The Waste Act of 1991 on the management of nuclear wastes in France

Impact and Perspectives

Bernard Frois

The French Legal Framework

- A political answer to public concerns
- A specific legal framework for the management of high level and long-lived medium level waste.
- Research on HLLLW is conducted in France under the terms of the 1991 Waste Act “Loi BATAILLE”
- The law provides a framework for a social, political and scientific debate.
- The goal of the law is to be able to decide in 2006

Three major research areas have been carried out

- 1. Separation and transmutation of long lived radioactive elements
- 2. Experimental study of deep geological underground.

  The law requests the construction of underground laboratories
- 3. Conditioning and long term storage

budget > 2000 M€

Clearly Defined Responsibilities

- CEA is responsible for partition/transmutation and long term storage research
- ANDRA is in charge of long-term waste management and responsible for deep geological storage research
- The Ministry of Research coordinates the strategy and research programs
- The National Evaluation Commission (NEC) has continuously assessed the results obtained by the different actors and presented its annual reports to the Parliament

30 June 2005

Official Presentation

by ANDRA and CEA

of their reports

1991 - 1995

Government Public Dialogue

- Local consultation before any site decision of an Underground Research Lab (URL)
- Well defined legal frame to authorise an URL
- Local Commissions provide exchanges of information at the local level between Government and Stakeholders
- Long process of Public Enquiry required before implementing any nuclear facility

Assessing Progress

- Annual review of the Ministry of Research with the participation of the Ministries of Industry and Environment, Cea, Andra, Dgsnr, Irsn, Cnrs, Cogema, EDF, Framatome,.
- Annual report of the National Evaluation Commission
- Safety analysis assessment by the Nuclear Safety Authority
- Peer review by OECD-NEA

Results: Partitioning and Transmutation

- Success of enhanced partitioning in Atalante: from 95% to 99% according to actinides species
- Studies of possible transmutation scenarios have defined the possible gains as a function of the type of fuel cycle. PHENIX transmutation research program in progress
- International studies completed: OECD-NEA, 5th and 6th EU Euratom programs

The European network ACTINET
Physics and Chemistry of Actinides

A network of excellence preparing the future in the European dimension

- CHALMERS
- CIEMAT
- CNRS
- CTU-Prague
- FZJulich
- FZRossendorf
- JOGU Mainz
- KTH
- Copenhagen Univ.
- NRI-Rez

CEA/Marcoule
Atalante Hot Lab

- PAS-Wroclaw
- PSI
- Stockholm Univ
- RUCA-Antwerpen
- Cambridge Univ.
- UCY-Cyprus
- Helsinki Univ.
- Liège Univ.
- Manchester Univ.
- UPC-Barcelona

Interim storage : why?

Significant advantage in terms of management. It gives flexibility to industry and important decisions.

Well established industry knowledge.

The finite duration of interim storage prevents us from considering this solution on the same footing as deep geological disposal.

It is not an alternative to deep geological disposal.

Containers and Storage

No longer a pure research problem

The results of R&D have shown that present concepts can be improved as much as needed

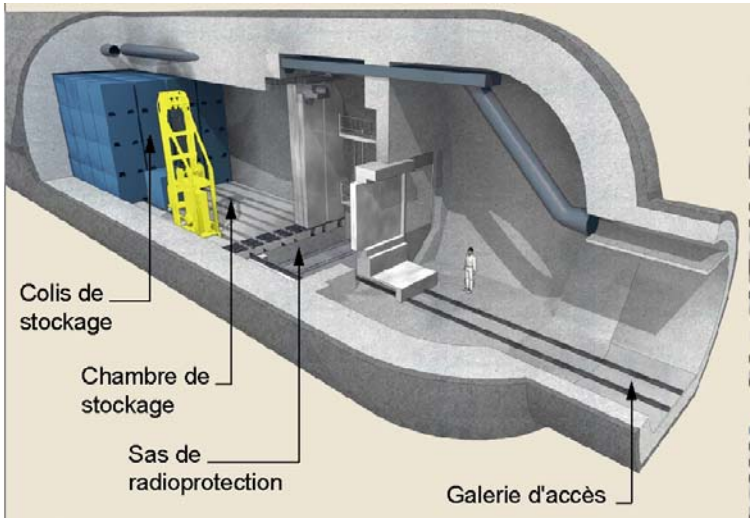
Research efforts will continue and will be bring a strong support to industry

