Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

French Policy for the Management of the Fuel Cycle's Back-end

Hearing by the Blue Ribbon Commission on America's nuclear future

11/15/2010

Pierre-Franck CHEVET, General Director for Energy and Climate change at the Ministry of Energy of France

Present for the future

France aims at allowing a sustainable development of nuclear energy, in France and abroad

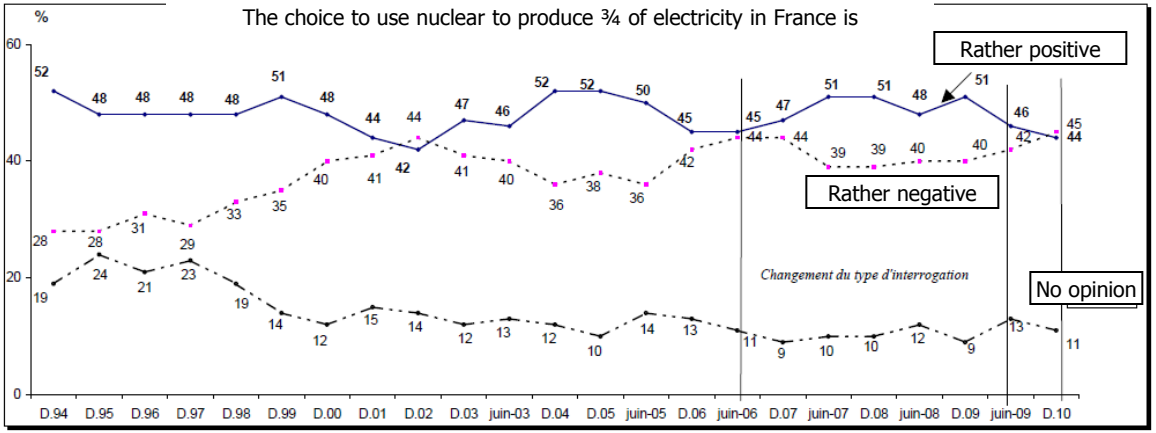
- Nuclear energy is part of the answer to 3 of the 4 main objectives of the French energy policy, as defined by the Act of July 13, 2005.
  - Energy independence, and security of supply.
  - Preservation of the environment, especially fighting against the greenhouse effect (CO_2 emissions).
  - Competitiveness of the energy.

- France is willing to help countries that wish to develop peaceful uses of nuclear energy, provided the highest standards of safety, non proliferation and environment protection are adhered to.
  - Any accident anywhere around the world concerning nuclear energy might have an impact on our national policy.
  - France promotes climate change mitigation.

Present for the future

The Need of a Comprehensive and Long-term Policy

- **Acceptance of nuclear energy relies at least on 5 pillars:** competitiveness, energy independence, climate change mitigation, safety/security/non-proliferation/sustainability, and management of radioactive materials and waste.
- **Public acceptance of nuclear energy is not vested**
  - Need continuous action. Eg: consultation through Local Information Commissions.



Source : CREDOC – SOeS, Enquêtes « Conditions de vie et Aspirations des Français ».

- **A policy taking into account the different timescales**
  - Extending the current fleet's lifetime.
  - Keep open the nuclear option beyond 2020: Decision to build 2 EPR in France; Active preparation of reactors' future (R&D on GEN IV, JHR, ASTRID…).
  - Active policy in SF & RW management.

