 100 MW SMR can potentially prevent the emission of over 2 million metric tons of CO_2 annually when it replaces coal-fired power plants (IAEA, 2025). Therefore, by lowering total carbon emissions from the energy sector, the broad adoption of SMRs could be crucial to reaching global climate goals.

While conventional nuclear plants need up to 2 square kilometers to accommodate reactors and supporting structures, SMRs run on sites between 0.1 and 0.5 square kilometers. Because SMRs require less infrastructure and land, environmental impacts diminish, and nearby ecosystems are better preserved (World Nuclear Association, 2021).

3.7 Consistency

Nuclear power, including small modular reactors, is often advantageous through its consistency; SMRs can offer a reliable and consistent energy source, in contrast to conventional renewable energy sources, irrespective of weather and environmental conditions. Small Modular Reactors exhibit an average capacity factor of approximately 90%, as illustrated in Table 2 (Mignacca, 2019). This exceeds the capacity factors of more prevalent renewable energy sources, such as solar and wind, which are 25% and 35%, respectively. The continuous availability of energy is vital for the dependable operation of critical infrastructure such as manufacturing facilities, educational institutions, and healthcare centers, where even a brief power outage can cause irreversible damage or disruption.

Despite their environmental benefits, natural renewable energy sources like solar and wind energy are unpredictable. Solar energy is produced solely during daylight hours, which may be limited in some places and seasons; wind energy can only be collected depending on several variables. Expensive energy storage systems or backup generators are required to guarantee grid stability among changes in the energy source.

Table 2: Cost Competitiveness: SMRs vs. Other Energy Sources (International Renewable Energy Agency, 2023)

Energy Source	Estimated Cost per MWh ($)	Average Capacity Factor (Energy Relative to Maximum Potential) (%)	Lifespan (Years)
Small Modular Reactors (SMRs)	$60 - $90	90%	40-60
Traditional Nuclear Reactors	$30 - $40	92-95%	60-80
Coal	$30 - $40	40-50%	40-50
Natural Gas	$15 - $20	50-60%	30-50
Wind	$15 - $20	35%	20-25
Solar	$30- $100	25%	25-30

4 Limitations

Despite their many benefits, SMRs are not widely utilized for several reasons. Because of the complexity of safety certification and licensing procedures, which vary by nation, regulatory approval represents a significant obstacle to deployment. Another obstacle is the high initial capital cost; although SMRs ultimately incur less costs per unit, which can be achieved through economies of scale, their high initial cost could keep them out of emerging nations. Public opinion and policy greatly influence implementation since political opposition and mistrust of nuclear energy can influence funding and regulatory support.

4.1 Historical Context and Public Perception

Catastrophic events—the most well-known of which happened at Chornobyl in 1986 and Fukushima Daiichi in 2011—have unfairly tarnished the public view of nuclear energy. Though these incidents were fatal, they led to an excessive public mistrust and anxiety about nuclear power that still exists today.

It is impossible to overestimate public opinion; in the wake of both tragedies, nuclear energy was connected with risk; media coverage of the long-term consequences of radiation exposure on human health and the environment expanded. Combining human mistakes with poor design, the Ukrainian nuclear plant Chornobyl turned into the scene of one of the most disastrous nuclear accidents in history. In Japan, an earthquake and a tsunami also contributed to the Fukushima accident, which required thousands of people to be evacuated because radioactive components leaked during both events. The mere possibility of another catastrophic incident, particularly in many developing countries lacking the knowledge of the technology, has caused nuclear power to be seen with extreme distrust. Such skepticism poses major hurdles to the take-up of SMRs and other nuclear technologies, even in cases where their safety features have been thoroughly tested and validated. To successfully establish nuclear energy in these regions, extensive collaboration with governments is essential to inform the public about its benefits and safety before implementation.

