



LONG TERM SUSTAINABILITY OF NUCLEAR ENERGY AN EDF PERSPECTIVE

Long term issues and huge investments

Energy issues are long term major issues

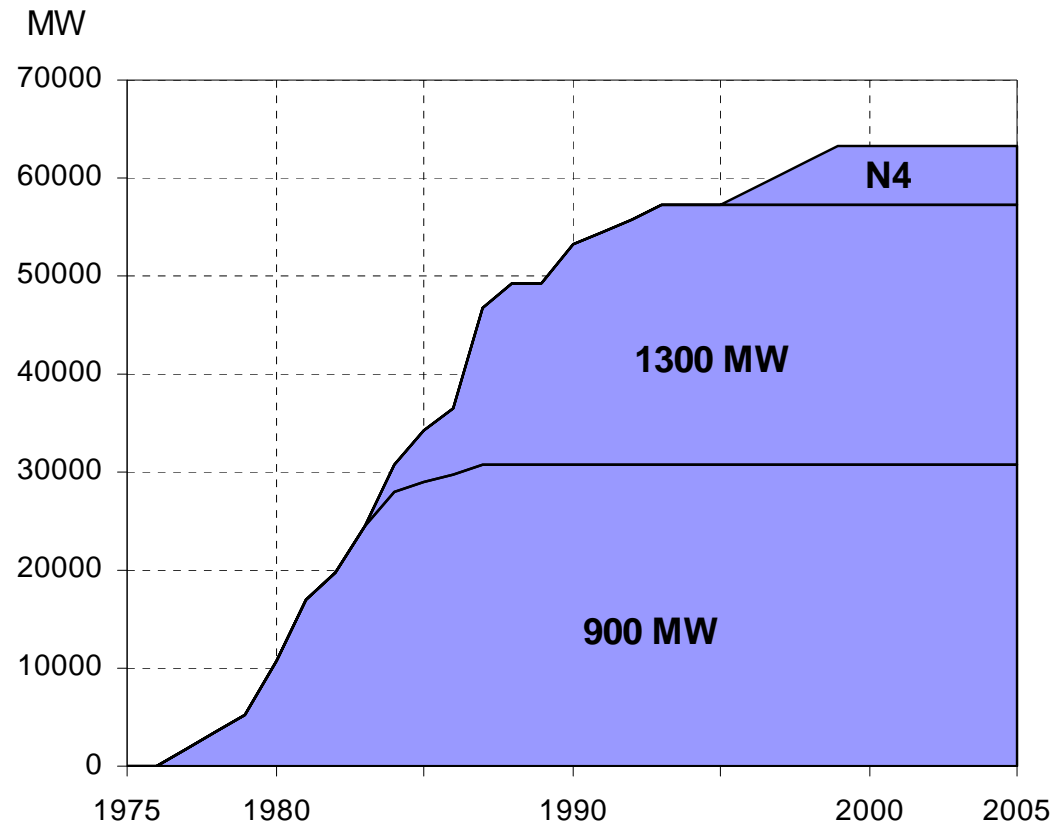
- 10 years of R&D for a new fuel concept
- 10 years to develop a new reactor design
- 5-10 years to license it
- 40 to 60 years of commercial operation

MASSIVE INVESTMENTS WITH LONG LASTING EFFECTS

- 3 billions EUROS for a nuclear plant
- 10 billions EUROS for fuel cycle facilities

NEEDS OF LONG TERM STRATEGIES FOR NUCLEAR UTILITIES

EDF FLEET , PRESENT SITUATION



- 58 reactors in operation: 3 series
- Commissioned, for its main part, in 10 years
- Still young. Average 20 years old

MEAN TERM STRATEGY

TO PREPARE THE RENEWAL OF THE PRESENT FLEET

TO SPREAD THIS RENEWAL OVER ABOUT 30 YEARS :

- *To smoothen the financial and industrial effort*
- *To favor the flexibility of choices : the future fleet will be in operation during most of the 21st century*
 - *Nuclear share in the mix*
 - *Diversification of nuclear options*

