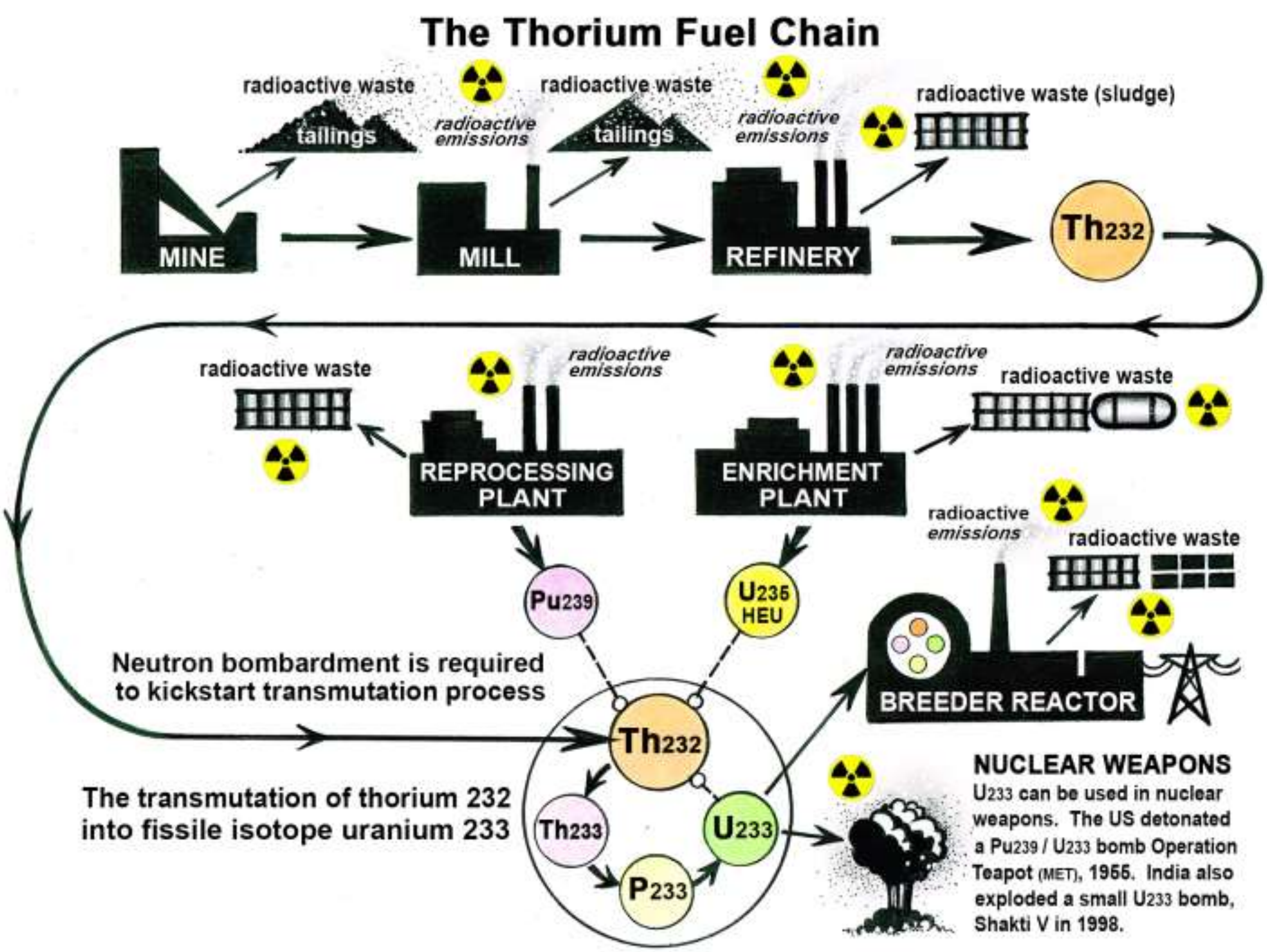
Thorium – hope or hype / dream or dystopia

Recently there has been an unofficial online and print campaign in North America promoting thorium as a superfuel of the future. Promoters talk of a new type of nuclear power which uses relatively abundant thorium instead of uranium - the promise is of unlimited, safe, clean, and cheap electrical power for many hundreds of years. The campaign makes thorium seem almost like the "holy grail" of energy.

Thorium enthusiasts want governments (ie. you the taxpayer) to facilitate and finance further research and development of this power source. Financial lending institutions find it too expensive and risky and do not see a market for it.

Uranium is currently fissioned in nuclear reactors to produce electrical energy. **Thorium** adherents rightfully say that these reactors pose undesirable financial, security, weapons proliferation, emissions, decommissioning, waste management, environmental, and health risks. However, replacing uranium fuel with thorium would not fix these problems, as explained below. It is not the 'silver bullet' the hype claims it to be.