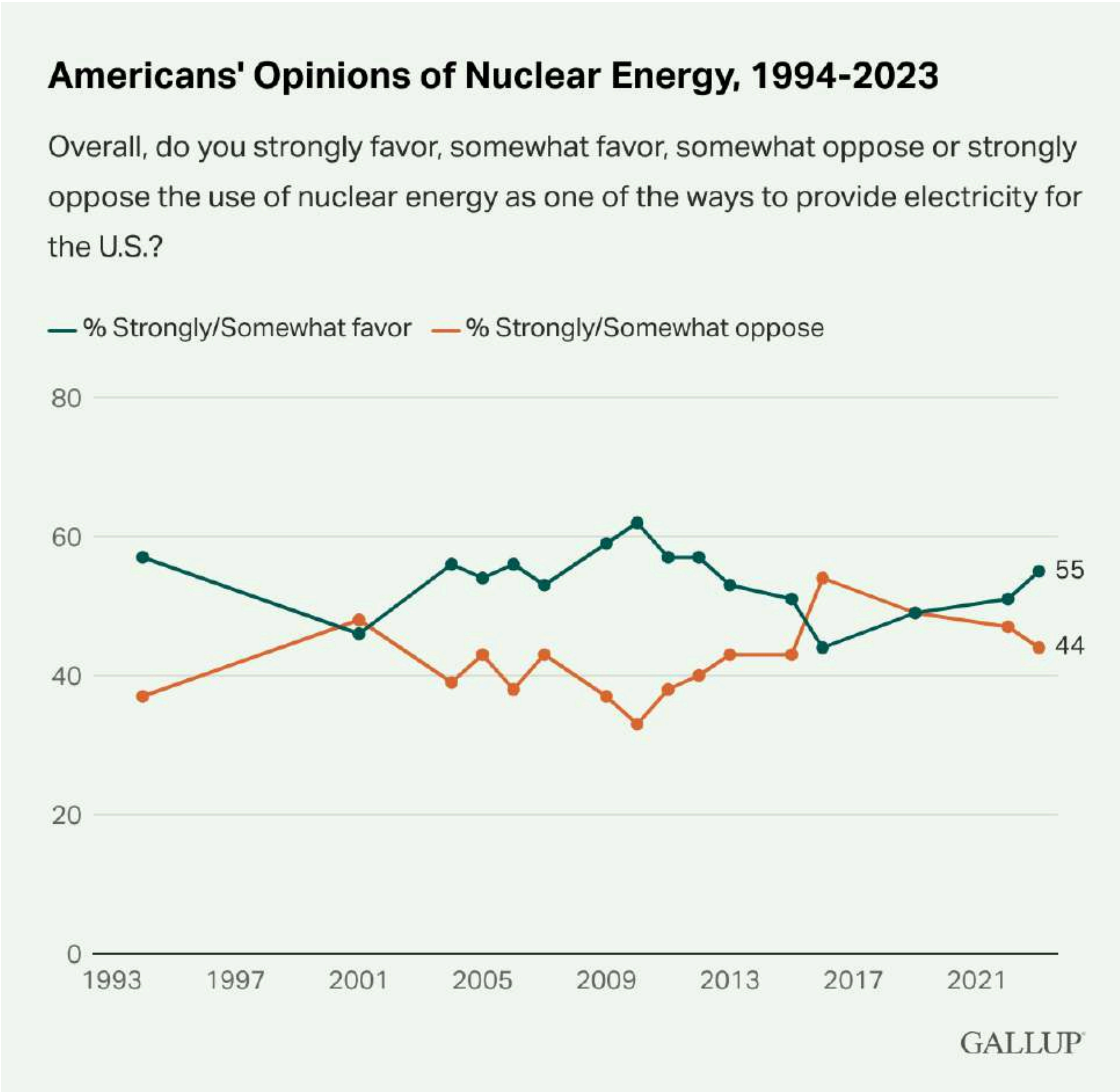

Figure 6: Percentage of American opinion regarding the use of nuclear energy from 1993 — 2021 (Brenan, 2023)

4.2Regulatory/Licensing

Since the nuclear power regulatory framework was initially created for large reactors, it is challenging to integrate Small Modular Reactors (SMRs), which have remote operation, modular construction, and passive safety systems. Longer approval times, greater compliance costs, and investor uncertainty result from the absence of regulations specifically designed for SMRs. The widespread use of SMRs is contingent on removing these regulatory barriers. Major licensing challenges, such as the need for in-factory certification, technological novelty, stringent regulatory approaches, antiquated legal frameworks, and regulatory fragmentation, must be addressed in order for the adoption of SMRs.

4.2.1. Outdated Legal and Regulatory Frameworks

Designed for large-scale reactors, the present nuclear regulatory system is incompatible with the design features of SMRs. Small core, passive safety measures, and modular scalability—which distinguishes SMRs from conventional reactors—cause new regulatory issues.

