

From Mine to Reactor: Securing the Nuclear Fuel Supply

The case of France

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The benefits for France of its full commitment to the nuclear option

France (12th largest energy consumer country in the world) built its nuclear fleet (60 reactors) in ~20 years

1/ Reduce the country's dependence on foreign imports of fossil fuels, given its lack of natural resources

Nuclear energy produces ~75% of its electricity

→ France independent from foreign imports, for its electricity needs → Nuclear = Ideal for a country poor in natural resources

2/ Only 56 reactors required to feed the need of the entire French population, ~64 million people

→ less than 1 reactor to feed the needs of 1 million people → Nuclear = Ideal for a small country

3/ France's electricity : thanks to its nuclear fleet :

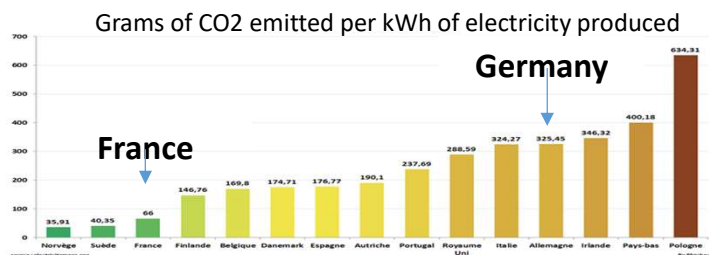
→ between 10 to 20% cheaper than the average price of the electricity produced in the EU

→ Stable electricity prices, regardless of the fluctuations of oil and gas prices

4/ France = world's largest exporter of electricity due to Nuclear Energy

→ France gains over €3 billion per year from these exports (Italy, UK, Spain...and Germany, which has phased out Nuclear energy...)

5/ Very unique feature of France's nuclear policy : the CLOSED FUEL CYCLE POLICY, for management of Spent Nuclear Fuel



France has set up an entire Nuclear Industry, covering both Reactor Technology as well as Fuel Cycle Technology, thus making it a **major exporter of Nuclear Technology**, capable of providing customers with an **integrated offer (Reactor + Fuel)**

From mine to reactor : Securing the nuclear fuel supply

Security of nuclear fuel supply : A process that covers BOTH, the FRONTEND and the BACKEND of the fuel cycle

1/ FRONTEND

-Ensuring a secure supply of nuclear fuel depends on reliability throughout the process that transforms uranium ore into reactor fuel:

**mineral exploration / mining and milling to produce U₃O₈ / conversion to produce uranium hexafluoride - UF₆ /
enrichment to low-enriched uranium - LEU (typically ≤5% U-235) / deconversion and fabrication into certified fuel assemblies /
and all associated logistics, safeguards and quality assurance.**

-Each stage has its own dynamics, regulations and timelines. A delay or disruption in one step can affect the entire supply chain.

-Orano covers all these activities, which makes it a MAJOR SUPPLIER WORLDWIDE of nuclear fuel

-Today's context : environmental/energy security concerns → increasing recognition of nuclear's role in delivering secure and clean energy :

→ After more than two decades of stagnation, global nuclear power capacity is set to increase by at least ONE-THIRD by 2035

→ In order to cope with this increasing demand of nuclear fuel, Orano is EXPANDING BY 30%, the capacity of its GB2 enrichment plant, thus contributing to supply enriched uranium to French as well as foreign (US, ...) utilities (first project ever funded by a financial institution – EIB)

-Orano also involved in helping the US secure its nuclear fuel supply :

→ IKE project : construction of an enrichment plant in Tennessee, which will produce the same amount of LEU as that currently imported by the US from Russia

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2/ BACKEND : The Closed Fuel Cycle Policy

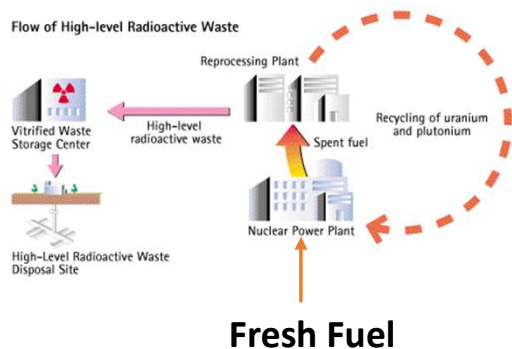
Nuclear Spent Fuel still contains **97% of the energy potential** of the fuel before it is loaded in the reactor

France therefore considers spent fuel **not as a waste, but as a recyclable matter**, which is reprocessed and recycled into **fresh fuel**

→ The Closed Fuel Cycle Policy

Arguments in favour of a closed-cycle policy

1. Saving uranium resources : 108.04 USD/LBS versus 20 USD/LBS a few years ago
2. Making the most of nuclear energy : use the 97% remaining energy
3. **ENERGY AUTONOMY AND SECURITY OF NUCLEAR FUEL SUPPLY (less imports of uranium)**
4. **Reduction :**
 - By a factor 10 of the radiotoxicity level of High Level Waste
 - By a factor 5 of the waste volume and waste footprint
 - By a factor 20 of the repository footprint
5. Safer long-term storage through vitrification process of the ultimate waste



Current backend policy :

Monorecycling

Future backend policy :

Multirecycling in Fast Neutron Reactors

- **No more need for any Uranium imports, as fuel will be made from Plutonium and depleted uranium only**
- enhanced security of nuclear fuel supply
- sustainability of Nuclear Energy

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Various other measures by France to ensure nuclear fuel supply security

-Domestic level :

The Jules Horowitz Reactor : A Material Test Reactor, to test and qualify nuclear fuel



-International Level :

Sapporo 5 :

**Group of 5 countries created on the side-lines of the 2023 G7 meeting in Japan
Canada, Japan, France, UK, US
Pooling efforts to stop reliance on ensure security of nuclear fuel supply**