LIFE EXTENSION OF A SIGNIFICANT PART OF THE FLEET TO 50 (60?) YEARS

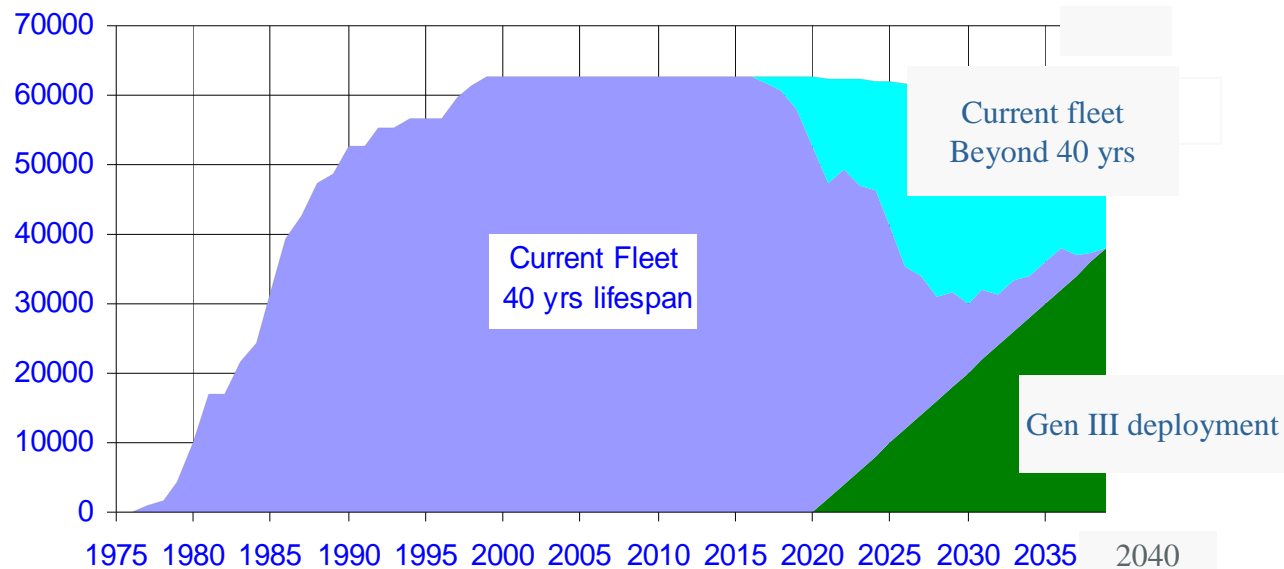
TO ENGAGE THIS RENEWAL WITH PROVEN TECHNOLOGY (EPR) AROUND 2020

**→FOAK EPR AT FLAMANVILLE
FIRST CONCRETE: 2007
COMMISSIONNING:2012**

The renewal of the French current nuclear fleet Mean Term

**An example : renewal at 60 000 MWe level
smoothened on 30 yrs (2020 – 2050)**

Commissioning pace : 2 000 MWe / yr



Fleet average lifespan : around 50 yrs

WHAT ABOUT LONGER TERM: A RESSOURCE PROBLEM

Uranium Ultimate resources are estimated at 15 MT

- 4 MT at a cost lower than 2 EURO/MWh part Unat
- 15 MT at a cost lower than 3 EURO/MWH (including speculative resources)

World Energy Context:

