A Game-Changer for Nuclear Safety

Nuclear energy modules are getting smaller and safer, making them viable options for remote communities.

Many people equate nuclear energy with the Fukushima disaster, and therefore consider it too dangerous to consider. But perhaps we should ask some questions before we dismiss what is an important source of low emissions electricity generation for many countries.

While modern nuclear reactors are much safer than the 1960s-designed reactors that were damaged at Fukushima, a recent advance in nuclear reactors is set to become a game-changer for safety.

In the case of an accident, old reactors like the ones at Fukushima were kept safe by pumping water supplies into the reactor to keep it cool. This required external electrical and water supplies. If these become damaged, as at Fukushima, cooling is lost and the nuclear fuel gets hot and eventually melts.

Modern reactors have a fundamentally different approach to safety. The water to keep the reactor cool is provided by gravity, natural circulation and pressurised water tanks. These systems rely on natural phenomena and do not require any external electrical supplies. All the safety systems are located within the reactor containment so that they are not affected by external events. They are referred to as "passive" safety systems.

Modern large reactors like the Westinghouse AP-1000 use these natural safety systems. The electrical output of an AP-1000 is 1200 MW – enough for 1.4 million homes. However, this is too large for small grid systems or remote areas.

Instead, small modular reactors (SMRs) with an output of around 100 MW are better suited for countries like Australia. These small reactors contain much smaller quantities of nuclear fuel, so they can easily be kept cool by natural cooling systems.

Some SMRs sit in a large water pool that can keep the reactor cool indefinitely. These SMRs are literally "walk away" safe, requiring no operator action, no electrical supplies and no additional water supplies. This is a similar concept to the Australian Nuclear Science and Technology Organisation's OPAL research reactor in Sydney, where the reactor core sits in a large "swimming pool" which will always keep the reactor cool.

The SMR module is factory-built and transported to the site as a complete module. Installing a complete module reduces the risk of on-site construction delays that have been associated with some large reactor projects.

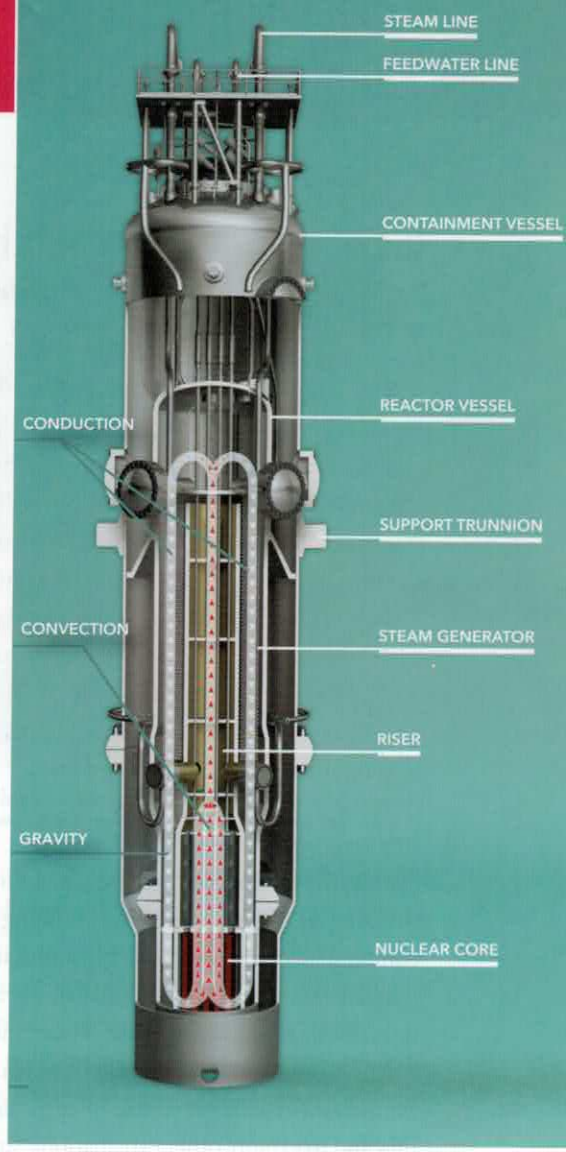
The reactor module can also be installed underground. This protects it from external hazards and also from unauthorised access.

The 50 MW NuScale module sits in a reactor pool 21 metres underground. Up to 12 modules can be installed in a NuScale power plant, providing an output of 600 MW on a site of 18 ha. By comparison, a 600 MW solar plant would require ~1500 ha. Since, the module's turbine condensers can be air-cooled, the plant can be located in remote areas where major water supplies are not available.

The first of the new generation SMRs are now under construction in Argentina, Russia and China. The CAREM SMR in Argentina has a 27 MW output, which is enough for 23,000 homes. CAREM will be operating in 2017.

In Russia, two reactors normally used to power icebreakers have been installed on a barge to provide 70 MW of floating nuclear power, with first deployment scheduled for 2016. The idea of floating nuclear power is not new – the Panama canal zone was supplied by a 10 MW barge-mounted reactor from 1968–75.

China is at the forefront of nuclear power development with 24 large and one small reactor under construction.



This 50 W NuScale module is 20 metres high and 4.6 metres in diameter, and employs conduction, convection and gravity to keep cool. Credit: NuScale Power LLC

Looking further ahead, small liquid metal reactors are being developed with lifetime cores that do not require refuelling. With an output of 10 MW, these would be suitable for remote communities where diesel power is particularly expensive.

Although there has been good progress with wind and solar power, Australia is still heavily dependent on fossil fuels for electricity generation. Nuclear power could help to reduce emissions from electricity generation.

A Royal Commission in South Australia is currently examining all aspects of the nuclear fuel cycle. Its report, due by May 2016, will put the facts on the table and enable a more informed discussion to take place.

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