



Status of the Cigéo Project in France

French Industrial Geological Disposal Project

LUCOEX Conference & Workshop

“Full Scale Demonstration Tests in Technology Development of Repositories for Disposal of Radioactive Waste”

Oskarshamn, Sweden - 2-4 June 2015

2006 Act

UOX fuel reprocessing, Pu+U recycling (MOX, URe)

Heat decrease storage of final HLW

Interim storage of final ILW

Interim storage of reusable matter (MOX SF)



GenIV waste disposal

spent fuel has been explored.

- By law end waste only can be disposed of (no recyclable material)
- Cigéo is designed for HL-LLW and IL-LLW generated by existing nuclear facilities, under operation (50 years for PWR) or licensed

Cigéo Inventory		
	Total volume to be disposed of (m ³)	Volume already produced in 2010 (m ³)
HLW	10 000	2 700
ILW	73 000	40 000



Vitrified HLW



Clads, ends



Solidified effluents

MAVL



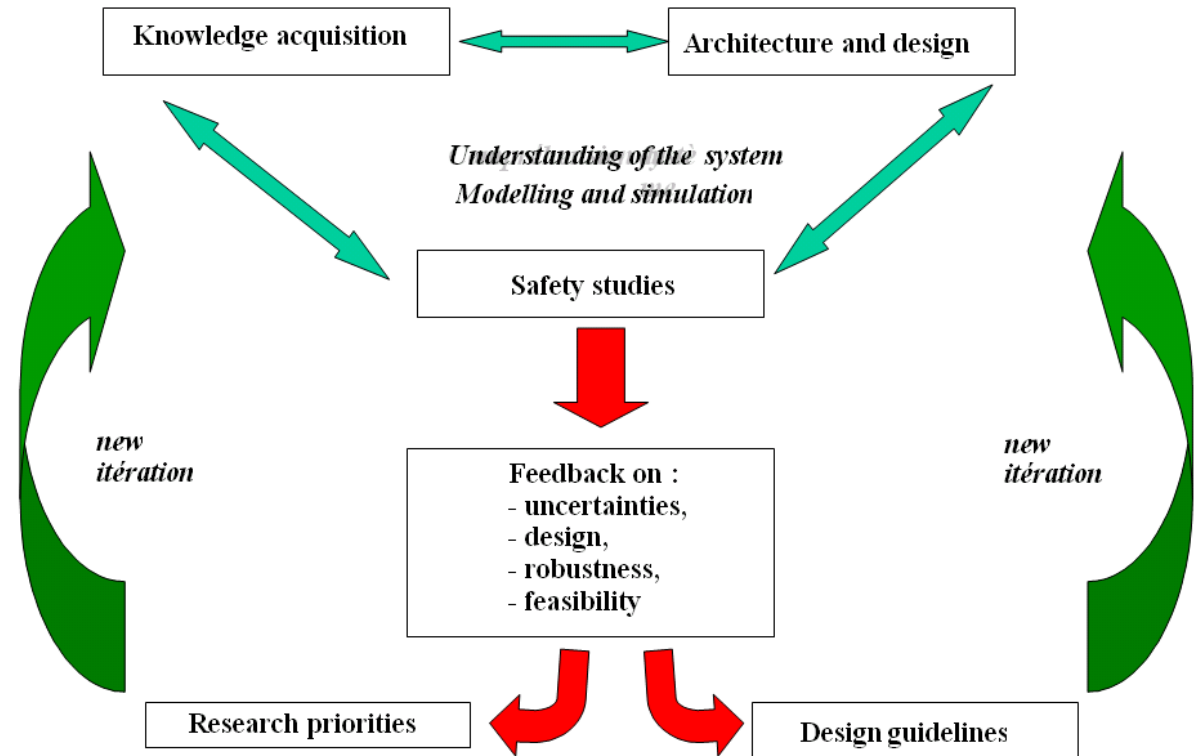
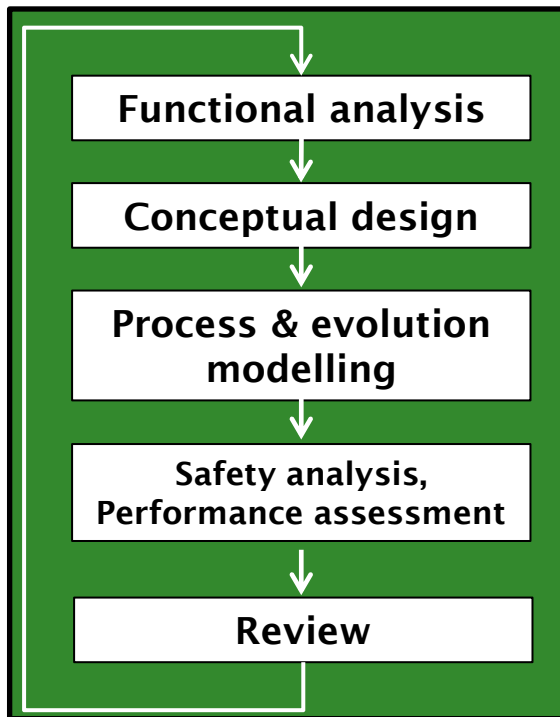
Maintenance waste



