

EDF GRAPHITE GAS REACTORS DISMANTLING PROGRAMME



Jérémy BOULET, Frédéric NOBILE

Electricité de France – Direction des Projets Déconstruction et Déchets (DP2D)

154 Avenue Thiers, LYON, France

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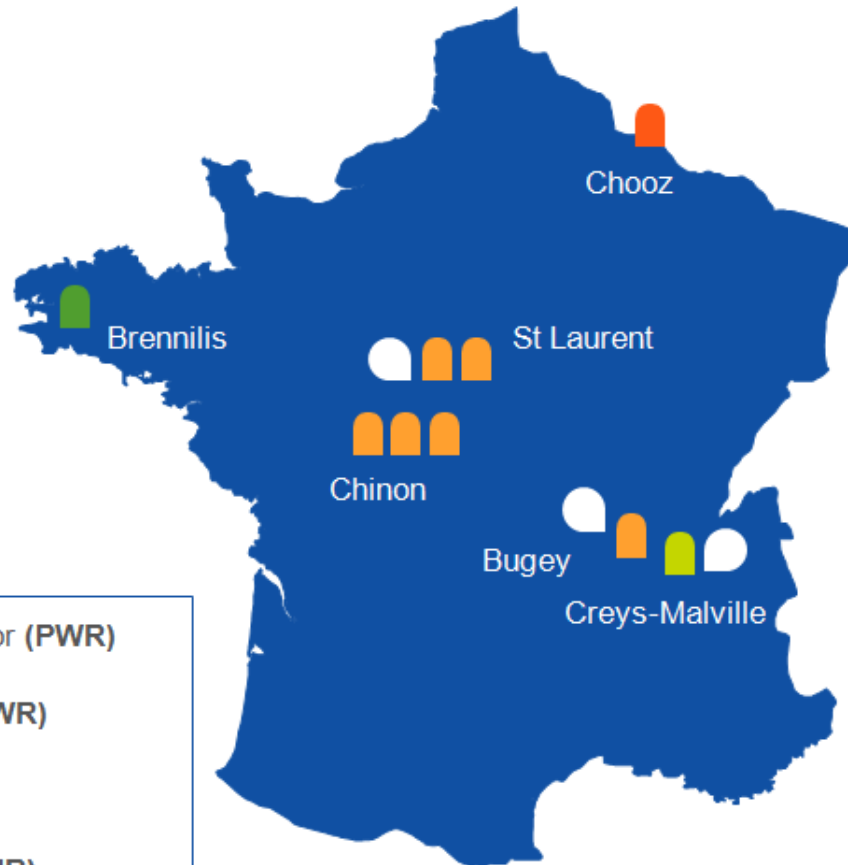
EDF DECOMMISSIONING ONGOING PROGRAM




+15 years of experience
on its own fleet
decommissioning


EDF has taken
9 units
from operating to
decommissioning

EDF is also preparing
AGR decommissioning
in the UK
that will begin by **mid-2020s**



 **1** pressurized Water Reactor (**PWR**)

 **1** Heavy Water Reactor (**HWR**)

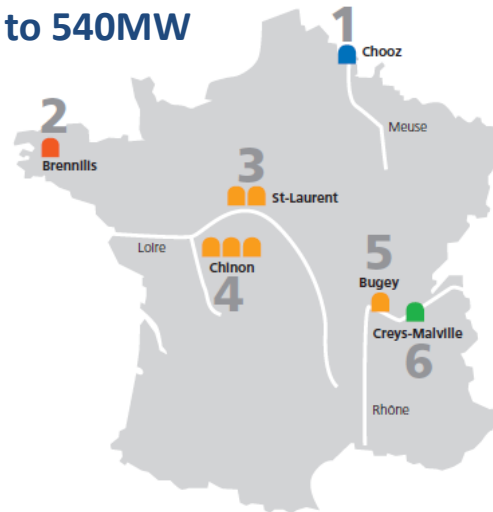
 **6** Natural Uranium Graphite Gas reactors (**UNGG**)

 **1** Fast Neutron Reactor (**FNR**)

 **EDF Main storage facilities**

ZOOM ON GRAPHITE-GAS REACTORS (6 IN FRANCE)

- First generation of nuclear power plant in France
- Built in the 1960
- Output ranging from 70MW to 540MW



Chinon A1 (70 MW)
Chinon A2 (200 MW)
Chinon A3 (480 MW)

