International Symposium

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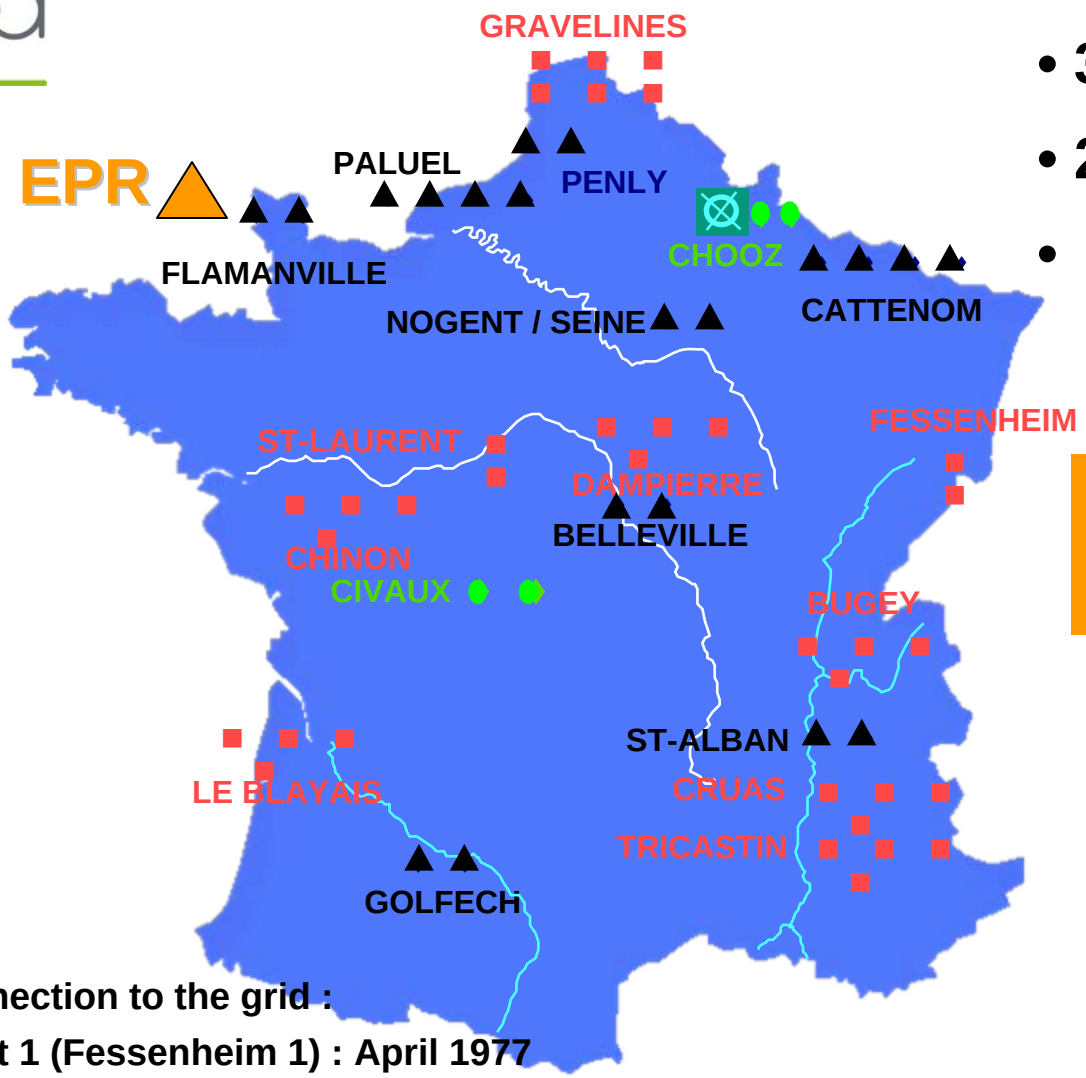
Current Status of Peaceful Nuclear Energy in France