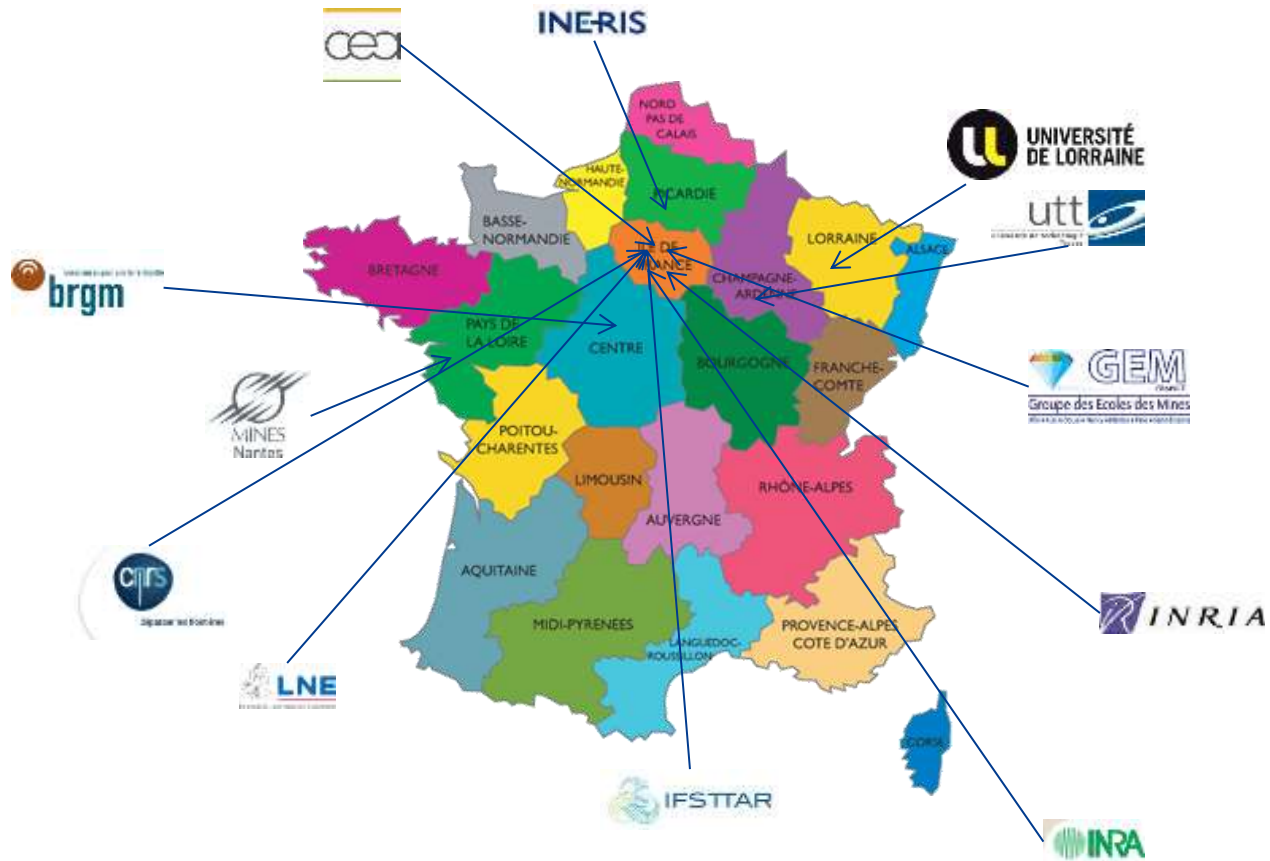
Activated waste and ITER

ITER

Cigéo is a complex process c/w design/safety iterations including national and international reviews: 1998, 2001, 2005, 2009...



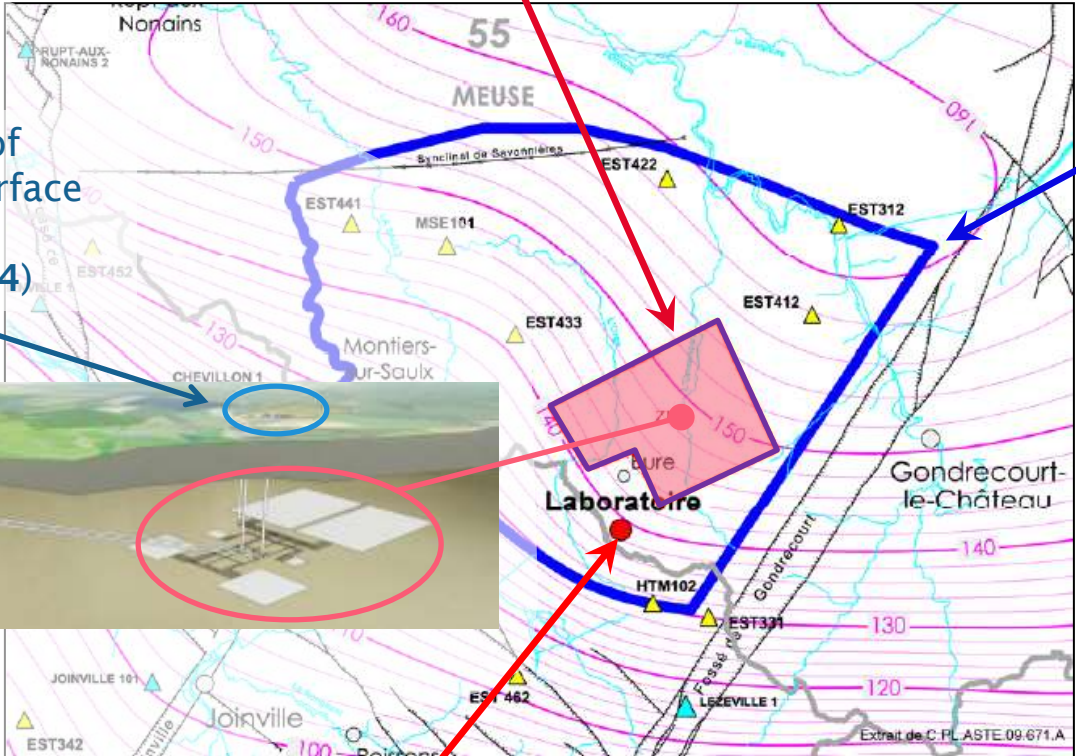
Cigéo Project is supported by an intensive R&D Network



