French LTO Context
&
Strategic Roadmap

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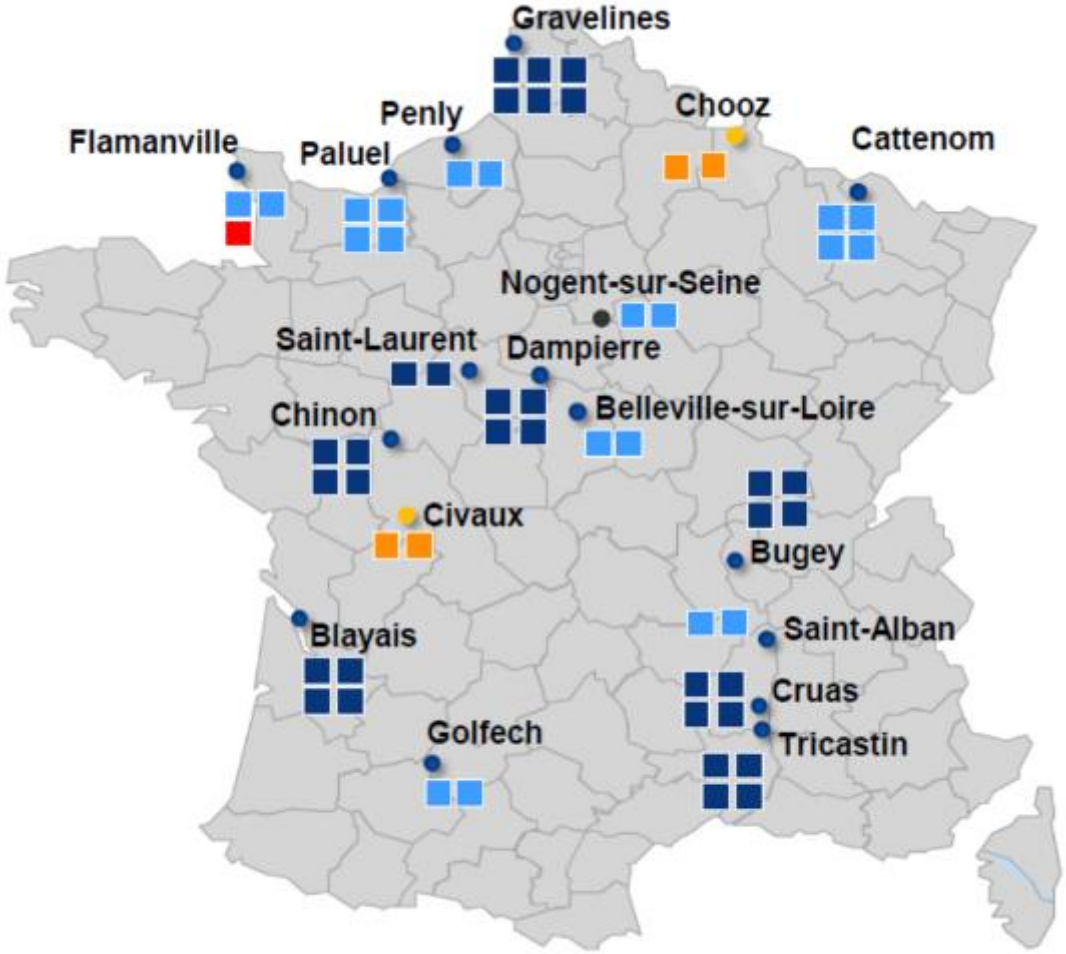
The French Nuclear Fleet

- **57 PWR in operation on 18 sites**
- **Standardized fleet :** 32 x 900MWe
  20 x 1300 MWe
  4 x 1450 MWe (N4)
  1 x 1650 MWe (EPR)
- **By the end of 2024 :**
  - Average age : **38 years**
  - **21 x 900 MWe NPP beyond 40 years**



Dates of commissioning	1979-1988	1985-1993	1994-1997	Final phase

LTO & PSR : 2 complementary approaches

PSR	LTO
❖ Legal requirement (Code de l'Environnement) applicable since the beginning of operation ❖ Every 10 years, demonstrating capability to operate the plant safely and with a high level of environmental protection for 10 additional years ❖ Some topics are looked at (~demonstrated) for longer term (20 years), e.g. Aging, climate change ❖ Scope consistent with IAEA SSG25	❖ Opportunity to set-up in France a dialog framework between EDF & the Regulator, in addition to the PSR process, for outlining the strategic long-term investments on the French nuclear fleet ❖ LTO up to 60 years → covered by the 4th and 5th PSR ❖ LTO beyond 60 years → currently covered by the LTO Roadmap that defines EDF working program with a longer-term view than the strict regulatory process (PSR). It is intended to provide a framework for getting a prospective/strategic view on LTO and ensure any issue is adequately and timely considered and assessed. → Performing detailed safety and environmental protection demonstrations will the be covered by the 6th and subsequent PSR

