
AREVA


Roundtable: The future of nuclear power
SPENT FUEL RECYCLING
IS COMPETITIVE
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Why recycling spent fuel now?

- **RESSOURCE MANAGEMENT:**
  - **Improve natural uranium utilization in now operating LWRs**
  - **Prepare the way to much better utilization of uranium in future FBRs (Generation IV)**
- **WASTE MANAGEMENT:**
  - **Minimise waste volume and toxicity**
- **In any country, recycling comes on the agenda as soon as nuclear power is considered as a long term domestic option (cf France and Japan)**

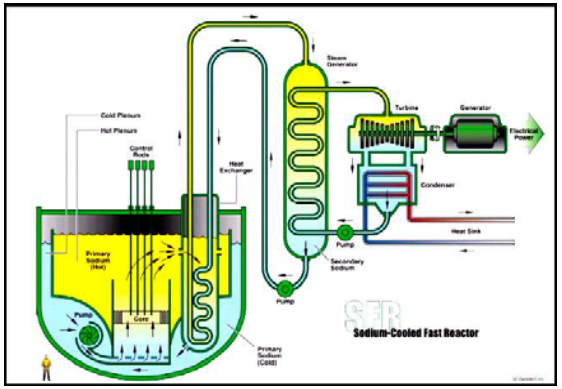
RESSOURCE MANAGEMENT

- Breeders are able to transform 238 Uranium in fissile material
- 238 U represents 99,3% of natural Uranium
- Thus, it is technically proven that **a multiplication by a factor up to 50 to 100 of energy content of Uranium ressources is achievable!**

The existing stockpiles of 238 Uranium are able to feed the existing nuclear capacity (with the breeder technology) for several hundredths of years

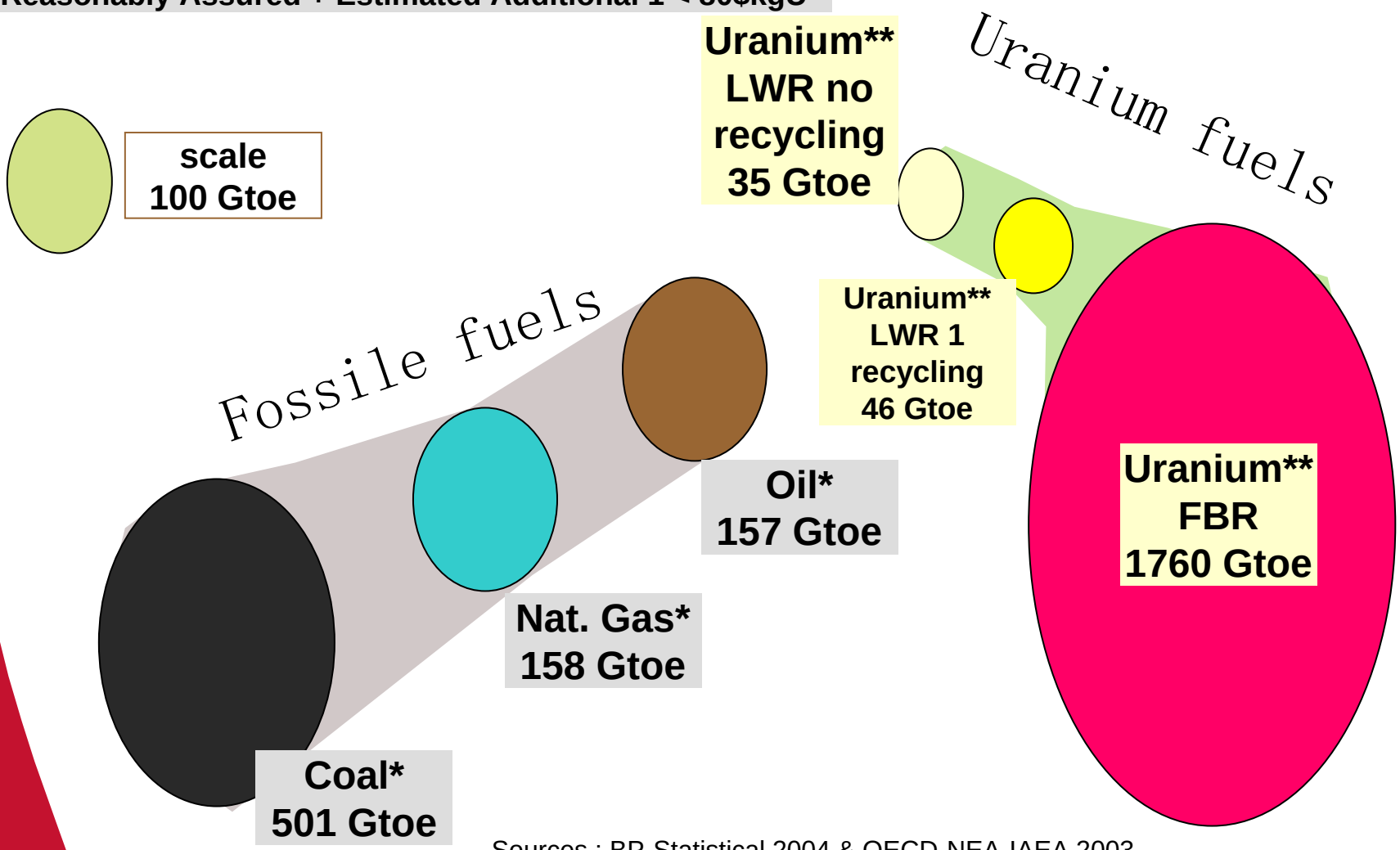
- Breeders technology are founded on closed fuel cycle strategies with spent fuel treatment