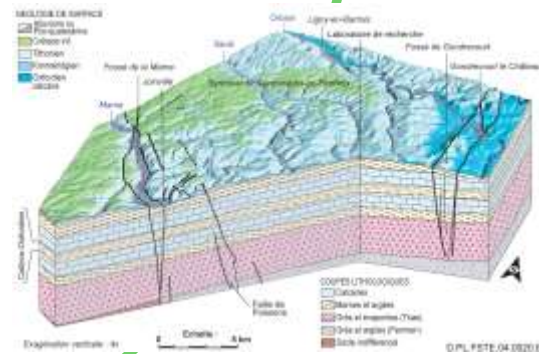
Cigéo Siting

Area defined after local consultation (2009) for location of repository U/G facilities and detailed geological survey from the surface

Location of repository surface facilities (2013-2014)



Transposition zone of URL results (proposed 2005)

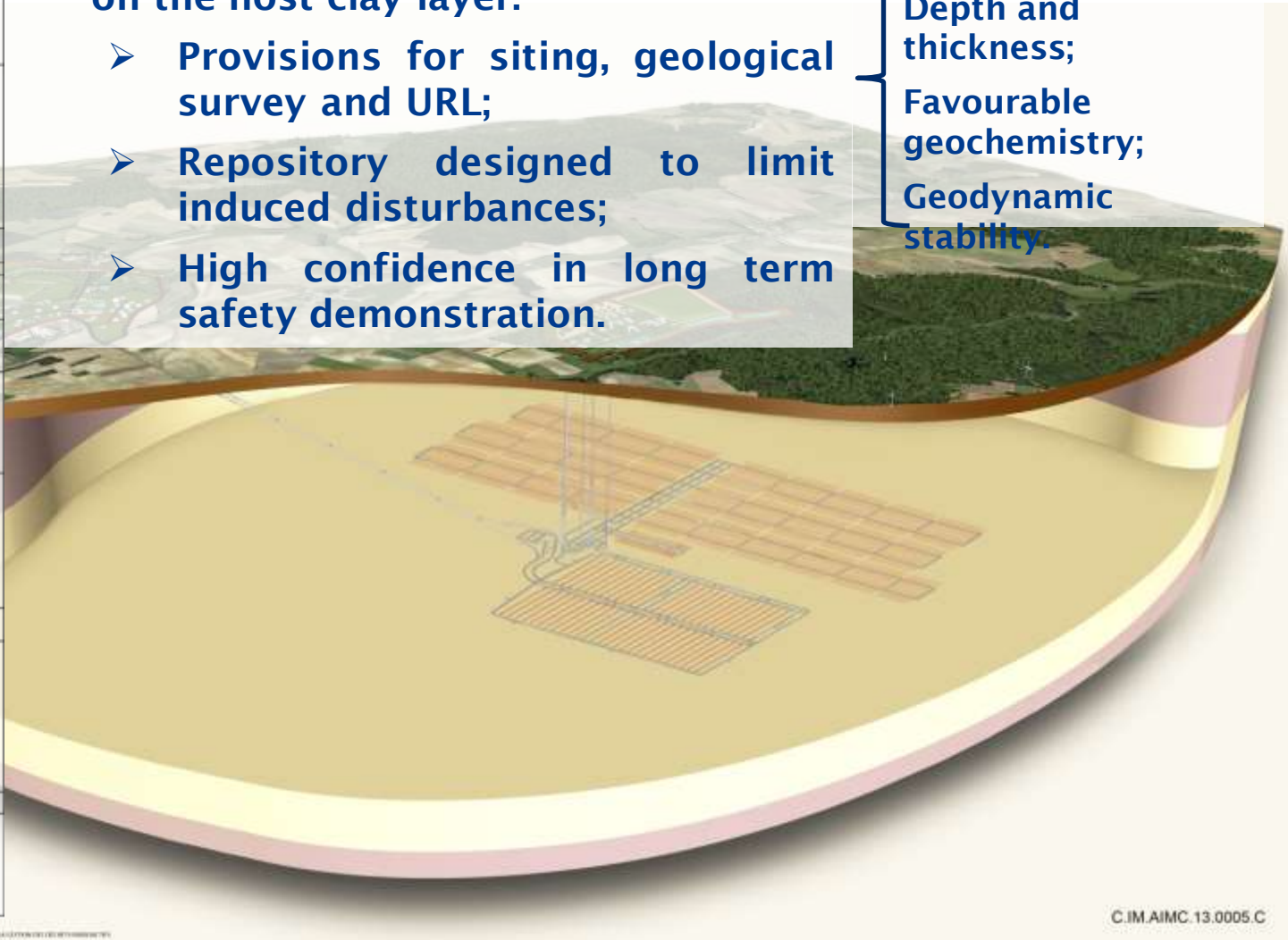
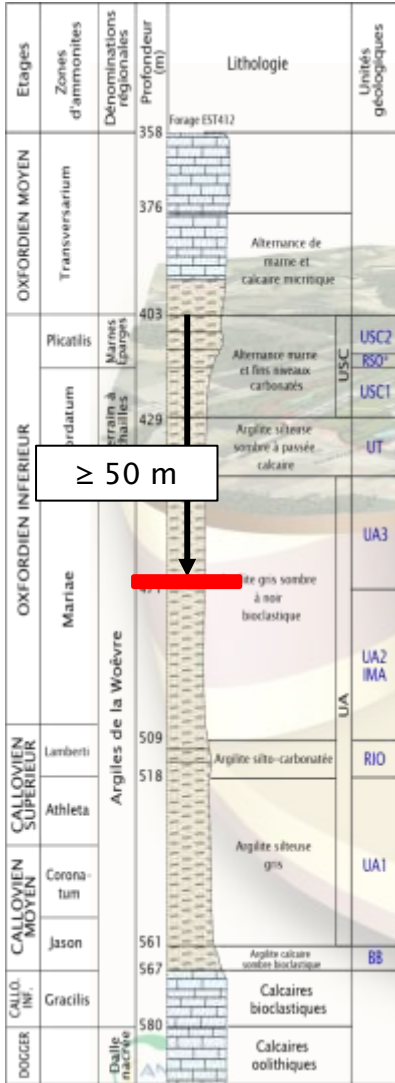


