

# **Regulatory challenges for the French Regulator with the future of the Nuclear Fuel Cycle**



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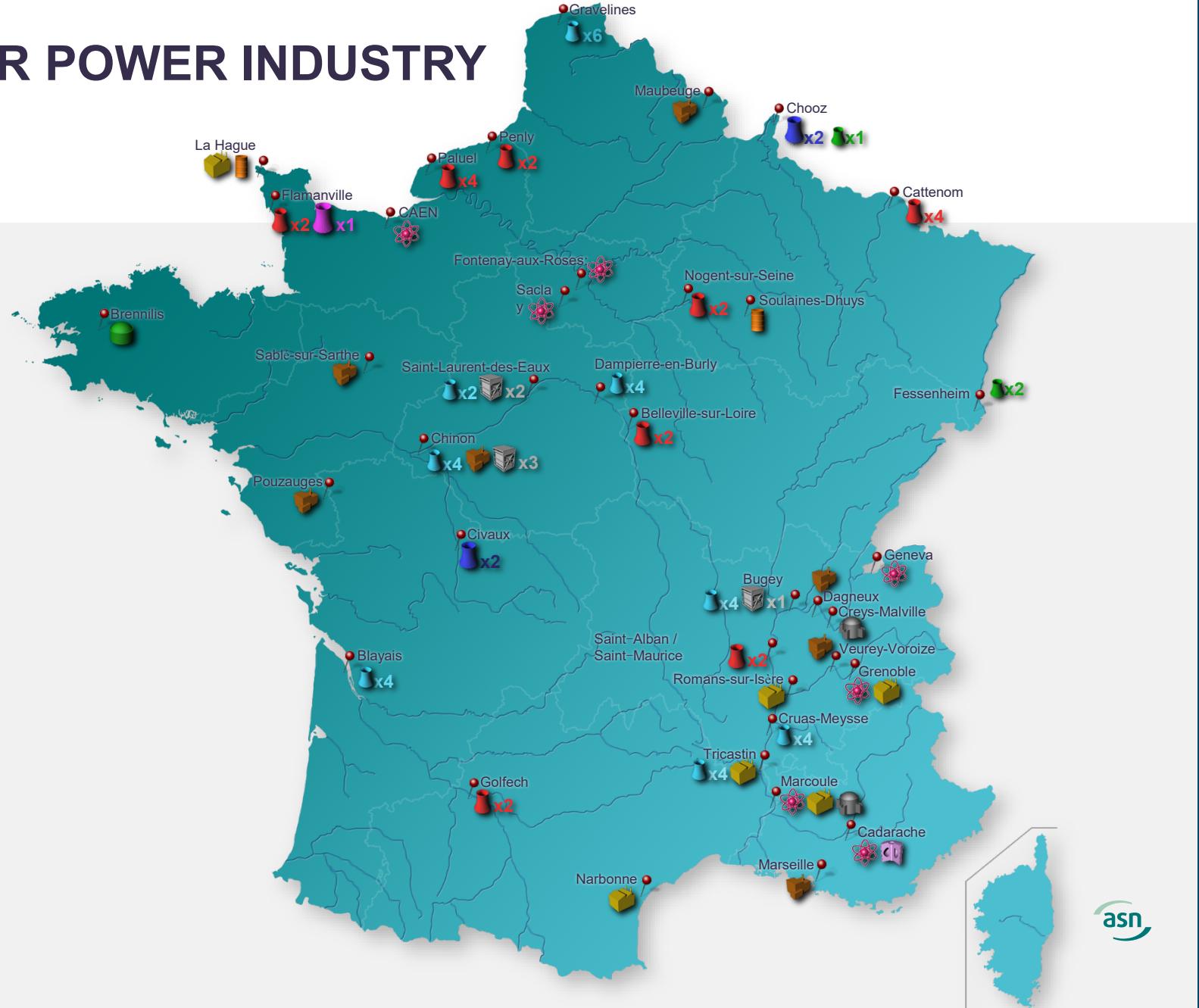
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# 1. THE FRENCH NUCLEAR POWER INDUSTRY