The new reactor designs, fuel types, and safety features that SMRs bring contradict current regulatory systems. As such, it is doubtful whether these novel concepts satisfy the standards of nuclear safety and performance. Among these difficulties are limited operational data and the need to prove products before commercial release. Given that SMRs are lacking in real-world data, regulatory validation calls for more caution and a longer period. Many authorities also demand operational proof before allowing a design, thus SMR developers are driven to build expensive demonstration plants before commercial release, which impedes the deployment process.

4.2.2. Regulatory Fragmentation

Regulatory fragmentation is a significant impediment to the global implementation of SMR, as each nation necessitates its own nuclear safety regulations. Developers of SMRs change their plans to follow particular national guidelines about nuclear facilities, affecting expenses and longer deployment times. This causes appreciable rises in manufacturing costs and apparent licensing delays.

5 Perspective

5.1 Goal Setting Approach

5.1.1 - Goal-Setting Framework

Changing from a prescriptive licensing model to a goal-setting framework allows regulators to define safety objectives based on performance rather than specific technical designs. Regulators can, for example, establish numerical risk targets and then require SMRs to meet a minimum level of safety performance (such as NuScale Power's Emergency Planning Zones). This framework promotes design innovation while prioritizing safety and reducing approval delays and compliance costs.

5.1.2 - Harmonize International Regulatory Standards

International organizations like the IAEA and NEA can help align requirements across countries and reduce fragmentation. Standardization would enable SMR designs to be certified once and approved across multiple markets without requiring significant design changes. Such a partnership would accelerate the global production of SMRs and eliminate superfluous design adaptations, potentially saving up to 30% in terms of costs (Sam, R., et al. 2023).

5.2 Government Subsidies

Government subsidies and funding initiatives are critical for accelerating the deployment of small modular reactors by lowering initial costs, mitigating financial risks, and encouraging private-sector investment. The governments of the United States, Canada, and the United Kingdom have developed several focused initiatives to support SMR research, development, and deployment in recognition of their potential to help alleviate greenhouse gas emissions and energy dependence.

5.2.1 - The U.S. Department of Energy (DOE)

US Department of Energy declared on October 16, 2024, a $900 million funding program to help Generation III+ Small Modular Reactors (SMRs) be deployed. Two funding levels comprise this program:

Up to $800 million for a maximum of two major projects aiming at grid-scale small modular reactors is offered by the First Mover Team Support (Tier 1) program. The applicant teams must comprise a US engineering, procurement, and construction company, a US Generation III+ Small Modular Reactor technology vendor, and a US commercial electric utility. This tier aims to establish a solid framework for forthcoming multi-reactor deployments.

Fast Follower Deployment Support (Tier 2) allocates up to $100 million for project initiatives aimed at addressing critical deficiencies, including site selection, supply chain development, and comprehensive project estimates. Tier 2 funding is categorized into three areas: SMR selection and permitting, supply chain development, and project development (US Department of Energy, 2024).

5.2.2 - Canada’s Small Modular Reactors Program

The Government of Canada has introduced the Enabling Small Modular Reactors Program to support the development and deployment of SMRs across its provinces and territories. This program's key objectives include financial support, and it is part of its broader commitment to clean energy, outlined in 2022.

The program offers non-repayable contributions of up to $5,000,000 per project, with an anticipated average funding range between $500,000 and $2,500,000 (Natural Resources, 2023). Notably, projects led by Indigenous applicants can receive up to 100% funding, reflecting the government's commitment to promoting diversity and supporting remote communities.

5.2.3 - The United Kingdom's Advanced Nuclear Technologies and Enabling Funds

The United Kingdom has integrated SMRs into its national strategy for a low-carbon economy, with several funding programs to advance both SMRs and broader advanced nuclear technologies.

1. Advanced Nuclear Fund: Announced as part of the Ten Point Plan for a Green Industrial Revolution, the fund will invest up to £385 million in next-generation nuclear technologies. Within this allocation, up to £215 million is designated specifically for SMRs, supporting the development of domestic, smaller-scale nuclear power plants.