Siting process started in 1992; Bure URL licensed 1998

→ Post closure safety is mainly based on the host clay layer:

- Provisions for siting, geological survey and URL;
- Repository designed to limit induced disturbances;
- High confidence in long term safety demonstration.

Low permeability;
Depth and thickness;
Favourable geochemistry;
Geodynamic stability.





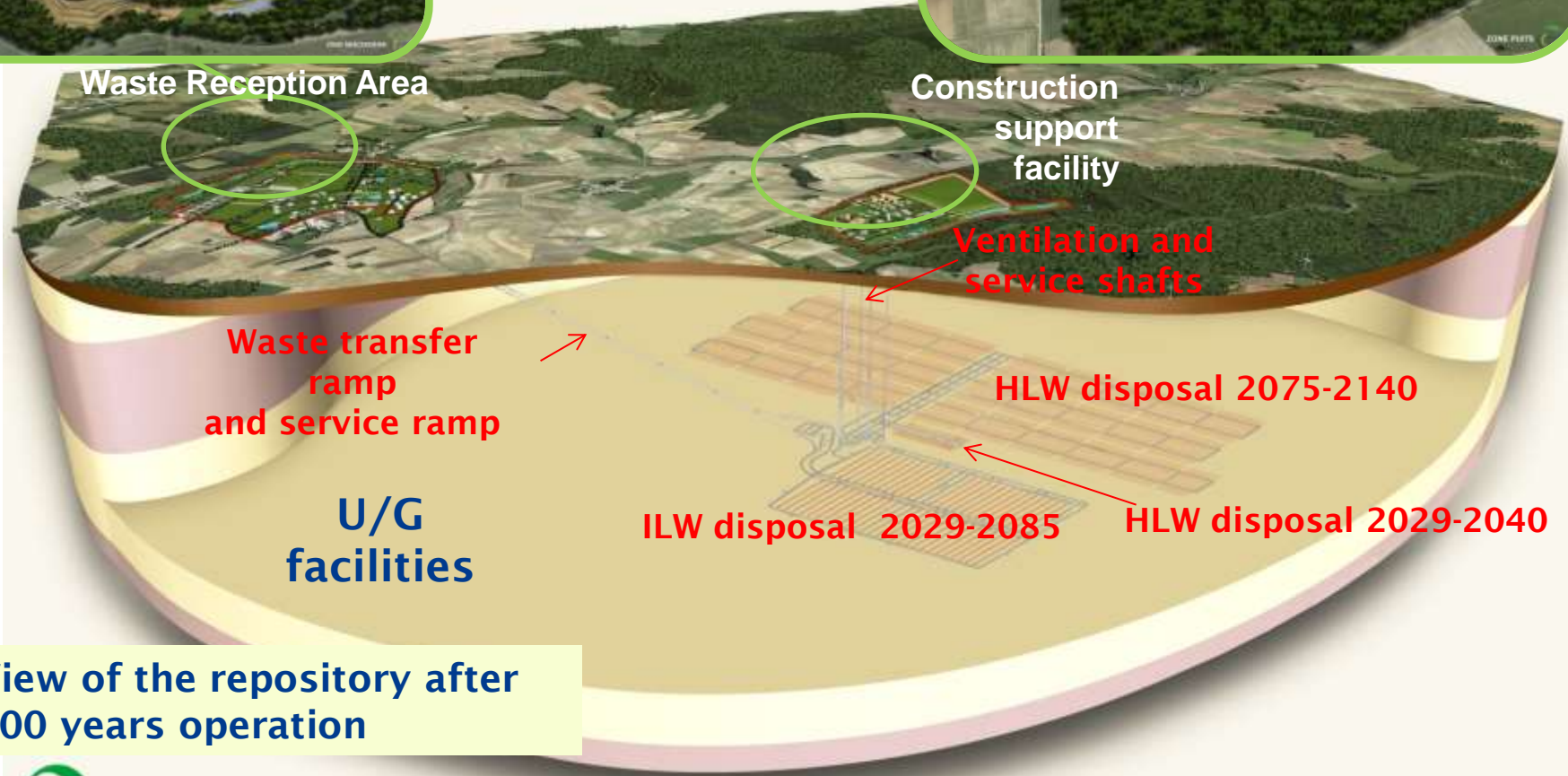
The Cigéo Project -Layout



Waste Reception Area



Construction support facility



Waste transfer ramp and service ramp

U/G facilities

Ventilation and service shafts

ILW disposal 2029-2085

