NUCLEAR INNOVATION ALLIANCE

Economics of Advanced Nuclear Energy

Summary

- Advanced reactors are designed to be economically competitive and reduce investor risks associated with construction.
- Nuclear reactors can economically provide energy over very long lifetimes, making them sound long-term investments.
- Levelized cost of energy (LCOE) estimates, while a convenient metric, exclude costs such as new transmission and storage. When all costs are included, nuclear energy is competitive with variable renewable generation, and may be essential in many regions.
- Most analyses of decarbonization pathways confirm that including firm energy sources such as nuclear energy, in addition to variable renewable energy, decreases the overall cost of decarbonization.
- Host communities find commercial nuclear plants attractive because they provide well-paying union jobs, bring investment, support the local tax base, and stimulate local economies.
- Recent interest demonstrates that advanced nuclear energy is particularly attractive as a replacement for retiring coal plants. They can be built on existing sites using existing transmission, making development and interconnection far simpler than for new, greenfield power generation.

Advanced reactor designs were developed with a specific focus on cost-competitiveness and reducing construction complexity and risk compared to conventional nuclear plants. Advanced reactor designs feature smaller physical footprints than conventional plants and emphasize the use of manufactured components to reduce the amount of on-site construction. Advanced reactors are designed for modular construction with reduced capital investment, and less construction complexity.[1] This enables faster construction and scalable, incremental power additions to meet energy demand as needed. Advanced reactors can be designed to limit water requirements and potentially reduce the need for large scale off-site emergency evacuation requirements, opening up deployment options, such as repowering retired coal facilities or providing heat and power to industrial sites. Further, smaller designs like microreactors can unlock new uses and enable decarbonization of high-cost, carbon-intensive remote grids.

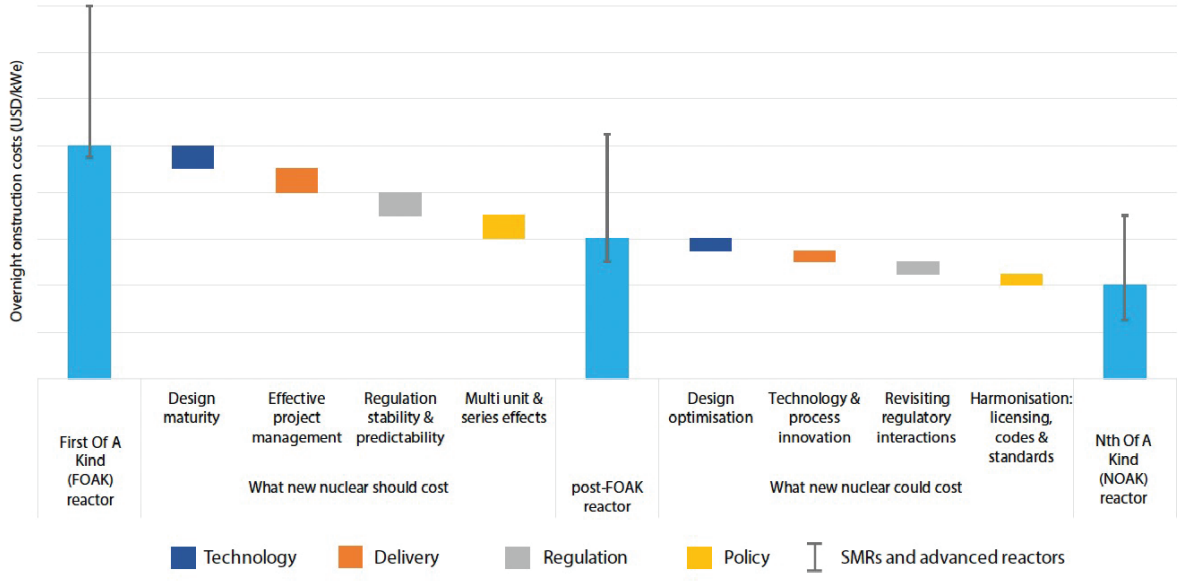

Figure 1: Simplified visualization on how advanced reactors can reduce construction costs Source: NEA

Nuclear power plants have the longest lifetime operation among energy sources. Nuclear power plants are typically designed to operate upwards of 60 years. The Nuclear Regulatory Commission (NRC), the independent federal agency with authority to license the operation of commercial nuclear power plants in the United States, issues initial operating licenses for commercial power reactors to operate up to 40 years. These licenses can be extended for an additional 20 years at a time after an initial license, and many nuclear power plant operators are expected to seek a second, and potentially even a third, license extension. Out of 93 operating commercial nuclear reactors in the United States, 79 have been granted their first license renewal, and 6 have been granted their second license renewal. Most advanced nuclear reactors are also expected to

[1]Megaprojects are complex ventures that cost billions of dollars. Examples include high-speed rail lines, airports, and large nuclear power plants – all of which in recent years in the United have typically been associated with cost overruns. Cost overruns with megaprojects are a function of poor project management associated with multi-billion dollar projects.

operate between 60-80 years or more.[2] In comparison, wind and solar energy sources are anticipated to operate on average between 30 and 40 years.

When all costs are included, nuclear energy is competitive with variable renewable generation, and may be essential in many regions. LCOE estimates are often cited to compare the economics of power generation options. However, the LCOE calculation has many limitations[3] and should be used in combination with other metrics and factors to give a more comprehensive view of the economic and environmental impact of specific generating technologies over its lifetime.

