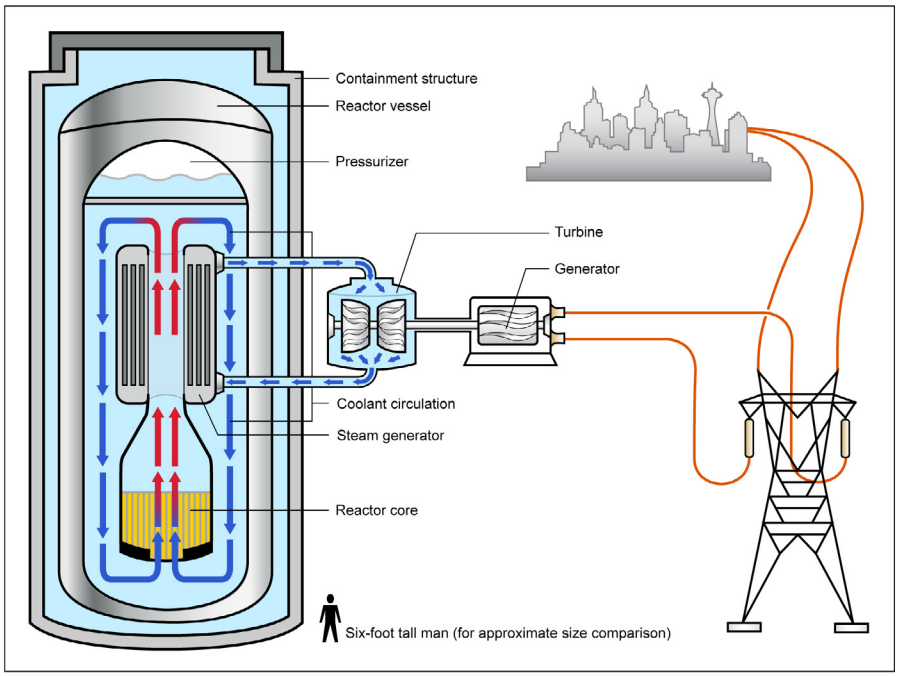
Illustration of Light Water Small Modular Nuclear Reactor (SMR)



Source: GAO, based on Department of Energy documentation. | GAO-15-652

Nuclear Energy

Small Modular Reactors

Nuclear power has proven to be one of the safest and cleanest technologies for supplying the constant, steady stream of electricity our modern economies need to operate effectively. This steady supply of electricity is often referred to as 24/7 power and is necessary to protect against the natural intermittency that comes with renewable power generation such as wind and solar. This is demonstrated by the reliability and safety of nuclear plants in the U.S.

Small Modular Reactors (SMR) are the next step in nuclear deployment and safety. SMRs provide carbon-free power and there is growing interest in this technology. The figure above is a representation of an SMR technology.

SMRs Defined

Nuclear reactor facility smaller in size than traditional nuclear power plants and that may employ multiple novel technological approaches, such as:

- Extensive use of factory-built modules
- Passive/inherent safety features
- Nuclear Reactors 1 MWe to 300 MWe (approximate)

SMR Technologies

Similar to larger reactors, SMRs generate steam to turn a turbine-generator and produce electricity. SMR technology is in two general categories, distinguished by coolant medium:

- Gen III+ More traditional light water cooled
- Gen IV Advanced design using molten salt, liquid metal, or high temperature gas cooled technology

Advantages of Nuclear/SMRs

- Nuclear energy has an important role to play in the clean energy transition along with other zero-carbon power generation sources. Currently, in the United States, nuclear power is responsible for more carbon-free electricity than all other sources combined, supplying approximately 54.8 percent
- Power supply that can also be used 24/7 or supplement the intermittent supply from wind and solar
- Lower up-front capital costs/reduced schedule as compared to large reactors
- Smaller size is easier to deploy in increments to meet demand
- Require less land use than other technologies

Safety

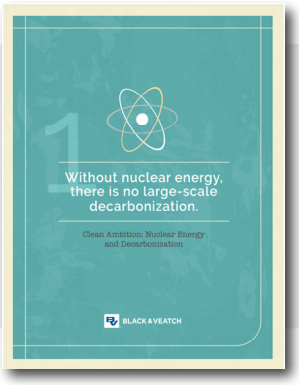
- Both the Gen III+ and Gen IV plants feature significant passive safety features that take advantage of natural driving forces such as gravity, heat conduction or convection, and pressure differentials. These advanced passive safety features are highly reliable and allow for safe shutdown of the unit with little to no human operator intervention.
- A key safety feature is the long time period that the natural driving forces provide before any operator intervention is required. This coping time is typically around seven days but could be longer if the reactor has a large surface area-to-volume ratio since the reactor decay heat can be transferred to another medium.
- Accident-tolerant light water fuels and high-heat resistant fuels, such as TRISO fuel, are being developed to further enhance the passive safety of these plants

Performance for Power Generation

- Nuclear energy is a proven method for electrical generation on a large scale
- SMRs represent the next generation in this established method
- Aside from the nuclear aspect of generating heat, the remaining parts of the power plant use existing technologies

Opportunities, Challenges, and Risks

- SMRs show significant promise to achieve long-term decarbonization goals
- SMRs are currently being developed on an international level
- Through 24/7 (baseload) and load follow capabilities, SMRs are designed to work well with renewables
- There are challenges associated with construction of new nuclear that have resulted in schedule delays and cost over-runs. The industry is taking aggressive actions to understand and meet these challenges.
- The first SMRs (Gen III+ and Gen IV reactors) are expected to be in commercial operation by 2030 and multiple other sites are under consideration
- Costs are expected to decrease as the technologies mature
- Long term solution for spent fuel assemblies



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