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Nuclear Energy and Spent Fuel Update
The case of France

Dr Sunil Felix
Nuclear Counsellor
French Embassy in Washington

National Association of Regulatory Utility Commissioners
NARUC Subcommittee on Nuclear Issues
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Washington, DC

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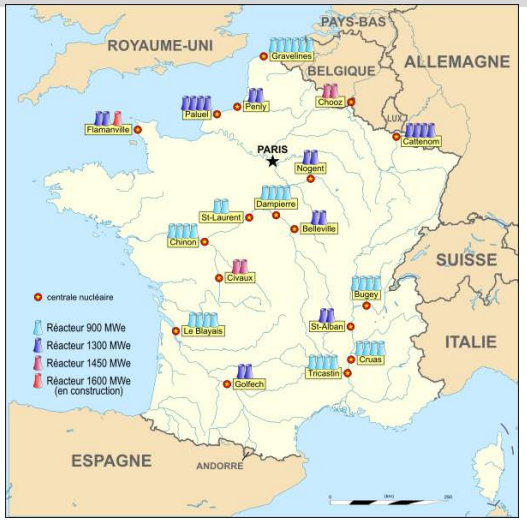
The French Nuclear Fleet

- **Current Status:**

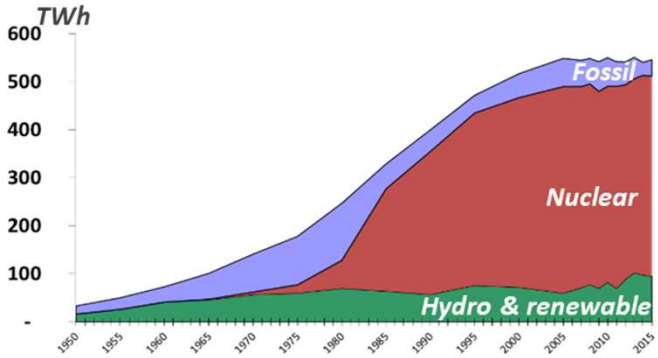
56 operating PWR on 18 sites (built on the **standardization** principle) :

  - 32 x 900 MWe,
  - 20 x 1300 MWe,
  - 4 x 1450 MWe,



- **Closed fuel cycle policy :** 10% of France's electricity from recycled spent nuclear fuel

- In 2020, 335 TWh produced (**70% of France's total electricity**)



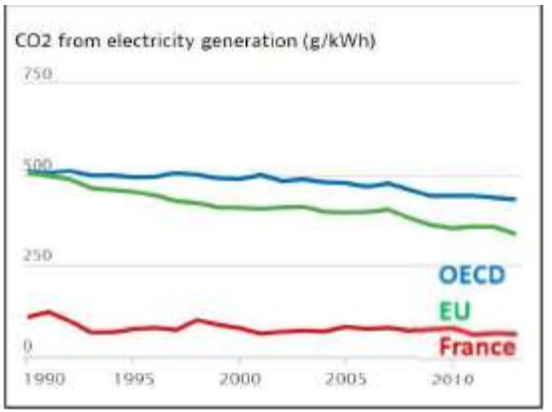
- **1 EPR under construction** in Flamanville (1650 Mwe)

- 40 % of the fleet (22 NPPs) will pass their 4th 10-year visit for LTO to 50 years by 2025

- **France world's largest net exporter of electricity** due to its very low cost of generation (over €3 billion earnings per year)

- French electricity **20% cheaper than the EU average electricity price**

- **Very low carbon footprint**



- **In 2022, President Macron ordered the launch of 6 new EPR reactors, to be followed by 8 more**

WASTE GENERATION IN FRANCE

➢ Electronuclear

NPPs, 56 reactors in operation, Recycling plants for the spent fuel

➢ Research

Commercial nuclear industry,

nuclear physics, agronomy, chemistry, biology ….

➢ Defence

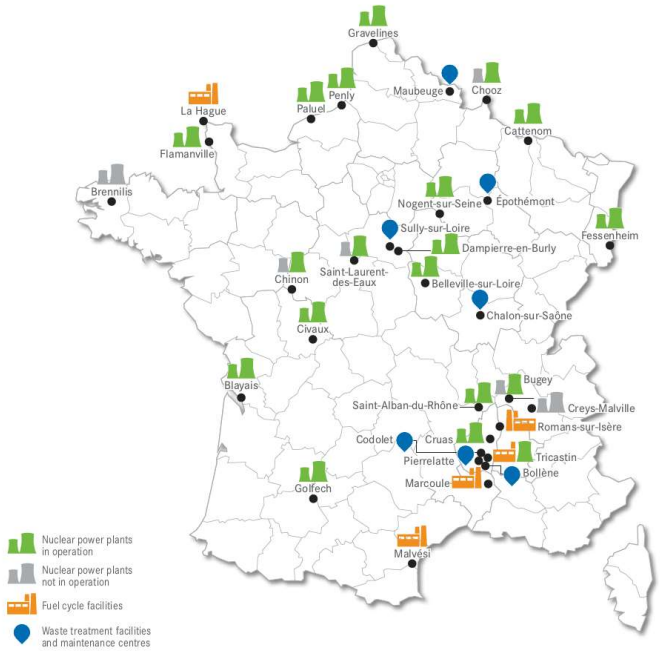
Military power, Associated Resarch & Development