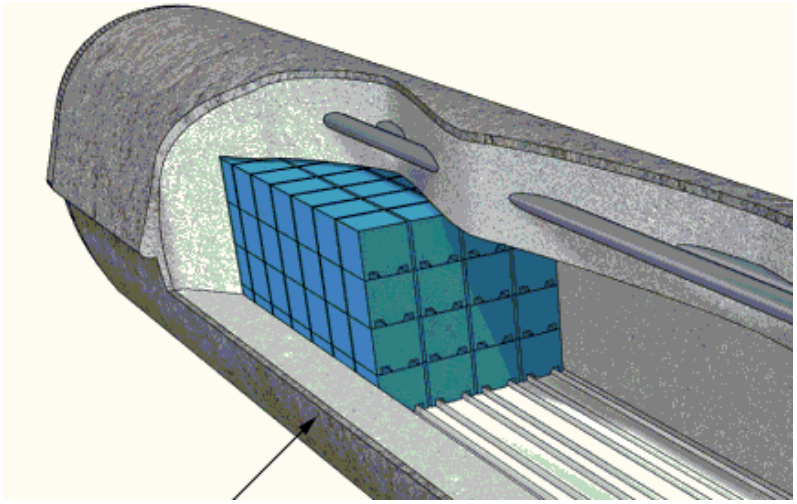
Containers

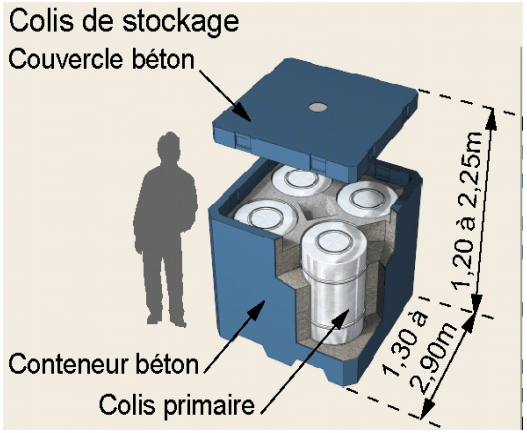
Andra, Cea and Industry have collaborated in the R&D on concepts and demonstrations for the successive phases of nuclear wastes management

CSD C

Disposal concepts for IL-LLW







- Choice of simple and robust architectures which enables to establish feasibility more easily
- Engineering studies in the frame of international consortia
- Reversibility has been taken into account

Long term storage of spent fuel

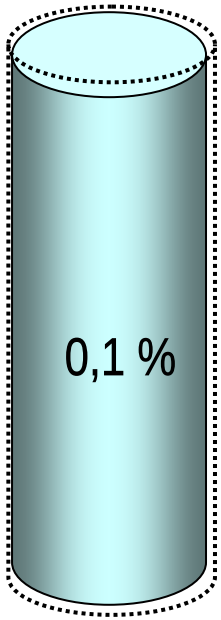
Démonstration of container for storage

Collaboration Andra, Cea, Edf

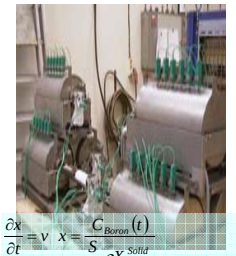
Long term durability of vitrified waste, alteration by water

Vitrified waste

After 10 000 years ?



Understanding of the phenomena



Construction of mathematical Models and forecasts

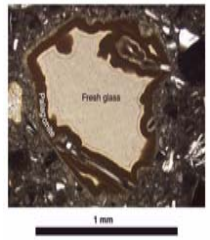
$$\frac{\partial x}{\partial t} = v \quad x = \frac{C_{Boron}(t)}{\frac{S}{V}\rho X_{Boron}^{Solid}}$$

$$\frac{\partial C_{Si}(t)}{\partial t} = v C_{slb}\frac{S}{V} + F\left(C_0 - C_{Si}(t)\right)$$

$$C_{slb} = C_{Silica}^{Glass}\left(1 - f\left(C_{Si}(t)\right)\right)$$

$$v = v_0\left(\frac{1-\frac{C_{Si}(t)}{C^*}}{1+v_0\frac{C_{slb}x}{D_g C^*}}\right)$$

Validation of calculations (natural analogues, expert opinions,...)