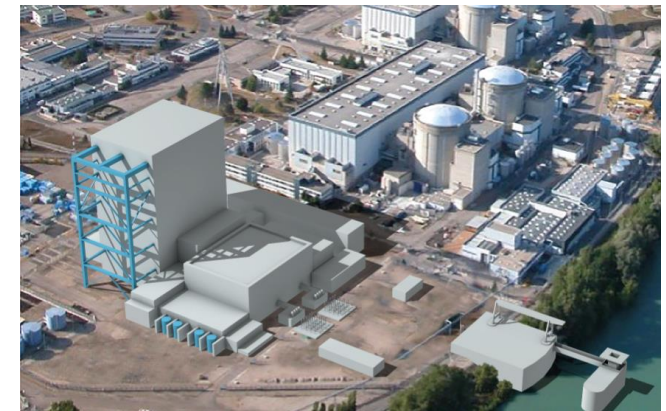


- Reacteur a eau lourde
- Reacteur a eau pressurisée
- Reacteur UNGG (Uranium Naturel Graphite Gaz)
- Reacteur a neutrons rapides

Saint-Laurent A1 (480 MW)
Saint-Laurent A2 (515 MW)



Bugey 1 (540 MW)



MAIN SEQUENCE FOR DECOMMISSIONING UNGG SITE

Defuelling and prompt dismantling

Dismantling of electromechanical circuits around the reactor

Reactor Dismantling

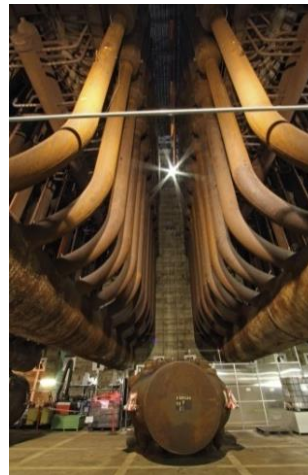
End of Operation

Decree for decommissioning

Main conventional facilities dismantled
Evacuation of radioactive elements (fuel, circuits, tanks...)
Nuclear facilities partially dismantled (emptying and decontamination of fuel pools Reactor)

CHA1	1982 (INB-E)
CHA2	1991 (INB-E)
CHA3	2010 (MAD-DEM)
SLA1/A2	2010 (MAD-DEM)
BUG 1	2008 (MAD-DEM)

Operations are ongoing



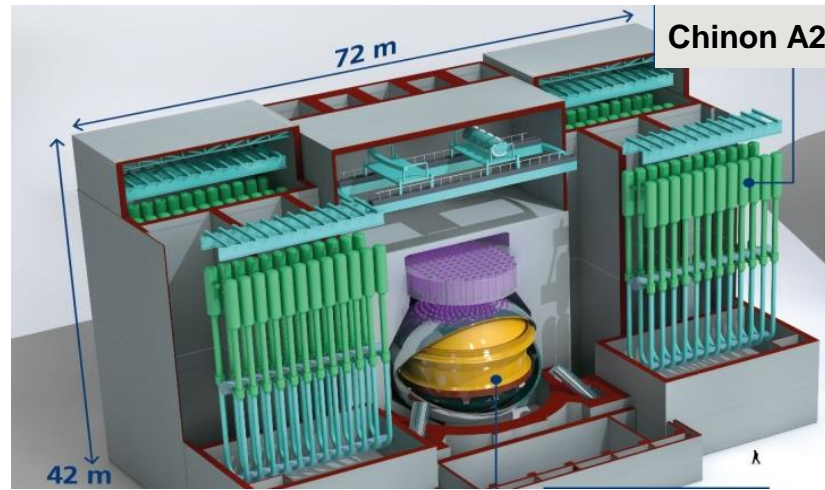
CHA2 REACTOR CONTAINMENT STRUCTURE

REACTORS CORE

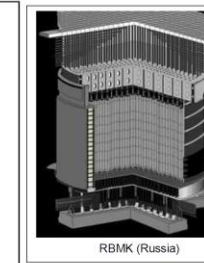
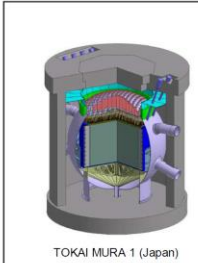
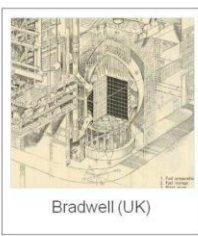
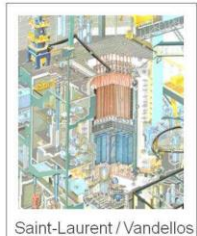
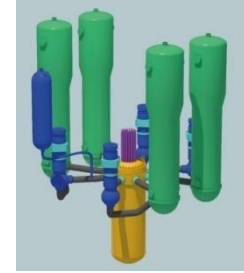
Large concrete layer
(5-8m thickness)