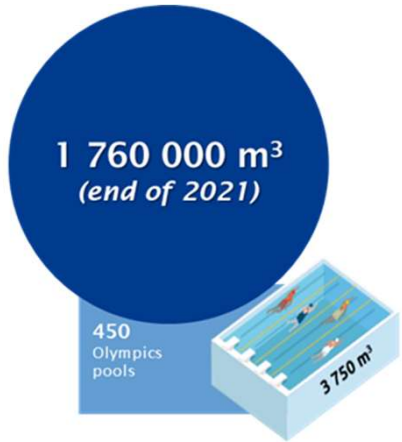
➢ Non-electronuclear industry

Rare Earth Extraction, mostly sealed sources

➢ Medical activities

Diagnosis & treatment





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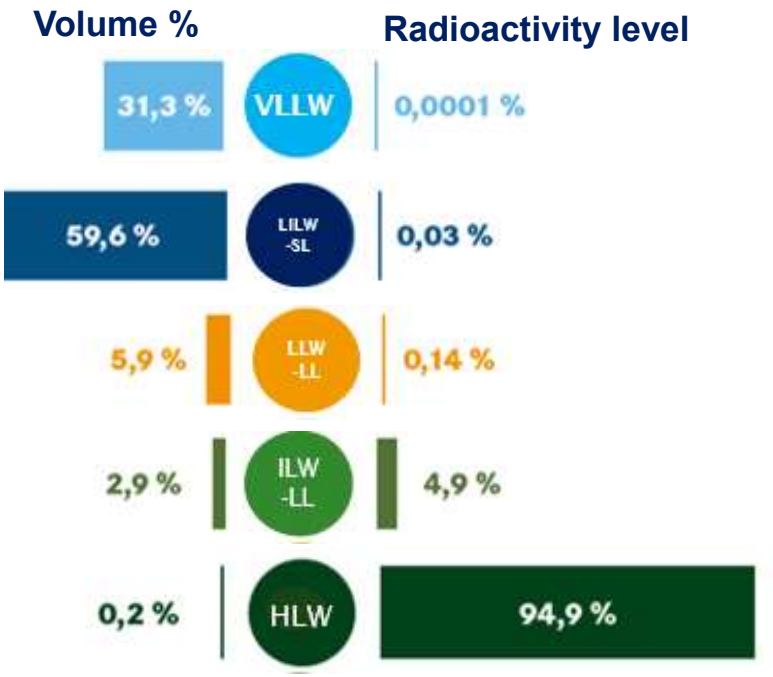
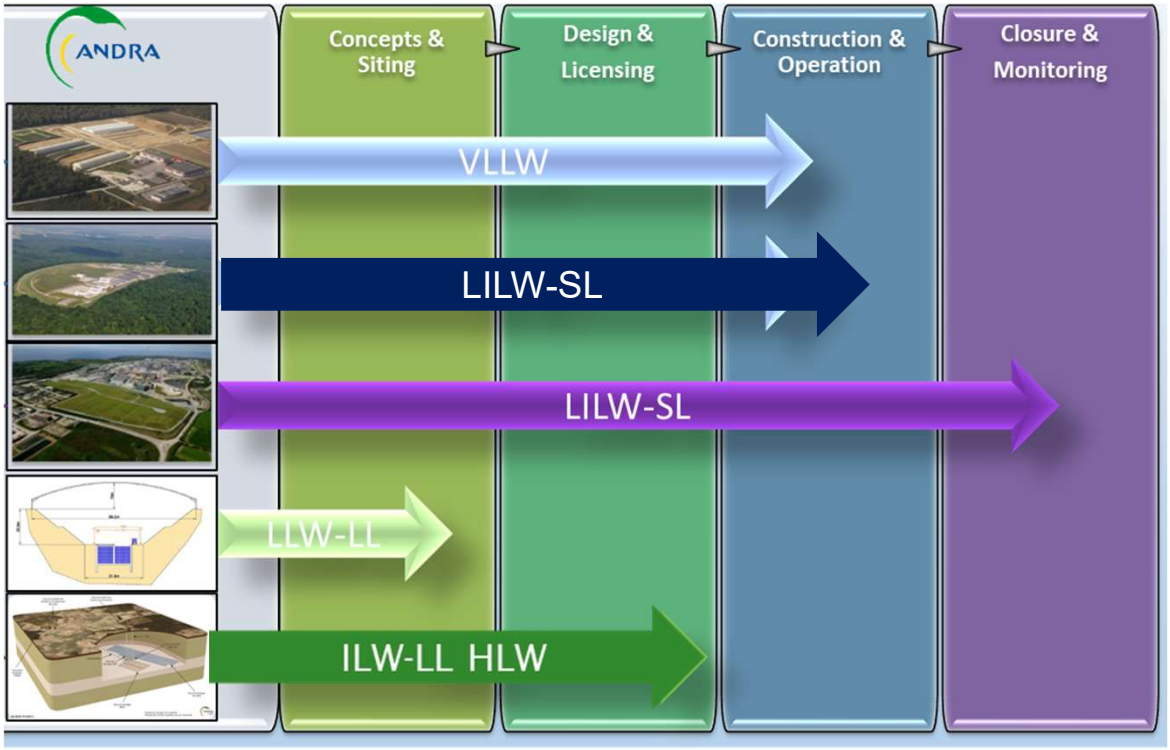
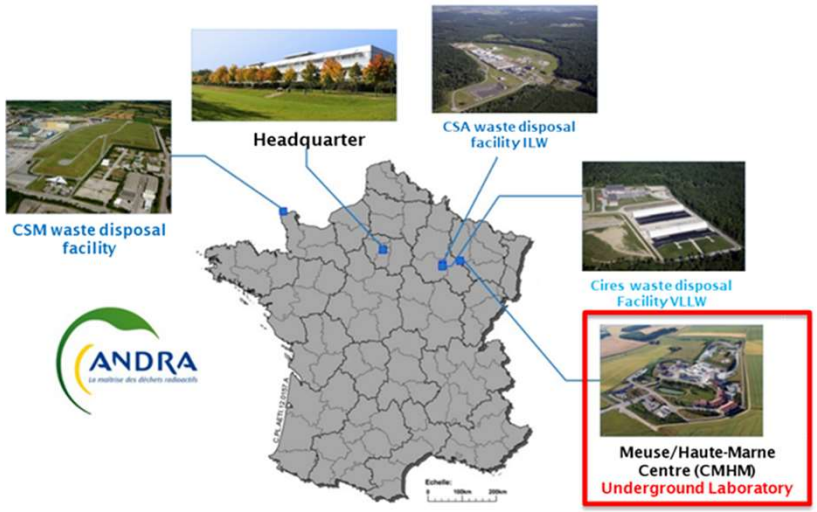
RADIOACTIVE WASTE AND THEIR DISPOSAL SOLUTION