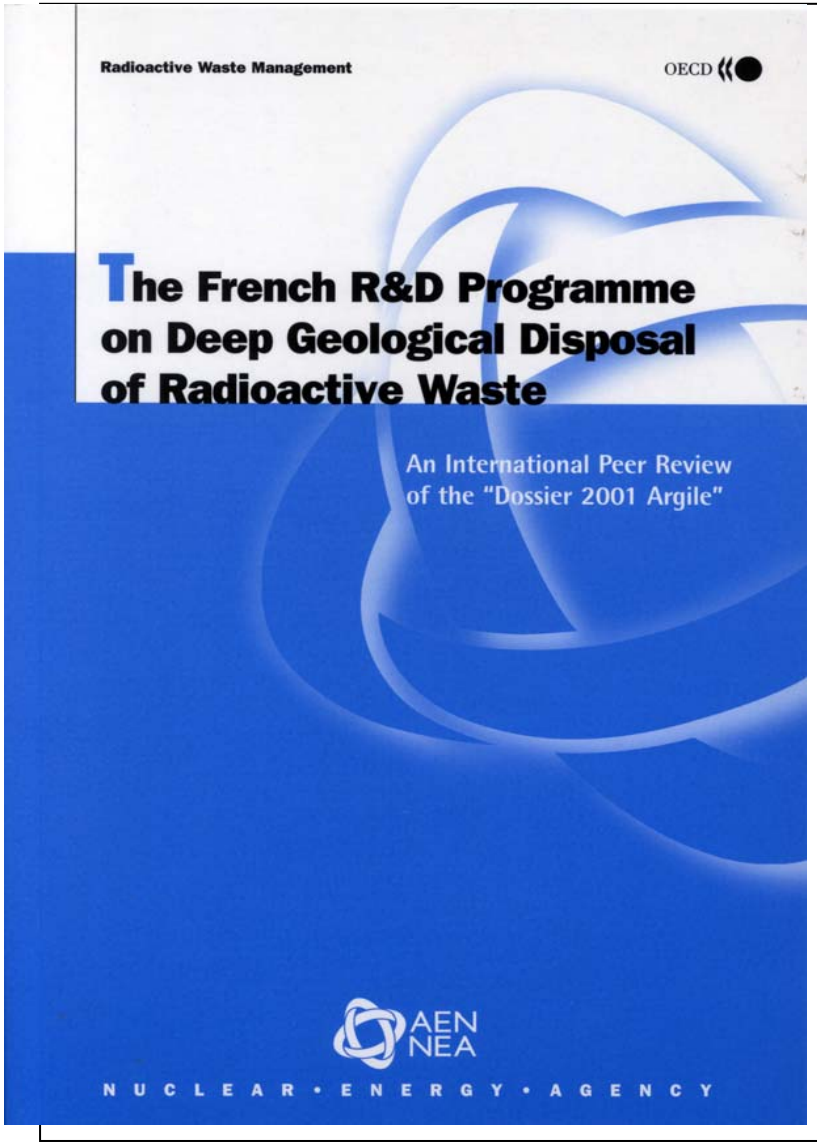


Fundamental research

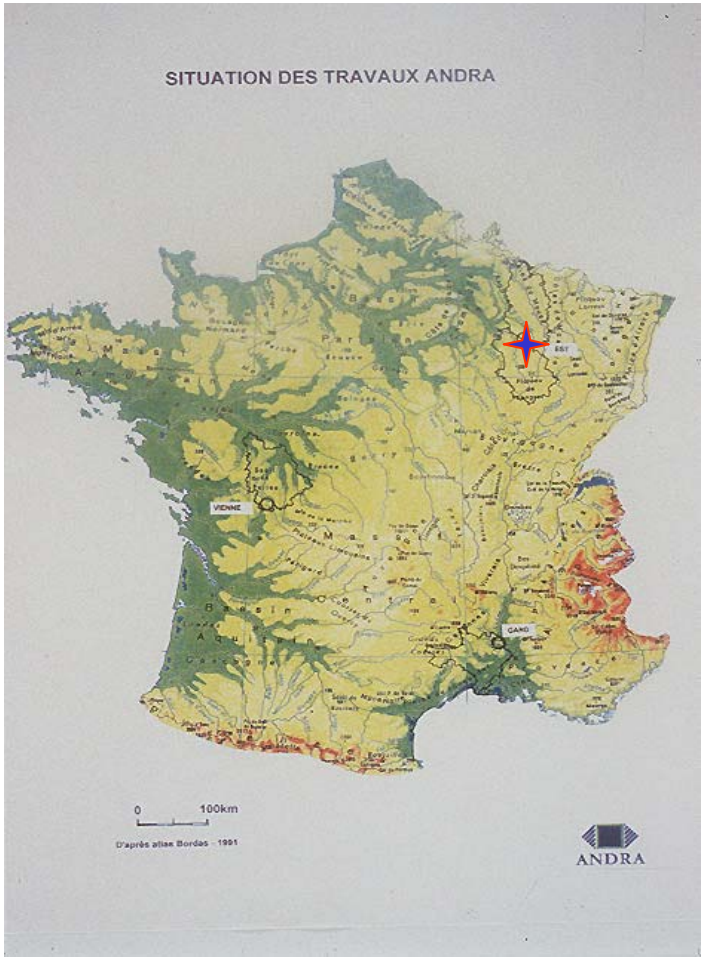
R&D on Geological Disposal

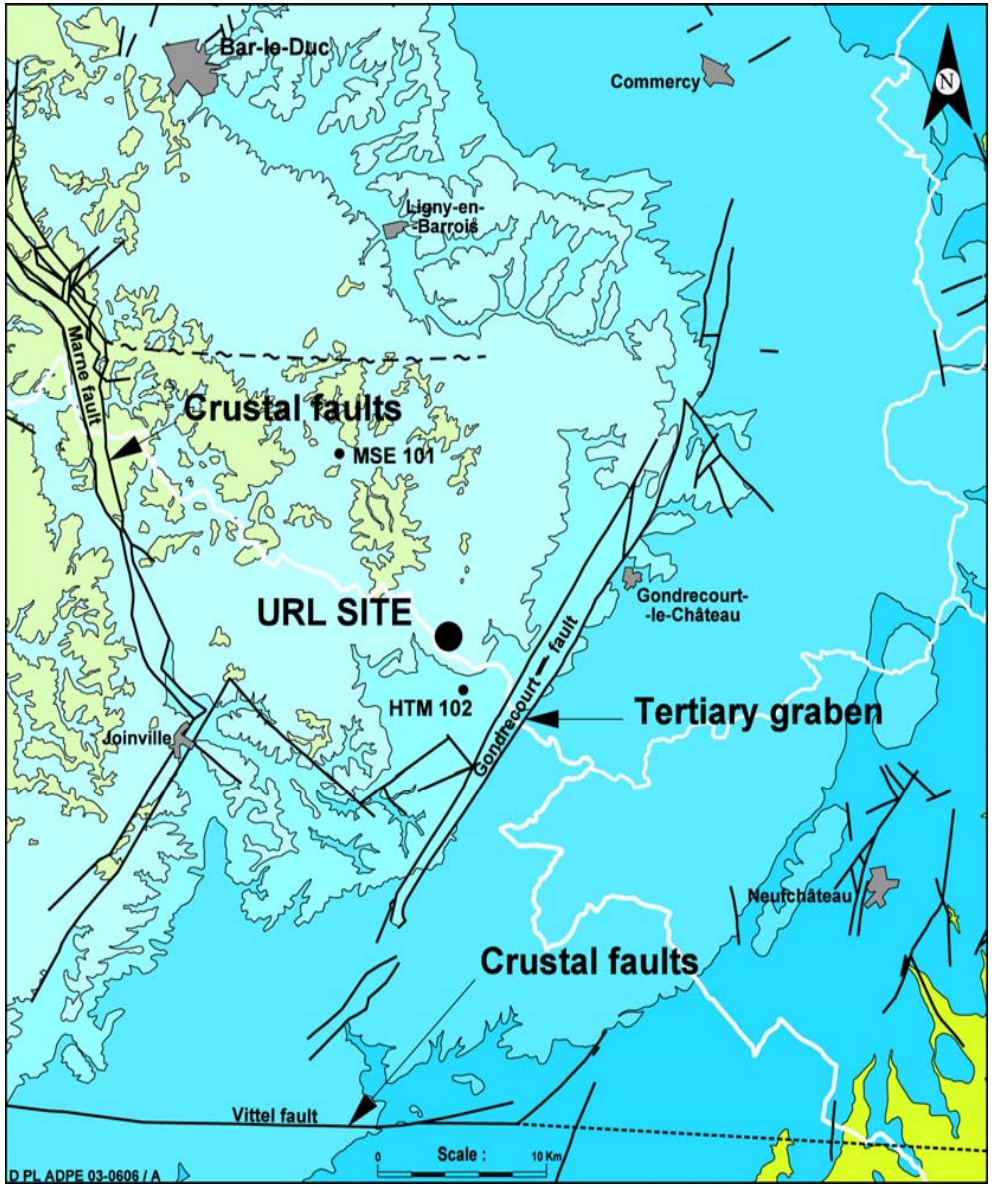
The strategy of Andra has led to an efficient research program in spite of unfortunate delays.

Experiments in collaboration with foreign laboratories bring important results.



