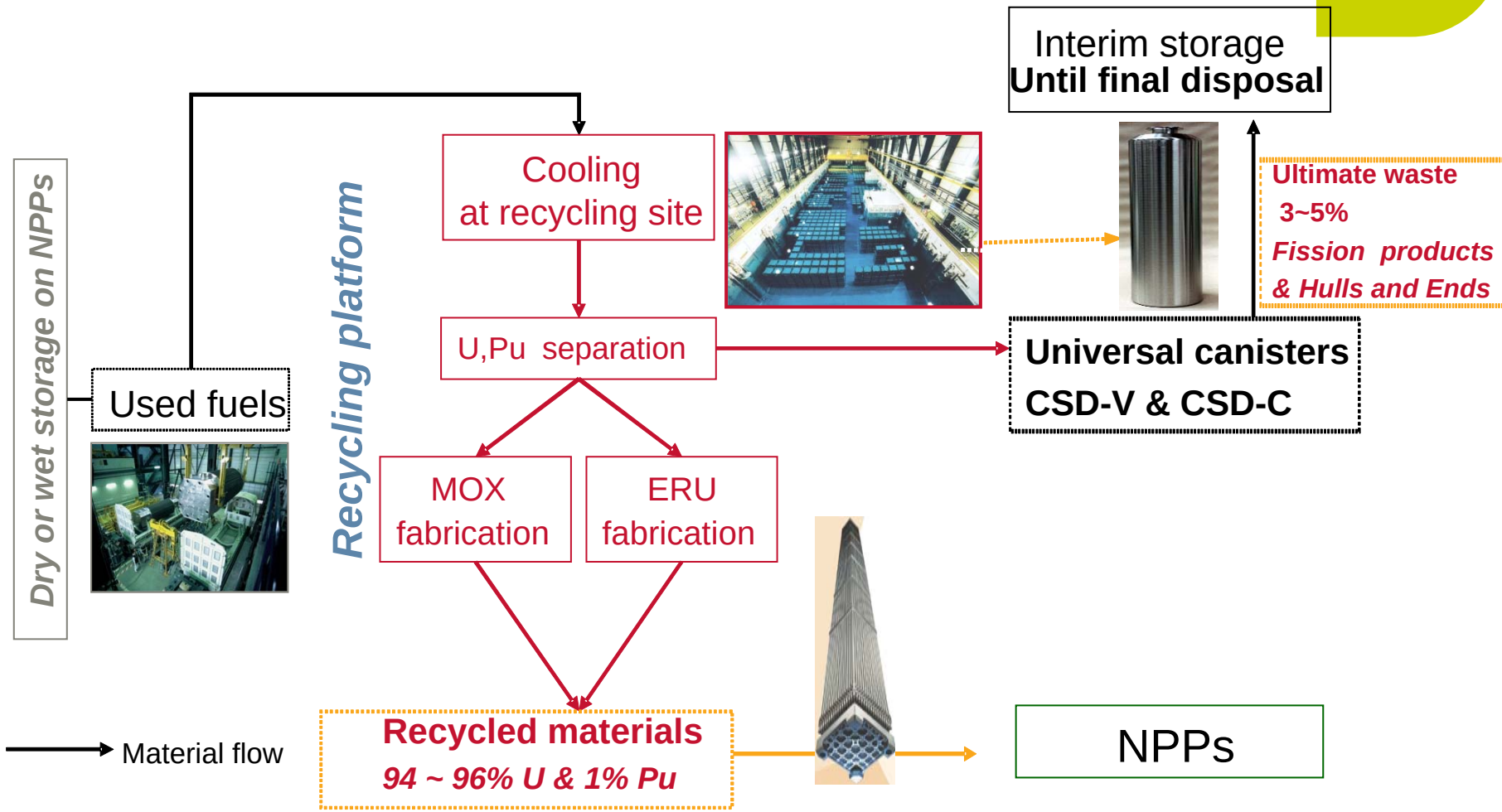

AREVA

Recycling solution

INER Conference in TAIWAN, on 16 December 2009

2009 Spent Fuel Symposium

Recycling nuclear fuels: a key element for a sustainable development of nuclear energy