Graphite Bricks (42 000)

Upper and lower metallic
structures within the core

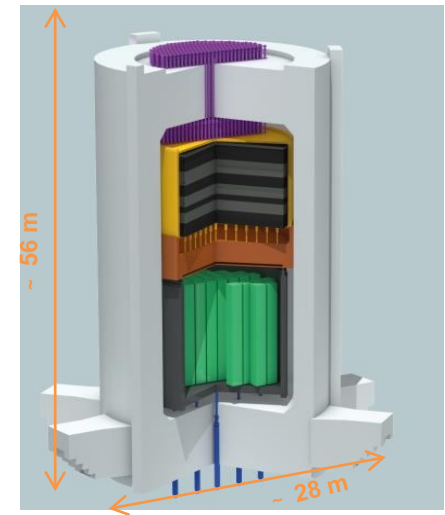


10 à 30 times
more
materials
than a PWR

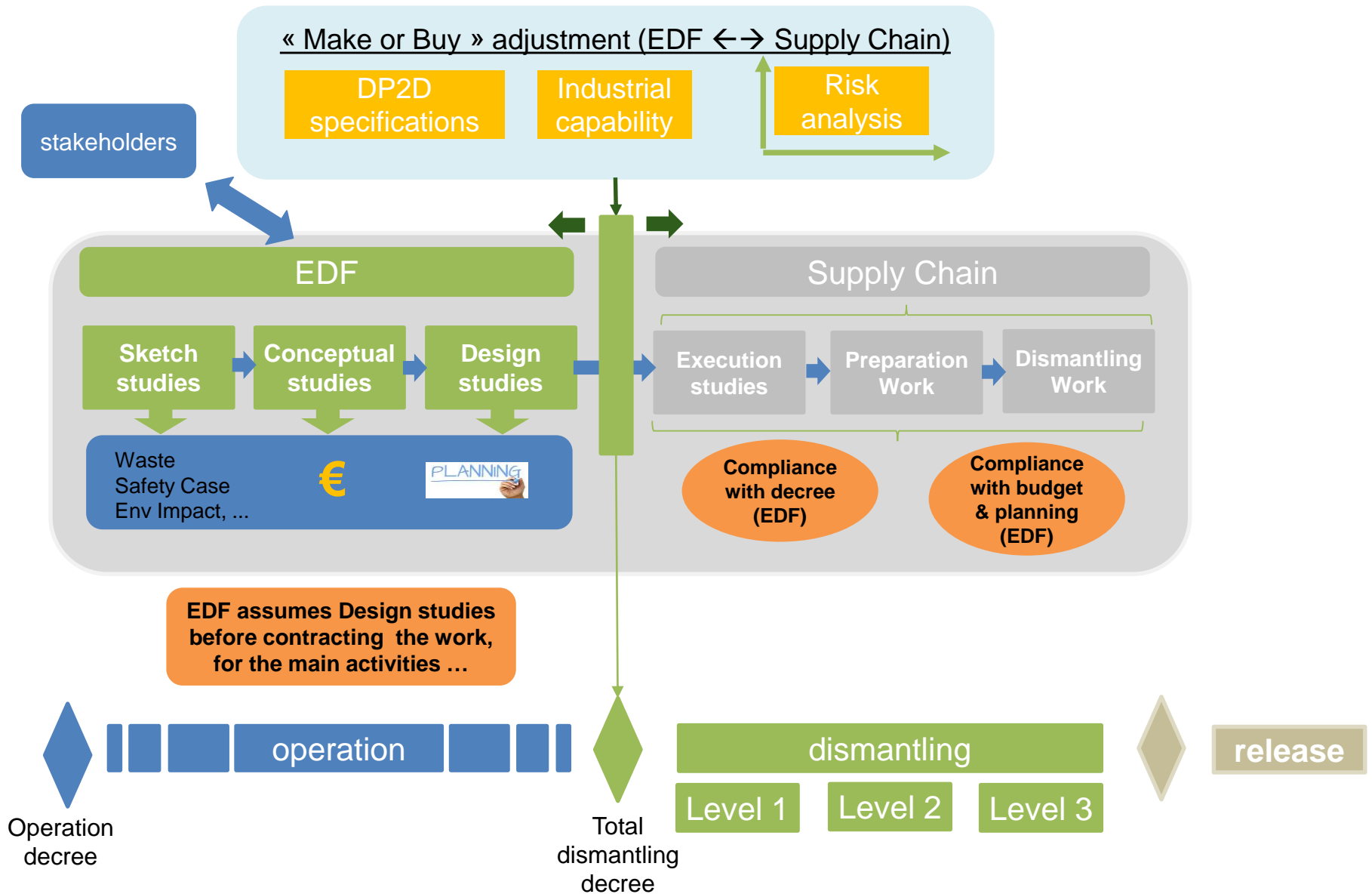


A big challenge

Scenario
adaptable and
transposable
to other plants



RISK MITIGATION – EDF DP2D DISMANTLING MODEL



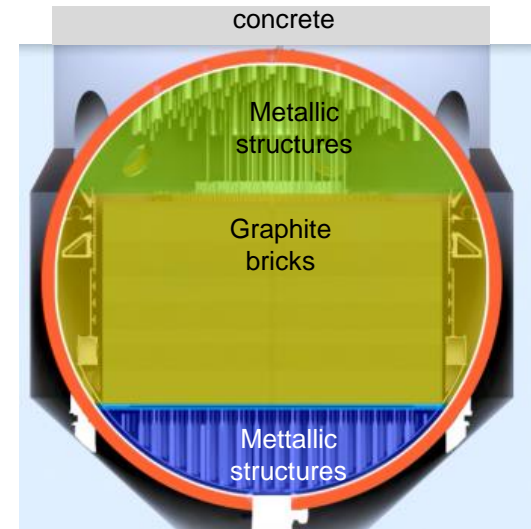
REACTOR DISMANTLING SCENARIO (DESIGN STUDIES)

For UNGG reactors, dry scenario is preferred to water scenario due to :

- ✓ Similar dismantling duration between water vs dry scenario
- ✓ Overall health Physics very similar
- ✓ Lower risk due to lack of Tightness of vessel and water management

The Dismantling scenario is similar for all kind of GG

- ✓ Concrete Opening from the top of the reactor,
- ✓ Platform installation on the top of the reactor
- ✓ Concrete opening of the remaining part
- ✓ Dismantling from the platform
 - ✓ Upper Metallic structures (internals)
 - ✓ Graphite layers of bricks
 - ✓ lower Metallic structures (supporting structure)



Dismantling duration of about 25 years in average for all EDF's graphite reactors

4 categories of risks



3 categories related to the design of graphite gas reactors :

- Concrete (reactor opening and biological protection)
- Metallic structures
- Bricks extraction

1 categorie related to the design and operation of the dismantling platform

Risk mitigation approach: A Fundamental Issue to control cost and timeline

R3 OPTIONEERING, CONCEPTUAL DESIGN AND EIAR DEVELOPMENT

EDF - DP2D experience of over 15 years in deconstruction

- The first of a kind **graphite reactor dismantling** (CHA2 and R3 Ignalina) is a **big challenge**.
- EDF manages the decommissioning of 9 EDF shut-down nuclear reactors in France and prepares the future decommissioning of EDF's operating nuclear fleet and **has developed tools and methods** (decommissioning studies, risks mitigation, ...) to compare scenarios and is testing new technical solutions (DEM+ *) to improve timeline, technique and cost, while maintaining an appropriate level of requirements.
- **Risk mitigation** regarding safety, decommissioning duration and mastering global cost is a **key factor** and EDF's new **Industrial Decommissioning Demonstrator facility** (operational by 2022 in Chinon – France) is an essential element of our approach.
- DP2D establishes **industrial solutions for intermediate (long-lived) and high-level radioactive waste** and develops efficient industrial solutions for managing all types of waste.
- DP2D has developed a **strong knowledge about graphite** (with the CEA) : characterisation, packaging, treatment, repositories

* <http://www.orekasolutions.com/demplusfornuclear>

MERCI

THANK YOU