Article 7: Policy

Several governments around the world are supporting the development and deployment of small modular reactors in a variety of ways (see Figure 7.1). In March 2012, the U.S. Department of Energy (DOE) established a cost-sharing program with the nuclear industry to support pre-construction activities for first-of-a-kind small modular reactors. The program was initially funded with $452 million to cover costs associated with research and development, design certification, and licensing. Although the program was open to any kind of small modular reactor, almost all the applications featured pressurized-water reactor designs from the first family described in Article 2.

Figure 7.1: Countries with small modular reactors under development.

In November 2012, the DOE selected the Babcock and Wilcox mPower reactor for cost-sharing. Babcock and Wilcox was to provide at least 50 percent of the total cost for the design, certification, and licensing of the mPower reactor; the maximum funding from the DOE was to be $226 million. A second award of up to $217 million over five years was provided to NuScale Power in December 2013. In early 2014, Babcock and Wilcox announced that it was significantly reducing its funding, by over three-quarters compared to the previous year, for research and development; subsequently, the DOE lowered its quarterly funding for the project as well.

In contrast to the United States, the first prototype small modular reactor construction occurring in China involves a reactor from the second family: a 210-megawatt pebble-bed reactor called the HTR-PM (High Temperature Reactor – Pebble-bed Module; see Box 2 in Article 2). The first reactor is being built in Shiadowan, in Shandong Province. The pebble-bed design was developed at Tsinghua University in Beijing on the basis of a design developed initially in Germany in the 1970s and considered seriously for a time in South Africa. Both Germany and South Africa, however, decided not to pursue the technology. But while the South African pebble-bed reactor design used helium to drive a turbine and generate electricity—a challenging technology—the Chinese design uses a more traditional steam generator that operates at a somewhat lower temperature. The China National Nuclear Corporation is also aggressively developing a light-water reactor design called ACP-100 (see Box 1 in Article 2). In April 2015, the China National Nuclear Corporation entered into an agreement with the International Atomic Energy Agency to have the design's safety reviewed by international experts.

Russia is developing two very different small modular reactors based on its marine reactors. The first 70-megawatt KLT-40S floating power plant is under construction (see Box 5 in Article 2), and a larger small modular reactor, the VBER-300, another pressurized-water reactor design, is in development. But Russia, like China, is also developing reactors that are not light-water reactors, such as a fast-neutron reactor cooled with molten lead, which is based on a reactor design used in a series of nuclear submarines built in the 1970s.

South Korea, France, India, and Argentina are also developing small modular reactor designs. In 2012, the South Korean regulatory agency, the Nuclear Safety and Security Commission, issued a Standard Design Approval, essentially a construction license without a specific site evaluation, for the SMART (100 megawatts; see Box 1 in Article 2), making it the first small modular reactor to be licensed that is based on pressurized-water technology (the first of our four families). France is drawing upon its experience with nuclear-powered submarines in developing the Flexblue reactor (see Box 5 in Article 2). In line with the traditional focus of its nuclear power program, India is developing an AHWR (advanced heavy-water reactor) that uses heavy water (water altered so that nearly all the hydrogen atoms are the heavier isotope of hydrogen, deuterium) to slow down neutrons. This reactor is fueled with a mixture of thorium and plutonium. While the design has received most regulatory approvals, no site has been selected, in part because the designers want to deploy it without an emergency planning zone. In 2014, Argentina started constructing CAREM-25, a prototype small modular reactor that belongs to the first family (see Box 1 in Article 2).

The International Atomic Energy Agency has initiated a series of programs aimed at promoting small modular reactors, especially for developing countries that are considering their first nuclear power plants. An important focus has been the evaluation of alternative technologies and the development of tools to facilitate national planning efforts.

Table 7.1 Small modular reactors discussed in Article 2

Name	Country	Family	Power Rating (mega-watts)	Moderator	Coolant	Fuel Type (uranium enrichment level)	Refueling period or lifetime
NuScale	USA	1	50	Water	Water	Enriched Uranium (4.95 %)	24 months
B&W mPower	USA	1	180	Water	Water	Enriched Uranium (4.95 %)	48 months
SMART	South Korea	1	90	Water	Water	Enriched Uranium (4.88 %)	36 months
ACP-100	China	1	100	Water	Water	Enriched Uranium (4.2 %)	24 months
CAREM-25	Argentina	1	25	Water	Water	Enriched Uranium (3.1 %)	14 months
HTR-PM	China	2	210	Graphite	Helium	Enriched Uranium (8.8 %)	Continuous refueling
IMSR	Canada	2	Variable	Graphite	Molten salts	Enriched Uranium	Continuous refueling
GE Hitachi PRISM	USA	3	311	None	Sodium	Plutonium (26 %)	18 months
General Atomics EM2	USA	3	240	None	Helium	Depleted Uranium plus Plutonium	30 years
Traveling Wave Reactor TWR	USA	3	600	None	Sodium	Depleted Uranium plus enriched Uranium as a seed	40 years
Waste-Annihilating Molten-Salt Reactor WAMSR	USA	3	520	Zirconium hydride	Molten salts	Enriched Uranium (2%)	Continuous refueling
Toshiba 4S	Japan	4	10	None	Sodium	Enriched Uranium (19.9 %)	30 years
G4M	USA	4	25	None	Lead Bismuth	Enriched Uranium (19.75 %)	10 years
AFPR-100	USA	4	100	Graphite	Water	Enriched Uranium (10 %)	40 years
KLT-40S	Russia	4	70	Water	Water	Enriched Uranium (14.1 %)	28 months
Flexblue	France	4	160	Water	Water	Enriched Uranium (5 %)	36 months

Note: Many of these designs are evolving, and the power levels and other characteristics keep changing. This table was constructed in May 2015. Blue-shaded designs are licensed while orange-shaded designs are currently under construction.