2. Low-Cost Nuclear Challenge Initiative: Led by a consortium headed by Rolls-Royce, this initiative has secured up to £210 million to develop a cost-effective SMR design. The consortium projects that the domestic SMR program could support up to 40,000 jobs at its peak and power approximately 450,000 homes per reactor.

These funding mechanisms underscore the UK government's commitment to nuclear energy as a key component of its Net Zero Strategy and overall energy transition (Government of the United Kingdom, 2017).

5.3 - International Case Studies

In its strategy to decarbonize the energy sector, the European Union (EU) has moved ahead in SMR planning.

This initiative has been well-received, with more than 300 applications submitted at an outreach event in March 2024. In May 2024, the alliance held its inaugural general assembly, during which they finalized the governing board and established technical working groups.

The EU is also investing in safety and SMR research. The Euratom Research and Training Programme has allocated 16 million euros for SMR safety research, plus 27 million euros for projects looking at SMRs and advanced modular reactors (European Commission, 2021). A political declaration was adopted in April 2023 reaffirming that the European Union was taking up a leading role in global SMR research, innovation, and education.

5.3.1 - SMRs as a Solution for Coal Plant Conversion

A particularly successful design for SMRs could be the conversion of existing coal-fired power stations into nuclear-powered facilities. This has a cost-effective pathway to convert existing energy infrastructure to low-carbon energy. U.S. Project PHOENIX was a prominent initiative to substitute SMRs for coal-fired power plants, both domestically and overseas. The approach reduces costs and accelerates the deployment of SMRs in coal-intensive regions by leveraging workforce experience and existing grid connections (US Department of State, 2025).

The United Kingdom has incorporated Small Modular Reactors (SMRs) into its long-term nuclear expansion strategy, intending to establish an array of SMRs by 2050. Great British Nuclear, an autonomous entity created to manage the expansion of nuclear energy in the UK, has initiated the selection process for the small modular reactor technologies most appropriate for national implementation.

5.3.2 - Small Modular Reactors in Emerging and Developing Economies

Outside of Europe and North America, nations are increasingly recognizing SMRs as a viable alternative to fossil fuels. Countries such as South Africa, Kenya, and Argentina are evaluating SMRs for underserved and remote regions where conventional grid expansion is impractical and costly.

Argentina's CAREM-25 Project: With its CAREM-25 reactor, which is intended to supply electricity to isolated areas and industrial locations, Argentina has made notable strides in the development of SMR. The reactor, which is being built under the direction of the Argentine National Atomic Energy Commission (CNEA), is anticipated to be among the world's first operational SMRs (CNEA, 2024).

5.3.3 - China’s ACP100

The ACP100 SMR (also known as Linglong One) is another design that is being developed by China and will be installed in industrial and rural areas across the country to give a push to the country's clean energy transition. Its generation capacity is 300 megawatts (Xu, 2016).

6 Conclusion

Small modular reactors can revolutionize the world's energy needs. This paper identifies the economic, environmental, and safety benefits of SMRs over traditional energy sources. SMRs are a more affordable option than conventional nuclear reactors due to their straightforward building procedure and lower initial costs. Their modular design, allowing for gradual deployment, makes them flexible enough to satisfy the rising energy needs of developing nations while encouraging domestic manufacturing, long-term operational employment, and job creation helps SMRs further stimulate the local economy. SMRs are a crucial weapon in the battle against climate change since they emit practically no greenhouse gases. Their small size and sophisticated water-efficient cooling systems help them to minimize land use and ecological disturbance, consequently making them perfect for areas with limited natural resources. By addressing public concerns about nuclear energy, features like self-pressurization and natural circulation cooling help to increase operational safety. These advances make SMRs a safer alternative than conventional reactors.

To fully evaluate the possibilities of SMRs, it must be admitted that thorough research is needed in several domains. Long-term cost-cutting objectives, including mass production to achieve economies of scale, should be investigated to lower the cost of SMRs for underdeveloped countries. To build public confidence and guide policy decisions, investigation, and public dissemination on the long-term safety and environmental effectiveness of SMRs are essential for obtaining support. The harmonization of international regulatory standards should be prioritized in policy projects meant to enable the global deployment of SMR. Governments ought to endorse pilot programs and demonstration projects to furnish empirical data and substantiate the safety and efficacy of SMR designs. By addressing these research and policy requirements, SMRs can significantly contribute to attaining a sustainable future.

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