Co2 Emission

Oil and Gas prices

Increase energy consumption mainly in China and India

Renewables cannot close the gap

▪ Nuclear Capacity worldwide is likely to be around 1300GWe by 2040

The 15 MT Uranium in reserve will have been earmarked by that time

→ A Generation IV option (reactors and fuel cycle) is needed around 2040

How to get ready for 2040 term

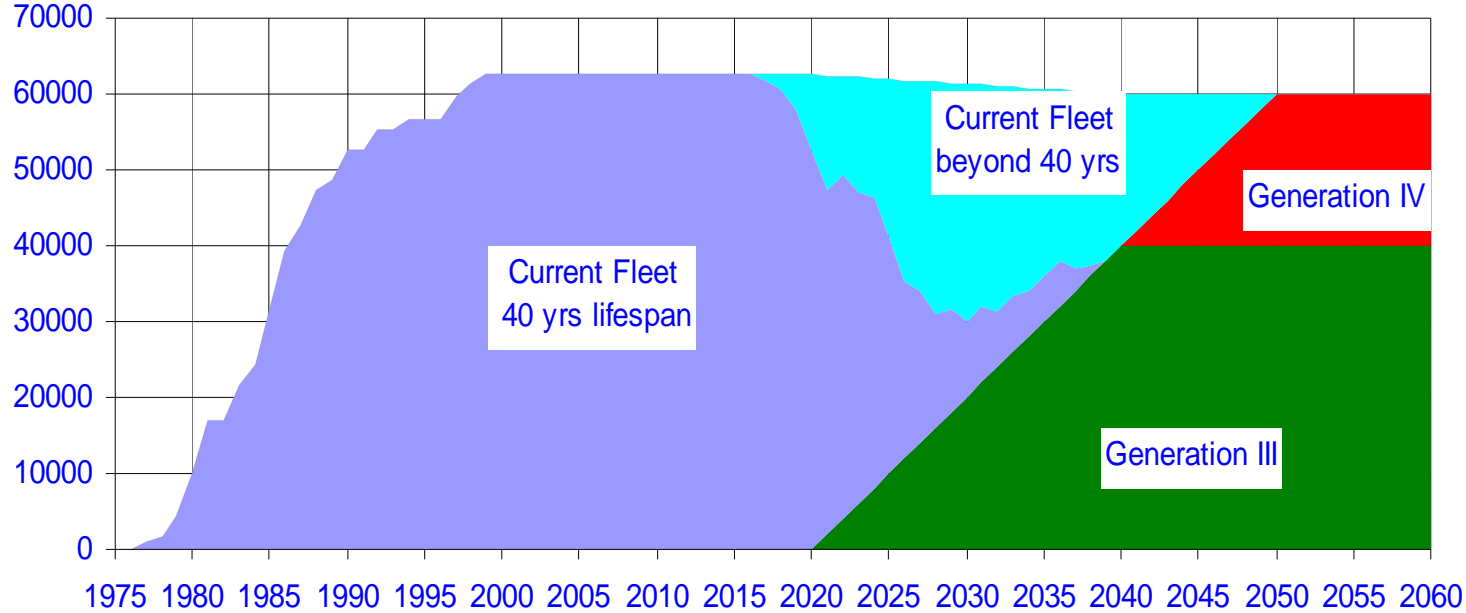
The deployment of a new nuclear option takes a long time : 30 to 40 years all in all in the past (LWR, Na FBR,...)