Bure's Underground research Lab





Research tools, means and assessment

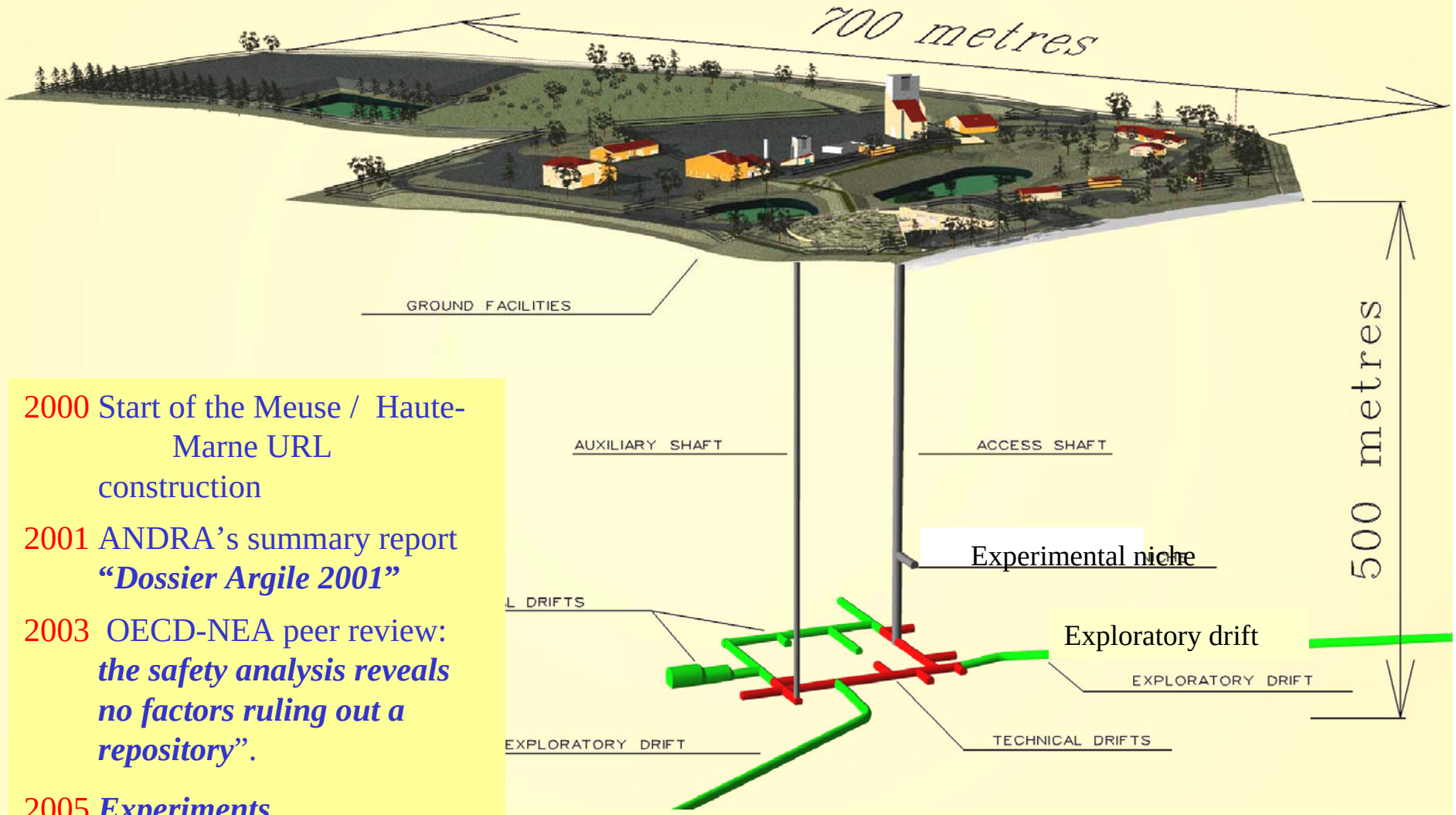
Underground methodological laboratories

Investigations and analyses
- Characterisation
- Modelling
- Engineering

On-site activities
- Surface survey
- Borehole drilling
- Underground installations

- Close to 100 associated laboratories
- 7 laboratory groups
- Partnerships with large R & D organisations

