IN FOCUS: Loud and Nuclear

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Tihange nuclear plant in Belgium

Nuclear power is the one of the safest and most reliable technologies for generating electricity, John Harries from the Australian Nuclear Association writes.

It is used in most developed and many developing countries as an essential part of their electricity supply. The very low-carbon emissions of nuclear power greatly assist these countries in meeting international carbon emission commitments.

Nuclear plants are very reliable with most modern nuclear plants averaging more than 90 per cent capacity factor and providing dispatchable electricity day and night. In 2016, nuclear supplied 10.6 per cent of the world's electricity.

The lifetime carbon emissions for nuclear power are very low and comparable to emissions from hydro and wind. Nuclear energy plays a key role in lowering carbon emissions from the power sector in many countries while improving security of energy supply.

In 2014, nuclear produced 32 per cent of the world's low-carbon electricity in the world; hydro was 49 per cent, and other renewables 19 per cent.

Nuclear power is a very well established technology with more than 17,000 power reactor-years of operation since the first commercial power reactors started operating 1956.

Currently, there are 447 nuclear power plants connected to the grid in 30 countries, with an additional 58 nuclear power reactors under construction and 157 nuclear power reactors on order or planned with approvals, funding or major commitment in place.

For example, Belgium has seven nuclear plants producing 52 per cent of its electricity. The Tihange nuclear plant (pictured) in Belgium consists of three pressurised water reactors with a net generating capacity of 3000MW.

The 130 nuclear reactors in operation in the 14 European Union countries generate almost 30 per cent of the electricity produced in the European Union. The use of nuclear enables countries with nuclear to achieve low-carbon emissions from electricity generation.

For example, France, where nuclear supplied 72 per cent of electricity in 2016, had an electrical generation carbon emission intensity generation that was less than a tenth of its neighbour Germany for similar-sized generating capacities.

China currently has 38 power reactors connected to the grid with another 20 under construction and 39 planned. China is also developing several advanced reactors including molten salt reactors and a 210MW demonstration high temperature gas-cooled reactor (HTR-PM) now under construction.

While the HTM-PM plant will initially be used for electricity production, its operation will pave the way for reactors generating hydrogen for metals reduction and transport fuel synthesis.

Another advanced reactor is the BN-800 sodium-cooled fast-neutron reactor (SFR), which started commercial operation in Russia in 2016.

Figure 2 shows the reactor inside the containment of the BN-800 sodium-cooled fast-neutron reactor. Major advantages of this type of reactor are its ability to burn up long-lived nuclear waste and extract 60 times more energy from the nuclear fuel than current reactors.

Figure 2: BN800 sodium-cooled fast-neutron reactor in Russia

The United Arab Emirates was a country with no nuclear power when it decided to introduce nuclear power. The Korean Electric Power Company is now building four Korean-designed pressurised water reactors at Barakah in the United Arab Emirates.

The first of these four 1400MW plants is expected to be connected in operation in 2018 with the last plant in 2020.

Notwithstanding the major accidents in Chernobyl and Fukushima, nuclear power remains among the safest of all generation technologies based on lives lost per unit of electricity produced during the 60 years of commercial operation.

The Chernobyl accident is the only accident in the history of nuclear power generation in which

members of the public are known to have been killed by radiation. The Chernobyl reactor type would not have been licenced outside the former Soviet Union.

The cost of nuclear electricity depends on many factors including the type of reactor, whether it is first or n-th of a kind, and the country where the reactor is being built.

The International Energy Agency (IEA) analysed different electricity technologies and found nuclear power is competitive in terms of the levelised cost of electricity (LCOE) with fossil fuel and renewables. Even though nuclear plants are expensive to build, they are cheap to operate so the power is competitive.

Although the construction of some first-of-a-kind reactors now being built in Finland, France and the USA have cost much more than expected, the overall conclusion of the IEA study stands – in most countries nuclear is economically competitive.

The design of reactors is continually being improved and new designs developed. This includes a new generation of small modular reactors (SMRs) that are based on factory-built modules rated from 10MW to 250MW and designed to load-follow.

Other developments include accident tolerant fuels that are resistant to the melting and from which more energy can be extracted.

R&D on six advanced reactor designs is being coordinated under the Generation IV International Forum. Australia became the 14th member of the Forum in June 2016. These Gen IV technologies will use fuel more efficiently, reduce waste production, be economically competitive, and meet stringent standards of safety and proliferation resistance.

Nuclear could make a significant contribution to the reliability of Australia's electricity grid. Historically, nuclear was not needed when Australia could rely on its extensive reserves of low-cost coal.

NOW, WITH THE URGENT NEED TO MEET INTERNATIONAL CARBON EMISSION COMMITMENTS, NUCLEAR IS A REAL OPTION TO BE PART OF AUSTRALIA'S ENERGY FUTURE AND HELP LIMIT CARBON EMISSIONS FROM THE ENERGY SECTOR.

Medium-sized nuclear power reactors (700-1000MW) and SMRs would fit well into Australia's transmission grid. They would be well suited for adding to Australia's National Electricity Market (NEM) as fossil fuel plants are retired.

The Australian grid as currently managed is focused on short-term economics with requirements to maximise use of renewables. This focus on short-term economics makes it very difficult for any high capital cost generator such as nuclear to obtain finances for construction.

There is an urgent need to modify or replace the NEM to give some assurance or guarantee on the future demand and price for the electricity generated in the future by high capital cost plant. In the UK, for example, contracts for difference have been negotiated to enable new nuclear to

be added to the UK energy system.

In the light of the recent cost and reliability issues in Australia, there is an urgent need to consider all technologies including nuclear and focus on the reliability, cost and emissions. The advantages and disadvantages of all technologies should be considered as part of an even-handed approach to planning Australia's energy future.

Although many federal and state politicians say they support technology neutrality, federal legislation currently prohibits consideration of nuclear power plant by prohibiting their environmental assessment and regulation by federal departments and agencies.

An important first step towards technology neutrality would be to remove the federal legislative prohibitions that serve no useful purpose and inhibit fair and balanced consideration of nuclear power.

Removal of these bans would demonstrate to nuclear suppliers that Australia would consider nuclear as an option in the country's future energy mix.

Nuclear power is a well-established technology that can make a very significant contribution to improving reliability and lowering carbon emissions of Australia's power system.