- **The future nuclear power will rely on spent fuel treatment technologies**



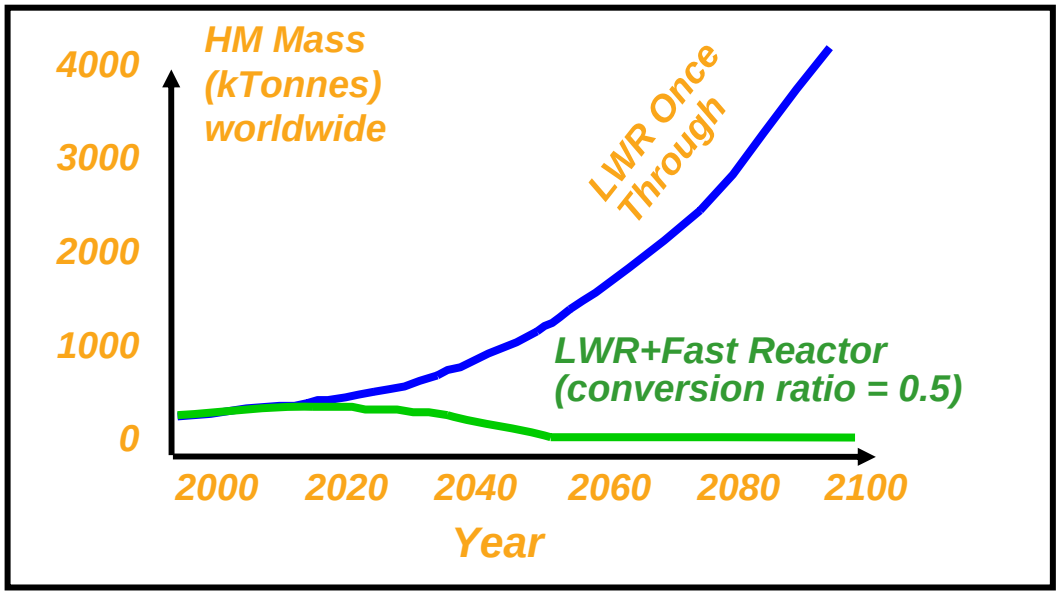
World Fuel Resources: oil equivalent content comparison

