AREVA

Nuclear fuel cycle engineering or how to efficiently support a sustainable nuclear energy renaissance

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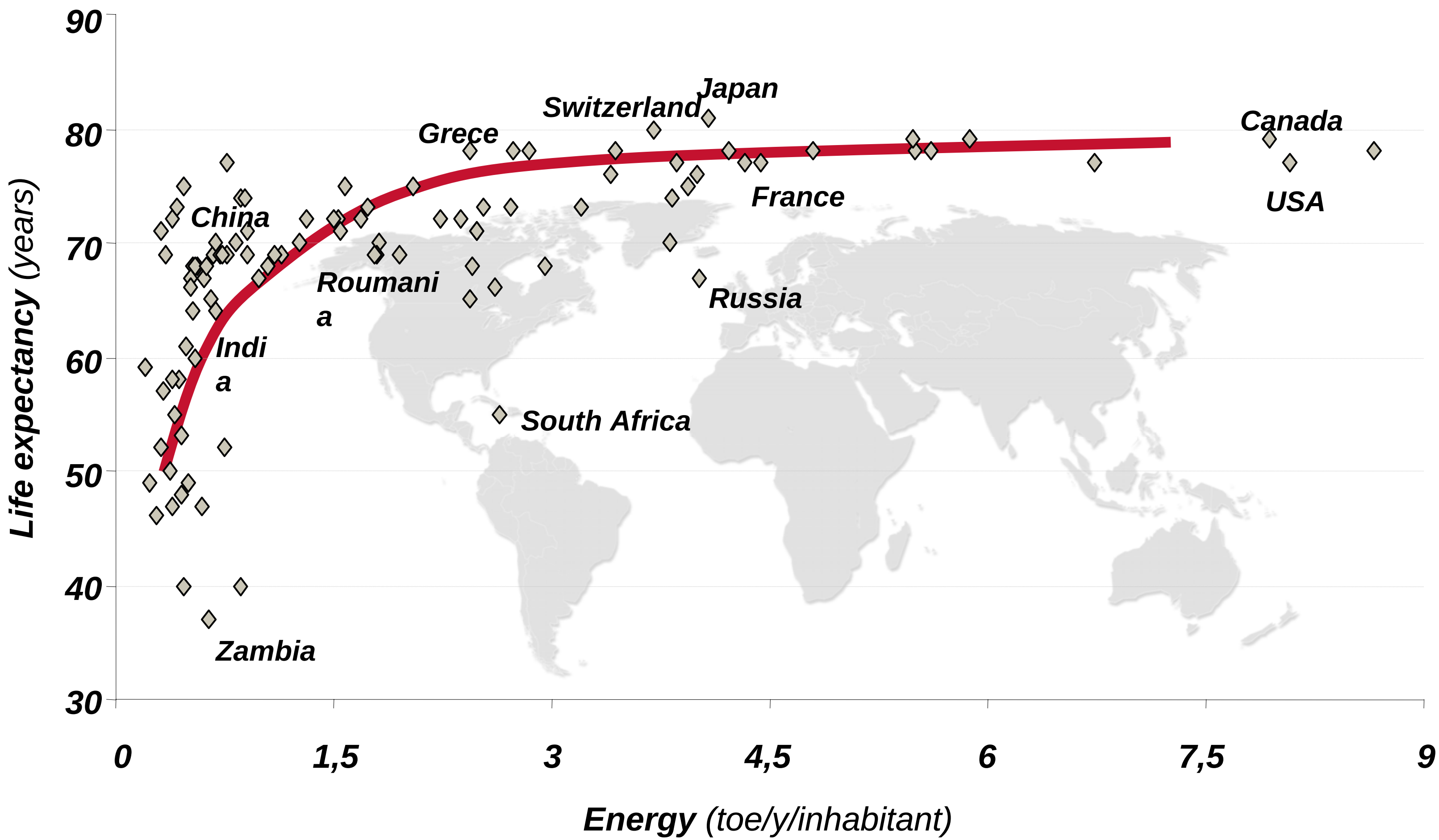
Why Nuclear renaissance is essential?