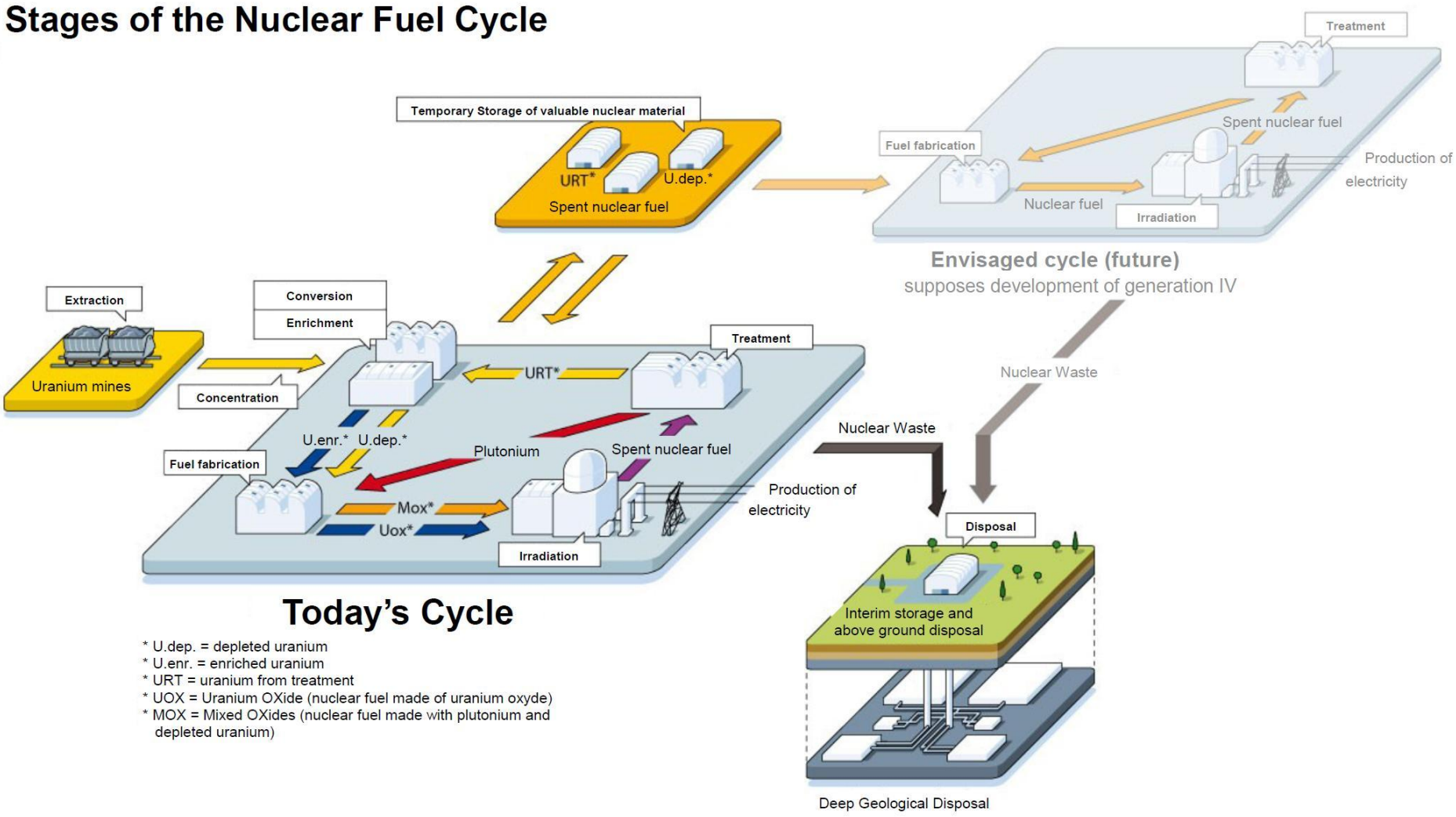
Present for the future

Nuclear - The Main Players in France

- **Defining the nuclear policy:**
  - The French President, Government and Parliament.
  - Within the Government, DGEC is the main department in charge.
- **Nuclear safety and radioprotection control:**
  - ASN (Nuclear Safety Authority).
  - IRSN (Institute for radiological protection and nuclear safety) as a Technical Support Organization.
- **Radioactive waste management :** ANDRA (National Radioactive Waste Management Agency).
- **Public Research and Development :** CEA (Atomic Energy and Alternative Energies Commission), ANDRA, IRSN, CNRS.
- **Companies with contractually-based relations:**
  - Utility : EDF.
  - Suppliers : AREVA, ALSTOM...