*** Proven reserves**
**** Reasonably Assured + Estimated Additional 1 < 80$kgU**



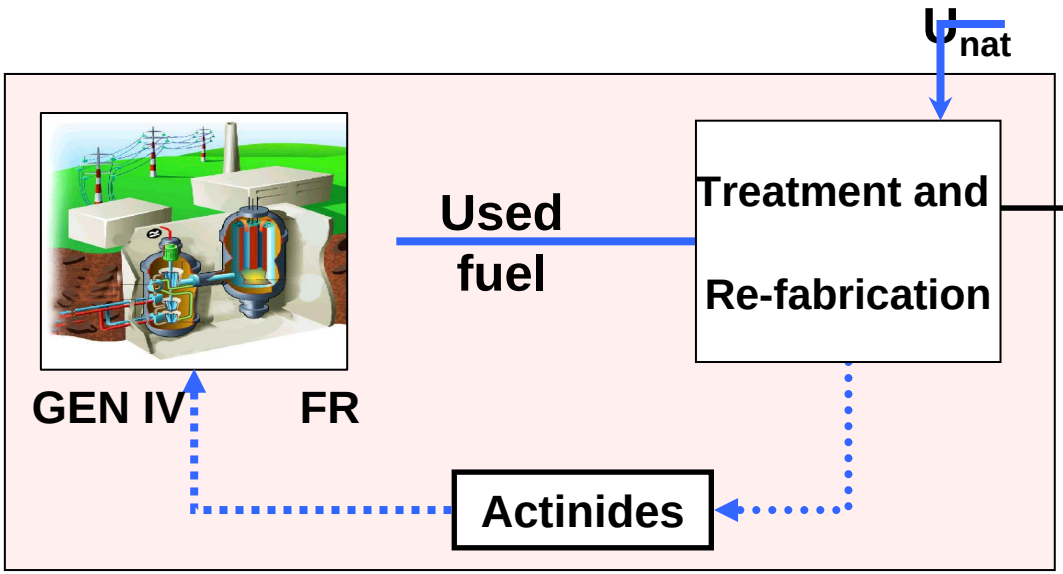
Sources : BP-Statistical 2004 & OECD-NEA-IAEA 2003

- **WASTE MINIMIZATION IN THE GENERATION IV INTERNATIONAL FORUM (GIF)**

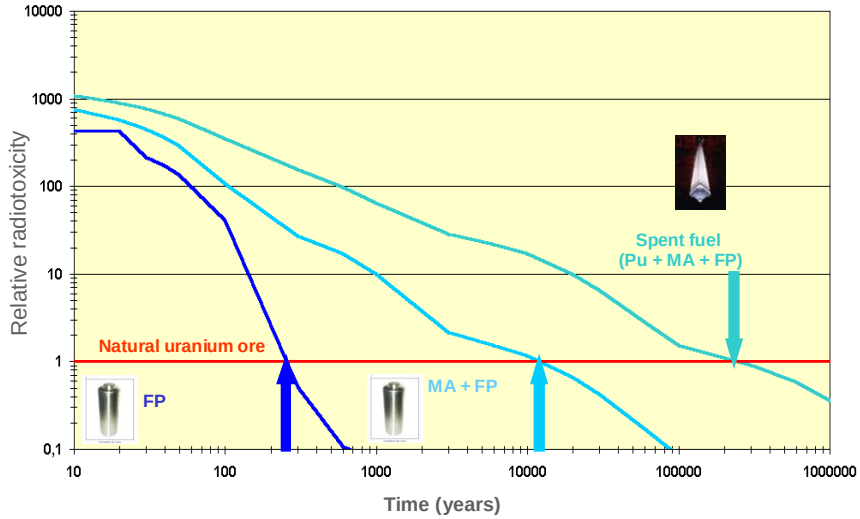


➔ **With used fuel recycling, the total amount of HLW would be dramatically reduced**

GEN IV SYSTEMS RELY MOSTLY ON TREATMENT TECHNOLOGIES (with full actinide recycling?)



- A drastic minimization of ultimate waste
  - Very small volumes
  - Decrease the heat loading
  - Hundreds of years versus hundreds of thousands
- An optimal use of energetic materials



