Submission Inquiry into Nuclear Power Generation in Australia

Introduction

My name is Norvan Vogt, and I bring over 29 years of experience in Information Technology, with extensive leadership roles in digital strategy, data governance, and transformation within healthcare, human services, and government sectors. As Director of Open Rationale Ltd., I work with healthcare and human services organisations, driving projects that improve system interoperability, enhance data security, and support sustainable technology adoption in complex client and operational environments. My career includes executive roles as Chief Information Officer for prominent health institutions in Queensland. I have successfully led digital transformation initiatives that optimised service delivery, streamlined operations, and strengthened digital infrastructure supporting essential services. This background and my commitment to environmental sustainability inform my support for incorporating thorium-based nuclear energy. Thorium reactors, in my view, present an ideal complement to renewables within our energy mix, particularly in providing a stable and reliable power source for essential services and industry sites where energy stability is crucial. Drawing on my experience, this submission advocates for the strategic integration of small-scale thorium reactors to advance Australia's energy independence and its capacity for secure, sustainable power while creating new, high-skilled employment opportunities in regional areas.

The Need

As an ICT professional with decades of experience supporting critical infrastructure in remote and regional areas, I have witnessed first-hand the challenges these communities face in achieving reliable, continuous power. The risks of depending solely on renewables, while vital to our energy mix, often leave regional centres vulnerable to intermittency, as recent events in places like Broken Hill have shown. These risks underscore the necessity of exploring alternative, more stable energy sources. I am writing to propose small-scale thorium-based nuclear reactors, specifically those producing between two and five megawatts, as a sustainable, secure solution that addresses the energy needs of remote and regional areas and offers broader benefits for Australia's economy, environment, and workforce. Integrating thorium reactors into the energy mix would secure steady power supplies, create high-paying science-based jobs in the regions, and advance Australia's commitment to a cleaner, more diversified energy portfolio.

This submission presents the unique advantages of thorium reactors, addresses common concerns, and provides a strategic vision for supporting Australia's energy resilience in regional and remote communities through small-scale, safe, and sustainable nuclear solutions.

1. Strategic Benefits of Thorium for Regional Energy Independence

Australia's thorium reserves rank among the highest globally, positioning it as a valuable natural resource for reliable, domestic power generation. Thorium is three to four times more abundant than uranium, making it a feasible option for energy independence. The study by Jyothi et al. (2023) highlights this abundance, suggesting that thorium could underpin localised, consistent power supplies, reducing the need for extensive energy transport infrastructure and dependence on external energy sources, often costly and unsustainable for remote areas.

Small-scale thorium reactors could provide baseload power to regional centres, thereby reducing their vulnerability to power interruptions associated with renewable energy intermittency. In my industry, ensuring continuous power is paramount for ICT systems and networks in critical sectors such as healthcare, emergency services, and logistics. By adopting thorium reactors, regional Australia could achieve reliable, self-sustaining energy, supporting local industries and communities.

2. Enhanced Safety Profile of Thorium-Based Small Modular Reactors (SMRs)

Traditional nuclear reactors have long been associated with high-risk, high-maintenance infrastructure. However, thorium-based small modular reactors (SMRs) offer significant safety advantages. Emblemsvåg (2021) notes that these reactors operate at atmospheric pressure, significantly reducing risks of catastrophic failure. Further, SMRs are designed for passive cooling, meaning that in the event of an operational failure, the system automatically shuts down without external intervention, unlike conventional reactors, where meltdowns remain a risk.

This advanced safety profile is particularly beneficial for regional Australia, where distances from emergency services make rapid incident response challenging.

In high-risk natural environments, where bushfires, floods, and extreme weather can disrupt infrastructure, thorium SMRs offer a safer alternative that maintains consistent power with minimal intervention. This technology could foster public confidence in nuclear energy and advance its acceptability as a stable energy solution.

3. A Science-Driven Future: High-Paying, Skilled Jobs in Regional Australia

A significant benefit of deploying thorium reactors in regional areas is the economic opportunity it presents. Establishing a network of small thorium reactors across regional centres would create high-skilled, high-paying jobs in nuclear engineering, materials science, and environmental sciences. The presence of these roles in regional Australia would not only support local economies but also attract talent to rural communities, revitalising these areas with knowledge-driven, sustainable job growth.

These reactors would require skilled personnel for operation, maintenance, and oversight, creating a demand for scientific expertise that aligns well with Australia's efforts to nurture a STEM-oriented workforce. The role of these reactors as hubs of innovation would encourage young Australians to pursue careers in science and technology, contributing to nation-building efforts that support economic and environmental goals.

4. Addressing Waste Concerns: Reduced Impact and Responsible Management

One of the most significant advantages of thorium technology is its waste profile. Unlike uranium reactors, which produce long-lived, high-level waste, thorium reactors generate substantially less hazardous by-products with shorter half-lives (Li et al., 2022). This waste is more accessible to contain and dispose of, making it an environmentally preferable option for areas with limited waste management infrastructure.