Olivier CARON

French Atomic Energy Commission

The French Nuclear Program at a glance



- 34 900 MWe units ■
- 20 1300 MWe units ▲
- 4 1500 MWe units ●

58 PWR units (20 MOX
63184 MWe installed

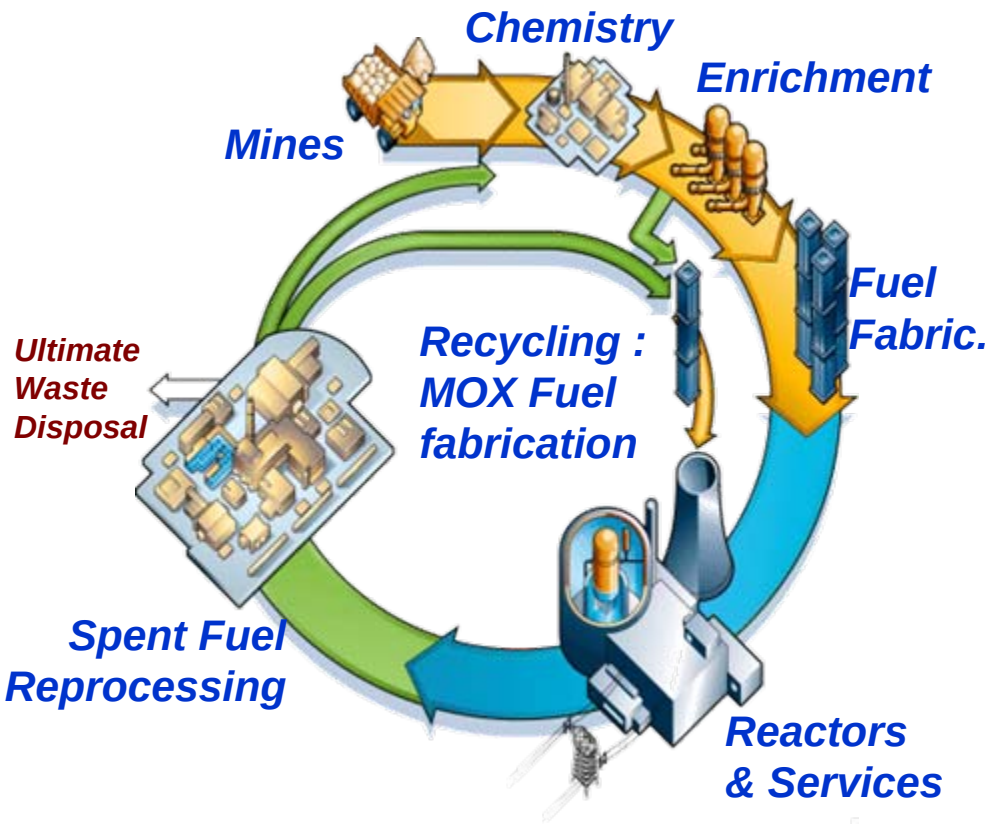
~78.5 % of french electric production in 2005

Average years' service in 2006 = 20 years

Connection to the grid :

- **Unit 1 (Fessenheim 1) : April 1977**
- **Unit 58 (Civaux 2) : December 1999**

A coherent Fuel Cycle Strategy



More than 25 years of unequalled experience in France :

- **58 PWRs → 415 TWh in 2004**
- **Until now: ~ 20 000 Mt_{HM} spent fuel reprocessed and more than 1200 Mt_{HM} MOX fuel recycled**
- **1100 Mt_{HM} /yr of spent fuel discharged from the French PWRs**
- **Up to 1 600 Mt_{HM} /yr of spent fuel reprocessed (domestic + foreign)**