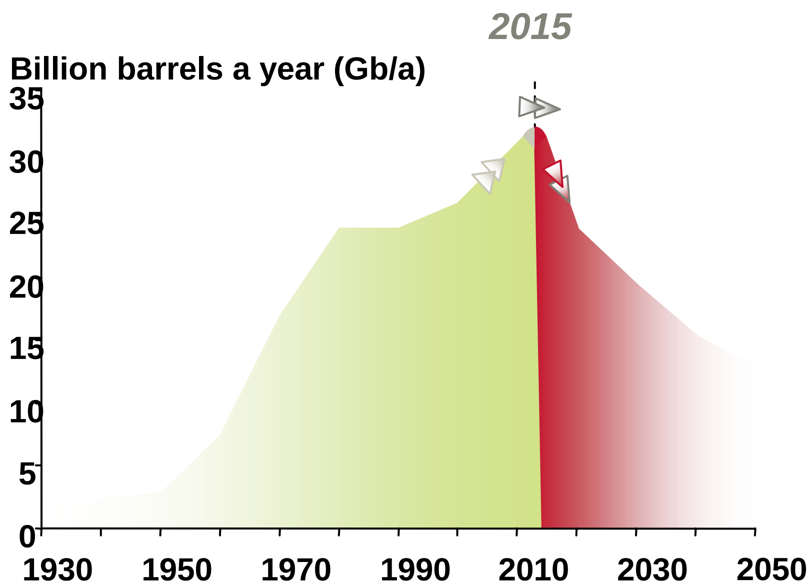
- Because **"Energy is life"**

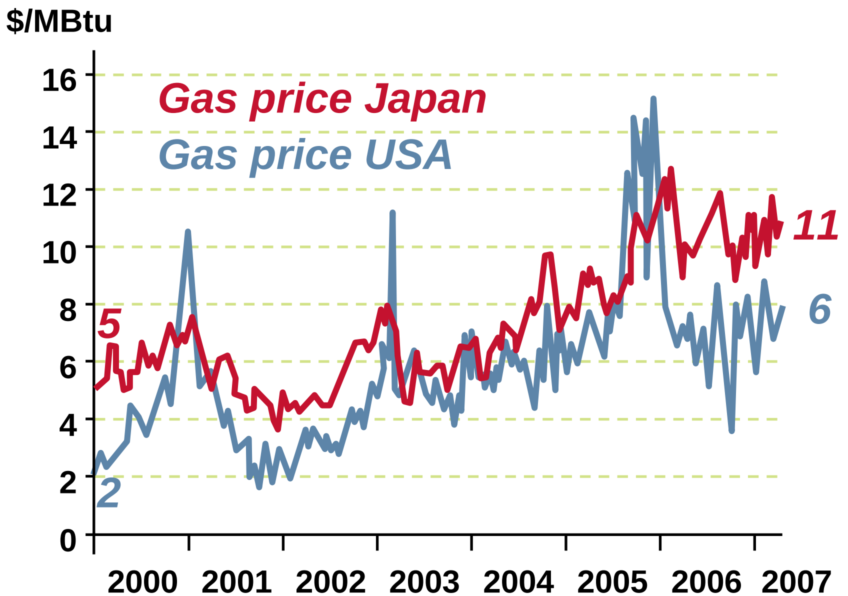


Energy needs will continue to increase, in line with development

Why Nuclear renaissance is essential?

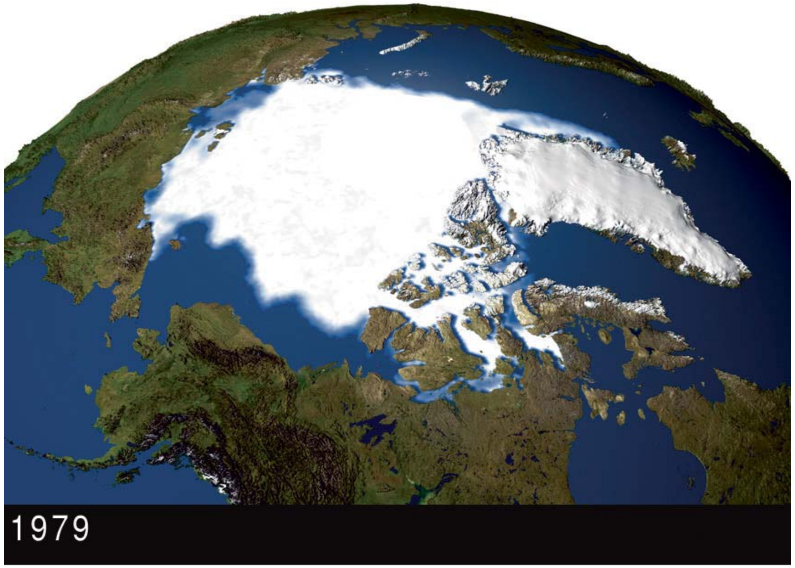
- **Because fossil resources is no longer "The" solution**

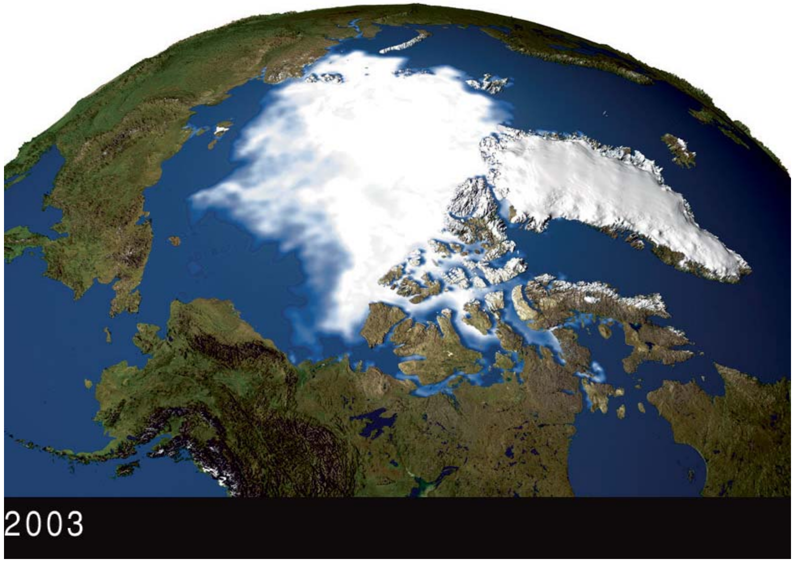




Why Nuclear renaissance is essential?

