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Uranium in phosphate rocks and future nuclear power fleets

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According to almost all forward-looking studies, the world's energy consumption will increase in the future decades, mostly because of the growing world population and the long-term development of emerging countries. The effort to contain global warming makes it hard to exclude nuclear energy from the global energy mix.
Current light water reactors (LWR) burn fissile uranium (a natural, finite resource), whereas some future Generation IV reactors, as Sodium fast reactors (SFR), starting with an initial fissile load, will be capable of recycling their own plutonium and already-extracted depleted uranium. This makes them a feasible solution for the sustainable development of nuclear energy. Nonetheless, a sufficient quantity of plutonium is needed to start up an SFR, with the plutonium already being produced in LWR. The availability of natural uranium therefore has a direct impact on the capacity of the reactors (both LWR and SFR) that we can build.
This paper discusses the correspondence between the resources and the nuclear power demand as estimated by various international organisations.
Uranium is currently produced from conventional sources. The estimated quantities of uranium evolve over time in relation to their rate of extraction and the discovery of new deposits. Contrary to conventional resources, unconventional resources –because they are hardly used –also exist. These resources are more uncertain both in terms of their quantities and the feasibility of recovering them. Recovering uranium from seawater would guarantee a virtually infinite resource of nuclear fuel, but its technical and economic feasibility has yet to be demonstrated, and huge advances need to be achieved in this direction. According to different publications on phosphate reserves, the potential amount of uranium recoverable from phosphates can be estimated at around 4 MtU. Furthermore, the production of uranium as a by-product of phosphate is determined by the world production of phosphoric acid. Uranium recovery as a by-product of phosphate rocks could be competitive for the moment, but limited at the most to 10 ktU per year, i.e. less than 20% of current world demand. The only way to lift the constraint of capacity production is to produce uranium as a primary product of phosphates. Unfortunately, this solution is very unlikely due to its high unit cost.
In line with these considerations, the correspondence between the estimated resources and the forecast energy scenarios is examined, first with the current type of light water reactors which burn uranium, and secondly with a mixed fleet with both light water reactors and fast reactors which use plutonium.

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