HLW disposal 2075-2140

HLW disposal 2029-2040

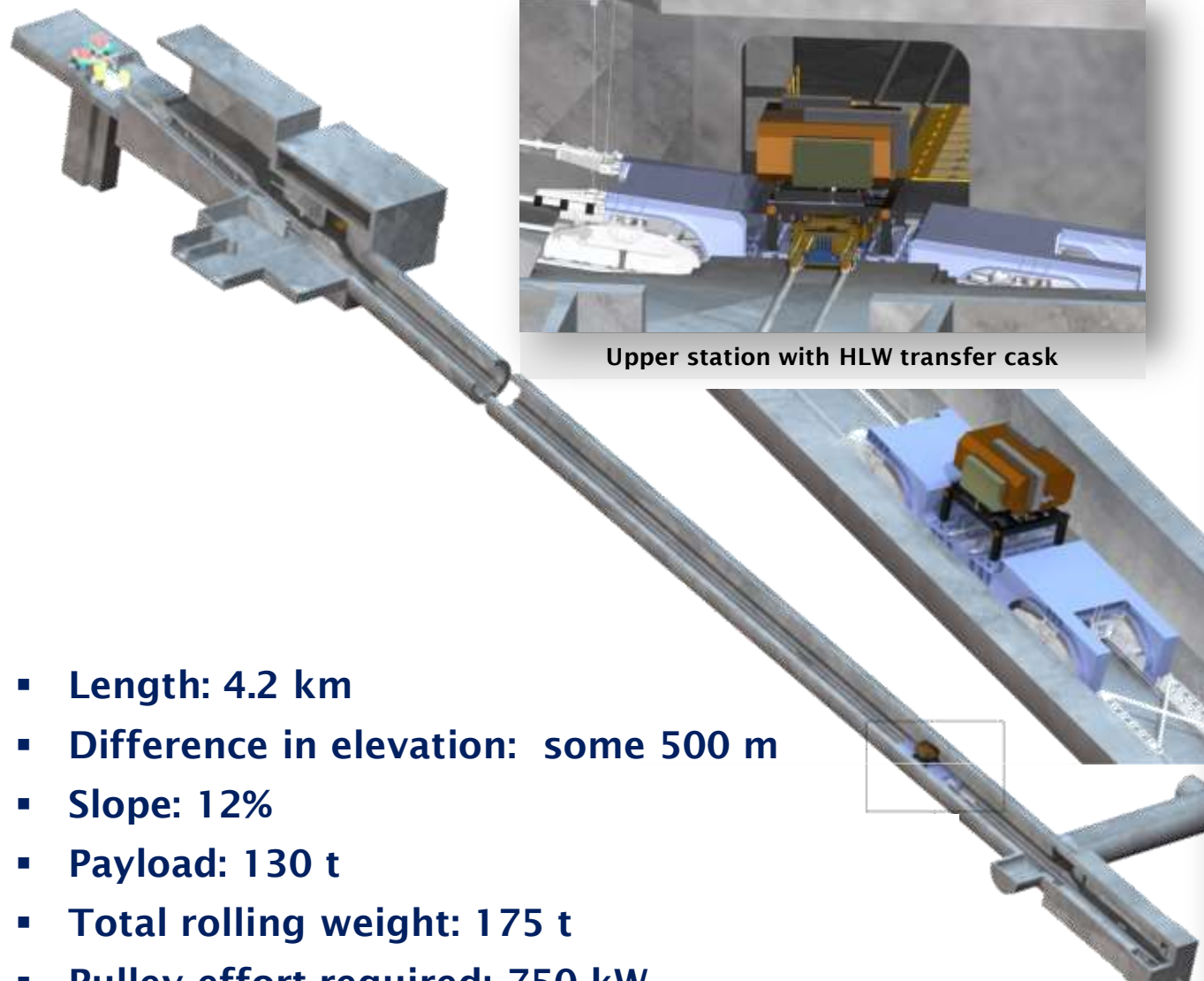
View of the repository after 100 years operation



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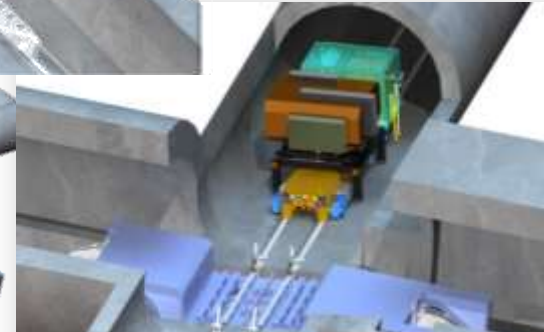
A Funicular Transportation System Developed for Waste Package Transfer between Surface & Underground



Upper station with HLW transfer cask



Ramp Funicular

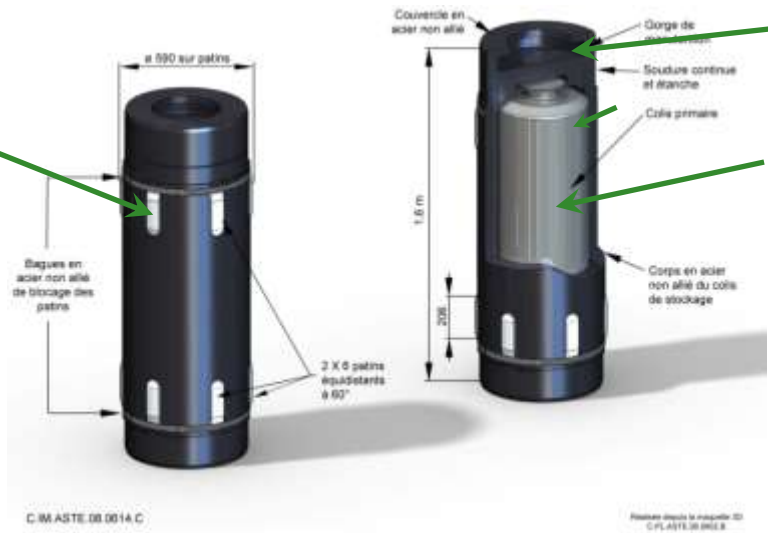


Lower station with HLW transfer cask

- Length: 4.2 km
- Difference in elevation: some 500 m
- Slope: 12%
- Payload: 130 t
- Total rolling weight: 175 t
- Pulley effort required: 750 kW