90% of Radioactive waste have a disposal solution



Cigeo



ANDRA
French national radioactive waste management agency

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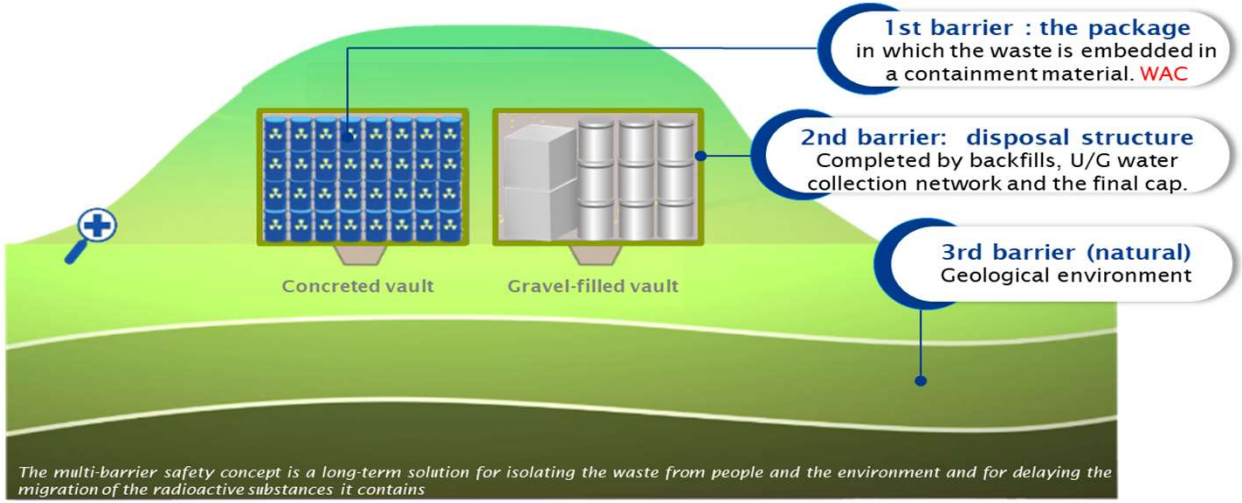
THE CIGEO PROJECT
THE INDUSTRIAL CENTRE FOR HLW AND ILW-LL REPOSITORY

