

Nuclear Energy Enabler: Small Modular Reactors – Building Blocks of the Future

We live in a constantly evolving world, from the AI boom to electric vehicles and growing data centers. Almost everything in our lives depends on electricity. As we innovate and change accelerates, our future requires energy that is clean, reliable, and affordable.

Nuclear energy has already helped power the United States for decades, but the next step is to build it smarter. Small Modular Reactor (SMR) technology can make nuclear energy more flexible and efficient, helping us meet climate goals with less land use, fewer emissions, lower social costs, and higher social benefits.

Nuclear Energy and Electricity today



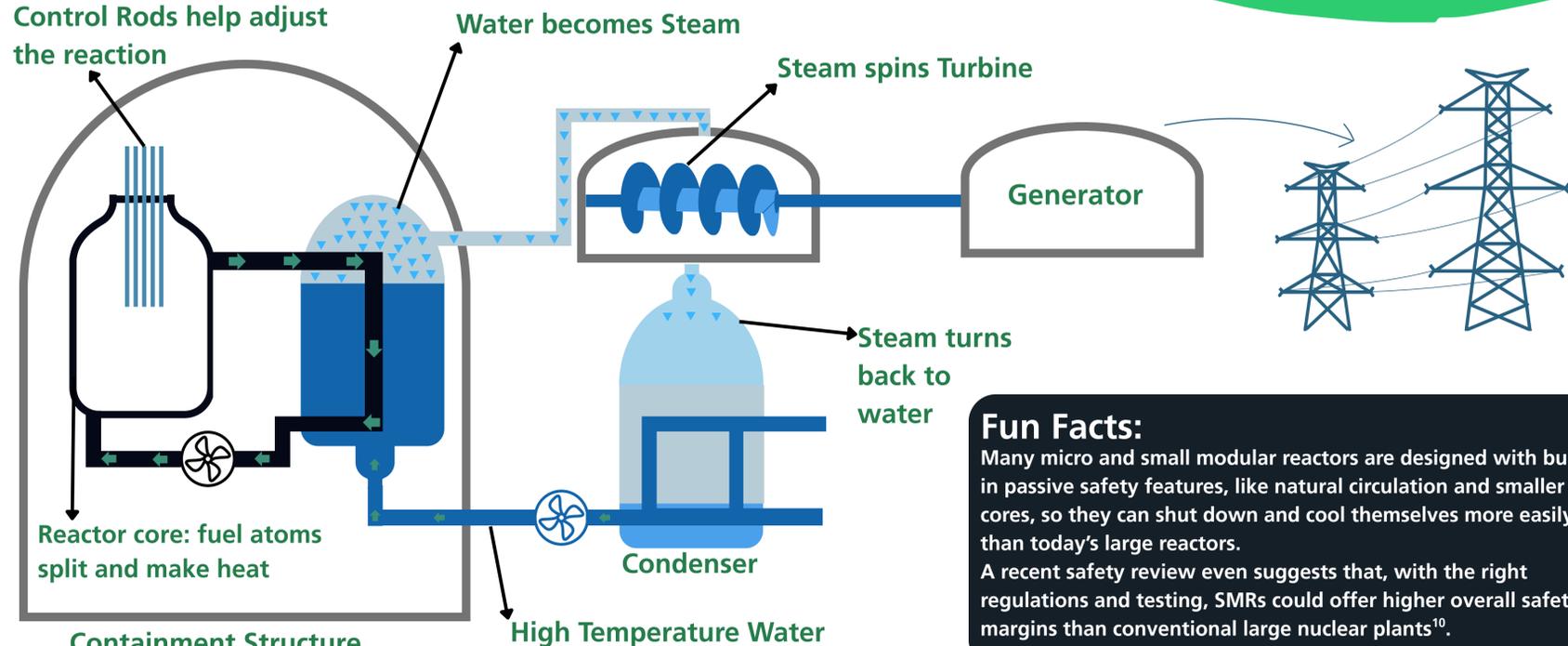
The U.S. energy and power system is an ever-changing, complex system that forms the bedrock of our society. People, hospitals, traffic lights, and data centers all need power 24/7, even at 3 a.m. This constant “always on” demand is called **baseload power** – the minimum amount of electricity we need all the time⁷.

Today, wind and solar are great for clean energy, but they don’t always produce power when we need it. Coal and natural-gas plants provide baseload power, but they create more pollution and health costs⁸, and many of these plants are getting old. In the future, SMRs can help nuclear energy provide clean, steady baseload power, help meet fast-growing data-center demand, keep residential electricity prices more stable, and replace aging fossil-fuel plants across America⁹.

How Small Modular Reactors create electricity

Even though there are many different SMR designs, almost all use the same basic concept. They use the heat from splitting atoms to boil water into steam, spin a turbine, and send electricity onto the grid—like a compact, factory-built version of large nuclear plants^{6,10,11}.

Control Rods help adjust the reaction



Fun Facts:
 Many micro and small modular reactors are designed with built-in passive safety features, like natural circulation and smaller cores, so they can shut down and cool themselves more easily than today’s large reactors. A recent safety review even suggests that, with the right regulations and testing, SMRs could offer higher overall safety margins than conventional large nuclear plants¹⁰.