	Being decommissioned	In operation	Under construction
300 MWe reactor			
900 MWe reactors			
1300 MWe reactors			
1450 MWe reactors			
1600 MWe reactors			
Fuel cycle plants			
Workshops and laboratories			
Study and research centres			
Experimental thermonuclear reactor (ITER)			
Waste disposal facilities			
Fast-neutron reactors			
Gas-cooled reactors (GCR)			
Heavy water reactors			

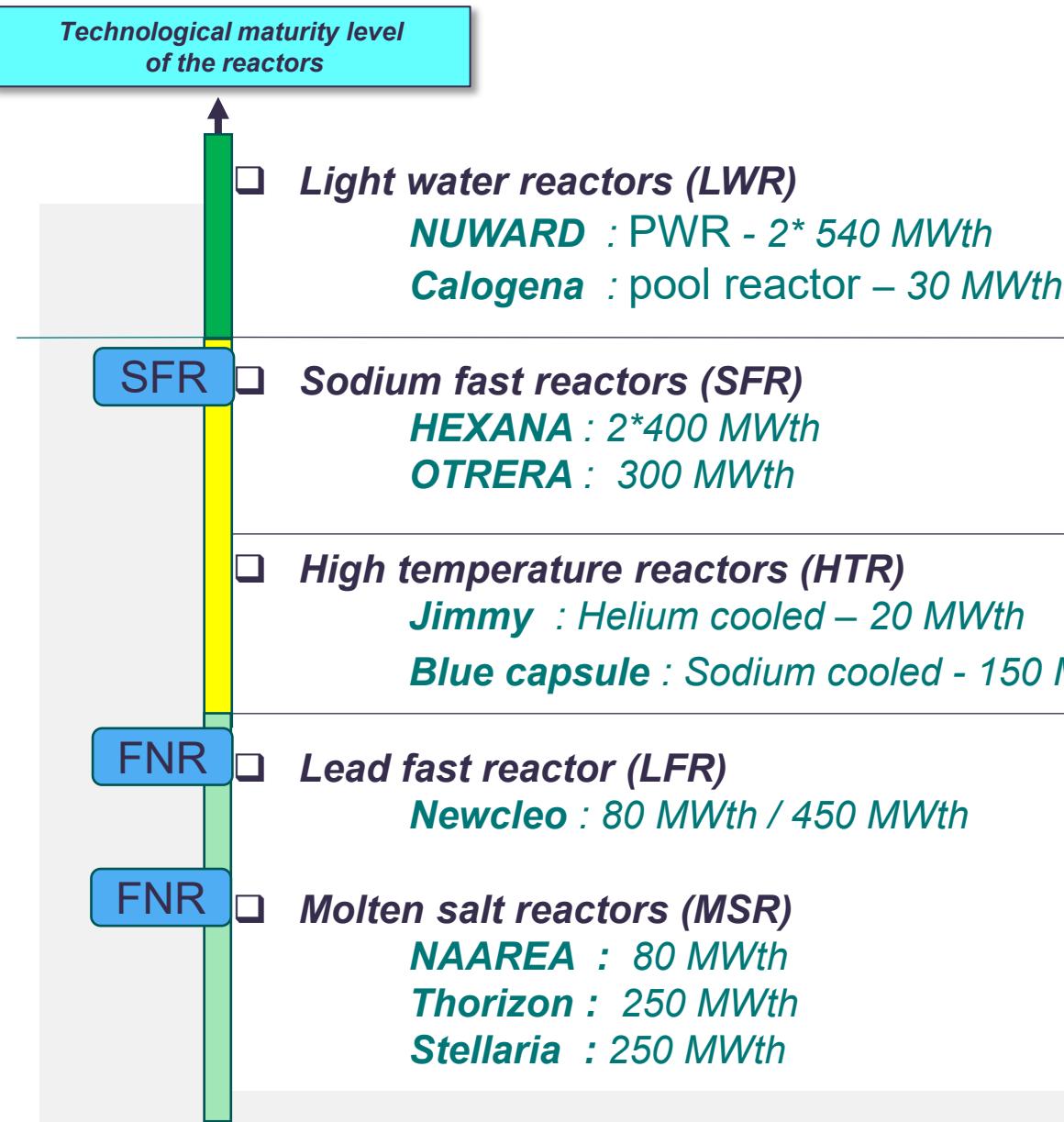


# 1. THE CURRENT FRENCH NUCLEAR POWER INDUSTRY

## The French Specificity

- A limited number of operators: EDF, ORANO, ANDRA, CEA
- Except the mines, Fuel Cycle Facilities in France
  - Conversion facility (Malvesi)
  - Enrichment facility (GB II)
  - Fuel fabrication (UO<sub>2</sub> Romans (Framatome/EDF), MOX (Melox))
  - Reprocessing Plant (La Hague)
- One type of Fuel: Light Water Reactor
- 2 main providers: Framatome and Westinghouse

## 2. SMR : the main projects in France



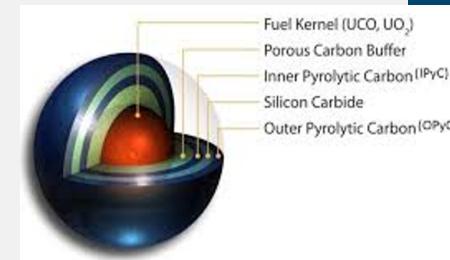
### Availability of the fuels

**F** Standard fuel U <5%

**F** Fuel MOX-SFR

**F** TRISO Fuel

- No industrial production capacity
- No HALEU supply in Europe



**F** Fuel MOX-LFR

**F** Chloride salts U/PU

- No industrial production capacity
- Step of prior enrichment in Cl<sub>37</sub> needed

## 2. SMR: FUEL CHALLENGES

For ASN the whole Fuel Cycle, the dismantling activities and the Radioactive Waste Management have to be taken into account since the beginning

Specific issues:

- ASN should receive (2024) a licence application for a modular construction facility by Jimmy (construction of the reactor vessels loaded with TRISO fuel).