Present for the future

The French nuclear fuel cycle



General principles and organization in France for fuel back end management

- **A clear, solid legal and regulatory framework:**
  - Act of June 28, 2006 "For the Sustainable Management of Radioactive Material and Waste", with the aim not to leave the burden of radioactive material and waste on future generations.
- **A comprehensive policy based on 3 pillars:**

1) strategic vision: publication every 3 years of a National Plan for the Management of Radioactive Materials and Waste (PNGMDR)

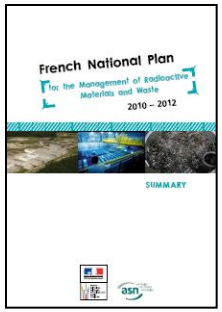
- Scope = radioactive waste + non-waste.
- Appraises existing management routes; identifies the foreseeable needs for storage or disposal installations ; determines the aims and R&D programs with due fall dates.
- A national plan on RW&SF is recommended in the EU, and may become mandatory.

	VERY SHORT LIVED (HALF-LIFE < 100 DAYS)	SHORT LIVED (HALF-LIFE < 31 YEARS)	LONG LIVED (HALF-LIFE > 31 YEARS)
VERY LOW LEVEL (VLL)	***Management by radioactive decay on the production site***	***Surface Disposal*** *(the Aube disposal centre for very low level waste)*	
LOW LEVEL (LL)	*elimination in the conventional management routes*	***Surface Disposal*** *(the Aube disposal centre for low or intermediate level waste)*	***Sub-Surface Disposal*** *(under study in compliance with the act of 28 June 2006)*
INTERMEDIATE LEVEL (IL)			
HIGH LEVEL (HL)		***Deep repository*** *(under study in compliance with the act of 28 June 2006)*	

Present for the future

General principles and organization in France for fuel back end management

- **A comprehensive policy based on 3 pillars:**

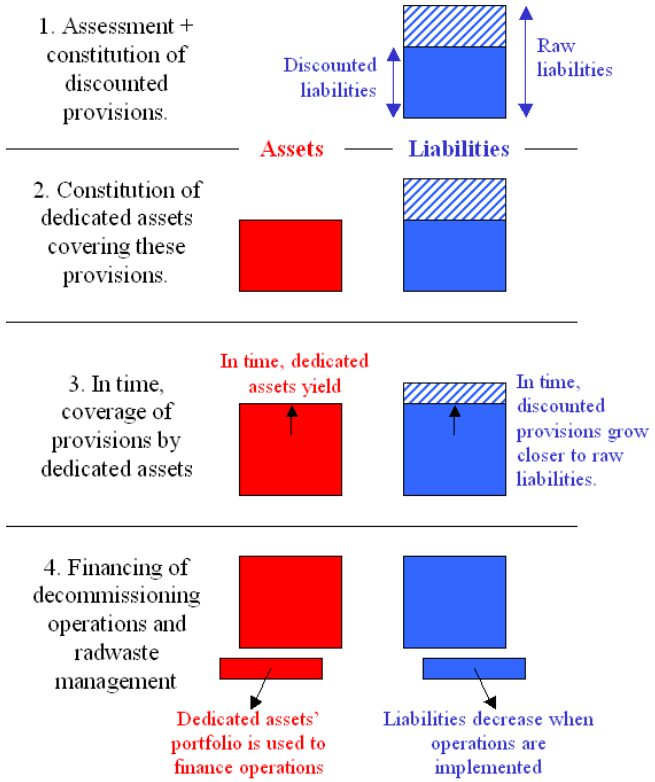


–2) Transparency and democracy requirements

- •Inventory of radioactive materials and waste in France + PNGMDR. High Committee for Transparency and Information on Nuclear Safety (HCTISN).
- •National Evaluation Commission, public reports on radwaste.
- •HLW disposal : specific procedures (public debate, future Act to be elaborated upon it).