- **Because nuclear energy is a CO2-free source of power**





Sustainability of the nuclear renaissance

- **To be sustainable, this renaissance must include**
  - **A responsible management of the natural resources**
  - **A responsible management of the ultimate waste**
- **The closed fuel cycle is the best option to these issues**
  - **Choice already adopted and confirmed in many countries (France, the Netherlands, Japan, China, India,…)**
  - **USA are now re-considering recycling as a possible alternative to direct disposal (GNEP initiative)**

Advantages of the closed fuel cycle

- **The closed fuel cycle is a model of waste management policy and fits perfectly into the global scheme of sustainable development**
  - **By recovering and recycling reusable materials**

    ➔ *Saves up to 25% of natural Uranium resources*
  - **By minimizing waste volume and radiotoxicity**

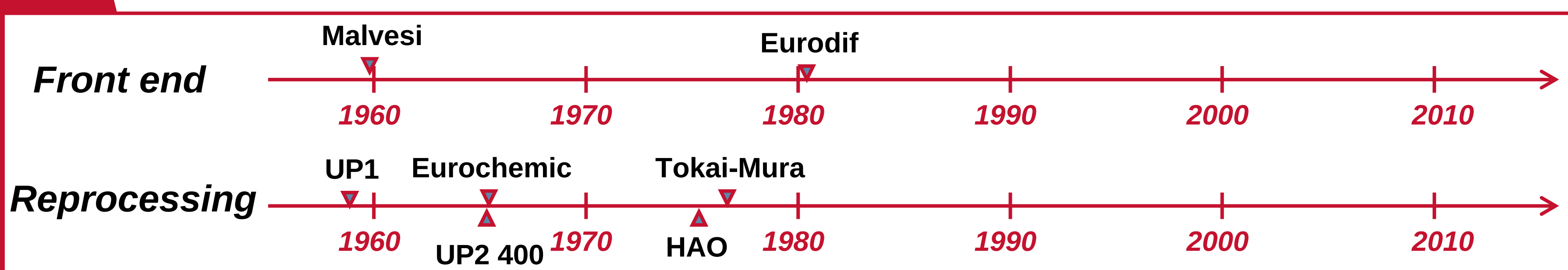
    ➔ *Divides by 5 the volume and by 10 the radiotoxicity of the waste to be geologically disposed of*
  - **By conditioning ultimate waste into a safe and durable form, specially designed for final disposal**

In every industry, recycling is the rule today,

…why nuclear industry should be the only one where it is questioned ?

AREVA fuel cycle engineering experience
SGN « Saint Gobain Nucléaire »

- **60’s and 70’s**
  - **First generation of nuclear fuel cycle plants**
  - **From defense needs to civil ones**
    - **UP1 (reprocessing plant, Marcoule, France)**
    - **Malvési (conversion plant, France)**
    - **Eurochemic (reprocessing plant, Mol, Belgium)**
    - **UP2 400 (reprocessing plant, La Hague, France)**
    - **HAO (reprocessing facility, La Hague, France)**
    - **Tokai-Mura (reprocessing plant, Japan)**
    - **Eurodif (enrichment plant, Pierrelatte, France)**

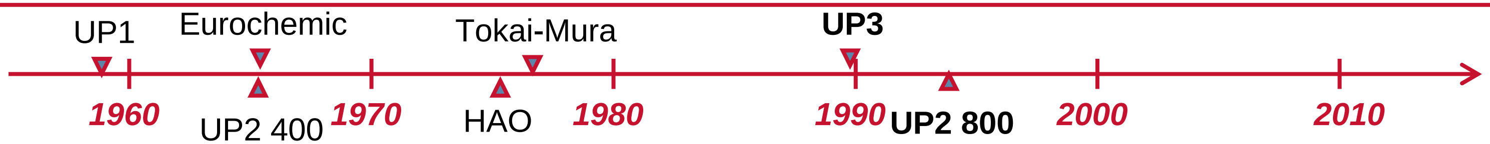


2nd Generation of reprocessing plants 80's up to now

- **UP3 and UP2 800 at La Hague (France)**
  - **First commercial plants with high nominal capacities: 800 tons/year**
- **Design requirements**
  - **Increase plant availability**
    - **corrosion free materials**
    - **fully remote maintenance**
    - **duplication of some equipment**
  - **Improve process performances**
    - **fully continuous process**
    - **stable performances of extraction process**
  - **Increase safety records**
  - **Condition all waste**