Used fuels recycling scheme

Recycling benefits: Standardized containers for Ultimate Waste

- **The non reusable materials are conditioned into a stable and compact form suitable for transport, storage and final disposal**

- Encapsulation of Fission Product in a stable, homogeneous,and durable glass matrix with a long-term predictable behaviour

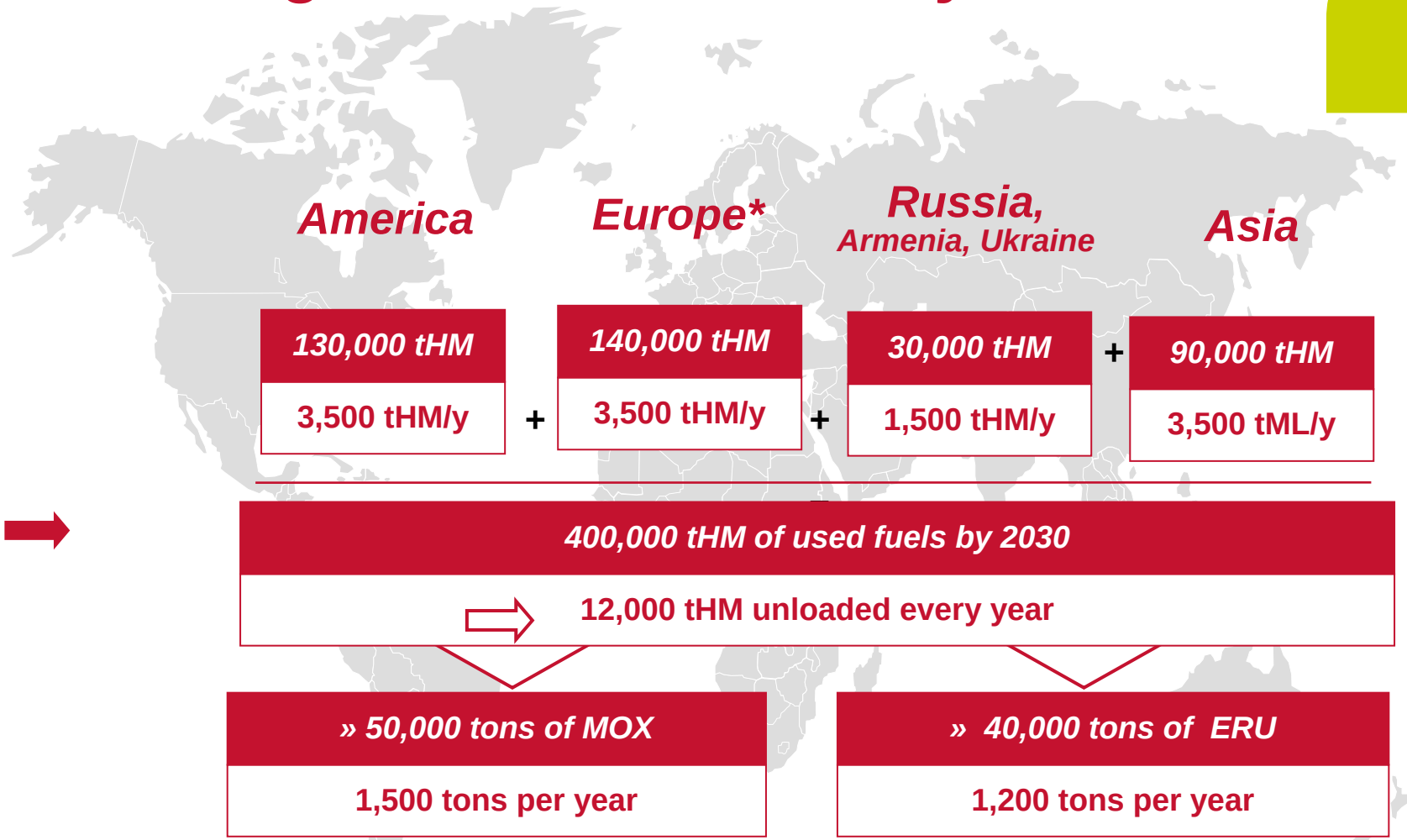
- Compaction of structural pieces hulls and end-pieces)

High Level Waste [HLW]

Medium Level Waste [MLW]