What are Small Modular Reactors?
 Small Modular Reactors, or SMRs, are a new generation of nuclear power plant technology designed to be **smaller, simpler, and more flexible** than the large reactors built in the past. Instead of building one huge reactor on site, an SMR is a compact unit that produces up to about **300 megawatts** of electricity and can be factory-built as a standardized product^{5,6}.
The “Modular” in SMRs

- **Design modularity:** They can split into **self-contained units** like plug-and-play components.
- **Manufacturing modularity:** modules are fabricated in a factory, in parallel, with **standardized processes**.
- **Construction modularity:** you bring finished modules to the site and assemble them like **big LEGO pieces**^{5,6}.

What Makes SMRs an Enabler for Nuclear Energy and the Nation’s Energy Goals:

C Because SMRs use standardized modules that are factory-built and shipped to the site, they can be deployed as single units or in multi-module plants as demand grows.
O Studies find that this modular approach generally requires smaller upfront investment than today’s large reactors^{7,6}.

S SMRs generate large amounts of clean electricity on a very small footprint, making them ideal for remote regions that are difficult to connect to large grids. This can expand access to reliable nuclear power, create high-quality local jobs, and support the just transition in coal-mining and fracking communities¹².

Renewable Energy Enabler

- Wind and solar are getting cheaper and have almost zero fuel cost, so they are great for low-carbon energy. But their output depends on the weather which makes them variable.
- Small Modular Reactors are dispatchable, firm, and flexible. They can run steadily as baseload or adjust their output to work alongside wind and solar, providing the reliable low carbon power that keeps the grid stable^{5,9}.

Energy and Economic Goals

- Jobs and industry competitiveness – Each SMR plant can support hundreds of construction and long-term skilled jobs and reduce the risk that factories or data centers move to countries with cheaper or dirtier power⁵.
- Hydrogen and clean industry – SMRs can be paired with hydrogen production and other industrial processes, helping the U.S. reduce pollution and climate impacts of factories, trucks, and heavy industry.

Current Status and Companies

Kairos is Developing the first U.S based SMR in Tennessee**

Citations and Readings

[1] World Nuclear Association. “Nuclear Power in the USA - World Nuclear Association.” World-Nuclear.org, 5 Mar. 2024, world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power.
 [2] Shehabi, Arman, et al. “2024 United States Data Center Energy Usage Report.” Escholarship.org, 20 Dec. 2024, escholarship.org/uc/item/32d6m0d1.
 [3] Staff, Office of Energy Statistics. “Planned Retirements of U.S. Coal-Fired Electric-Generating Capacity to Increase in 2025 - U.S. Energy Information Administration (EIA).” Eia.gov, 2025, www.eia.gov/todayinenergy/detail.php?id=64604.
 [4] Schipper, Mark, and Tyler Hodge. “After More than a Decade of Little Change, U.S. Electricity Consumption Is Rising Again - U.S. Energy Information Administration (EIA).” Eia.gov, 2025, www.eia.gov/todayinenergy/detail.php?id=65264.
 [5] International Atomic Energy Agency. (2024). Small modular reactor technology catalogue: 2024 edition (Supplement to Small modular reactors: Advances in developments 2024*). International Atomic Energy Agency. <https://aris.iaea.org>
 [6] Hussein, Esam. “Emerging Small Modular Nuclear Power Reactors: A Critical Review.” Physics Open, vol. 5, no. 100038, 1 Dec. 2020, p. 100038, <https://doi.org/10.1016/j.physo.2020.100038>.
 [7] Daigle, B., Decarlo, S., & Lotze, N. (2024b). Office of Industry and Competitiveness Analysis. https://www.usitc.gov/publications/332/working_papers/smrs_fo_ma.pdf
 [8] Mayfield, E. N. et al. (2019). Cumulative environmental and employment impacts of the shale gas boom. Nature sustainability, 2, 1122–1131. <https://doi.org/10.1038/s41893-019-0420-1>
 [9] SMR Start. (2021). The economics of small modular reactors. Nuclear Energy Institute. [https://www.nei.org/CorporateSite/media/filefolder/advanced/SMR-Start-Economic-Analysis-2021-\(APPROVED-2021-03-22\).pdf](https://www.nei.org/CorporateSite/media/filefolder/advanced/SMR-Start-Economic-Analysis-2021-(APPROVED-2021-03-22).pdf)
 [10] Pal, U. K., & Zhang, C. (2025). Phase-based safety review of Micro and small modular reactors from design to decommissioning. Safety Science, 188, 106882. <https://doi.org/10.1016/j.ssci.2025.106882>
 [11] Rolls-Royce SMR. Our technology. Rolls-Royce SMR – Generic Design Assessment. <https://gda.rolls-royce-smr.com/our-technology>
 [12] Wieser, E., Clarno, K., Haas, D., & Webber, M. E. (2025). The economics of small modular reactors at coal sites: A program-level analysis within the state of Texas. Energy Policy, 202, 114572. <https://doi.org/10.1016/j.enpol.2025.114572>