THE WARREN CENTRE

Generation IV Nuclear Energy Agreement

25 April 2017

About the Warren Centre for Advanced Engineering

The Warren Centre brings industry, government, and academia together to create thought leadership in engineering, technology, and innovation. We constantly challenge economic, legal, environmental, social, and political paradigms to open possibilities for innovation and technology to build a better future.

The Warren Centre advocates for the importance of science, technology and innovation. Our 30 years' experience of leading the conversation through projects, promotion, and independent advice drives Australian entrepreneurship and economic growth.

This document forms the response of the Warren Centre to the Parliamentary Joint Standing Committee on Treaties on the Generation IV Nuclear Energy Framework Agreement. We thank the Committee for the opportunity to respond.

Executive Summary

It is in Australia's national economic and security interests to join the Framework Agreement for International Collaboration on Research and Development of Generation IV Nuclear Energy Systems.

Participation in the Generation IV International Forum provides the opportunity to improve awareness and understanding of nuclear energy developments and to influence Australia's international non-proliferation, security and safety goals. Accession to the Agreement will enhance Australia's international and regional influence with the International Atomic Energy Agency. Australian participation will increase the international status and influence of ANSTO and Australia's universities.

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Context

Energy is critical to global social and economic development, but climate change requires net zero atmospheric carbon emissions in the second half of this century to avoid exceeding a dangerous 2.0°C rise in global temperatures. Without strong actions, especially in the Asian region, carbon dioxide emissions will continue to increase. Scientists and economists warn of irreversible consequences. Every country must participate and support the technical development and economic deployment of new energy sources with drastically reduced carbon emissions.

Nuclear energy can contribute to meeting the challenges of the future. A new generation of technologies envisioned in the Generation IV International Forum ("GIF") may become feasible in the 2030 to 2050 timeframe.[1] GIF is a major international research collaboration. Technologies emerging from GIF are aimed to demonstrate superior operational safety, improved non-proliferation protection and cost-effective economics compared to today's Generation III nuclear technologies.

Demonstrating this next generation of nuclear energy is already underway. China is currently in the early stages of commissioning a high temperature gas-cooled pebble reactor in Shandong province.[2,3] In the United States, the US Department of Energy has awarded the start-up company X-energy a $53 million Advanced Reactor Concept Cooperative Agreement for that company's xenon pebble bed reactor design development.[4,5]

Six technology options have been identified in the Gen-IV Technology Roadmap, and leading economies are cooperating in technology development.[6,7]

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[1] GIF (Generation IV International Forum) (2014), Technology Roadmap Update for Generation IV Nuclear Energy Systems, Generation IV International Forum, Paris.
[2] Richard Martin, China Could Have a Meltdown-Proof Nuclear Reactor Next Year, *MIT Technology Review*, 11Feb2016, https://www.technologyreview.com/s/600757/china-could-have-a-meltdown-proof-nuclear-reactor-next-year/
[3] Zhang, Z., Dong, Y., Li, F., Zhang, Z., Wang, H., Huang, X., Li, H., Liu, B., Wu, X., Wang, H. and Diao, X., 2016. The Shandong Shidao Bay 200 MWe High-Temperature Gas-Cooled Reactor Pebble-Bed Module (HTR-PM) Demonstration Power Plant: An Engineering and Technological Innovation. *Engineering*, *2*(1), pp.112-118.
[4] James Conca, X-Energy Steps Into The Ring With Its Advanced Pebble Bed Modular Nuclear Reactor, *Forbes*, 27Mar2017, https://www.forbes.com/sites/jamesconca/2017/03/27/x-energy-steps-into-the-ring-with-its-advanced-pebble-bed-modular-nuclear-reactor/#aa23d62745d1.
[5] Energy Department Announces New Investments in Advanced Nuclear Power Reactors to Help Meet America's Carbon Emission Reduction Goal, US Department of Energy, 16Jan2016, https://www.energy.gov/articles/energy-department-announces-new-investments-advanced-nuclear-power-reactors-help-meet.
[6] Locatelli, G., Mancini, M. and Todeschini, N., 2013. Generation IV nuclear reactors: Current status and future prospects. *Energy Policy*, *61*, pp.1503-1520.
[7] GIF 2014, [1] above.

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Australia's role and national interests

The Australian Nuclear Science and Technology Organisation (ANSTO) has outstanding technical capabilities within its employee pool and due to its research hardware assets. The Open Pool Australian Lightwater (OPAL) reactor has proven to be instrumental to the development and international supply of medical radioisotopes[8, 9, 10] and to expanding material science research. Regionally, Australia is the most advanced nation in the South-East Asia and Pacific Regional Group. In addition to ANSTO, Australian universities have research capabilities that can play an important role domestically, regionally, and in the broader international arena.

It is proposed that ANSTO would support the international cooperation efforts by researching materials solutions that could deliver new alloys or ceramics for the intense conditions of Gen-IV power systems.[11] Indeed, novel high temperature nickel alloys, new steels and innovative ceramics must be invented to support construction of the Gen-IV systems.[12,13] Entire new supply chains of materials and service expertise could flow from timely engagement with international materials engineers to support global Gen-IV efforts.

Australian participation in GIF would allow the nation to stay closely informed on advanced technology developing from the international collaboration. It would contribute to maintaining and improving international relationships with like-minded international partners in research, low-carbon affordable energy and the peaceful aims of the technology. Participation in GIF will provide collaboration opportunities domestically and internationally across boundaries of government, universities and newly forming industry. Australian participation is a sensible approach to keep all options on the table for future energy.

Accession to GIF would increase Australia's ability to influence international nuclear policy according to Australia's national interests. It would enhance Australia's

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[8] Ruth, T.J., 2014. The medical isotope crisis: how we got here and where we are going. *Journal of nuclear medicine technology*, *42*(4), pp.245-248.
[9] Ballinger, J.R., 2014. Short-and long-term responses to molybdenum-99 shortages in nuclear medicine. *The British Journal of Radiology*.
[10] Macfarlane, I. First steps underway: Australian nuclear medicine project, 08May2014, http://www.minister.industry.gov.au/ministers/macfarlane/media-releases/first-steps-underway-australian-nuclear-medicine-project
[11] National Interest Analysis [2017] ATNIA 13, paragraph [17].
[12] Hassan, T., Lissenden, C. and Carroll, L., 2015. *Multiaxial Creep-Fatigue and Creep-Ratcheting Failures of Grade 91 and Haynes 230 Alloys Toward Addressing Design Issues of Gen IV Nuclear Power Plants* (No. DOE/NEUP--09-832). North Carolina State Univ., Raleigh, NC (United States).
[13] Ren, W. and Swindeman, R., 2014. Status of Alloy 800 H in Considerations for the Gen IV Nuclear Energy Systems. *Journal of Pressure Vessel Technology*, *136*(5), p.054001.

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regional leadership and support Australia's seat on the International Atomic Energy Agency (IAEA) Board of Governors.

Conclusion

Because participation in the Gen-IV International Forum is in Australia's best long-term national interests, the Warren Centre recommends that Australia accede to the Agreement.

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About the Warren Centre for Advanced Engineering

The Warren Centre constantly challenges the economic, legal, environmental, social and political issues raised by innovation. We collaborate with industry, government and academia to achieve globally significant outcomes.
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