Focus on the French Geological Disposal
The Cigéo Project

Pierre-Marie ABADIE
ANDRA - CEO

Atoms for the Future 27 June 2016, Paris
Andra is responsible for the Cigéo Project in France

- State owned, independent from the waste producers
- Responsible for the long-term management of all radioactive waste produced in France
- 650 employees
- Funded mainly by waste producers
  - on a commercial basis for industrial activities
  - through a tax for RD&D on geological disposal

Andra's activities are conducted under the aegis of the 2006 Waste Act

- 3 main activities
  - R&D for new projects as well as for already operated facilities
  - Operation of existing disposal facilities
  - Design, study and construction of new disposal facilities
A bit of history .... and future

2013
Public consultation on the Cigéo project, organized by the National Public Consultation Committee.

2012
Presentation of an overview of the repository, named Cigéo. Creation of an interdepartmental host territory development plan by the State.

2011
Publication of a Decree authorizing Andra to pursue its activities in the underground laboratory until 2030.

2009
Proposal made by Andra, and approved by the Government, of a 30 km² (984 km² zone) "special detailed survey zone" to carry out investigations concerning the creation of the underground disposal facility.

2007
Approval of a Decree by the Government, authorizing Andra to conduct research in the underground laboratory to refine the repository design.

2006
Parliamentary debates and passing of Parliament Law No. 2006-729 of June 24, 2006 which endorses reversible deep disposal as the reference option for the long-term management of HL and ILW-L waste.

2005
Submission of dossier 2005 to the Government, a report by which Andra confirmed the feasibility and the safety of a deep disposal within a 250 km² area around the underground laboratory, assessment and approval of the report by the CNE, the ASN, the DPE/EST and an international group of experts.

1998
Construction of the Meuse/Meuse Maas site is selected by the Government to host an underground laboratory.

1994
Geological surveys on 4 sites approved by the Government for the construction of underground laboratories in order to study the feasibility of deep disposal.

1991
Passing of Law No.91-1381 of December 30, 1991 concerning research on the management of radioactive waste, known as the "Bataille" law.

For more information:
DINT/16-00112
Atoms for the Future 27 June 2016, Paris

This document is the sole property of Andra. It cannot be reproduced or communicated without its prior permission.
At first, a Research Underground Laboratory
Already 1,6 km of experimental drifts
Scientific and technology experiments

Underground laboratory  R&D programmes and operations

Characterization  Drift-opening test  HLW-cell excavation test
Then a political decision

- Results of the 15 year research period submitted to assessment and international review

- A new act passed by the Parliament: 2006 Planning Act
  - Decision in principle to manage HL and IL-LL radioactive waste by disposing them of in a geological formation
  - The geological formation had to be previously investigated from an underground laboratory
  - Description of a process to reach a target date for commissioning in 2025
  - Requirement for reversibility
A progressive and converging approach

1- Siting started in 1992 with a National call for volunteering; URL licensed 1998

2- Transposition zone of URL results (proposed 2005)

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

4- Location of repository surface facilities to be presented during the Public Debate

Detailed survey in 2010

Additional above-ground geological survey 2007-2008
And an industrial process

◆ 2011: launch of the first industrial organization

◆ 2014: start of the basic design phase
  - Based on the basic design, several documents were produced and some were submitted to the Nuclear Safety Authority early 2016
    - Safety options file in operation and post-closure
    - Master plan for operating Cigéo
    - Technical options of retrievability
    - Territory document

◆ 2016: launch of the detailed design phase
High-level waste (HLW) and intermediate-level long-lived waste (IL-LLW)

1- Waste issued from the processing of spent fuel

- Vitrified fission products and minor actinides (HL)
- Hulls and end pieces (IL-LL)

2- Waste produced by nuclear operations and other facilities (IL-LL)

High level waste (HL) and intermediate-level long life waste (IL-LL) represent:

- 3% of the volume, but 99% of the radioactivity
- Lifetime > 100,000 years
- Origin: Nuclear Industry, Research, Defense
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

Steel containers have also been studied and prototyped for Spent Fuel
Inventory of Primary containers and of Disposal packages