…ctd…

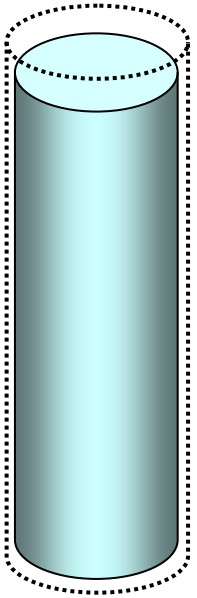
- **Recycles 96% of spent fuel materials**
- **Saves 30% of natural resources**
- **Costs less than 6% of the kWh total cost**
- **Reduces by 5 the amount of wastes**
- **Reduces by 10 the waste radiotoxicity**
- **Adapted technologies allow a safe conditioning of wastes to guarantee their long term confinement and stability, for dozens of thousands of years**

Vitrified wastes

and CSD-V canister

Alteration of glass by water :

< 0,1 % at 10 000 years



A new French nuclear context

Public debates and a new legislation

✓**2005 / 2006 : Two public debates** (Radioactive Waste and EPR)

✓**January 2006 : a new prototype**

- ✓ The construction of a 4th generation prototype reactor in 2020
- ✓ In the frame of a new law on nuclear transparency, an independent authority will be created

✓**2006 : two new legislative Acts**

- On the 13th of June 2006, a new Act on **nuclear transparency and security**
- On the 28th of June 2006, a new Act on **sustainable management of radioactive waste**

About the new law on waste management

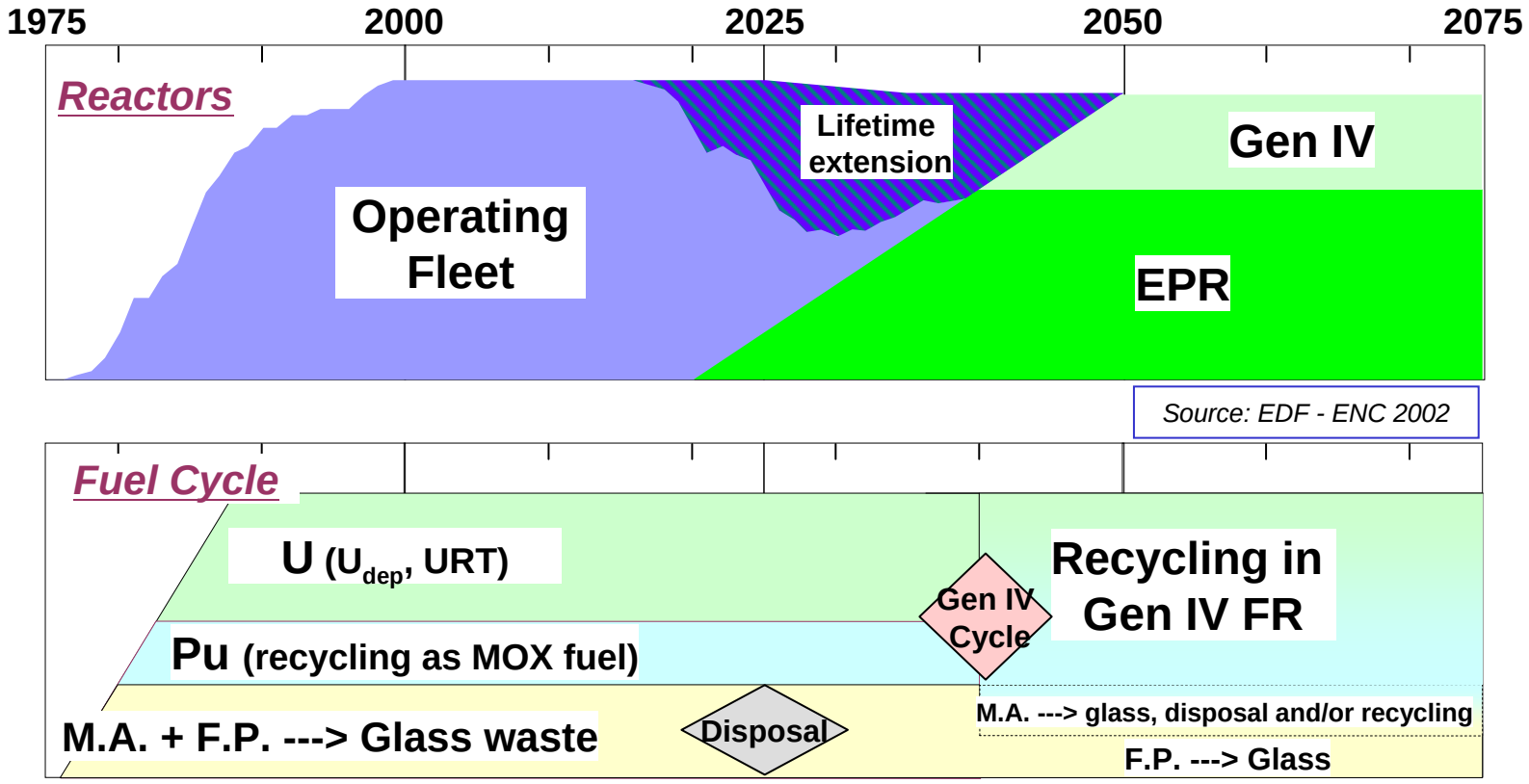
- **A national plan** (PNG-MDR) **on radioactive materials and radioactive waste management** (up-grading by Parliament every three years)
- **A step by step programme of HLLL waste management, including the complementarity of 3 solutions :**
  - **Partitioning-transmutation :**
    - **2012 : assessment of 4th Generation reactor technologies**
    - **2020 : operation of a prototype fast reactor**
  - **Geological disposal for ultimate HL waste :**
    - **2015 : authorization to build**
    - **2025 : operation**
  - **Intermediate storage (as needed)**
- **A secured financing of radioactive waste management and R & D** (Dedicated fund)