- ASN should receive (2024) a licence pre-application license for a MOX fuel fabrication facility by Newcleo

Safety objectives:

- SMR : how safe is safe enough?

The assessment of several unusual applications is also a real challenge for ASN



## 2. ACCIDENT TOLERANT FUELS CHALLENGES

Fuel modifications result from several industrial needs:

- to take into account operating experience or new operating constraints
- to improve the behavior of fuel assemblies under accidental conditions

Regarding ATF, EDF strategy is based on evolutionary designs of the fuel rods:

- development in cooperation with suppliers
- with preliminary qualification, including test in nuclear reactors

Implementation takes 5 to 10 years when a modification requires the use of precursor test fuels (more than 10 years with breakthrough technologies)

## 2. ACCIDENT TOLERANT FUELS CHALLENGES

### EDF mid term strategy:

- Consideration of chromium-coated cladding (already tested on operating reactors)
- Pellets doped with Cr<sub>2</sub>O<sub>3</sub> and Al<sub>2</sub>O<sub>3</sub>-Cr<sub>2</sub>O<sub>3</sub>
- Need to take into account the possibility to reprocess the fuel in La Hague (solubility)

### EDF long term strategy:

#### Issues under evaluation:

- Ceramic cladding
- High density pellets

=> For ASN it's a « usual » assessment process

### 3. CONCLUSION

For ASN, the current main regulatory challenge is with SMRs

- Many newcomers with a limited nuclear experience
- Innovative designs
- Innovative fuel concepts mainly not anticipated
- A limited capacity of assessment at ASN

International cooperation is thus welcome



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