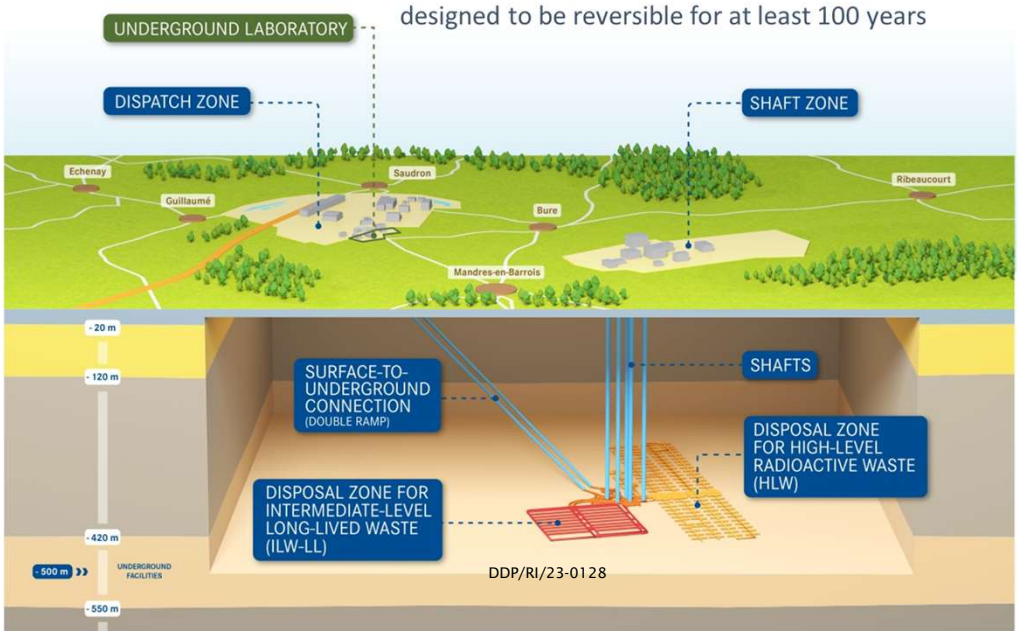
(Sub-)Surface disposal for :

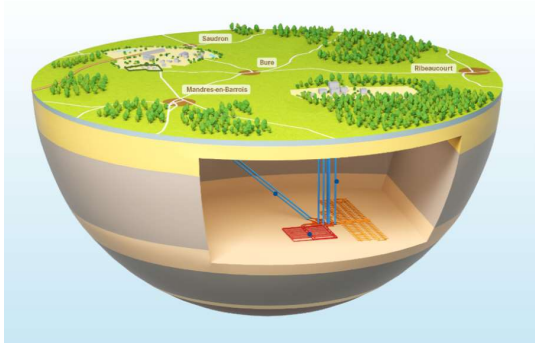
- VLLW
- LIL-SL

➔ 3 such disposal sites, which are **operational** and run by ANDRA, which **contain 90% of France's waste**



CIGEO : Industrial Centre for HLW and ILW-LL, i.e. **for management of the 10% remaining waste**





CIGÉO, WHERE ARE WE NOW ?

ILW -LL

HLW

CIGÉO PROJECT - MAJOR MILESTONES

DECLARATION OF PUBLIC UTILITY DECREE — 2022

SUBMISSION OF CONSTRUCTION LICENCE APPLICATION — 2023

CONSTRUCTION LICENCE DECREE — around 2027

INDUSTRIAL OPERATION LICENCE — around 2035-2040

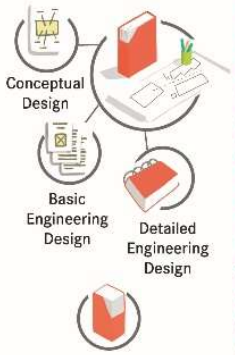
LAW ON CONDITIONS FOR CONTINUING CIGÉO OPERATION — around 2040-2050