Including nuclear power gives the world the best chance to tackle climate change and energy security. Princeton University's Net Zero America study analyzed the ability and affordability of five distinct technological pathways, all using technologies known today, to decarbonize the United States' economy. Out of the five pathways, all but one used nuclear energy and the pathway which used the largest amount of nuclear energy was also the most affordable. While it is impossible to predict the exact energy mix necessary to fully decarbonize the world's economy by 2050, nuclear energy will likely play a significant part.

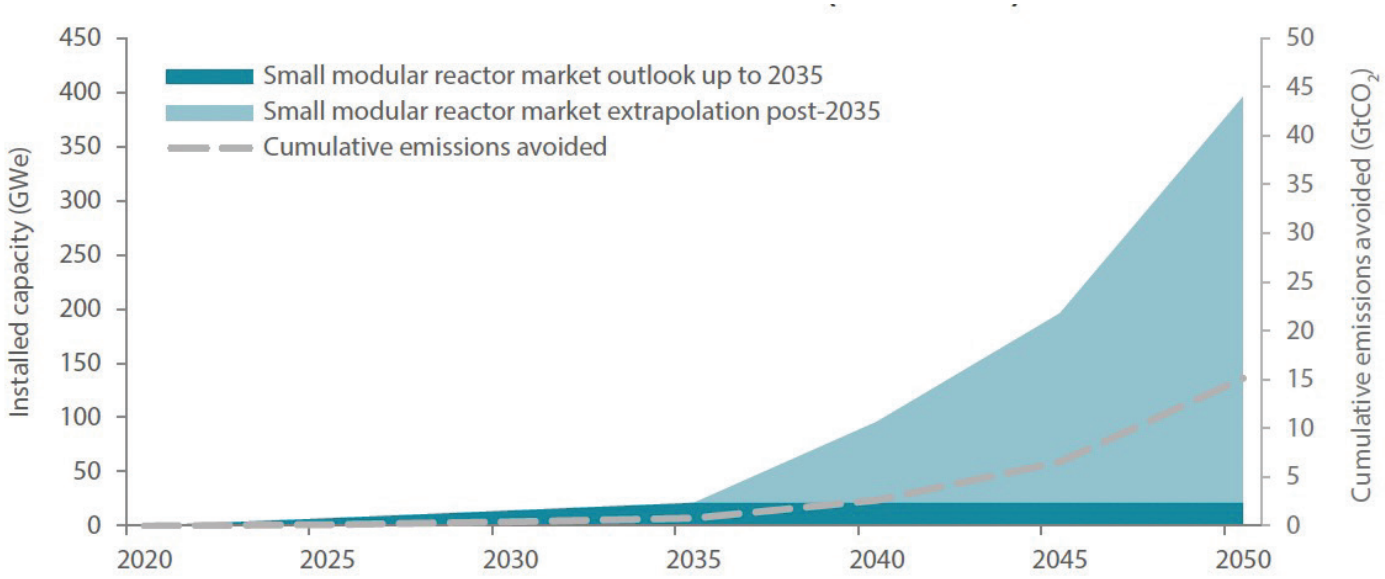

Figure 2: The potential of advanced nuclear to help reduce global GHGs. Source: NEA

Building new nuclear plants will allow communities to retain well-paying union jobs and a significant tax base in the clean energy transition. Beyond competitively priced power, nuclear energy brings significant economic benefits to individuals, local communities, and states. Each year, a typical commercial U.S. reactor generates tens of millions of dollars in state and local tax revenue, stimulating local economies through local infrastructure buildout and maintenance. Construction of new nuclear power plants also benefits local and regional suppliers of design, engineering, procurement, construction and consulting services. These are well-paying jobs with high union rates that will allow communities the opportunity to retain workforces as carbon-emitting sources around the country retire.

Advanced nuclear energy can also repower retiring fossil fuel sources. A September 2022 U.S. Department of Energy report on coal-to-nuclear feasibility found that advanced nuclear energy could play a major role in communities with retiring coal facilities. The DOE found that 80% of retired and operating coal power plant sites could host an advanced nuclear reactor, paving the way for 263.3 GWe of coal-to-nuclear replacement projects across the United States. A 924 MWe coal-to-nuclear conversion could increase regional economic activity by $275 million and add 65 new, high-paying, permanent jobs to the region, many of which are traditional coal jobs that could transition to roles at an advanced reactor.

Advanced reactors have the potential to supply low-cost, zero-carbon energy for industrial and other energy needs. Many advanced reactors designs will be able to operate at and produce high-temperature heat that can be used for industry, hydrogen production, desalination, and similar applications. This is why certain companies, like Dow Chemical, are exploring using high-temperature gas reactor technology to decarbonize some of their industrial processes. Similarly, the University of Illinois-Urbana Champaign is also planning to take advantage of process heat from a USNC microreactor to provide clean heat and power to its campus.

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[2]Reactor developers may choose to apply for an initial reactor operation license that is under 40 years. Examples include test, non-power reactors that have shorter life-spans.
[3]LCOE only considers the cost of building and operating a power plant and not other factors such as environmental impacts, transmission costs, and the cost of storage to address variable output. LCOE also does not consider potential social and economic benefits such as job creation and local economic development, and may not incorporate the full feasible economic lifetimes of the technologies.