–3) Mechanisms to secure financing (to be borne by waste generators)

- •Dedicated assets to cover liabilities for decommissioning and for RW management.
- •Financing of R&D on RW management (tax on nuclear facilities).



- **Andra: national centralized public body:**
  - responsible for operation of disposal centers, R&D, overall consistency of management routes, providing information to the public.
  - consistency, comprehensiveness, continuity of management.

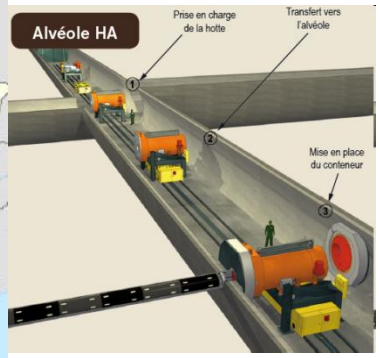
Present for the future

Industrial facts on the French fuel cycle

- **EDF: the world's leading nuclear operator, with 58 NPP in operation:**
  - 1,250 tons of spent fuel every year.
  - 22 reactors currently have the authorization to use MOX fuel.
  - 4 other reactors are currently authorized to use reenriched reprocessed uranium.
- **AREVA: reactor supplier; operator in the full fuel cycle; the leader in back end services.**
  - La Hague and Melox plant: more than 20 years of operation ; current capacity=1,700 t/year.
- **In terms of RW management:**
  - Disposals in operation by Andra for VLLW and LILW-SL.

Present for the future

France's achievements in radioactive waste management



- **Management routes currently under research:**
  - LLW-LL.
  - HLW & ILW-LL
    - underground laboratory in Bure
- **Achievements and prospects for geological repository for HLW & ILW-LL**
  - Callovo-Oxfordian argillite highly confining.
  - Approval of a zone for location of the underground HL waste disposal facility (15 km² from 30).
  - License application for the construction of the geological repository: expected at the end of 2014.
  - Conditions of reversibility, to be defined by law.
  - Operation expected to start in 2025.

Policy for the management of spent fuel

- **Why recycling ? Technical advantages:**
  - Recycling of nuclear materials: strategic in security of supply.
    - Better use of energy resources still in spent fuel.
    - Full recycling enables to save up to 25% of natural uranium consumption.
      - Half from the use of MOX fuel.
      - Half from the re-enrichment of reprocessed uranium.
    - Participate in security of supply, as part of diversification of supplies, which is particularly relevant for countries that are poor in energy resources.
      - In France, this provides now an economy of 17%.
      - Today, in France, equivalent of 11 reactors among 58 reactors fully independent from natural uranium.
        - » 22 can use MOX fuel (up to 1/3 of the assemblies).
        - » 4 can use re-enriched reprocessed uranium (all assemblies).
    - Relevant with a long term use of nuclear:
      - Provides a stock of recyclable uranium
      - Gen IV.

Present for the future

About Gen IV
Fast neutron reactors, the next step

- **Optimize the use of natural resources:**
  - To burn plutonium in a more efficient way (all isotopes can be fissioned).
  - Thus to achieve the best use of uranium natural resource (recovered energy from initial uranium around 100 times higher with fast neutron reactors).

- **Recycle in fast neutron reactors: the key for long-term sustainable nuclear systems.**
  - ASTRID prototype in France starting in the 2020s.

Present for the future

Policy for the management of spent fuel

- **Why recycling ? Technical advantages**
  - Significant advantage for the disposal of RW
    - Adequate conditioning for storage and disposal:
      - No IAEA safeguards. Easy to handle and transport. Easy storage / disposal over a long period. Flexible, modular.
    - Reduced volume & heat loading => facilitates the disposal:
      - Significant advantage regarding disposal cost (and associated uncertainties).
      - Reduced footprint for storage and disposal facilities (reduced need for volume/number of repositories).
    - Environmental advantage: high quality containment
      - Very high stability of the vitrified waste (an international reference). Limited part of the activity of SF is considered as labile, while no labile radionuclides in vitrified HLW.
      - Long-term radiotoxicity of the final waste drastically decreased. Low amount of secondary waste, very low impact of RN release.
      - =>**Key asset on the long term safety**, that should be fully taken into account in the assessment of the choice of recycling.