Back-End Fuel Cycle Transition to Gen IV

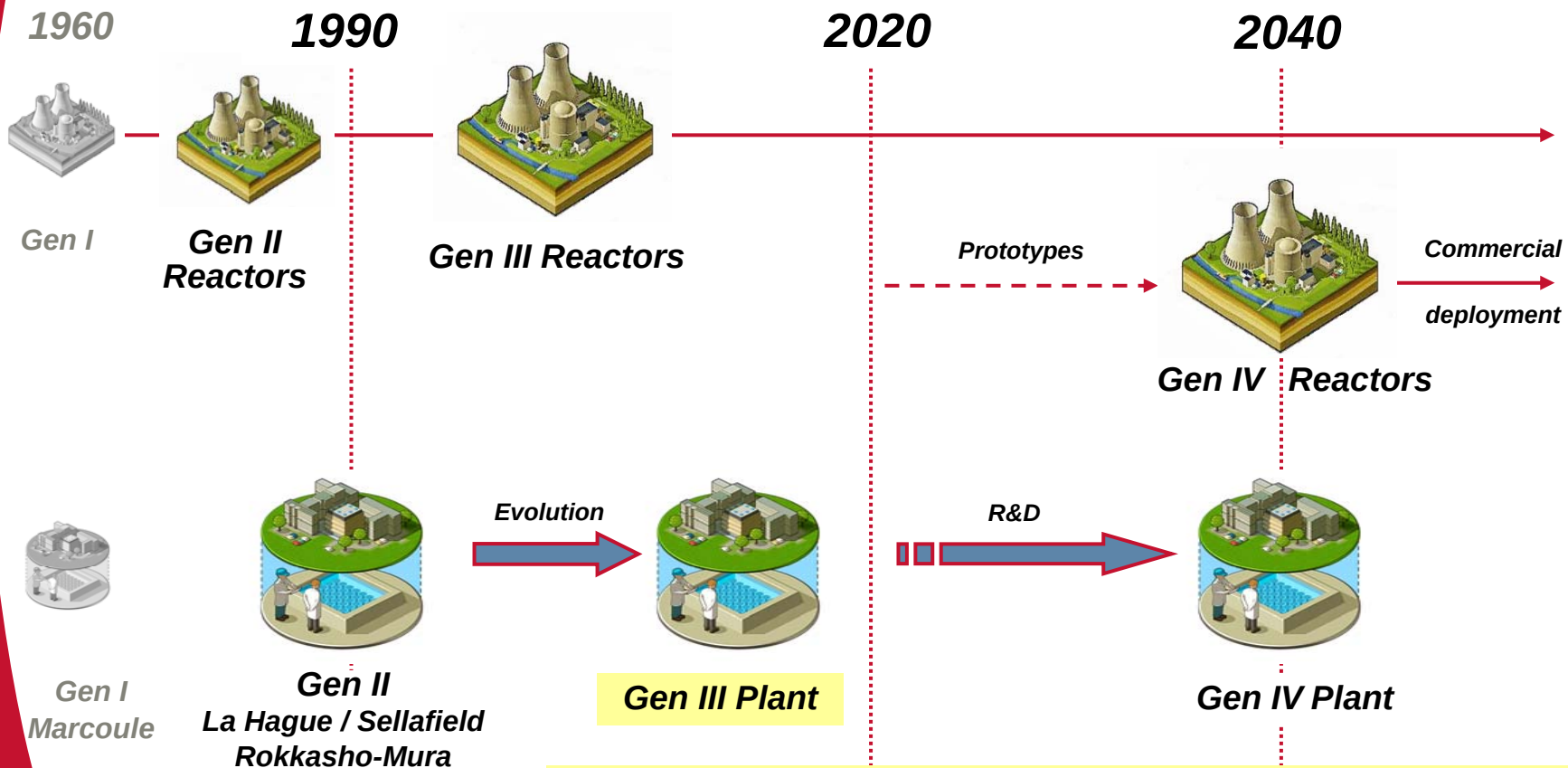
- **The US-Global Nuclear Energy Partnership vision (issued January 10, 2007)calls for the short-term developement, demonstration, and deployment of advanced reactors that consume transuranics (ie fast reactors with closed cycle)**

- **Need to synchronize fuel cycle and reactor fleet**
  - **Light Water Reactor used fuel will constitute for many years the vast majority of the fuel to be recycled**
  - **Light Water Reactors are for many years the natural users of recycled fuel**
  - **Utilities priorities are now on advanced Light Water Reactors**

  → **Long transition period**

- **There is room for transition recycling plants, based upon proven technologies**

Gen III and Gen IV Recycling Plants



- **Integrated Treatment-Recycling plant**
- **Co-extraction and co-management of Uranium and Plutonium**
- **In-line fabrication of LWR MOX fuel [U + Pu]**
- **Evolutive design to integrate over time new processes**

Is it cost effective?

- **Recycling cost effectiveness is the balance between:**
  - **The cost of uranium saved + the cost of HLW disposal saved + the long term value of « extended nuclear capacity » (extended technology, know-how and natural resources)**
  - **The cost of operations (used fuel processing, UREP and MOX fuel manufacture)**

- **There is no general positive answer, but at least one implemented and proven case (EDF fuel cycle in France, 1100 tHM/ year) plus one persuasive study for the US in the future (2500 tHM/year)**

Recycling : is still a competitive option !