Bure sur Marne
Underground Laboratory



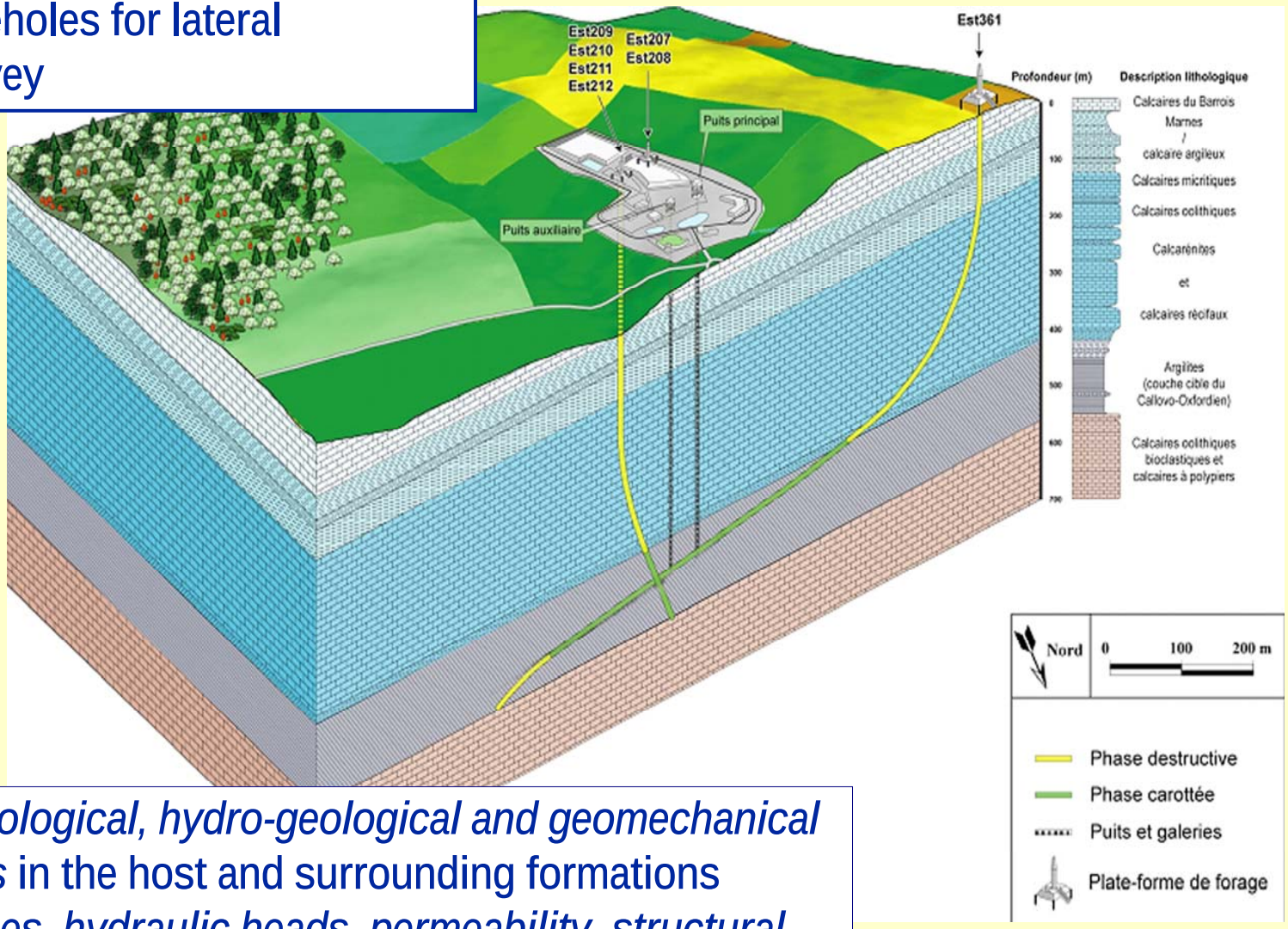
2000 Start of the Meuse / Haute-Marne URL construction

2001 ANDRA's summary report ***"Dossier Argile 2001"***

2003 OECD-NEA peer review: ***the safety analysis reveals no factors ruling out a repository***".

2005 ***Experiments***

Adaptation of oil exploration technology to shallow boreholes for lateral geological survey



Program of *geological, hydro-geological and geomechanical measurements* in the host and surrounding formations (*natural stresses, hydraulic heads, permeability, structural survey)*

Geological investigations conducted on clay over the last decade

- **27 deep boreholes** drilled since 1994 (site and sector)
- 5 km drilled including **coring on 4.2 km – 2.3 km of argillite cores**
- More than **30,000 samples** collected (incl. 7,300 fluid samples); **5,300 rock samples analysed**
- **First sensor installed in the host formation in 1996**
- Experimental Programme at **Mont Terri** (1996-2004)
- **Direct observation** of the host formation since **March 2004**
- **40 m of drifts** available and fitted since November 2004

→ A complete geological model
→ A good understanding of the clay history

National (and International) Consensus Solutions do exist…

- The safest range of possible solutions are based on multi barrier confinement together with deep geological underground storage
- Long term storage in safe conditions is feasible but needs continuous surveillance and maintenance.