Vitrified HLW canister

Present for the future

  - Mature technology with decades of experience.
    - 25,000 MT processed at La Hague, 2,000 MT MOX fuels manufactured for recycling under international safeguards.

Policy for the management of spent fuel

Why recycling ? Significant advantage for the disposal

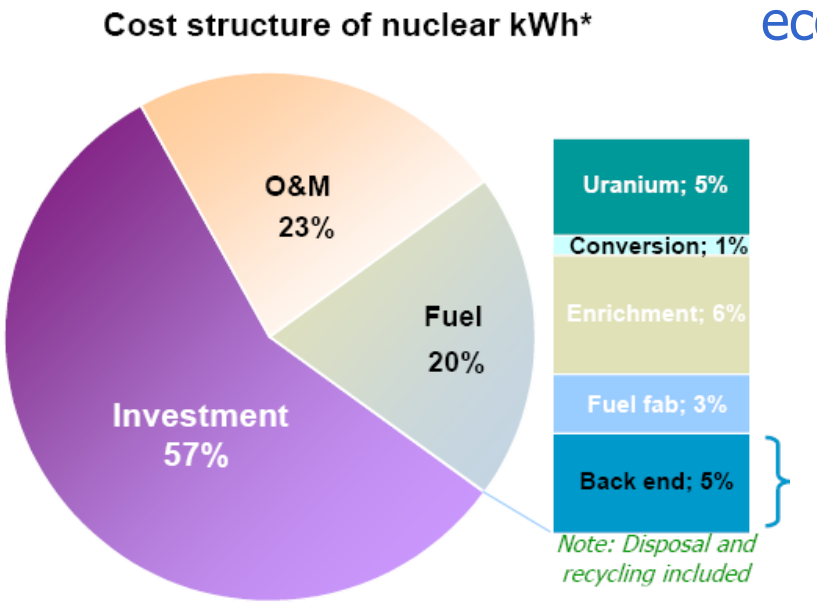
	Reprocessing of all spent fuel	Direct spent fuel disposal
Waste form	Vitrified waste: 6,330 m^3 Ends & hulls	UOX spent fuel: 20,000 m^3
Volume of waste containers ready for disposal	Vitrified waste: 14,550 m^3 (+Ends & hulls : 22,000 m^3)	Spent fuel :90,000 m^3
Total footprint	5.5km^2 for 45,000MTHM ~122 m^2/ton of reprocessed SF (UOX+MOX)	14km^2 for 45,000MTHM ~ 311 m^2/ton of SF (UOX)
Safety and retention capacity	Minor actinides Fission products	Minor actinides Fission products Uranium, Plutonium Labile radionuclides
Canisters	Smaller steel canisters (2 t) 1.4 t / MTHM	Large size steel canister (43 t) 21 t / MTHM
Other materials	Steel and concrete for construction Bentonite for plugs and seals	Steel and concrete for construction Bentonite for plugs and seals

Present for the future

Data related to the operation of the French nuclear fleet during its planned lifetime (for the reprocessing option, the waste evaluations are related to a scenario where all used fuels are reprocessed, including all used Mox fuels).

Policy for the management of spent fuel

- **Choice of recycling: economic features**



–This choice has a limited impact on economics: comparable cost.

- Fuel costs represent only ~20% of the total cost of generating electricity with nuclear energy.
- Back-End costs (either open or closed cycle) represent about 5% of the total cost of electricity generation.
  - Open and closed cycle economics are comparable.

*** Source: OECD/AEN 2002 "*Trends in the Nuclear Fuel Cycle: Economic, Environmental and Social Aspects*"**

– Nuclear energy is competitive, with or without recycling.

– And recycling reduces the exposure to uncertainties (disposal), which is the main issue of the back end.