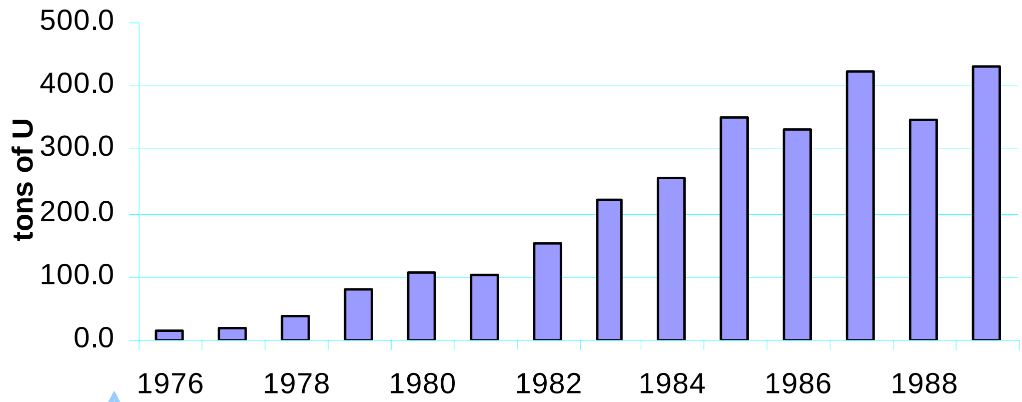
Close cooperation between oerating teams from UP2 400 and engineering teams