Both the glass matrix and compacted waste are encased in a **standard "Universal Canister"**

2030, a huge mine of secondary resources

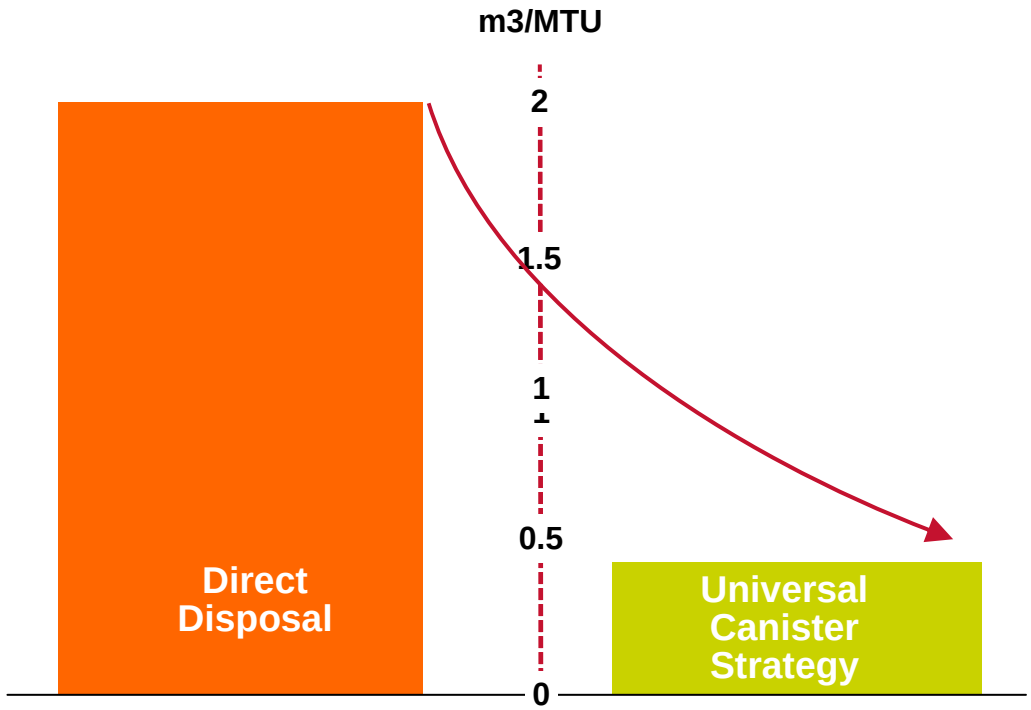


LWR used fuel cumulated unloading, extrapolated notably from IAEA, WNA ...

Recycling such an impressive inventory would allow feeding the current French fleet (58 NPPs) for more than 100 years !