Present for the future

Policy for the management of spent fuel

- **Recycling strengthens non-proliferation:**
  - Recycling facilities such as La Hague and Melox have a perfect track record with respect to fissile materials safeguards.
  - Plutonium recycled in MOX fuel:
    - Consumes roughly one third of the plutonium.
    - Significantly degrades the isotopic composition of the remaining plutonium and thus the potential attractiveness for non-peaceful usage.
    - Recycling driven by MOX needs, which minimizes the stock of separated plutonium
  - Recycling restricted to a few regional centers under international safeguards, whose services can reduce proliferation risks in the world:
    - Offering recycling services to a wide range of customers.
    - Avoiding the accumulation of used fuel in multiple storage sites worldwide.
    - Returning to customers final waste not subject to IAEA safeguards.
  - Recycling contributes to international non-proliferation initiatives:
    - Weapon-grade plutonium disposition (MFFF project).
    - Securing « gap material » (DOE).

Present for the future

Policy for the management of spent fuel

- **Why recycling ? Political issues**
  - We have to demonstrate our capacity to find a final solution for the waste. Leaving the burdens on future generations would never be considered acceptable in France by both the public and the Parliament.
  - Nuclear materials and waste have to be dealt with in a sustainable development approach:
    - Recycling, minimization and conditioning of the waste, as elsewhere.
    - It is important for the acceptance of the industry and for the acceptance of the final disposal.
    - Recycling services can reduce proliferation risks in the world.
  - It is today the best available technology.
    - No better technology can be expected for the short / medium term.
    - Using this technology today is the best way to prepare tomorrow's technology (cf. usual incremental improvements in nuclear sector).
  - It leaves all options open for the future (with GEN IV or not).

- **These elements are not specific to France: several other countries have chosen to use recycling.**

Present for the future

French international policy related to fuel cycle management

- **Front-end fuel cycle: support of multilateral fuel bank initiatives.**
- **Back end: France is prepared to cooperate with countries to establish their national policies for the spent fuel and radioactive waste management and their strategies for implementation:**
  - Promotion of technical cooperation, with respect to safety & non-proliferation.
  - Providing commercial services (reprocessing and recycling).
- **But with specific attention on disposal of radioactive waste:**
  - France considers that any country using nuclear energy, or willing to embark in nuclear program, should be ready to take responsibility in its RW management:
    - Otherwise, its commitment in embarking in a responsible use of nuclear energy should be questioned.
    - Responsible use of nuclear ("4S": Safety, Security, Safeguards, but also Sustainability) implies long term commitment to safety and to RWM.
  - Importing foreign radioactive waste for disposal can hamper public acceptance, and can interfere with national procedures for the opening of disposal centers.

Present for the future

USA and France : Shared Interests

- **We have several areas of convergence on the future of nuclear** (need for R&D to further improve LWR technology, R&D on innovative reactors and fuel cycle), **and common challenges** (opening of a geological repository).

- **France's main principles regarding its back end policy are:**
  - We have to demonstrate our capacity to find a final solution for the waste, and to avoid leaving the burdens on future generations.
  - Nuclear materials and waste have to be dealt with in a sustainable development approach. Recycling the spent fuel achieves this objective. This is the general principle we apply in the classical industry.

- **There is already a cooperation between France and US in the fuel cycle:**
  - AREVA's investments in the US.
  - cooperation on GEN IV.
  - CEA-DoE agreement covers technical exchanges on radioactive waste.

Present
for
the future

USA and France : Shared Interests

- **=> Cooperation could be pursued:**
  - France is ready to share its experience to enable a better understanding of what would help developing a global vision of varied paths to make nuclear energy sustainable worldwide. Concerning the back end of the nuclear fuel cycle, France believes that cooperation between the US and France should be pursued.
  - France is willing to work with the US on common objectives, especially on the spent fuel & waste liabilities of newcomers.
  - France would be happy to provide any further information on its policy, on recycling, on waste management, to organize technical visits in France, etc. Both countries could also go into detail on back-end issues, including the economics. France would be happy to organize in a few months a workshop with the US.

Present for the future