The recent Boston Consulting Group Study

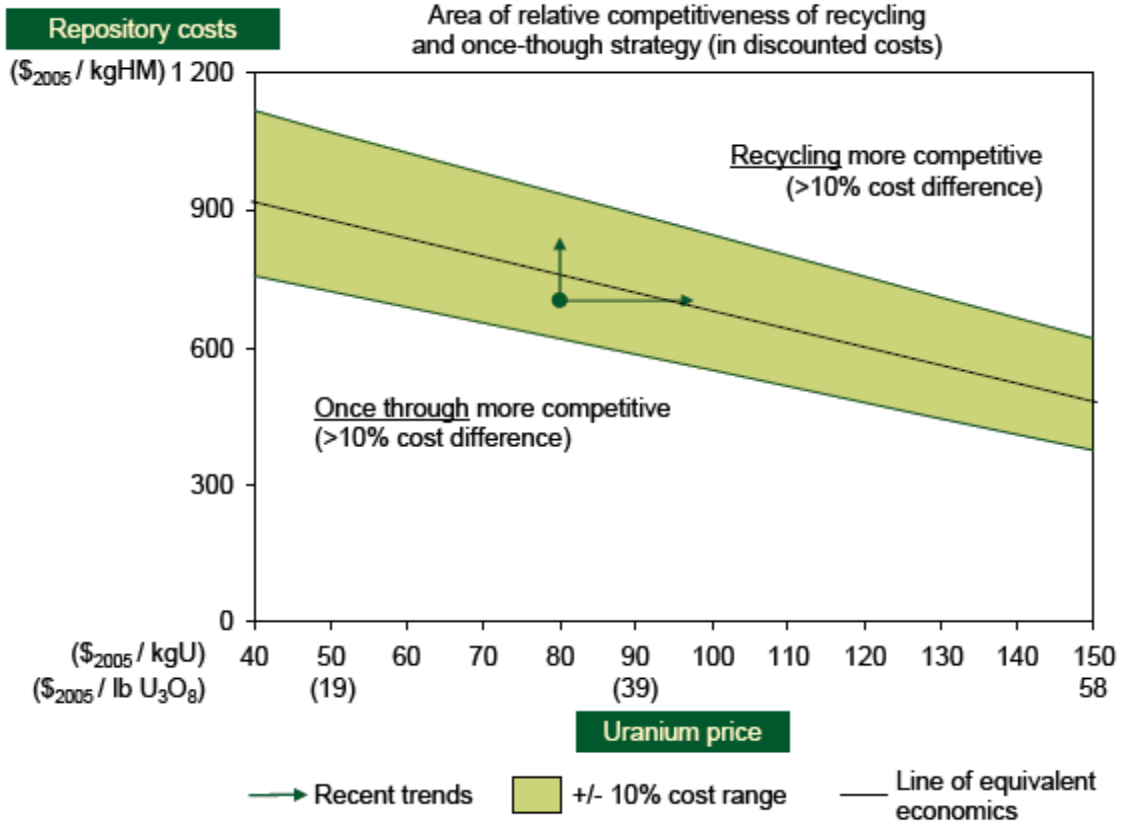


Figure 12: Effect of uranium prices and repository costs on economic comparison

BACK UP

- **Gen III and Gen IV cycles are not opposed but complementary**
  - **Used MOX and Minor Actinides management through Gen IV fuel cycle**
  - **Significant improvement in natural resources management through FNR**

- **A Gen III MOX cycle offers significant flexibility in case Gen IV reactors are delayed**
  - **Quantities of used MOX interim stored are very small (1/8 of used UOX)**
  - **If needed, possibility to recycle used MOX likely with the introduction of Minor Actinides separation (for storage pending their re-use in Gen IV reactors)**

JOB CREATION ASSOCIATED WITH THE RECYCLING PLANT

- **The implementation of the recycling strategy would create a significant amount of highly compensated jobs that require significant skills**
  - **for the construction the plant would create ~ 10,000 jobs (for 10 years)**
  - **for on-going operational activities of the plant would create ~5,000 jobs (for 50 years)**
- **The total number of people indirectly employed as a result of the presence of the plant would be approximately six times as high. The large number of indirect jobs is a result of**
  - **the impact of the plant's large scale of investment activity (nearly all of which is sub-contracted)**
  - **the significant level of operational procurement (including contracted out services)**