In remote settings, where environmental conservation is critical, thorium reactors offer a manageable, lower-impact waste profile. This reduced waste production aligns with regional Australia's commitment to sustainable development, supporting local and national environmental standards.

5. Non-Proliferation and Strategic Security in a Regional Context

The thorium fuel cycle is inherently resistant to proliferation and does not produce weaponisable materials. Manchanda (2023) notes this characteristic aligns well with Australia's commitment to peaceful nuclear energy. Thorium cannot directly fuel atomic weapons, a key consideration given Australia's location in a geopolitically sensitive region. Developing thorium reactors in regional centres supports Australia's non-nuclear stance, promoting energy security and innovation.

6. Responding to the Challenges of Small-Scale Thorium Reactor Implementation

Thorium-based small modular reactors are relatively new, and challenges remain around their commercialisation, cost, technical limitations, and current lack of industry support. However, with strategic government investment and a clear policy framework, these challenges can be managed to ensure thorium's effective integration into Australia's energy mix.

a) Unproven Commercial Viability

While thorium reactors are still emerging, many of today's dominant renewable technologies are also in their early stages. Other countries, including India and Norway, are advancing thorium research and bringing pilot projects closer to commercial scale. With targeted investment and a clear regulatory pathway, Australia can become a leader in this field, ensuring a viable, scalable energy solution for remote regions. Manchanda (2023) thoroughly examines the separation science challenges associated with thorium fuel cycles, particularly the chemical and radiochemical separations required to extract thorium and maintain purity for reactor use. These advancements are crucial for transitioning thorium from theoretical feasibility to commercial viability, especially in remote locations where operational reliability and minimal maintenance are essential. Kurniawan, Hasanah, & Pamungkas (2023) present a case study focused on thorium-based nuclear power's feasibility and developmental challenges in Indonesia, specifically on Bangka Island. The authors identify infrastructural and logistical challenges for thorium deployment, pertinent to Australia's ambitions in establishing scalable thorium energy solutions in similarly isolated and rural areas. They underscore the need for advanced transport, fuel processing, and a streamlined regulatory framework to achieve commercial viability.

b) Cost and Subsidy Considerations

Thorium reactors, like all energy technologies, require upfront investment. However, thorium is more abundant and cost-effective than uranium, with reduced long-term waste management costs. By prioritising a diversified energy strategy that includes small thorium reactors, Australia could manage risks tied to renewables' intermittency while creating a self-sustaining energy resource in regional centres. Jyothi et al. (2023) underscore the high natural abundance of thorium, especially in monazite sands, and discuss the potential for reduced fuel costs compared to uranium.

The authors also note the isotope's high neutron yield in breeder reactors, which could improve overall reactor economics by reducing the frequency and cost of fuel reprocessing. Emblemsvåg (2021) argues for the cost-effectiveness of thorium-fuelled molten salt reactors (MSRs), detailing their operational efficiencies and enhanced fuel burn-up rates. Emblemsvåg explains that MSRs enable continuous processing, effectively minimising the need for costly refuelling outages and reducing overall fuel cycle costs. By addressing cost structure through these design optimisations, MSRs represent a financially feasible option with proper subsidy frameworks to mitigate initial capital expenditure.

c) Waste and Safety Profile

Though thorium reactors produce some radioactive waste, the volume and hazard are considerably lower than that of uranium reactors, with shorter-lived by-products. Small modular reactors are also designed with passive safety features, operating at atmospheric pressure and significantly reducing operational risks. This makes thorium SMRs safer for remote regions, addressing community concerns around nuclear safety. Emblemsvåg (2021) discusses the lower waste profile of thorium-fuelled MSRs, which produce predominantly low-activity waste isotopes due to the neutron efficiency of the thorium-232 cycle and reduced plutonium production. The study underscores the passive safety features of MSRs, which are inherently designed to operate at atmospheric pressure, lowering the risk of criticality accidents and ensuring structural containment even in seismic zones. Lapanporo & Su'ud (2022) conducted a parametric study on small modular pressurised water reactors (PWRs) utilising thorium. They report on the reduced radioactive inventory and shorter half-lives of fission by-products, contributing to a more manageable waste management profile than conventional uranium reactors. Their findings also highlight the reduced volume of high-level waste, particularly isotopes that complicate long-term waste disposal and public acceptance.

d) Technical Dependency on Uranium-233

Thorium reactors require a neutron source, typically uranium-233, to sustain their reaction. However, technologies like accelerator-driven systems (ADS) minimise this dependency, allowing for safe and effective power generation in remote areas. This characteristic supports safe operational control, with minimal risks associated with critical mass reactions. Li et al. (2022) present a detailed exploration of transuranic transmutation in thorium chloride salt-fast reactors, illustrating alternative neutron sources that minimise reliance on uranium-233. Their findings demonstrate that thorium chloride salt reactors can use transuranic as a primary neutron source, optimising neutron economy and reducing the need for continual uranium-233 breeding. This innovation supports operational independence in remote locations where the fuel supply chain for uranium-233 is economically prohibitive. Manchanda (2023) reviews progress in thorium separation technologies, particularly in advanced molten salt reactor designs that leverage accelerator-driven systems (ADS) to generate neutron flux without the direct use of uranium-233. These systems support safe, self-sustaining reactions with minimal dependency on critical mass, broadening the technological applications for remote power generation.