HLW will be placed in ~65mm steel overpacks to prevent glass leaching during the thermal phase:

Ceramic skids for easy handling



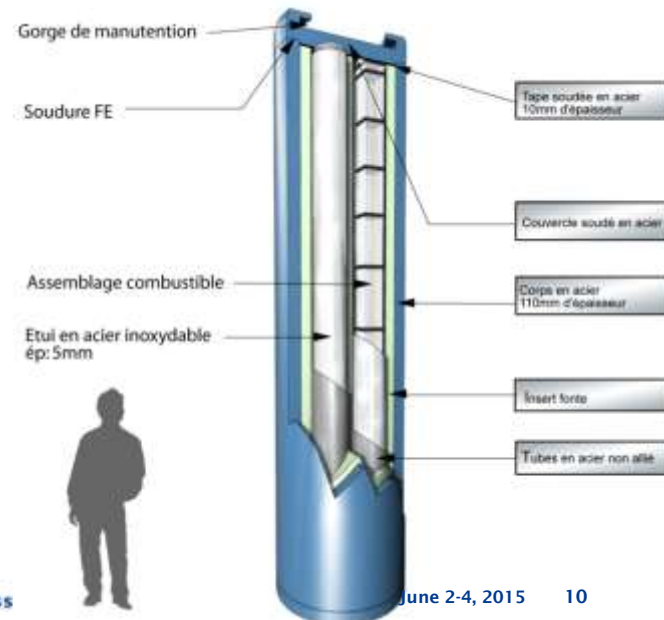
Gripping Interface

Vitrified HLW Stainless Canister



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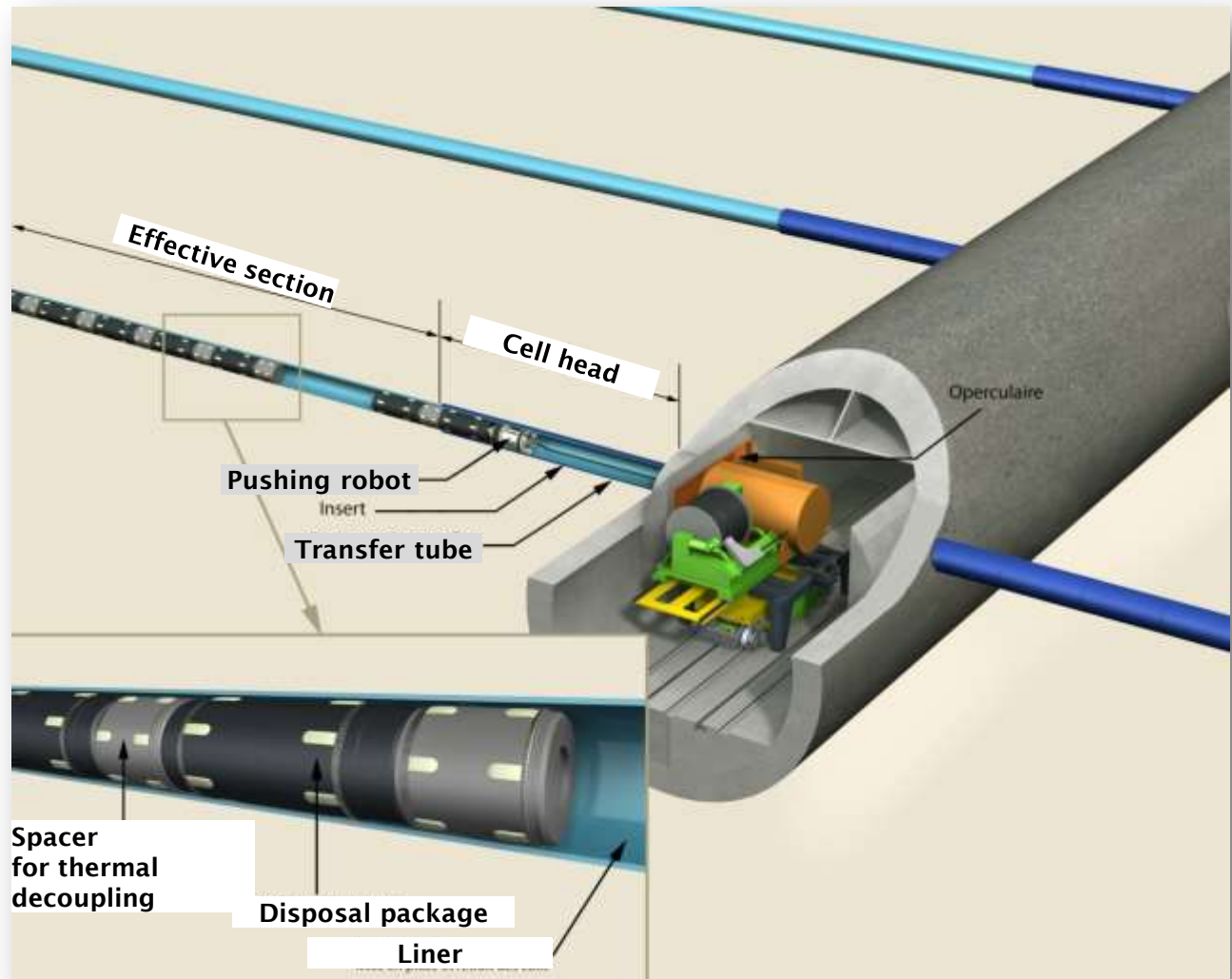
Représentation simplifiée de l'élément de combustible