Thorium is a radioactive element, a heavy metal, found in many parts of the world, usually as part of the phosphate mineral monazite. It has been used to produce small amounts of energy at experimental nuclear reactors in the 20th Century, but was not generally pursued as a commercial energy source - it is very expensive and, from an engineering perspective, a much more complicated procedure than the uranium fuel alternative which was developed instead.



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THORIUM ORE - TRANSMUTATION - FISSION - POWER GENERATION (refer to illustration)

Widespread thorium **mining, milling**, and **refining** would be an energy intensive and costly undertaking. As is the case with uranium, it would be highly polluting as well. Heavy metals, arsenic, volatile organic compounds, radioactive mine tailings and other effluents are routinely released into the air and water. Many are neuro-toxins and carcinogens that will pose hazards to human health for centuries. After refining, once the feedstock material **thorium 232** is isolated it still cannot be used as a nuclear fuel. That is because unlike uranium, thorium is not a "fissile" material, but is a "fertile" material. "Fertile" means it cannot be fissioned, ie. undergo a sustained chain reaction like uranium *but* it can be **transmuted** into something which does, namely fissile **uranium 233.** *U233 can be, and has been, diverted for use in nuclear weapons. See diagram.*

The Th232 transmutation process required is complex, expensive, and technologically challenging.
First, **neutron bombardment** from a weapons grade radioactive material is needed to kick-start the process which ultimately creates fissile **U233**. The radioactive material used is from either of two sources:

- One neutron source, highly enriched uranium 235 (**HEU**), is produced in an **enrichment facility** like the one Iran has recently developed.

- Another source, **plutonium 239**, is produced in a **reprocessing plant** like the one at La Hague, France.
Both facilities are energy intensive, strategically vulnerable, highly polluting, and create long-lived radioactive waste.

During neutron bombardment, **thorium 232** in the breeder reactor absorbs neutrons enabling it to begin the transmutation process - first into **thorium 233,** then **protactinium 233**, and finally into **uranium 233** - the isotope which fissions to create heat. The heat boils water to power a steam turbine producing electricity, as shown in the diagram.
- Like existing nuclear reactors, excessive heat generated will cause serious environmental concerns regarding water usage. Also during normal operations it would routinely release carcinogenic radioactive gaseous and liquid effluents into the surrounding area, as other reactors do.
- A thorium breeder reactor would be as vulnerable as any other nuclear reactor to radioactive leaks, premature corrosion of materials, sabotage, catastrophic accidents like fires, and to containment-breaching terrorist attacks. The latter scenario could create a "dirty bomb" effect spreading radioactivity far and wide.
- A thorium reactor would create long lived high-level nuclear waste that must be carefully managed & guarded for centuries in a deep geological repository. These hazardous products would be of a different spectrum (eg. no plutonium, a transuranic element) and created in different proportions than those from uranium reactors, but they are equivalent in their alpha and beta radio-toxicity and in their very long half-lives.
-The reactor's ultimate decommissioning and dismantling would require the separation and sequestration of all its metallic components – pressure vessel, tubing, etc. (considered nuclear waste) in a deep geological repository. So in effect even more radioactive waste would be created at the end of its life cycle.

Some of the dangerous radioactive products in high-level nuclear waste from thorium reactors:
Uranium 232: half-life = 160,000 years. **Technetium 99**: half-life = 300,000 years. **Iodine129**: half-life = 15.7 million years. The actinide **Protactinium 231**: half-life = 33,000 years. Residual **Uranium 233**: half-life = 159,200 years.

- As detailed above, thorium reactors are no better than conventional nuclear reactors when it comes to high cost, radioactive pollution, proliferation risks, high level radioactive waste, and decommissioning concerns.

It's no surprise then to learn that it is *not* the big players in the nuclear establishment trumpeting thorium as a superfuel. They tried going down that road decades ago and learned that it's not worth the effort. Instead, it is a relatively small group of "true believers" with an almost missionary zeal. These ardent armchair advocates generate much discussion in the blogosphere, on YouTube, and occasionally in the print press. But their enthusiasm seems based on incomplete information. They are a certain type of nuclear technophile or ideologue. But wishful thinking and a misplaced emotional attachment to nuclear ideology, instead of to real-world practicality, can serve to distract from what really is necessary - namely, to apply creative thinking in achieving modern, rational, environmentally sustainable, and cost-effective energy solutions.

Today, engineering breakthroughs and global financial investments in renewable and low emission energy technologies and strategies vastly exceed anything in the nuclear sector. That is the true energy revolution for our times and for the future.

- David Geary, 2019.
www.cleangreensask.ca more info: **www.ccnr.org/Thorium_Reactors.html** Thorium - a better fuel for nuclear technology? https://wiseinternational.org/nuclear-monitor/858/thorium-—better-fuel-nuclear-technology