Close cooperation between R&D teams from CEA and engineering teams

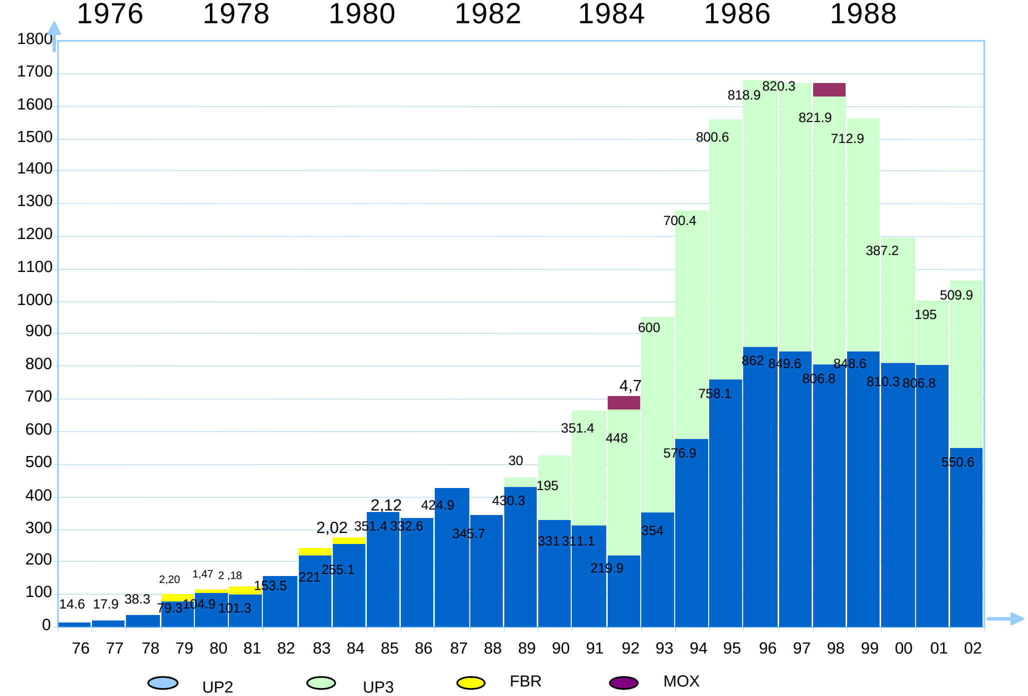


AREVA reprocessing plants
Annual production results

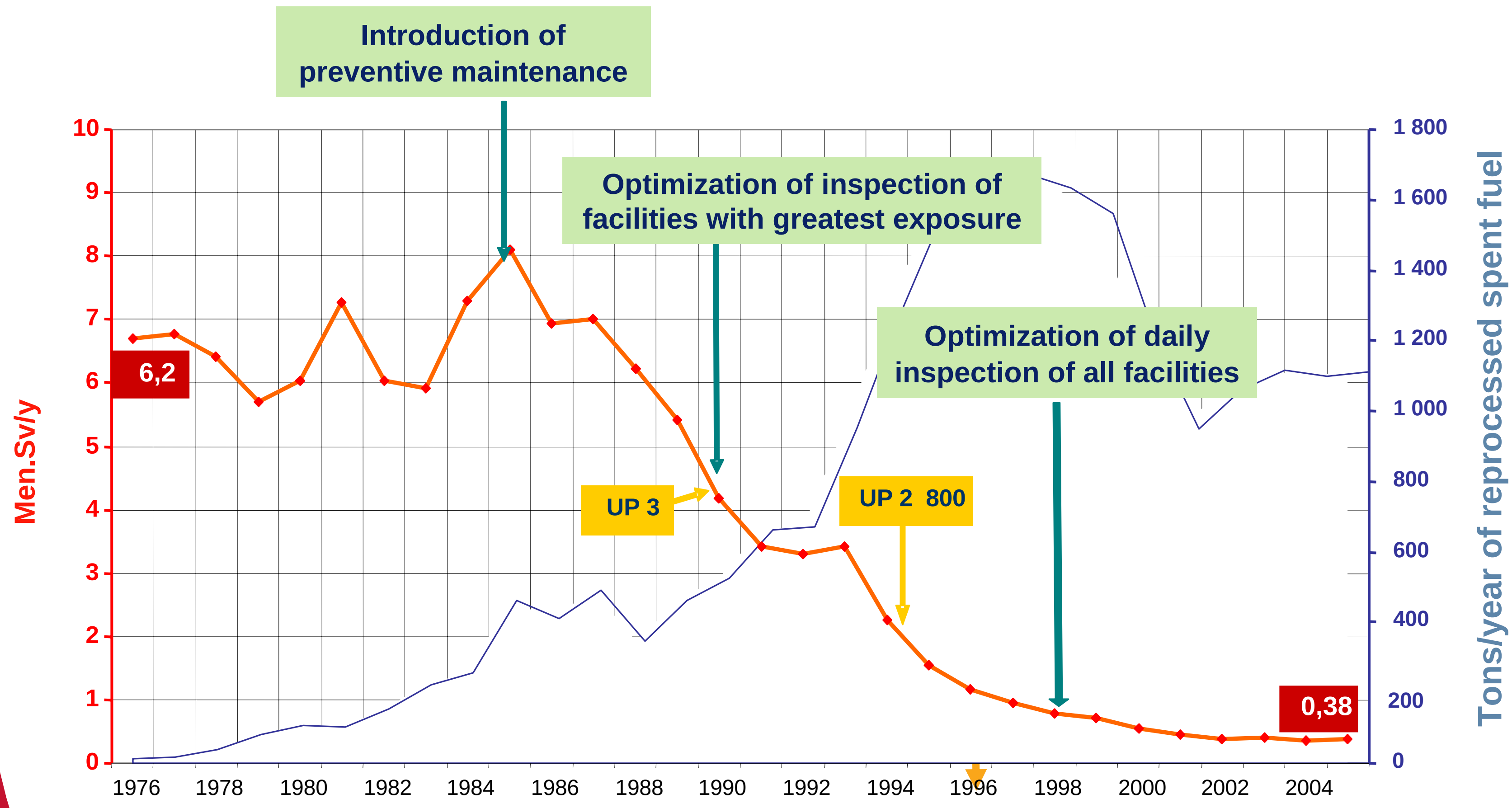
- **UP2 400**



- **UP3-UP2 800**



Dosimetric survey on UP2 and UP3 plants
Operations and maintenance



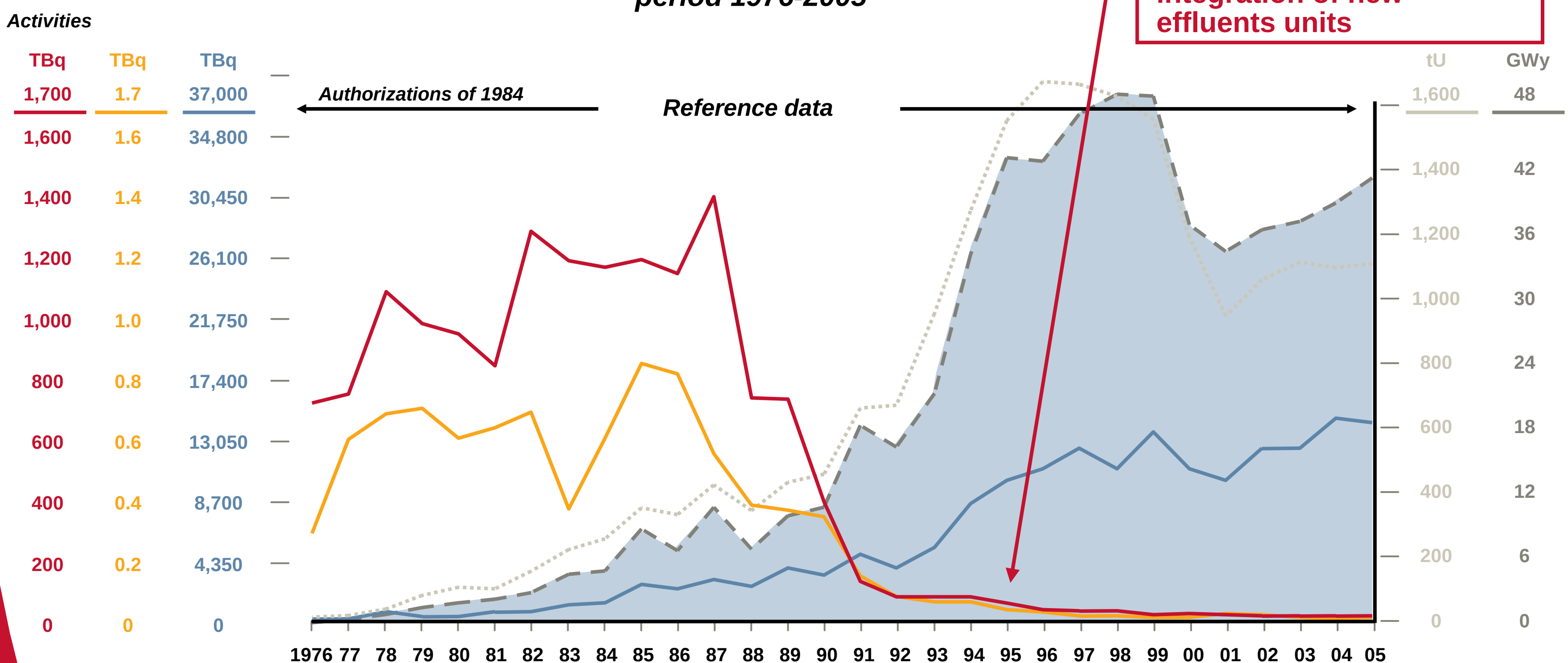
Taking radiation protection into account at the design stage has allowed us to reduce personnel exposure over the years