FURTHER DECISIONAL MILESTONES — around 2080

ACT AUTHORISING FINAL CLOSURE OF THE REPOSITORY — around 2150

DESIGN | REVIEW | INITIAL CONSTRUCTION | OPERATION & GRADUAL CONSTRUCTION | CLOSURE & MONITORING

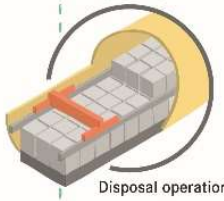
Industrial Pilot Phase



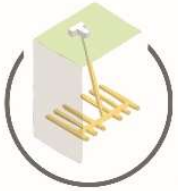
SUBMISSION OF REPORTS
- Safety Options Report
- Retrievability Technical Options Report
- Proposed Master Plan for Operation
- Security Options Report

Start-up tests and inactive tests

Commissioning tests and gradual ramp-up to full operation



Disposal operation



SITE CHARACTERISATION, RESCUE ARCHAEOLOGY & SITE PREPARATION
(enclosure, earthwork, preparation of water and power connections, etc.)

First radioactive waste packages reception

Report on the industrial pilot phase

Start disposal of all high-level waste packages

Subject to construction licence being granted

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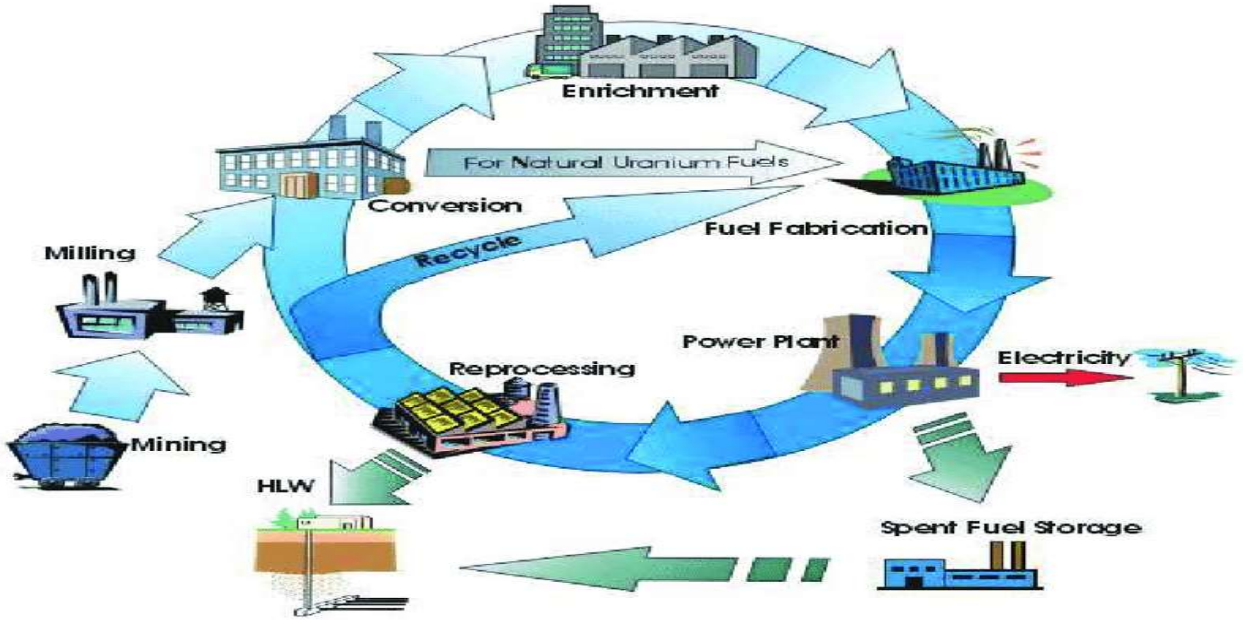
THE CLOSED FUEL CYCLE POLICY
SPENT NUCLEAR FUEL IS NOT A WASTE, BUT A RECYCLABLE MATTER

Current French closed fuel cycle policy = **Mono-recycling**

Moving towards

Multi-recycling



Arguments in favour of a closed-cycle policy (Multi-recycling)

1. Saving uranium resources : 108.04 USD/LBS versus 20 USD/LBS a few years ago
2. Making the most of nuclear energy : SNF still contains 97% of the energy potential of fresh fuel
3. Energy autonomy and security
4. Reduction :
    - By a factor 10 of the radiotoxicity level of HLW
    - By a factor 5 of the waste volume and waste footprint (factor 1.6 in the case of mono-recycling)
    - By a factor 20 of the repository footprint (factor 1.2 in the case of mono-recycling)
5. Safer long-term storage through vitrification process of the ultimate waste