Uranium: An Essential metal for the green transition

## Introduction

Named after the icy planet Uranus by German chemist Martin Klaproth in 1789, Uranium is one of the most famous and powerful metals known to humanity. Its radioactive properties have been harnessed to kill thousands and decimate entire cities during the second world war, but have also saved lives by being used in medical treatment. Uranium occurs naturally in most rocks, as well as in seawater (in lower concentrations) and is about 500 times more abundant than gold and about as common as tin.  It is the heaviest naturally occurring element on earth and exists as a solid at room temperature with high melting and boiling points (1135°C and 4131°C respectively

The distinguishing feature of uranium is its high energy density (24 GWh/kg), which makes 1 kg of commercially enriched uranium equivalent to 14 tons of coal or 73 barrels of oil. The energy needs of the entire world could be satisfied by less than 2 Olympic sized swimming pools filled with uranium ! Nuclear power is generated in a carefully controlled process called nuclear fission, where subatomic particles released by the unstable uranium atoms collide with one anther to cause a chain reaction thereby releasing large amounts of energy. The dual use nature of this metal has necessitated the oversight of global regulatory bodies such as the Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA) in uranium processing and trade.

## History

Uranium was historically used in glassware and ceramics due to its fluorescent yellow/light green glow. Scientific research conducted by famous physicists throughout the early twentieth century helped uncover the radioactive properties of uranium and radium, which led to many of them being awarded Nobel prizes for their discoveries.

Uranium was a key component in the efforts of the US military to develop atomic weapons in the 1940’s. The success of the ‘Manhattan project’ helped the allied forces win the second world war as well as establishing US as a global superpower. This ushered in the golden age of atomic energy in the 1960’s, with the US setting up international nuclear programs to encourage commercial development of nuclear energy for civilian use worldwide.

Nuclear power started losing popular support, as news of accidents like the 1979 Three Mile island accident (US) and the 1986 Chernobyl disaster (Soviet Russia) heightened public awareness over the dangers of nuclear radiation. A similar policy outcome was provoked after nuclear contamination from the Fukashima Daichi plant caused by the 2011 tsunami, which resulted in the Japanese and German governments phasing out their nuclear programs. Public fear of nuclear disasters combined with the challenges of storing nuclear waste led to a slowdown in the global nuclear industry from 1978, with the approval of new plant designs falling from 50% in 1980to 5% in 2002.

## Commercial Applications

The primary use of uranium is as a fuel for energy generation in nuclear reactors. A nuclear power plant works in a similar fashion as a traditional thermal power plant, with the heat released from the splitting of unstable uranium atoms used to generate steam, which moves a turbine and generates electricity. Many EU countries (France, Sweden, Finland) meet their energy needs using nuclear power, since it is a more sustainable and reliable form of baseload energy, which does not rely on weather conditions (unlike solar/wind).

The high density of uranium (1.67 times more than lead) makes it suitable for shielding people from gamma radiation and is used extensively in the medical, research and transport sectors. It is also used as a counterbalance weight in equipment such as boats and satellites due to the same reason.

One big disadvantage of using uranium is the problem of dealing with nuclear waste.

## Uranium mining

Uranium ore, similar to other metals, is obtained either by underground/open pit mining (43% of world production) or in situ leaching (57% of world production). In situ leaching consists of pumping a chemical solution down drill holes into the uranium ore deposit, which is then pumped back to the surface to extract the ores from the solution. Both processes give out uranium ore concentrates in a yellow powdered form (called ‘yellowcake’), which is then sent for enrichment.

Naturally occurring uranium is a combination of the U-235 isotope (0.7%) and the U-238 isotope (99.3%) which differ in their physical properties, notably their mass. This difference is exploited in the enrichment process of the ore, which increases the concentration of the fissile U-235 isotope from 0.7% to 3.5%, to be used as fuel for nuclear power plants.

Uranium enrichment is strategically sensitive and capital intensive, hence, there are relatively few commercial enrichment suppliers operating a limited number of facilities worldwide. The three major producers currently are: Orano, Rosatom, and Urenco operating large commercial enrichment plants in France, Germany, Netherlands, UK, USA, and Russia.

## Uranium Reserves & Production

The total amount of uranium reserves worldwide, based on profitable recovery, is estimated at 6 million tons. Australia leads with 28% of the world’s identified recoverable resources, with 80% of it originating from a single site: the Olympic Dam deposit. The next largest reserves are found in Kazakhstan, Canada, Russia and Namibia. The world's known uranium resources has increased by 25% in the last decade due to increased exploration efforts led by Canada, China, India, Russia and Kazakhstan. Searching for uranium deposits is easier than other mineral resources because of its radiation signature which allows them to be mapped from the air. A significant share of uranium mine production (53%) is controlled by state-owned mining companies like Kazatomprom (Kazakhstan), Orano (France), CGN (China) and Uranium One (Russia) which prioritize secure supply over market considerations.

## Current Trade & Demand

The current global demand for uranium is about 67,000 tU/yr (tons uranium per year) with the vast majority consumed by the power sector and a small amount being used for medical and research purposes. 440 reactors across the world use uranium as fuel and generate 10% of the world’s electricity (390 GWe). With China’s ability to build multiple reactors with predictable costs and schedules, the world is projected to experience significant growth in nuclear capacity until 2040.

The Chicago Mercantile Exchange (CME) offers a standard unit contract for 250 pounds of U308 (triuranium octoxide), the most commonly occurring form of uranium ore. Low market prices due to an oversupplied uranium market led to significant reductions in uranium production and delays in some mine development projects over the past few years. However, prices have risen sharply in 2022, due to a supply squeeze brought about by delivery delays along with logistical concerns from the Russian invasion of Ukraine. At an average mining cost of 130 dollars/kg, 75% of the current world reserves of uranium are economically recoverable, which covers the world’s demand for the next 100 years.

## **Future Opportunities**

Despite the current oversupply of uranium, there are a number of factors that suggest that the uranium market is poised for a rebound in the coming years.

First, the perception of nuclear energy as an energy source with low carbon/land footprint has started to emerge in many countries, as reflected by recent EU policy changes to recognize nuclear energy as a green fuel (link). Second, technological advancements in nuclear waste treatment and fuel efficiency has made operations more safer and reliable. Third, many countries are actively constructing new nuclear plants. For example, 100 power reactors are being constructed in 15 countries, and even Japan has restarted their nuclear program ([The Economist article](https://www.economist.com/asia/2023/01/12/japan-pivots-back-to-nuclear-power)). The need to meet the energy demands of a growing population and decline of the petrodollar system makes it an important priority, especially for developing nations like China and India.

We at the Commodity Discovery Fund, see the demand for good uranium projects growing in the coming years. We have invested in significant uranium discoveries globally like {}. For more information regarding our portfolio and fund, please visit the the [Portfolio](https://en.cdfund.com/track-record/portfolio.html) page and download our [brochure](https://en.cdfund.com/download-brochure.html).

Sources:

[Uranium Enrichment | Enrichment of uranium - World Nuclear Association (world-nuclear.org)](https://world-nuclear.org/information-library/nuclear-fuel-cycle/conversion-enrichment-and-fabrication/uranium-enrichment.aspx)

Maps:

1. Uranium historical price
2. Global demand and supply
3. No. of reactors and planes
4. Mine locations
5. Energy density comparison
6. Photos

A graph showing the consumption of uranium

Description automatically generated

A graph of a price

Description automatically generated with medium confidence

A graph of the global warming

Description automatically generated A graph of a number of countries/regions

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