R&D supporting LTO 60+

Main objectives and principles

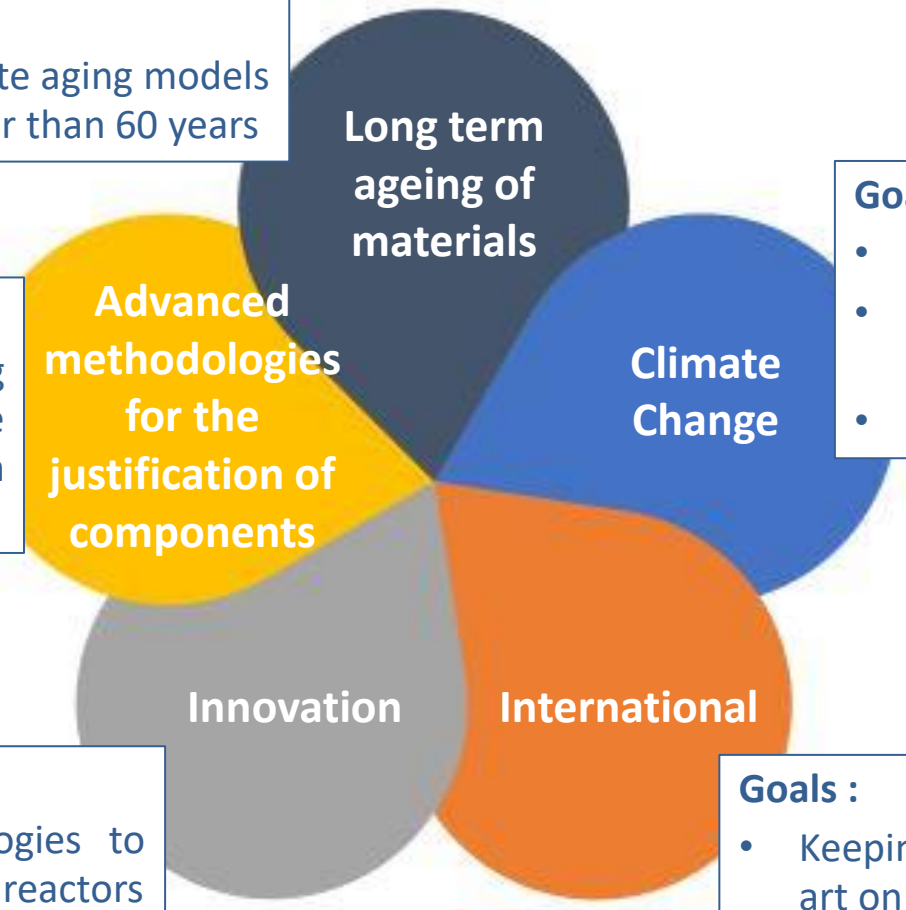
- **Contribute to the success of French LTO roadmap program:**
  - The scientific challenges necessary for the success of the program have been identified. They are the subject of the priority work of the R&D project
  - R&D program mirrors EDF LTO 60+ project. In particular, the project deals with:
    - Non replaceable components: RPV, containment and biological shield
    - Difficult to replace components: CASS E elbows, internals and cables
    - Maintenance of components
    - Climate change
- **Get a global view of research and take a step forward to anticipate needs though:**
  - Expert reviews
  - Active participations in international research in the LTO field
  - Analysis of innovative solutions to secure long-term reactor operation…

R&D supporting LTO 60+

Main areas of development

Goals:

- Acquire aging data, verify the absence of deleterious effects at LT
- Develop, verify and validate aging models for operating times greater than 60 years



Goals:

- Licensing of methods determining the available margins in a more realistic manner for the justification of components and civil works

Goals:

- Adapting global scenarios to local scales
- Assessing the resilience of nuclear power plants to climate change
- Propose adaptation solutions

Goals:

- Use the best available technologies to secure the long-term operation of reactors
- Benefit from new technologies developed outside the nuclear sector

Goals :

- Keeping up to date with the state of the art on issues related to operating life
- Have scientific and strategic relays outside France

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A long-term program!

DO = decenial outage

Thank you

LTO beyond 40 years - EDF current major renovation program

- **4th PSR** allows achieving a major step in safety at a full fleet scale, bringing the safety of EDF 56 GEN-2 PWR up to levels compatible with GEN3 safety goals.
  - At the end of 2023, 22 “4th ten-yearly outages” (VD4) have been completed for the 900 MW series

Hazards

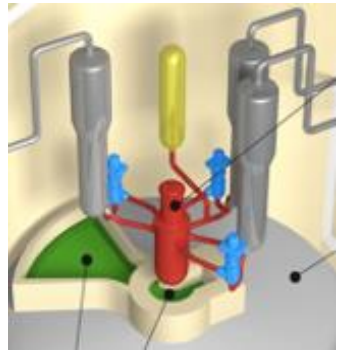
Ultimate diesel generator (DUS)

Diversified heat sink (water source for emergency supply to steam generator and fuel pool)

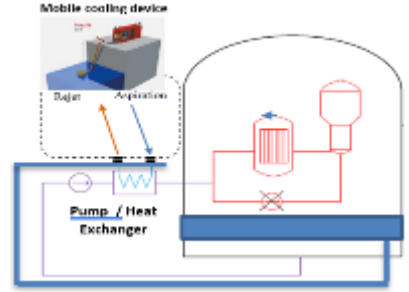
Nuclear rapid intervention force (FARN)

Examples of 4th PSR plant modifi-cations

Severe Accidents



Corium spreading area



Corium extra cooling system (EASu)

Spent Fuel Pool

Third train for fuel pool cooling (PTRbis)

- **5th PSR** will target mitigation of global warming impacts.
  - Safety and Environmental protection objectives under discussion with ASN
  - First 'fifth ten-yearly' (VD5) outage in 2029 (first unit reaching 50 years)