To explore the direct disposal option, steel containers have also been studied and prototyped for Spent Fuel

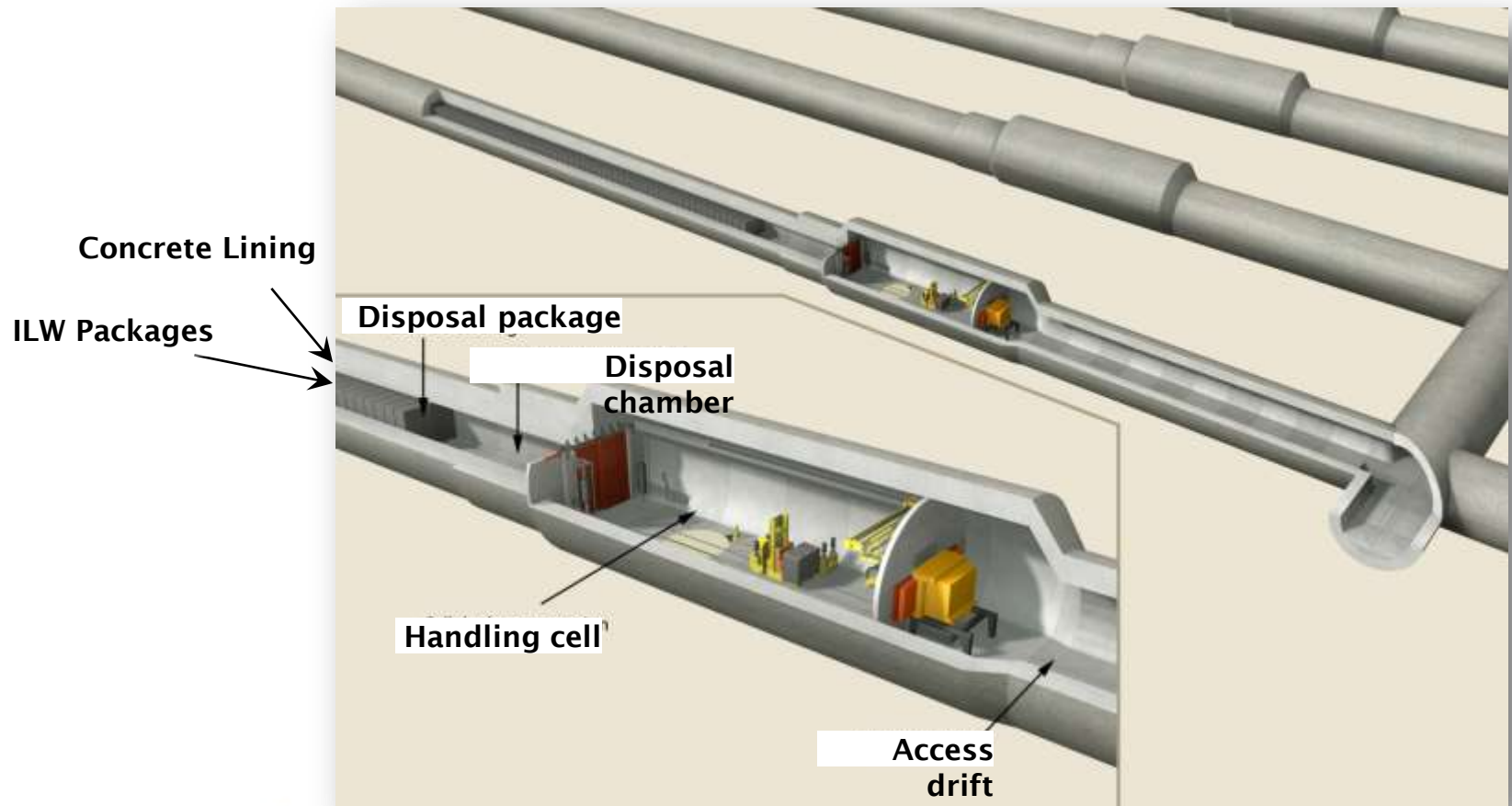
HLW will be disposed of in lined horizontal micro-tunnels:

- » Heat conduction in clay
 - max. temp in clay rock: 90 °C
 - Limitation of large scale THM effects
- » Steel liner
- » Cell length to be optimized with regard to technological limits and cost
- » Cell pattern heavily dependent on THM



ILW disposal vaults are horizontal tunnels located at the median of the host clay layer:

- » Thick concrete lining to limit long term deformations;
- » Ventilation of ILW repository vaults as long as they are not closed.



2011: the results of 20 years of R&D made it possible to issue detailed project technical requirements:

- Post-closure Safety,
- Nuclear safety and security in operation
- Waste emplacement and retrievability
- Control, monitor, surveillance
- Sustainable development, corporate and social responsibility
- Project governance

2012-2013: design contract executed with several engineering companies :

- overall system;
- conventional surface facilities;
- nuclear surface facilities;
- nuclear process underground;
- underground facility
- *waste storage containers are Andra designed*
- *External amenities (power grid, gas pipe, water ducts, road, railway) are sub-contracted to “classical” utilities*