Greatly reduced discharges at La Hague

Continuous partnership with operators

Flexibility of the facilities: integration of new effluents units

Liquid radioactive releases: period 1976-2005



Releases to the sea: β,γ activities (exept tritium)

Releases to the sea: α activities

Release to the sea: tritium

tU: Annual tonnage of reprocessed spent fuel

GWy: Annual energy produced by reprocessed spent fuel

By analogy with EDF, the energy produced by reprocessed spent fuel is now expressed in GWy instead of YWh

The term source until 1998 was reconstituated in 1999 in the working Group # 1 (inventory of radioactive releases of nuclear plants) of the Nord - Corentin Radioecology Group.

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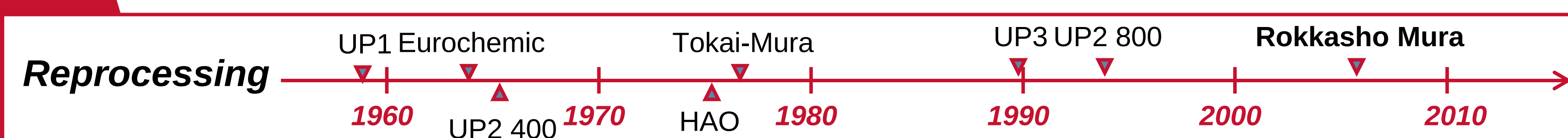
Japan cooperation: Rokkasho Mura project

- 1987: signature of the TTA (Transfer of Technology Agreement) based on UP3 between SGN and JNFL for RRP (Rokkasho Reprocessing Plant)
- 1993: beginning of construction
- 2001-2005
  - Cold and U tests
  - Training of 100 personal of JNFL at UP3
- Since 2006: hot tests using 400 tons of spent fuel
  - Both PWR and BWR can be treated
  - Facilities deliver expected performances
- TTA signed between AREVA and JNFL to use Melox Advanced process used at MELOX for J-MOX plant

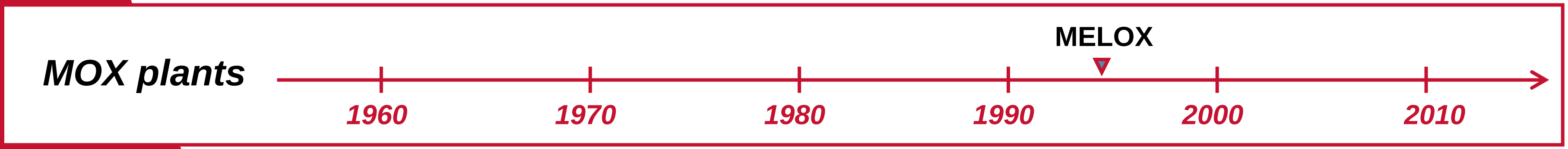


Future in reprocessing

- GNEP
  - AREVA Federal services LLC and its international partners (MHI, JNFL, WG, BWXT, Battelle Memorial Institute) selected by DOE to
    - Explore technical and business models for GNEP
    - Issue its conclusions
    - Provide recommendations for the Secretary's record of Decision in June 2008