* *South African unloading are included in these figures*

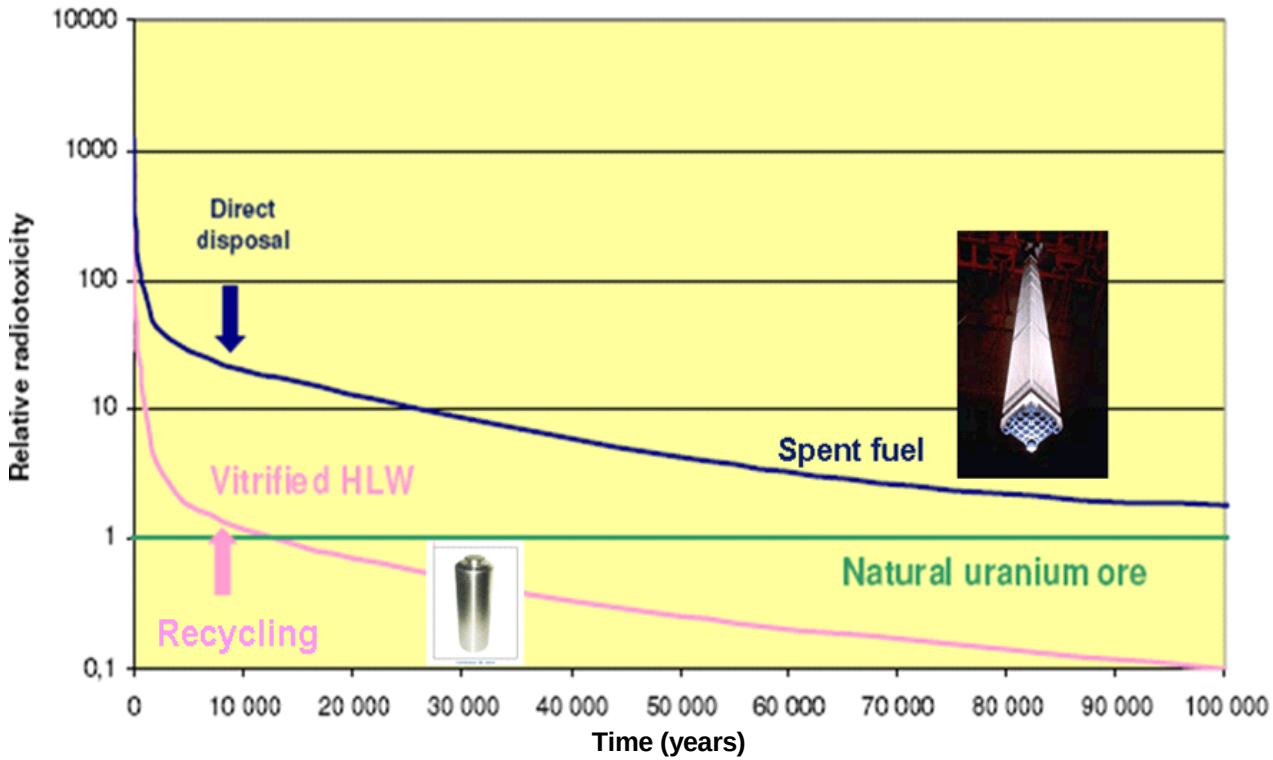
Recycling Benefits: Volume Reduction



RECYCLING + UNIVERSAL CANISTER STRATEGY = DRASTIC WASTE VOLUME REDUCTION

Recycling benefits: Toxicity reduction

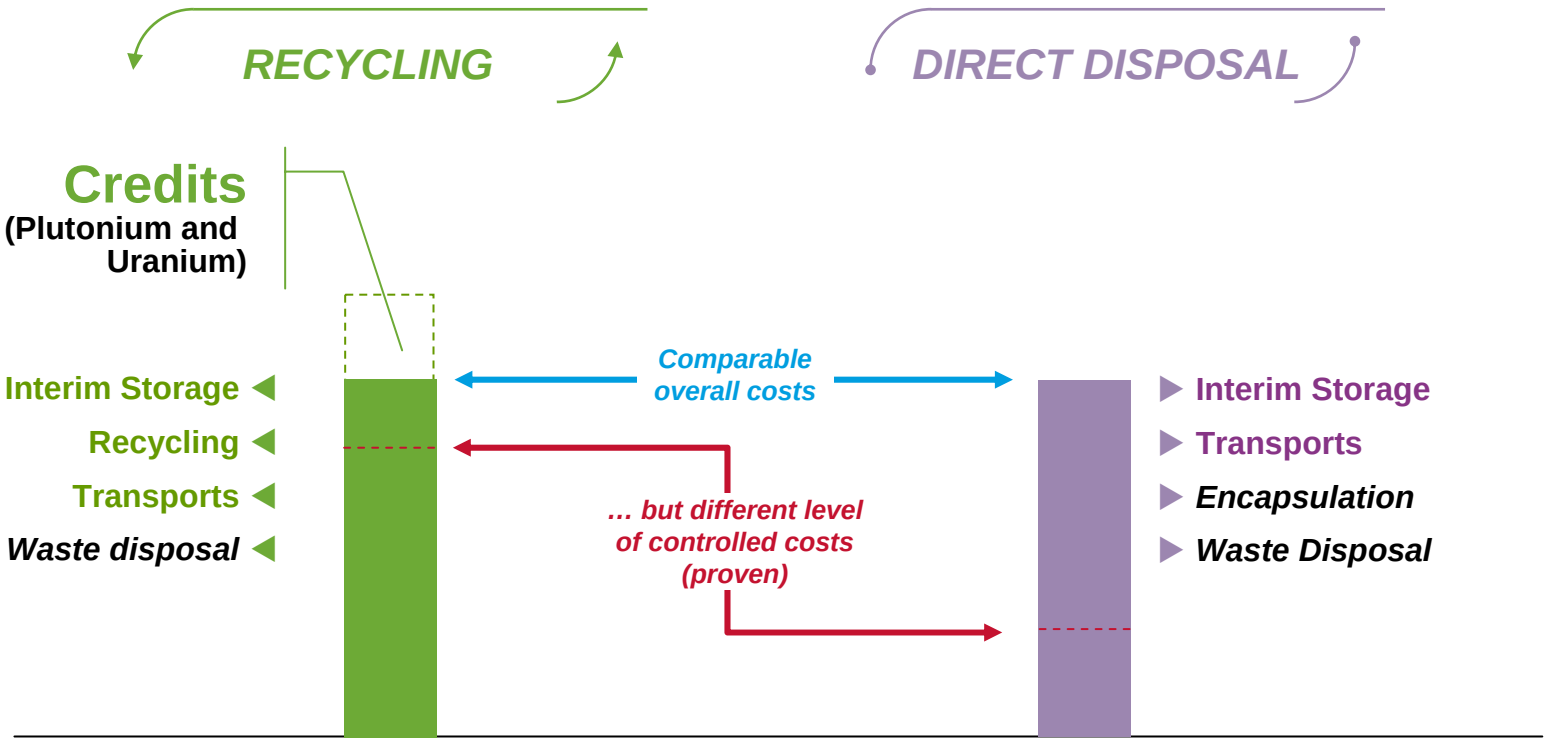
- **Radio toxicity divided by 10**
- **Time needed to decrease to the natural U activity divided by 20**



