The Next, Safer Generation of Nuclear Reactor

Hugh MacDiarmid and Simon Irish

The 2011 Fukushima nuclear disaster had an understandable chilling effect on public policy discussion around nuclear energy. But in the industry itself, progress has continued toward making nuclear energy the cleanest, safest option for this and future generations. That progress includes a new focus on a different—much cheaper and safer—class of nuclear reactor known as the molten-salt reactor, or MSR. The global race to commercialize MSRs is on, and Canada is competing.

Canadian scientists have been at the leading edge of nuclear technology since the dawn of the Atomic Age, and Canadian nuclear technology has been shipped around the world. Canada can remain at the forefront of the civilian use of nuclear energy, but we must act quickly.

Perhaps, as Canadians, we have been lulled into complacency by the abundance of oil and gas that lies beneath our land. The recent dramatic reduction in oil prices, and continued low natural gas prices, make it easy to continue following the path of least resistance.

Some are pinning their hopes on solar and wind power—even though renewables have made barely a dent in the global energy supply.

But now, there are developments in nuclear technology that promise to provide a safe, reliable and cost-effective alternative to our reliance on fossil fuels.

Only the most ardent climate-change denier would argue there is no role for nuclear in achieving a cleaner energy future. Among the virtues of nuclear energy is its near absence of carbon emissions.

Where opposition persists, it is focused on the perceived risks of nuclear reactors and on the tremendous up-front costs we require to mitigate those risks.

Ensuring the safety of a good solid-fuel reactor like the CANDU comes at a high price. Containment structures, multiple fail-safes and other highly engineered safety solutions have driven the capital costs of modern solid-fuel reactors so high that their cost-competitiveness against other energy sources is severely eroded—despite their acknowledged advantage on the carbon emissions front and low operating costs.

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These next generation reactors are smaller, more efficient, less expensive and lower risk, and they address the safety and environmental issues that have slowed the pace of development of the current generation of nuclear technology.

Ottawa has acted to restructure Atomic Energy of Canada Limited, initially selling the commercial reactor division to SNC-Lavalin and now implementing a “Government-Owned, Contractor-Operated” (GOCO) model for Chalk River Laboratories. This introduction of private sector management expertise and incentives is designed to boost the competitiveness of our nation’s nuclear heartland.

Ontario is continuing the refurbishment of its reactor fleet in a program that will take a decade and cost billions of dollars, and will extend by 30 years the operating lives of the reactors that are the backbone of Ontario’s nuclear electricity generation. But what lies beyond the existing infrastructure and capacity?

Our reactor fleet today is operated to the highest standards among global nuclear utilities. Canada has an impressive cadre of nuclear scientists and a wealth of nuclear expertise. There is an impressive supply chain in this country that can compete with the best in the world. How do we leverage these substantial strengths to create a bright future as a self-sufficient energy-centric economy?

The option we should be considering is a completely different class of nu-

The Bruce Power site is the world's largest operating nuclear facility, with eight CANDU reactors supplying over 6,300 megawatts to the Ontario electricity grid. Photo, Bruce Power

clear reactor known as a "molten-salt reactor," or MSR. In these machines, the nuclear fuel and reactor core is in a liquid form, a fundamental departure from all previously commercialized reactors, including the CANDU, which use solid fuel.

The use of a liquid fuel is the root of the MSR's economic and social virtue. It makes the MSR passively safe and stable, addressing the key concerns associated with solid-fuel reactors—as well as much of the expense required to address those concerns.

Specifically, MSRs operate at atmospheric pressure; as such, the reactor vessel contents are not under pressure, they cannot create explosive hydrogen, and the fuel cannot "melt down," as it is already a liquid. Passive stability thus makes many of the most costly fail-safes in solid-fuel reactors irrelevant and redundant—making the MSR less costly to build.

MSRs can use conventional uranium fuel—or they can use alternative fuels, including the waste fuel piles and waste plutonium of earlier-generation reactors.

Current solid fuel reactors require six times the fuel to produce the same output as an MSR and leave six times the waste—waste which, in an MSR, can be recycled and mostly used up. As an energy source, the MSR is compact, scalable and available wherever it is needed, and, therefore, free from the constraints of a large-scale transmission infrastructure.

In short, this next generation of reactors is poised to become that revolutionary civilian energy source we were promised 60 years ago when US President Dwight Eisenhower talked about Atoms for Peace.

Ironically, when Eisenhower spoke those words, the concept of an MSR was already known—and functioning MSRs were actually developed and heavily researched over the next two decades. But funding for liquid-fuel MSRs was withdrawn in favour of solid-fuel pressurized water reactors. (People familiar with the Avro Arrow or the battle between VHS and Betamax will understand that this was not the only time we failed to choose the better technology).

Thankfully, today's imperatives are different. Today, scientists, engineers and the private sector are re-visiting those decisions of the past and looking at them through the lens of today's urgent needs—cost, safety, risk and waste footprint.

Reviving this 50-year-old MSR research has not yet attracted much attention in Canada, but the idea already has important backers around the world—including the Chinese government, which has earmarked $350 million to build an MSR. The Indian government is also exploring the technology. As the world's two most populous nations, China and India recognize that developing a secure and inexpensive alternative to fossil fuels would provide a boost to their economic development plans that few other actions could match.

The global race to commercialize the MSR has begun. The question is whether, in this new century, Canada will be a key player in the biggest industrial market of all—the market for secure, safe, clean and cost-competitive energy.

Canada should be there. We have strong international credentials in nuclear technology. We are particularly well-placed to develop this new technology. Our regulatory process lends itself to timely review of new technologies. And we have a near-endless supply of the nuclear fuel it requires, plus a long history of producing and handling the material safely and securely. Canada's Athabasca basin alone currently supplies 20 per cent of the world's uranium, and could supply all of Canada's electricity needs for many lifetimes.

Canada can build on its widely respected history of nuclear research and its great pool of nuclear talent to realize the enormous promise of a prosperous nuclear future. P

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