Scenario with FR and New Fuel Cycle Plant in 2040

2040: - Deployment of Fast neutron systems *(SFR or GFR)*

- New spent fuel treatment plant at La Hague (Ganex) –

- **Future goal : Integral recycling of U-Pu-MA**
- **Interim goal : Recycling of U-Pu and separate management of MA** *(to waste or interim storage)*



EPR, Gen III reactor

- **A matured concept, based on experience feed-back of current PWRs**
- **Significant improvements in safety**

- Under construction in Finland at Olkiluoto

- **July 05** : French Energy orientation Act
  - A Gen III plant operational by 2012
- **Oct 05 – Feb 06** : public debate to build a First-Of-A-Kind EPR in Flamanville
- **October 10th 06** : Laying of the foundation stone in Flamanville

Nuclear Fuel Cycle Goals

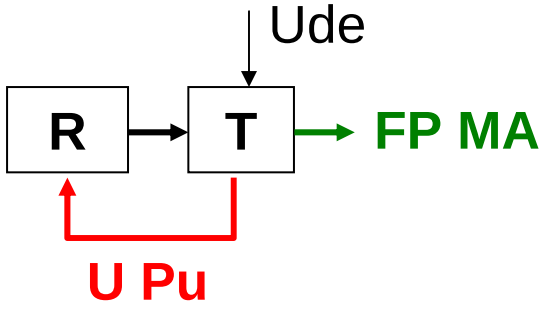
→ **Natural resources conservation**

→ **Waste minimization**

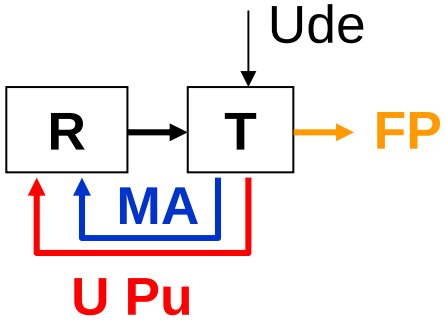
→ **Proliferation resistance**

To produce **50 times** more electricity with the same uranium amount

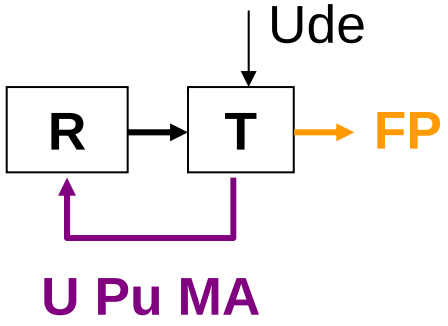
All paths should be kept available, **they could be used in sequence.**