Recycling reduces drastically waste radio toxicity

A cost competitive solution which provides fuel cycle cost certainty

- **Back-end cost is only a few % of kWh cost**
- **Overall costs of Recycling and Direct Disposal are comparable (U&Pu credits)**
- **Ability of recycling to demonstrate controlled costs**



A cost competitive solution which provides fuel cycle cost certainty

- **General long term trend : increase of UO_2 performances and burn up**
  - **In the case of UO_2: need of increasing UO_2 lifetime with more U5 enrichment**
  - **In the case of MOX: simple increase of Pu content**

- **For the long term , Recycled fuels (MOX and ERU) presents unique features**
  - **Secured source of supply (up to 25%)**
  - **High predictability of the costs**
  - **Stability compared to volatility of the cost of natural uranium supply**

Recycling is a way to further strengthen proliferation resistance

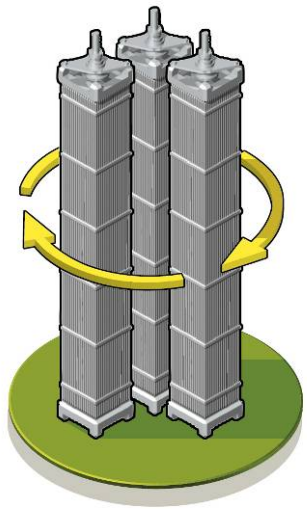
- Recycling plutonium in MOX fuel:
  - consumes roughly one third of the plutonium (single recycling)
  - significantly degrades the isotopic composition and thus the potential weapon attractiveness
- The ultimate waste (Vitrified and Compacted Waste) do not contain IAEA-safeguarded fissile materials
- Existing Recycling facilities have been designed and constructed to satisfy all relevant national and international standards for the safekeeping of nuclear materials
- The Recycling facilities and the separated fissile materials are safeguarded both by EURATOM and the IAEA

AREVA Experience: Over 24,000 tons of used fuel recycled

At 1 January 2009	Tons treated
EDF *France*	***14,260***
German utilities	***5,479***
Japanese utilities	***2,944***
Swiss utilities	***771***
Synatom *(Belgium)*	***672***
EPZ *(Netherlands)*	***336***
SOGIN *(Italy)*	***82***