e) Renewable Compatibility and Grid Integration

Thorium reactors could complement renewables by providing reliable baseload power, reducing dependence on energy storage systems and extensive grid infrastructure. Small-scale thorium reactors in regional centres would enhance grid stability and contribute to a decentralised, resilient energy network that supports local needs and mitigates renewable intermittency challenges. Kurniawan, Hasanah, & Pamungkas (2023) explore grid stability considerations in Indonesia's proposed thorium plant development, indicating parallels with Australian regional grid integration. They discuss hybridised thorium-renewable systems that maintain baseline grid stability, reducing demand on energy storage infrastructure. Such configurations are critical for integrating thorium reactors within decentralised microgrid architectures in areas with limited grid access. Lapanporo & Su'ud (2022) elaborate on the suitability of small modular thorium reactors (SMRs) in complementing renewables, noting that their modularity allows phased deployment to match local energy demand profiles. They propose that SMRs when synchronised with renewables, can reduce the dependency on conventional grid infrastructure and storage systems by providing reliable baseload power.

f) Limited Industry Support

The current nuclear industry focus has historically centred on uranium. However, as the global shift towards safer, cleaner energy continues, interest in thorium is growing. With supportive policy, funding for R&D, and public-private collaboration, Australia can lead in thorium technology adoption, bringing a new energy solution to regional centres while fostering broader industry interest in thorium. Jyothi et al. (2023) address the lack of infrastructure and research funding historically allocated to thorium, contrasting with uranium-centric nuclear development. They identify necessary public-private partnerships and government interventions to facilitate the adoption of thorium, especially in energy sectors with safety and environmental priorities. The authors argue that regulatory reforms, such as standardising thorium processing and utilisation, are pivotal in expanding industrial support.

Emblemsvåg (2021) argues that thorium-based MSRs align with global sustainability and safety objectives and present a viable pathway to decarbonisation. The paper recommends an R&D pipeline focused on thorium-specific reactor materials, processing technologies, and operational safety standards, which could stimulate industry interest. With strategic policies, thorium can become a cornerstone of nuclear energy innovation.

Conclusion: A Nation-Building Energy Strategy for Australia

Small-scale thorium-based nuclear reactors present a valuable opportunity for Australia to build a sustainable, resilient energy future. Integrating these reactors into the energy mix, particularly in remote and regional areas, would:

1. Ensure consistent power supply essential for critical infrastructure and ICT needs in remote sites.
2. Reduce environmental and economic risks by providing a cleaner, safer, and proliferation-resistant energy source.
3. Drive regional economic growth by creating high-paying science-based jobs, fostering skilled labour, and attracting young Australians to STEM careers.
4. Support Australia's climate and sustainability commitments by minimising waste and emissions compared to traditional nuclear and fossil fuel sources.

Incorporating thorium reactors into a nation-building strategy would enable Australia to meet its environmental, economic, and energy security objectives. Thorium technology promises a greener, more sustainable future and supports regional resilience and energy independence, providing an innovative path forward for Australia's energy sector.

I recommend that Parliament consider thorium technology as a cornerstone of Australia's energy strategy, supporting the transition to a secure, sustainable, and economically prosperous future for regional and metropolitan communities.

Thank you for considering this submission. I am open to providing further input or clarification on the recommendations outlined above.

Norvan Vogt

Sources:

- Jyothi, R., De Melo, L. G. T. C., Santos, R., & Yoon, H.-S. (2023). An overview of thorium as a prospective natural resource for future energy. *Frontiers in Energy Research, 11*. DOI: 10.3389/fenrg.2023.1132611.
- Manchanda, V. (2023). Thorium is an abundant source of nuclear energy, but there are challenges in separation science. *Radiochimica Acta*. DOI: 10.1515/ract-2022-0006.
- Emblemsvåg, J. (2021). Safe, clean, proliferation resistant and cost-effective Thorium-based Molten Salt Reactors for sustainable development. *International Journal of Sustainable Energy, 41*, 514–537. DOI: 10.1080/14786451.2021.1928130.
- Kurniawan, N., Hasanah, M., & Pamungkas, W. A. (2023). The challenges of nuclear power plant development in Indonesia: A case of thorium power plant in Bangka Island, Indonesia. *IOP Conference Series: Earth and Environmental Science, 1199*. DOI: 10.1088/1755-1315/1199/1/012014.
- Li, X., Cui, D., Hu, G., Cai, X., & Chen, J. (2022). Potential of transuranics transmutation in a thorium-based chloride salt fast reactor. *International Journal of Energy Research, 46*, 16461–16475. DOI: 10.1002/er.8309.
- Lapanporo, B. P., & Su'ud, Z. (2022). Parametric study of thorium fuel utilization on small modular pressurized water reactors (PWR). *Journal of Physics: Conference Series, 2243*. DOI: 10.1088/1742-6596/2243/1/012062.