Search For Solutions: Thorium and Next-Generation Nuclear Fission

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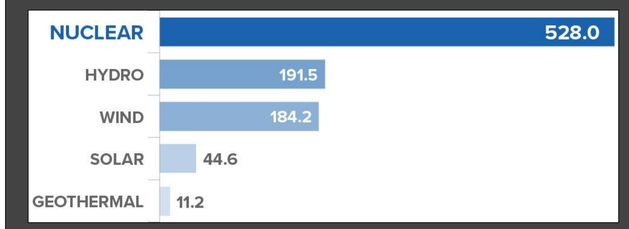
How Does A Thorium Reactor Work?

In a nuclear reactor, neutrons are shot at atomic nuclei in order to create fission (splitting of nuclei). The neutrons are shot at the reactor fuel, which in this case is thorium (^{232}Th). Fission results in the release of energy that is used to drive turbines and produce electricity. The benefits of ^{232}Th as reactor fuel are:

- Fertile material (i.e. will not split unless acted upon by fast neutrons). Thus, reaction can be stopped anytime by cutting off neutron supply.
- Produce less waste that is less radioactive.
- Cannot be weaponized.
- 3x more abundant than uranium.
- Most mined thorium is already 232Th; mined uranium is 3-5% 235U [4].

89	90	91	92	93	94
Ac	Th	Pa	U	Np	Pu
Actinium	Thorium	Protactinium	Uranium	Neptunium	Plutonium
Actinide	Actinide	Actinide	Actinide	Actinide	Actinide

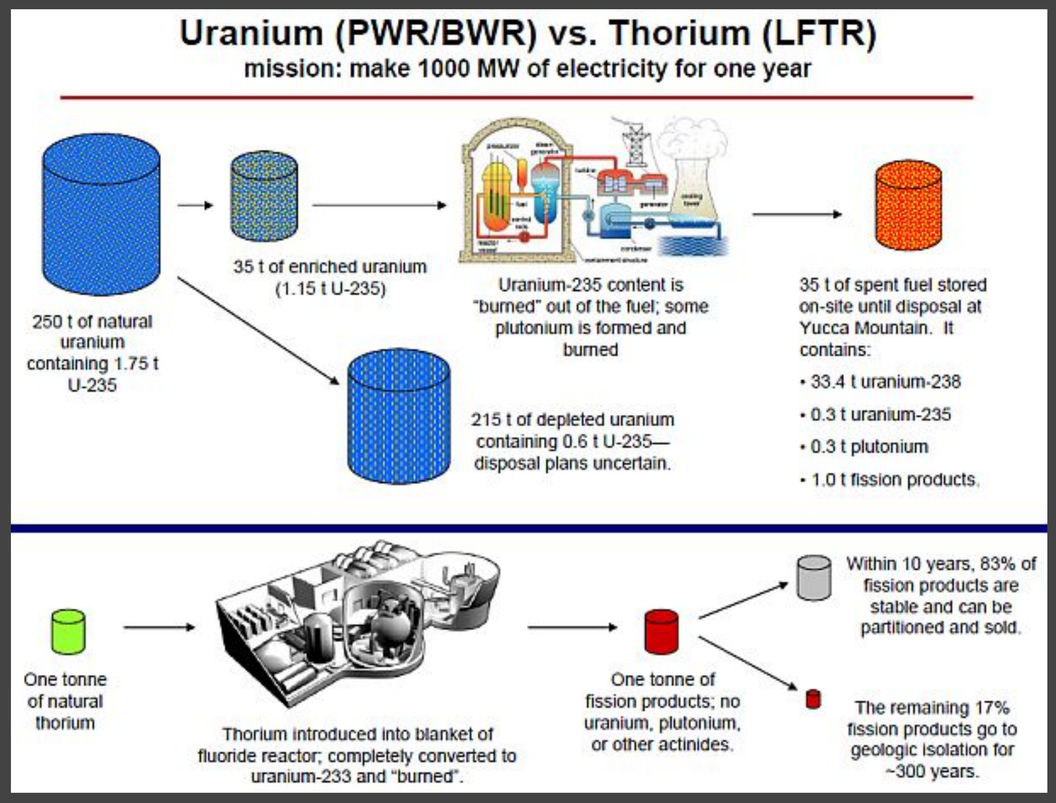
Thorium shares the same characteristics as uranium, making it suitable for reactor fuel [3].



This chart represents the CO_2 emissions avoided by the U.S. power industry in million metric tons in 2018. Nuclear power avoided CO_2 emissions the most by far among all other primary energy sources [4].

Why Use Thorium in Nuclear Fission?

Nuclear energy has obtained a bad reputation due to events like Chernobyl and Fukushima. These nuclear reactors produced energy by using enriched uranium, which has a dangerously high energy density. Thorium is a fertile material that can be used as an alternative reactor fuel to ^{235}U because it is safer from the reaction process to the radioactivity of the waste. In addition to safety benefits, plutonium is not one of thorium's byproducts, which is the element used in weaponization (i.e. the atomic bomb).



Limitations

The big limitation of thorium would be the lack of weaponization associated with it, thus reducing the amount of people who would want to invest in it. Smaller limitations include it being site specific, as this task requires the use of thorium reactors to accomplish (see picture below).

Costs

The fuel cost is significantly lower than the a typical solid fuel reactor. The thorium for the reactor cost $30 per kg and the uranium costs $150 per kg. If thorium becomes more popular, the price will continue to decrease due to the wide availability of thorium in the earth's crust combined with the demand.

Addressing Climate Change

- ^{232}Th reactors produce less waste, meaning less storage needed.
- Very few to no carbon emissions.
- De-weaponizes nuclear power, preventing devastating consequences of war.

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