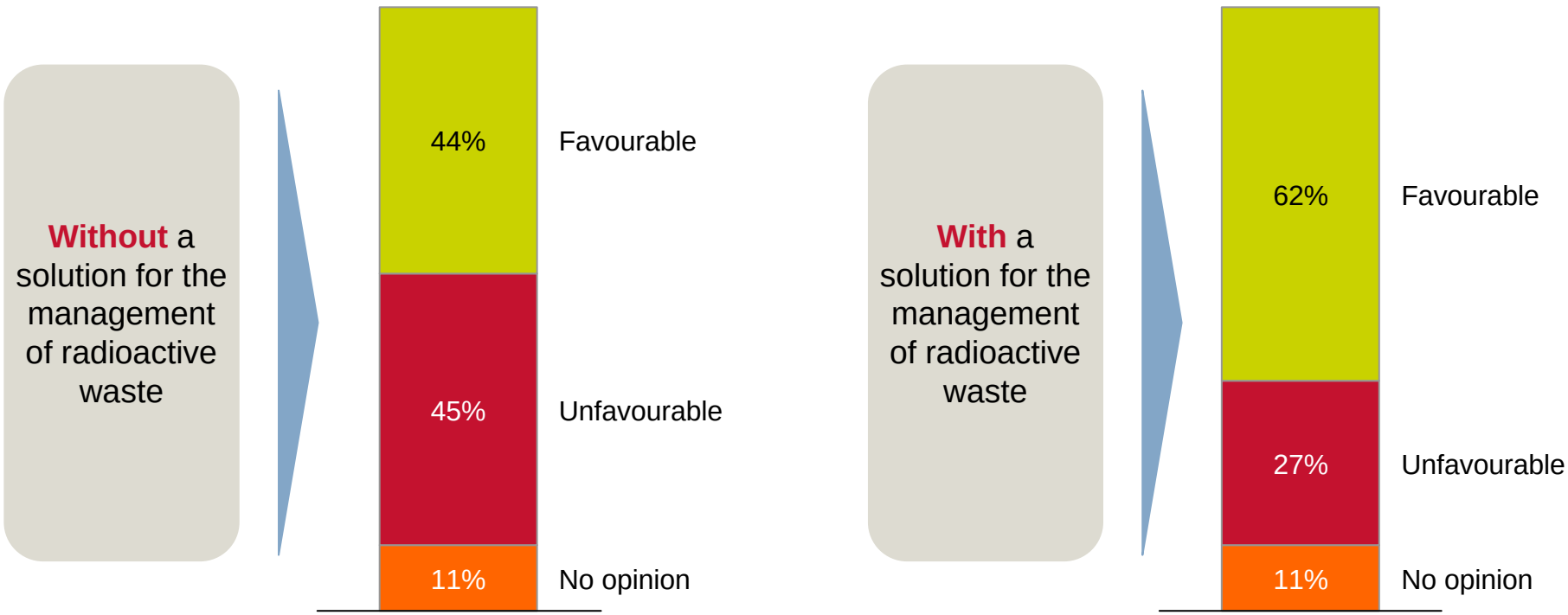
Recycled fuels performance in reactors

- **MOX & ERU fuels can accommodate all Light Water Reactors (80% of worldwide nuclear capacity)**
- **More than 10 000 recycled fuels have been successfully used in LWRs worldwide since the 70's**
- **For Utilities, recycled fuels have outstanding performance**
  - **Excellent reliability track record**
  - **Equal energy performance compared to natural uranium**
  - **MOX in-core behavior similar to Uranium fuel under normal and accidental conditions**
- **The EPR™ concept in reactor enables the use of a 100% MOX fuel core.**



What about nuclear acceptance in Europe?

Level of acceptance of nuclear energy by European Union citizens



Source : EUROBAROMETER 2008

An example of successful recycling scheme: The Netherlands

Transport and Interim storage of vitrified residues to HABOG facility (COVRA)

Conclusion

- Nuclear energy will play an ever-increasing role on a world-wide scale to fulfill both the growing energy demand and the need to move towards emissions-free energy sources
- Recycling increases public support towards nuclear energy
- Recycling allows to significantly reduces the volume and toxicity of the ultimate waste to be interim stored and disposed of while enhancing proliferation resistance
- Recycling Used Nuclear Fuel supports the sustainable development of nuclear power allowing mitigating supply risks
- Recycling features predictable and competitive economics:
  - Comparable economics as for direct disposal
  - Reduced fuel cycle cost uncertainty