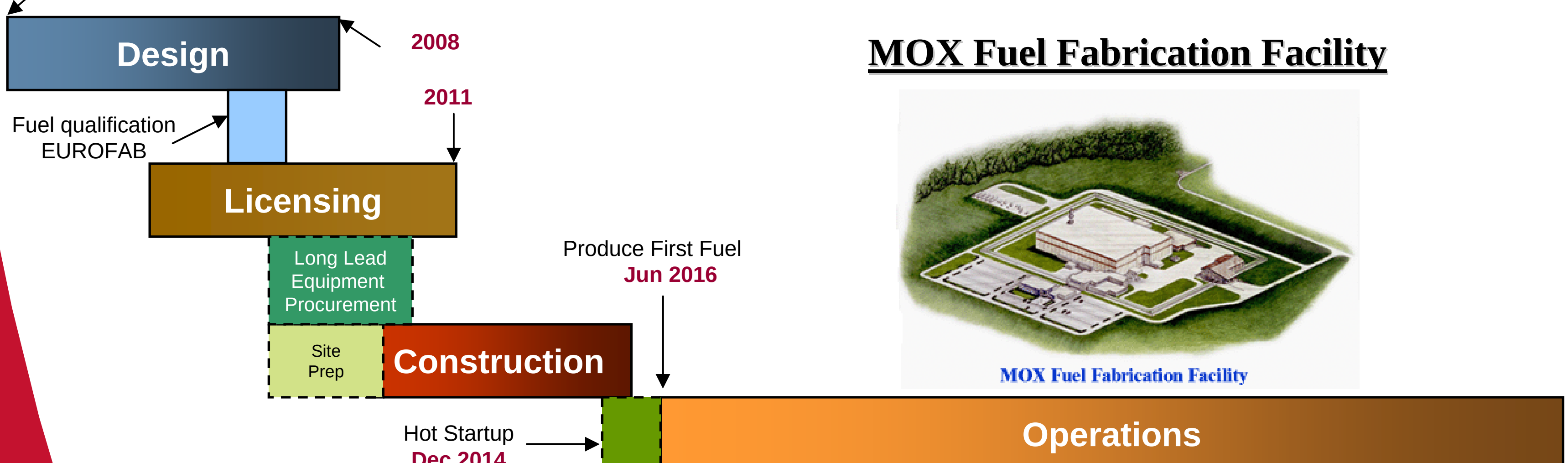
MOX fabrication plants

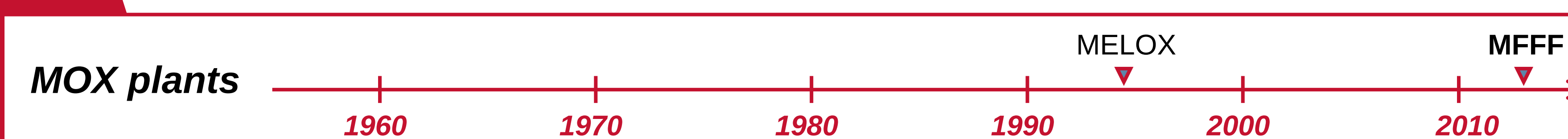
- **MELOX project (Marcoule, France)**
  - **First commercial plant for manufacturing MOX fuel at a high capacity: 100 tons/year**
  - **Very high level of automation**
  - **Total quality management**
- **Evolutive concept**
  - **Implementation of a multi-design production line in 1999**
  - **2^{nd} capacity license 145 t/y in 2003, reached in 2005**
  - **3rd capacity license 195 t/y in 2007**



MOX Fuel Fabrication Facility at Savannah River (USA)

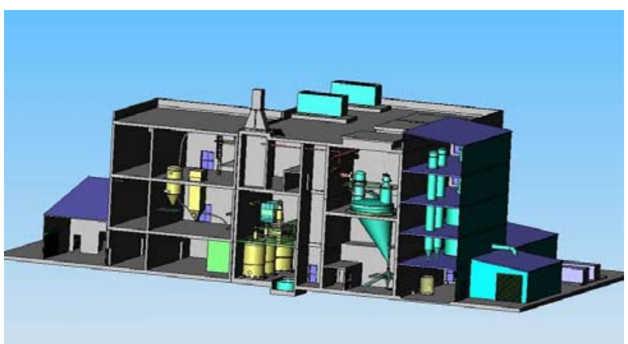
- **Shaw AREVA MOX Services (formerly DCS) - DOE Contract**
  - ***BASE CONTRACT (1999– 2011)***
    - **Design, licensing, fuel qualification (EUROFAB), manufacturing and software design**
  - **Technology transfer agreement**
    - **Pu polishing**
    - **MOX fabrication**