- Prediction made on the basis of the « National Inventory »: recycling of all the SF generated by the NPPs over their life cycle (50 years of operation for 58+1 reactors);

- PIGD = Document elaborated by Andra & Waste producers (concerning the IL-LLW & HL-LLW inventory) and serving as a design basis for the dimensioning of CIGEO;

- Figures below are ( marged ) input data specified for detailed Engineering Studies:

<table>
<thead>
<tr>
<th>Waste types</th>
<th>Inventory of primary containers</th>
<th>Inventory of disposal packages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Volume (m³)</td>
</tr>
<tr>
<td>HL W</td>
<td>56 033</td>
<td>10 072</td>
</tr>
<tr>
<td>IL-LL W</td>
<td>175 981</td>
<td>73 609</td>
</tr>
</tbody>
</table>
Cigéo facilities

2 surface facilities:
- **Nuclear**: Receiving, inspecting, and preparing packages
- **Non Nuclear**: Shafts for construction work

Underground facility in clay (500m depth)
Surface installations

**Digging area (240 Ha)**
(non nuclear)

**Reception Area (200 Ha)**
(nuclear)
Automated handling devices

- **Length**: 4.2 km
- **Difference in elevation**: more than 500 m
- **Slope**: 12%
- **Payload**: 130 t
- **Total rolling weight**: 175 t
- **Pulley effort required**: 750 kW
Zoom on IL-LLW disposal galeries

- Length: ≈400 m
- Excavated diameter: 9 m
- 2x2 or 3x3 packages
- No. of containers: 800-1,900
Zoom on HLW disposal cells

- Length: 100 m
- Diameter: 70 cm
- No. of containers: 7-20
The development of the project is very progressive, as will be its construction.
This progressivity implies the concept of reversibility

- Take a decision which commits the society for 120 years (4 generations!) is not reasonable
- It is therefore necessary to make the decision progressive in order to make it possible

The concept of reversibility is moving towards a Governance approach

- Master plan of operations
  - Moving from a static vision of the project to an alive one
  - Defining major milestones and decisions to be taken during the lifetime of the repository

Technologies provide tools for reversibility

- Monitoring
- Retrievability
Reversible disposal may be defined as a progressive process, where freedom of choice is left at each step.

So that:
- The process may be *controlled*
- *Alternative waste management options* may be chosen if relevant
- In case of undesired repository evolution, *corrective actions* may be implemented
- If waste becomes a *resource*, it may be retrieved.
Updated vision on “reversibility”

- Allows a gradual and controlled implementation of the repository
- Provides the possibility to retrieve already disposed of radioactive waste packages
- It also offers opportunities for
  - Controlling: monitoring
  - Adaptability, including optimization
  - Flexibility (options for SF direct disposal)
  - Testing at scale 1 (industrial pilot phase)
  - Implying next generations in the decision process, letting them a burden with already available solutions, but also with the freedom of developing their own solutions
  - Making funds available
- In such a context it becomes possible
  - To allow a learning phase
  - To give way to technical progress
  - To enable the next generation to redirect choices made before or to go back: every generation decides for itself, leaving open the option for the following
Retrievability is a tool for reversibility

- Retrievability can’t be demonstrated indefinitely

- Retrievability can only be a tool for reversibility, not an objective and an end by itself

- **COST** linked to retrievability

  - Retrievability does not imply high costs if it is considered at the design phase and thus be intrinsic to the disposal design
  - Taking account of retrievability from the early design stages is estimated to be at the level of a few % of the total cost (2 to 10)
  - The cost for retrieving will have to be supported by the generation making the decision for; it does not need to be provisioned by the present generation
Next steps

**Engineering**

- Detailed design
- Preparation of the field works, networks and investigations prior to construction

**Licensing and Governance**

- Application for the license, including all the technical and safety demonstrations
- Develop the integration in the territory
Updated Provisional Time-schedule

Public Debate 2013

Proposed Master Plan
Safety Options
Retrievability Technical Options

2016

Application 2018
Licence 2021

Start of Industrial Pilot Phase 2025

First Waste Package Emplacement 2030

Detailed design

Reviews

Amenities

Construction

Atoms for the Future 27 June 2016, Paris