2013-2017: industrial preliminary and detailed design

Excavation Techniques, Rock Support

TBM Test in the URL



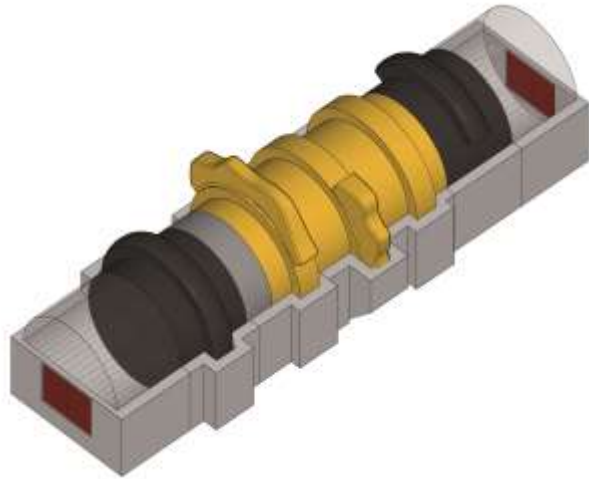
HLW Microtunnel Construction Test in the URL



Drift Rock Support Tests in the URL



Sealing Technology and Demonstration



**Full Scale Test
DOPAS* European
Project**
*(Demonstration of
plugs and seals)*



Waste Package Handling

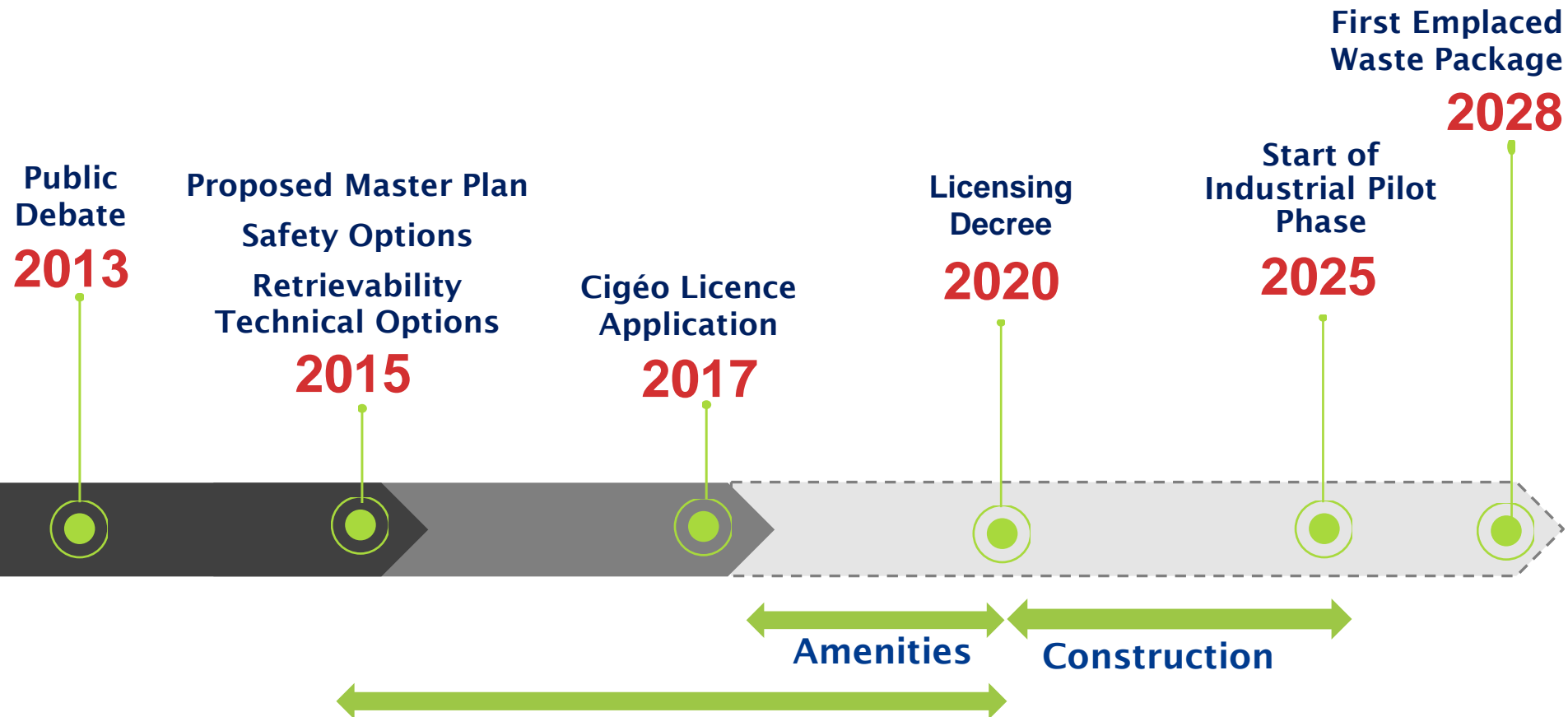
WP
Emplacement
and Retrieval
Tests

← ILW

HLW →



- ❑ A higher progressivity with an **industrial pilot phase**.
- ❑ A higher **involvement of Societal stakeholders** in the project
- ❑ A long term visibility based on a periodically revised **master plan for Cigéo operation**.
- ❑ An **updated Time Schedule**
- ❑ Preference for **waste transportation by rail**



Reviews by:

- Evaluators (ASN, CNE),
- Parliament (OPECST)

With its entry into the industrial phase, Cigéo has switched to full gear, but:

- some technical and scientific issues remain partially unanswered;
- some input data deserve clarifications to help the design contractors.

Large scale or full scale experiments are the only way to satisfy the above needs and to convince the evaluators - E.G. :

- cf. François Chauvet's presentation in Session 3 - "Excavation of Tunnel & Drifts"- about the learnings from the Bure URL and their transposition the Cigéo Underground Works,
- Cf. Frédéric Bumbilier's presentation in Session 2 - "Full Scale tests" - about the HLW Cell Full Scale Demonstration Test at Bure (LUCOEX WP3),
- Cf. Régis Foin's presentation in Session 2 - "Full Scale tests" - about the Feasibility of the Cigéo Seals in link with the FSS test (DOPAS WP3).