Considerable Activity to Prepare 2006

- Synthesis of the results obtained by 15 years of technological research in France and abroad (Ministry of Research)
- The Parliament has auditioned all the actors in 2004-2005
- Multi-criterion analysis (Ministry of Industry)
- a National Plan for the management of nuclear wastes has been prepared by the National Safety Authority

The success of the R&D program on actinides separation opens a new door on future

- The target shared by a growing number of countries becomes now the sustainable development of nuclear power using a closed fuel cycle
- The models developped in collaboration by CEA-EDF would allow to stabilize Plutonium and minor Actinides with a new generation of fast reactors

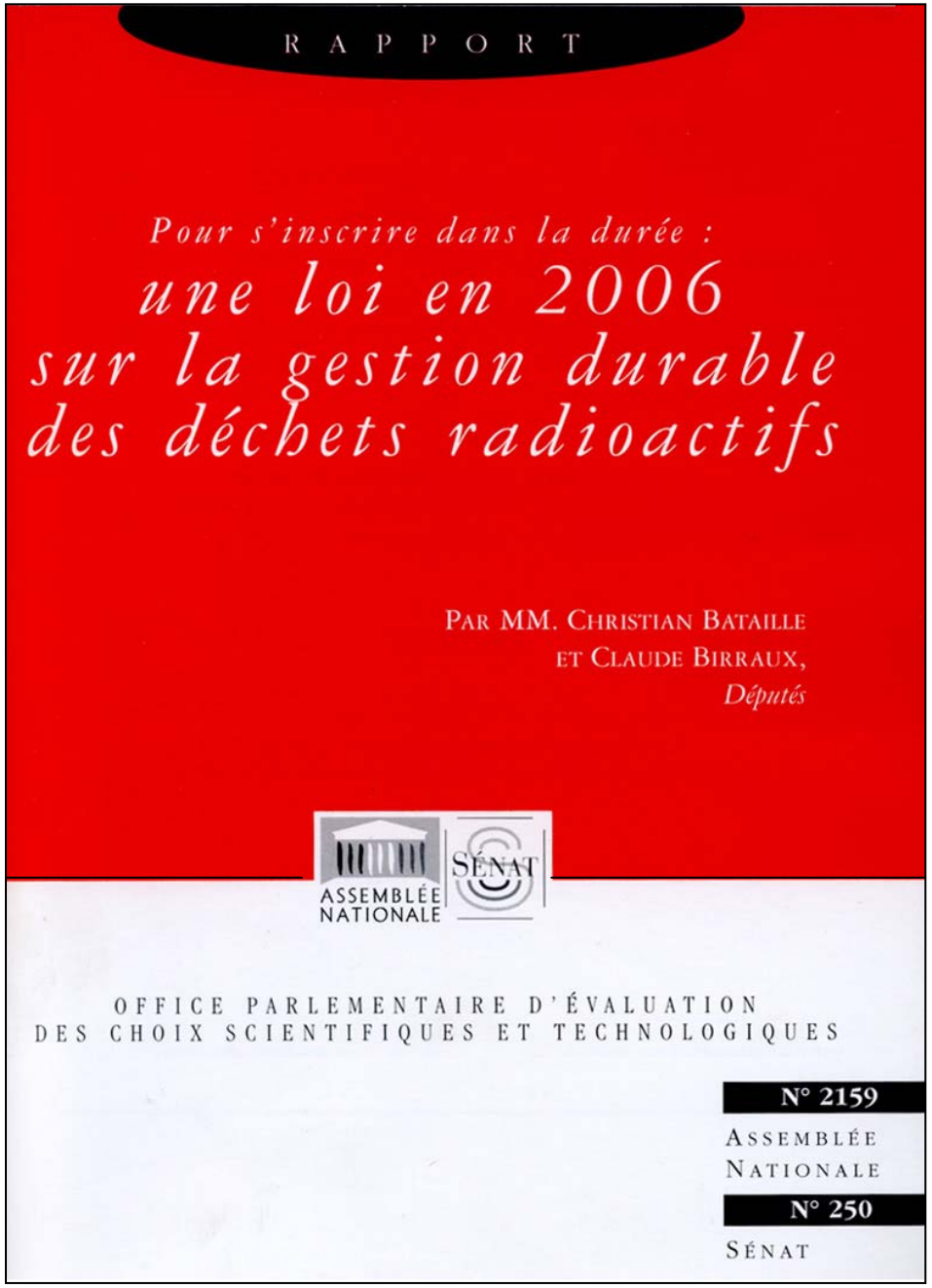
2005

Three meetings have been organized by the:

French Parliamentary Office of Science and Technology.