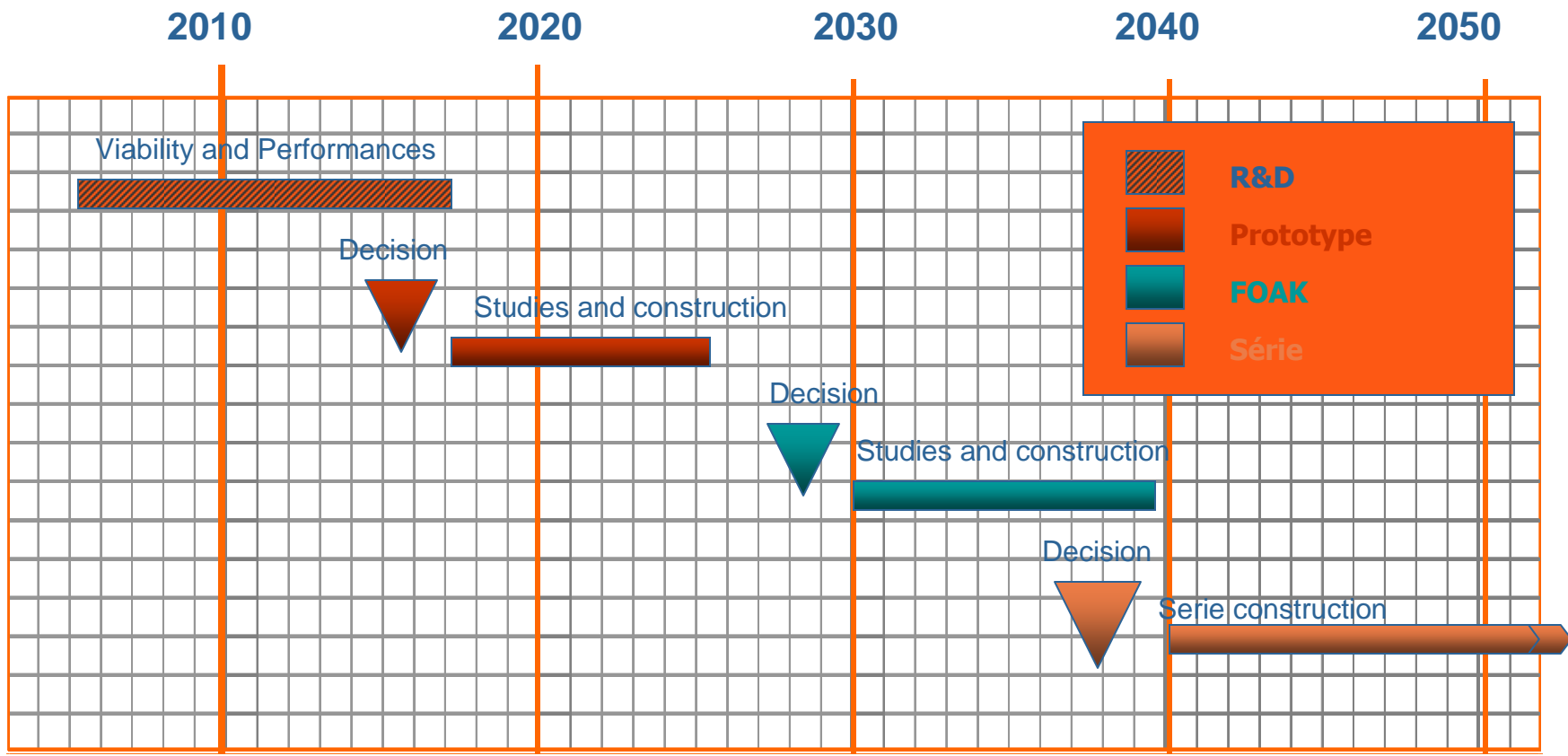
Generation IV systems are innovative, or even very innovative : 30 to 40 years to deploy industrial series is ambitious

- Viability and performances phases to overcome the technological hurdles, followed by
- Demonstration phases with prototypes, more or less long and difficult according to the innovation level

→ The countdown from 2040 shows that system choices have to be made by 2015/2020 to engage an industrial prototype

The renewal of the French nuclear fleet Long Term





SYSTEM CANDIDATES

- HTR-VHTR: No close fuel cycle
- SCWR and MSR: No industrial reference
- GFR: Very innovative
- SFR: Industrial experience but needs for improvements:
 - Safety
 - Economy
 - Easier ISI
 - Maintenability

EDF preferred choice:

- SFR is the only credible system to be ready by 2040
- GFR back up candidate if the 2040 milestone shifts 10 or 20 years

Conclusion

GEN IV reactors are a necessary condition for Long term nuclear sustainability

EDF wants to be ready to introduce this kind of reactors in its nuclear fleet by 2040

