Japan fires up nuclear power again, but can it ever be safe enough?

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After two years without any nuclear power in response to the 2011 Fukushima earthquake, tsunami and subsequent nuclear crisis, Japan has restarted its first reactor, Sendai 1.

Following the Fukushima event, Japan's nuclear power generators were gradually shut down. Before the earthquake, nuclear power accounted for around 30% of Japan's electricity. After the shutdown, fossil fuels largely picked up the slack and have been doing the heavy lifting ever since, causing a sustained rise in greenhouse gas emissions.

The restart of Sendai 1 is good news for Japan's response to climate change, and comes with heightened safety regulations around nuclear energy. Based on our assessment of the evidence, this only makes a safe industry safer. But there are still large psychological barriers to overcome.

Visiting Fukushima

In May this year we returned to the megalapolis of Tokyo, following our visit to Fukushima prefecture and the site of the destroyed Daiichi reactors.

We carried dosimeters (a device that measures radiation) through the 20 km radius exclusion zone and wore them at the site. At the very foot of reactor unit 1, the dose rate was serious (greater than 400 microsieverts

per hour). Just a couple of hundred metres away at the undamaged reactor 6, the rate was normal background (less than 5 microsieverts per hour).

Our cumulative dose for the site visit during the course of that day was about one-seventh the dose we received on our flights to Tokyo.

The nuclear accident destroyed four of the six reactors at this site. The decommissioning will take a long time. But it did not irrecoverably poison a landscape. Formal expert studies have shown that the radiation has caused and will cause no discernible human harm.

The psychology of a nuclear disaster

The most serious outcomes have, again, been psychological hurt inflicted on those affected. As we heard first-hand from officials in Naraha town, "unfounded rumours" continue to be one of the biggest obstacles for the community to recover from this event.

The prolonged closure of the rest of the largely undamaged Japanese fleet of reactors also led to a steep increase in fossil fuel importation, hurting the Japanese economy and sending greenhouse emissions rising steeply. Japan's recent electricity supply has come to resemble Australia's dependence on fossil fuels. That's not a good thing, unless you sell fossil fuels.

Yet despite the economic hit and the massive setback to its previously announced climate change targets, Japan has been struggling to restart its reactors. When we visited the Japan Atomic Industrial Forum on this same visit, the mood was sober. Public opinion was holding hard against nuclear. The restart was far from certain despite exhaustive checks and approvals.

One in our number was prescient when he said that Prime Minister Shinzo Abe's government will simply need to spend political capital, restart reactors and manage the response. That appears to have been the case with the restart of 30-year-old, 890-megawatt Sendai 1 reactor this week.

Making a safe industry safer

No informed observer argues that the failings displayed at Fukushima, both technical and procedural, were not serious. So how can people, most of all the Japanese, feel confident in the restart of other reactors?

The Japanese regulator took strong action with major boosts in safety standards. Here are some of those new actions:

A nuclear plant must be designed to withstand a tsunami larger than any recorded event - which includes the 2011 events. As a result, major new seawall infrastructure has been installed to protect plants.

The major failure at Fukushima, the loss of power to the reactor, has been addressed. Off-site power supply must now be from two fully independent circuits. Previously, two emergency on-site generators were required. This has been boosted to a third permanent installed generator, plus two mobile units located in nearby elevated terrain, all with a seven-day fuel supply. These requirements apply to all plants.

Previously, internal flooding was not regarded as a plausible event. Now it is. No matter the hypothetical cause, all critical buildings must demonstrate protection from flooding, for example through the installation of new watertight doors.

At Fukushima Daiichi, the loss of cooling in the core during the first day of the accident led to the buildup of steam and hydrogen gas in the

reactor pressure vessel. After delays due to power loss to the pressure pumps, these gases were eventually released from the containment vessel, but the power failure meant that venting from the reactor building itself to the outside failed. The highly volatile hydrogen gas accumulated and chemical explosions subsequently ensued.

There are new systems tied to the additional backup power supply to ensure prompter venting from the containment vessel. Permanently installed filtered venting systems are now in place to then vent any gases from the reactor building.

If containment does fail, large-scale water cannons will be deployed to douse the reactor building and prevent the dispersion of material away from site.

Reactors that have been operating for more than 30 years will require assessment of structure, systems and components at year 30 and every decade thereafter. Operational lives are limited to 40 years with one potential extension of not more than 20 years.

Such extraordinary measures, piled on top of a sector that has operated very safely bar one accident triggered by an extraordinary external catastrophe, will make the very safe even safer.

But do we feel safe?

Despite the increase in regulation, many people still feel unsafe around nuclear energy. This may in fact be *because* of the high levels of regulation – if something needs so much attention, it must be dangerous, right?

We can contrast this with the risks of fossil fuels. More than 7 million deaths are attributed to air pollution annually, with fossil fuels an

important contributor to this figure. Burning coal for energy and heat contributes 20% of greenhouse gases that are warming the earth every year. That all happens when they are in perfect working order.

Will nuclear technology ever win hearts and minds to scale-up and replace coal?

The focus now is on "stupid-proofing" nuclear technology - making nuclear power immune to human error (also called "walk-away safe"). Reactor technology is heading increasingly in this direction.

Today's designs like the AP-1000 from Westinghouse go a long way towards "stupid" safety. It will likely be metal-fuelled, liquid-metal-cooled recycling reactors like the PRISM, or fluid-fuelled reactors like the IMSR from Terrestrial Energy (for whom Ben has consulted) or the ThorCon reactor that decisively change the game for nuclear technology.

All of these designs incorporate "inherent" safety systems. Rather than requiring an operator, they rely on physical principles to regulate the reactor (for instance, gravity-fed cooling systems or the expansion of the fuel with heat).

Can Japan and the world be confident their nuclear sector is safe? The only evidence-based conclusion we can reach is "yes". But it may take fundamental changes in the technology before most people will believe it.

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