U & Pu recycling



Heterogeneous recycling



Homogeneous recycling (GenIV)

Worldwide needs

- Mankind needs energy,
- Oil and gas are becoming scarce and expensive,
- Climate change due to CO_2 emissions is a concern

Nuclear energy is a necessity

- Expansion of installed capacity in the next few decades : will rest upon LWRs.
- The countries which will build reactors in 2050, aimed at operating until 2110, will have to take into consideration uranium supply issues
- There is a need for a clear and proven provisions for waste management

Generation IV : Making Nuclear Energy Sustainable

New goals for sustainable nuclear energy

Continuous progress :

- Economically competitive
- Safe and reliable

Break-throughs :

- Waste minimisation
- Natural resources preservation
- Proliferation resistance

Systems marketable from 2040 onwards

True potential for new applications

Heat for industrial processes, hydrogen, drinkable water,

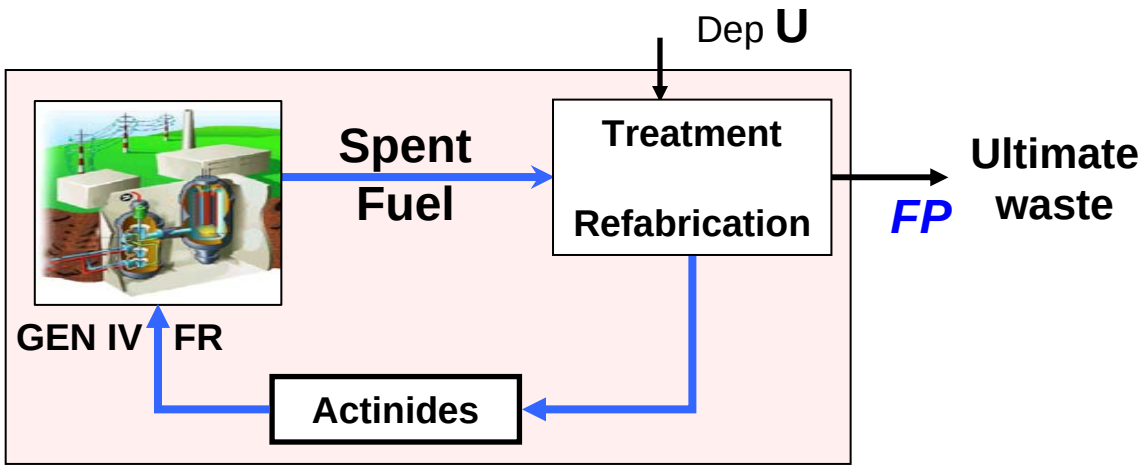
Internationally shared R&D

Gen IV and proliferation issues

- FBRs already built operate with a Uranium core and fertile blankets.

- The reference concept selected by the Gen IV international Forum (GIF) is a core without blankets with an breeding ratio near to 1

- Global recycling of actinides improve the proliferation resistance



Generation III fuel treatment plants

Characteristics :

- **Large capacity**
  - Lower the cost furthermore
  - Adapted to increasing needs worldwide (« fuel treatment centers »)
- Design adapted to a **larger spectrum of fuel type**
  - High fissile isotopes content (i.e. MOX)
  - Very high burn-up fuel
- **Co-management of U & Pu**
  - New security standards worldwide
  - Enhance MOX fuel performances
- **Integration of reprocessing and fuel refabrication**
  - Limit fuel transports and storage needs
  - Flexibility in material management
- Reservations to introduce **advanced technologies**