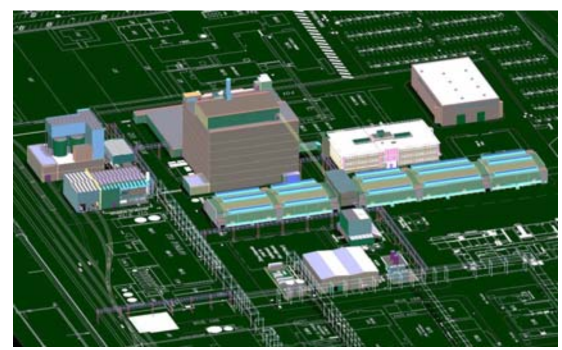


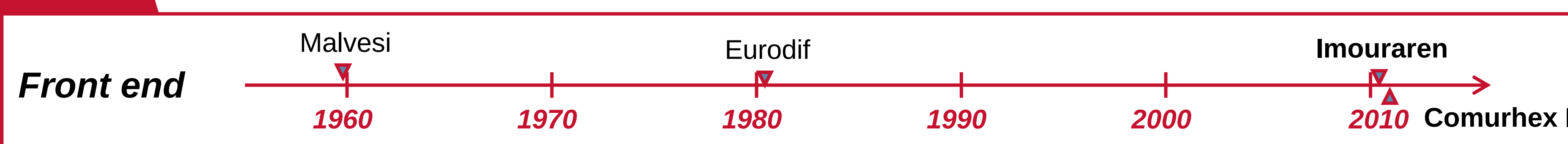


Front end facilities

- **New projects to renew and/or increase capacities**
  - **Mining: Imouraren project**
    - **Will produce 4,000 tons/year during 30 years**
    - **Beginning of operations expected before 2011**
  - **Conversion: Comurhex II**
    - **New facilities in Malvesi and Pierrelatte**
    - **15,000 tons/year starting in 2012**

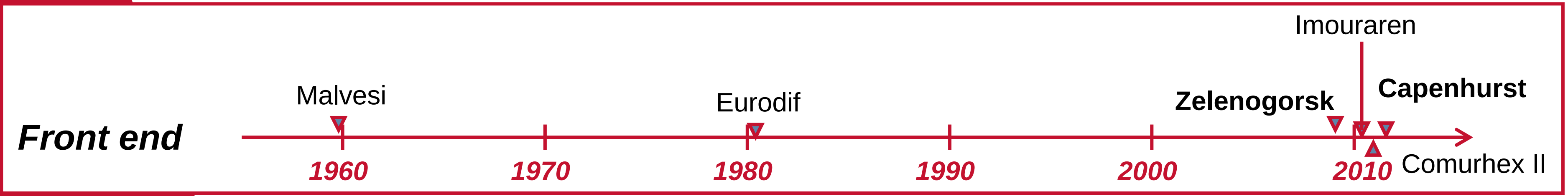






Front end facilities

- **International projects with Technology Transfer**
  - **Deconversion plants in Russia and UK**
    - **10,000 tons of depleted UF6/year**
    - **Identical technology to the W2 deconversion plant in Pierrelatte**
    - **Russian plant in Zelenogorsk**
      - **Start-up: 2009**
    - **British plant in Capenhurst**
      - **Start-up: 2013**

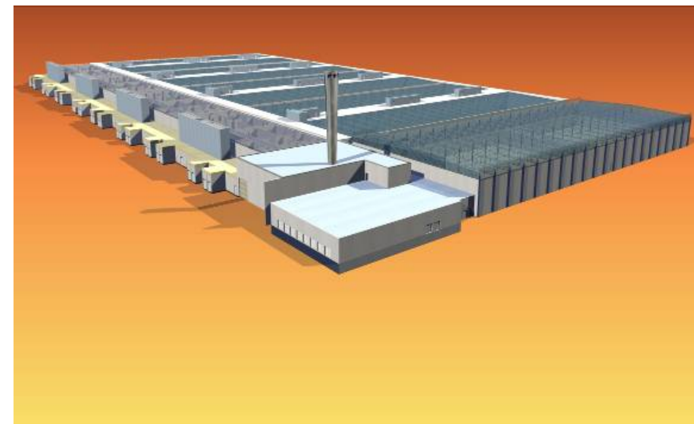


Front end facilities

Enrichment

Georges Besse II

- Joint venture between AREVA and URENCO to develop, manufacture and assemble the centrifuges
- Construction start: sept 2006
- Start of production: 2009
- Capacity: 7.5 millions SWU



End of the first generation plants
Dismantling operations

- **UP1 end of production: 31 Dec 1997**
  - **Deactivation and dismantling operations**
    - **1,000 cells and rooms among which 600 restricted areas**
    - **27,000 tons to be removed**
  - **Retrieval and repackaging of on site waste**

- **Organisation to collect and analyse D&D experience**
  - **For further D&D operations**
    - **UP2 400 at La Hague**
  - **For future plants**
    - **Integrate more access to cells for example**

Conclusion

- Through 40 years of experience in the design and construction of fuel cycle facilities
  - In France and abroad
- With a continuous assistance to the operators to optimize and keep their facilities in line with the changing rules and constraints ensuring
  - The integration of a wide experience feedback
  - The ability to design flexible facilities
- With a continuous partnership with R&D teams to integrate industrial constraints and improve processes and technologies

AREVA fuel cycle engineering teams

Have steadily maintain a very high level of competencies in nuclear engineering

Are ready to give the best answer to the growing needs going along the nuclear renaissance