Thorium Powered Submarines for Australia.

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This submission addresses issues contained in Issues Papers Two and Three.

Australia is currently considering the future of submarines and an expansion of nuclear fuel cycles. Nuclear power and submarines are two of the most mutually complimentary technologies. Such submarines can stay deep under water for months or even years and are one of the most stealthily assets a country can have. These subs are vital to protect Australia's fisheries and LNG industry which will be the envy of the world in the centuries ahead. They are also good for Australia's security generally. Diesel powered subs have to be at the surface for most of the time because they need atmospheric oxygen to burn the diesel. In an age of commercial satellite imagery this makes them almost pointless. Refueling vessels at sea perhaps more obvious. Any new diesel powered subs, wherever built, will be poor value for money.

Australia, India, and the USA have ca. 50% of the world's high grade thorium deposits. Again, Australia is the lucky country with 18% of world resources with the best deposits co-located with valuable mineral sand deposits (ref 1) where mines are already operating for other commodities (see map, ref 2). China and the USA also have stockpiles of thorium. Complaints from American companies would say that thorium is currently considered almost a waste product from the rare earths industry with little global demand that amounts to a few tonnes per year for non-nuclear purposes. It is thought that if this thorium had a value as an energy metal then rare earth mines outside China would be more profitable. This might then, in turn, make rare earths more available for the high-tech renewable industries and demote the influence of China's hold on rare earths. Compare the effect of America's shale oil with Saudi Arabia's previous hold on oil.

Natural thorium is essentially isotopically pure ^{232}Th. It doesn't need enrichment and all ore bodies will result fungible cargoes. It has a half-life of 14 billion years. Thorium oxide is stable if stored in drums under dry conditions. Thorium nitrate is another stable compound that can be warehoused for years. Thorium tetrafluoride is used in the reactor. Fuel fabrication depends on reactor design. Liquid salt designs dominate for their simplicity and safety. They achieve high temperatures at atmospheric pressure and have a plug at the bottom of the reactor that melts in the event that the reactor overheats, meaning no backup power required such as Fukushima.

The chemical toxicity of thorium is low because thorium and its most common compounds (mostly the dioxide) are poorly soluble in water (ref 3).

Historically thorium was overlooked after WWII because the cycle only produces very small quantities of weaponisable isotopes that are difficult and expensive to process (refine) compared to uranium/plutonium cycles. An experimental thorium reactor was operational in America from 1964 to 1969 and the whole idea abandoned in 1973. They had a huge stockpile of nuclear weapons (from uranium/plutonium cycles)

at this time as did the Russians. Times have changed.

Burning thorium as a nuclear fuel results in 50% less waste that is 90% less toxic than uranium/plutonium fuel cycles and is safe in 200-300 years of storage. As said, thorium fuel cycles are highly resistant to producing isotopes of uranium and plutonium that can be used for weaponisation. Therefore it has political advantage over uranium. Does Australia really want to expand the business of refining weaponisable isotopes of uranium? Australia has been wise to be cautious about nuclear energy. We're now at a fork in the road - let's go thorium.

Australia has all its ducks in a row to develop both thorium processing and reactor technology generally for electricity generation and thorium powered submarines at a secret purpose built facility on the isolated coast of South Australia. Small reactors suit distributed electricity generation on land and provide some base load to compliment intermittent renewable power such as wind and solar, and peak shaving gas turbines. This technology and the thorium itself could be exported to further Australia economically. We would be adding information to the thorium exports and diversifying the economy towards knowledge and service sectors. It would take billions and decades but would be a good earner for Australia in the centuries ahead, and the intellectual property, prestige, and projection of power would be Australian. The interest in land based nuclear energy may wax and wane, but the demand for nuclear powered subs will always be there for countries with vast coastal territories. Suggest Bechtel Corp, Westinghouse, or GE gets the contract. (I don't own any shares in these companies)

Regards.

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References.

1. "All of Australia's thorium resources occur in multi-commodity deposits, dominantly the heavymineral sands and rare earth deposits where the extraction cost would be shared with, if not totally supported by, the other commodities in the deposit." p.23, "A Review of the Geochemical Processes Controlling the Distribution of Thorium In the Earth's Crust and Australia's Thorium Resources", Terrence P. Mernagh and Yanis Miezitis, GEOSCIENCE AUSTRALIA 2010.

http://www.academia.edu/685828/A_Review_of_the_Geochemical_Processes_Controlling_the_Distribution_of_Thorium_In_the_Earths_Crust_and_Australias_Thorium_Resources accessed July 2015.

2. ibid, p.24

3 . *Untersuchungen zur radiologischen Emission des Uran-Tailings Schneckenstein*, **1988** (PDF; 4 MB), TU Bergakademie Freiberg and TU Dresden. B. Merkel, G. Dudel et al.: accessed July 2015.