Their report and their proposal for a new law has been published this year.

The public debate has just begun

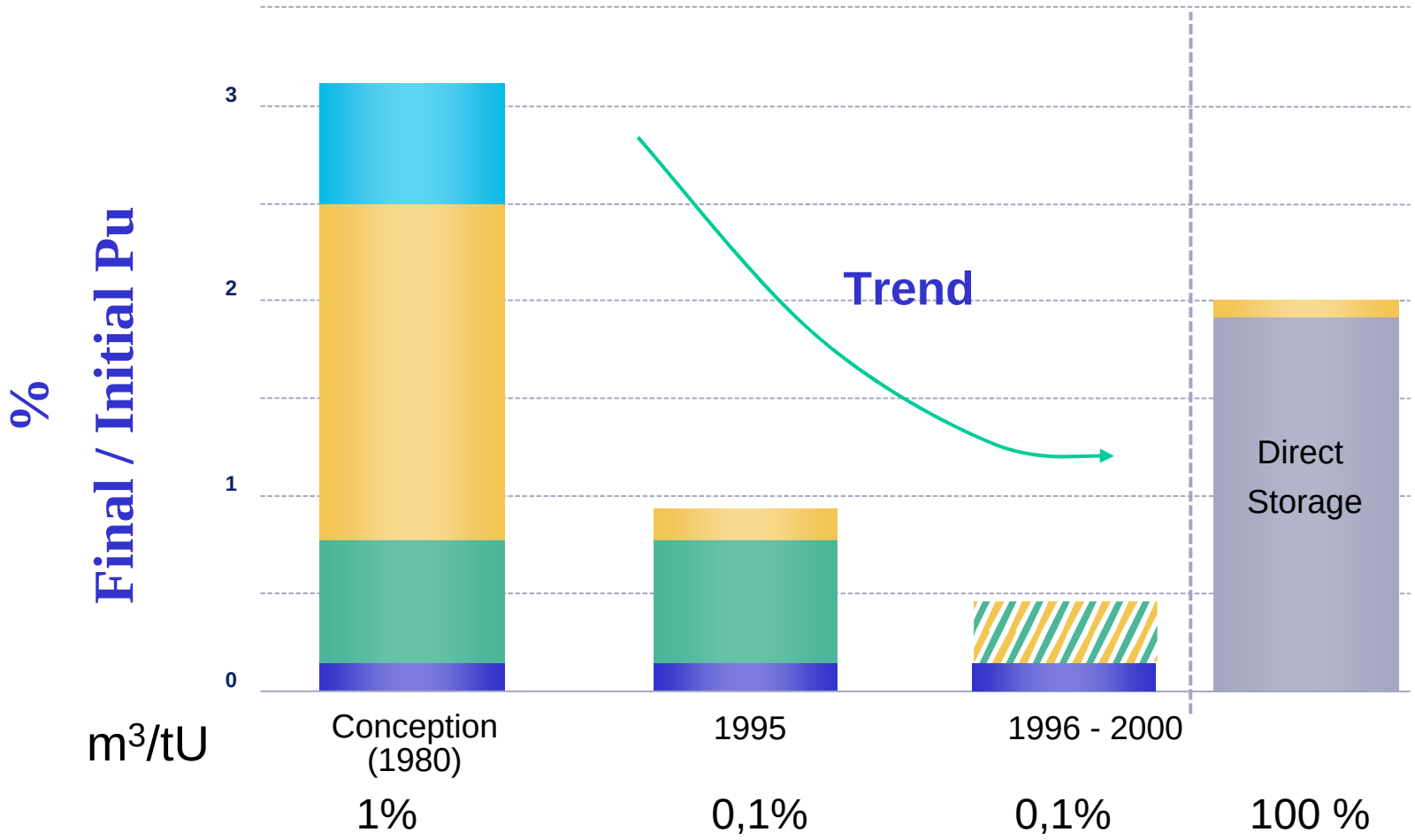


PUBLIC DEBATE

2005 - 2006

cndp
Commission particulière
du débat public
Gestion des Déchets Radioactifs

Volume of final wastes after conditioning at La Hague is considerably reduced



CONCLUSIONS

Considerable advances in R&D

Efficient coordination of research organizations and industry

A shared vision on problems and solutions

Important innovations implemented in Industry

An involvement of academic research

Research is a key element to reach robust decisions