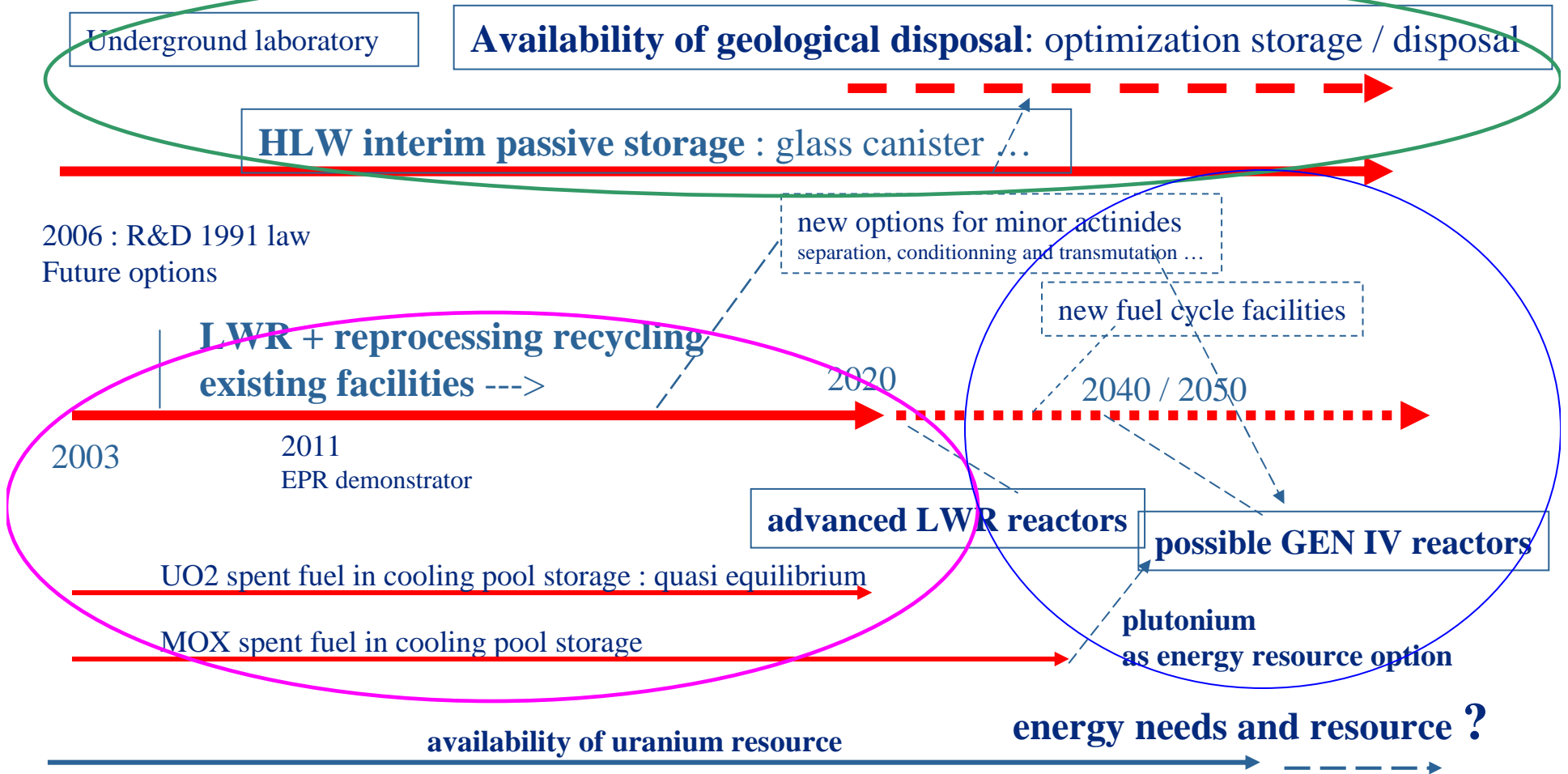
SFR is presently the preferred concept, GFR back up

R&D road map is being defined to reach this objective

Supplementary slides



A necessary consistency in the long term



Nuclear sustainability and perspective along time



Evaluation of plutonium amount necessary to start a GEN IV fast breeder reactor

□ The starting of 1 Generation IV fast reactor of 1GWe will necessitate approximately 14 t Pu_{total} (10 t Pu_{equivalent239}), based on sodium cooled fast reactor SFR

- It is roughly the inventory resulting from the operation of one 1 GWe PWR during 50 years

□ Overall spent fuel Pu inventory necessary to start Gen4 fast reactors system

- for 30 Gwe : $30 * 14 = 420$ t
- for 60 Gwe : $60 * 14 = 840$ t