October 27, 2009 – Vienna

Nuclear Power: an Irreplaceable Option for Sustainable Development

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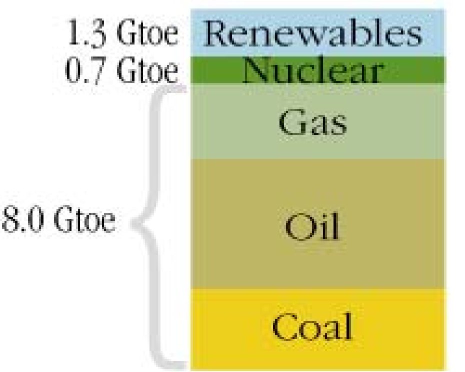
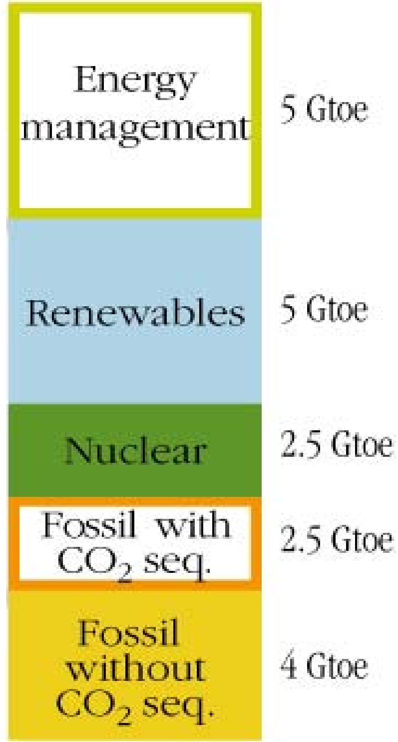
French Atomic Energy Commission (CEA)

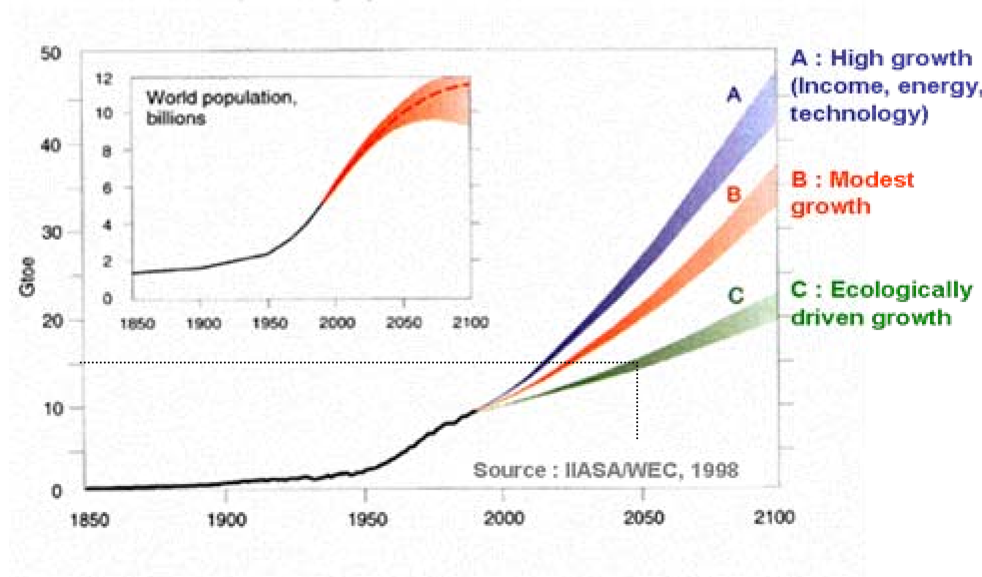
Low carbon energy scenario for 2050



Total: 10.1 Gtoe (2000)



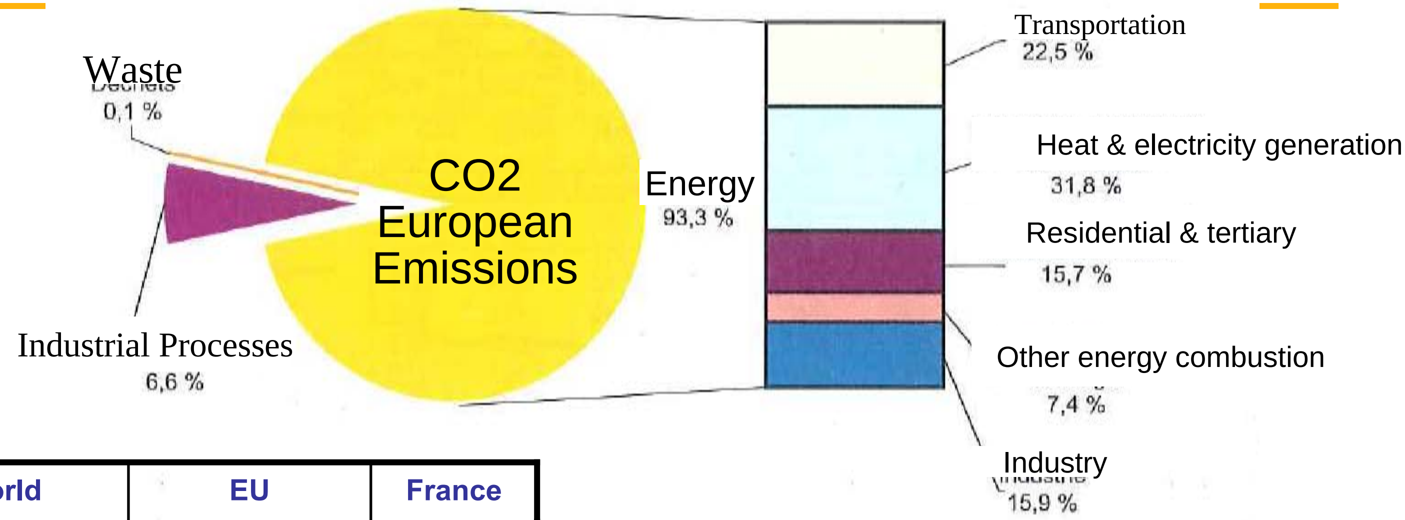
Total 19 Gtoe (low-carbon scenario: 2050)



- Energy demand will increase (approx. double if no strong energy management / saving policy is implemented)
- Nuclear will play a major role along side renewables (including hydro), fossil with carbon sequestration (still under development).

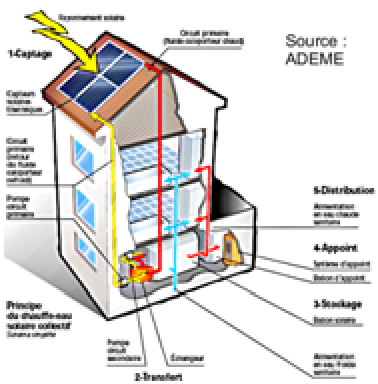
Today, nearly 2 billion people without electricity

Climate challenge & sustainable nuclear energy



	World	EU	France
electric power in the final energy consumption mix	16%	20%	23%
Nuclear electricity / total electric power output	15 %	30.5 %	78.5 %

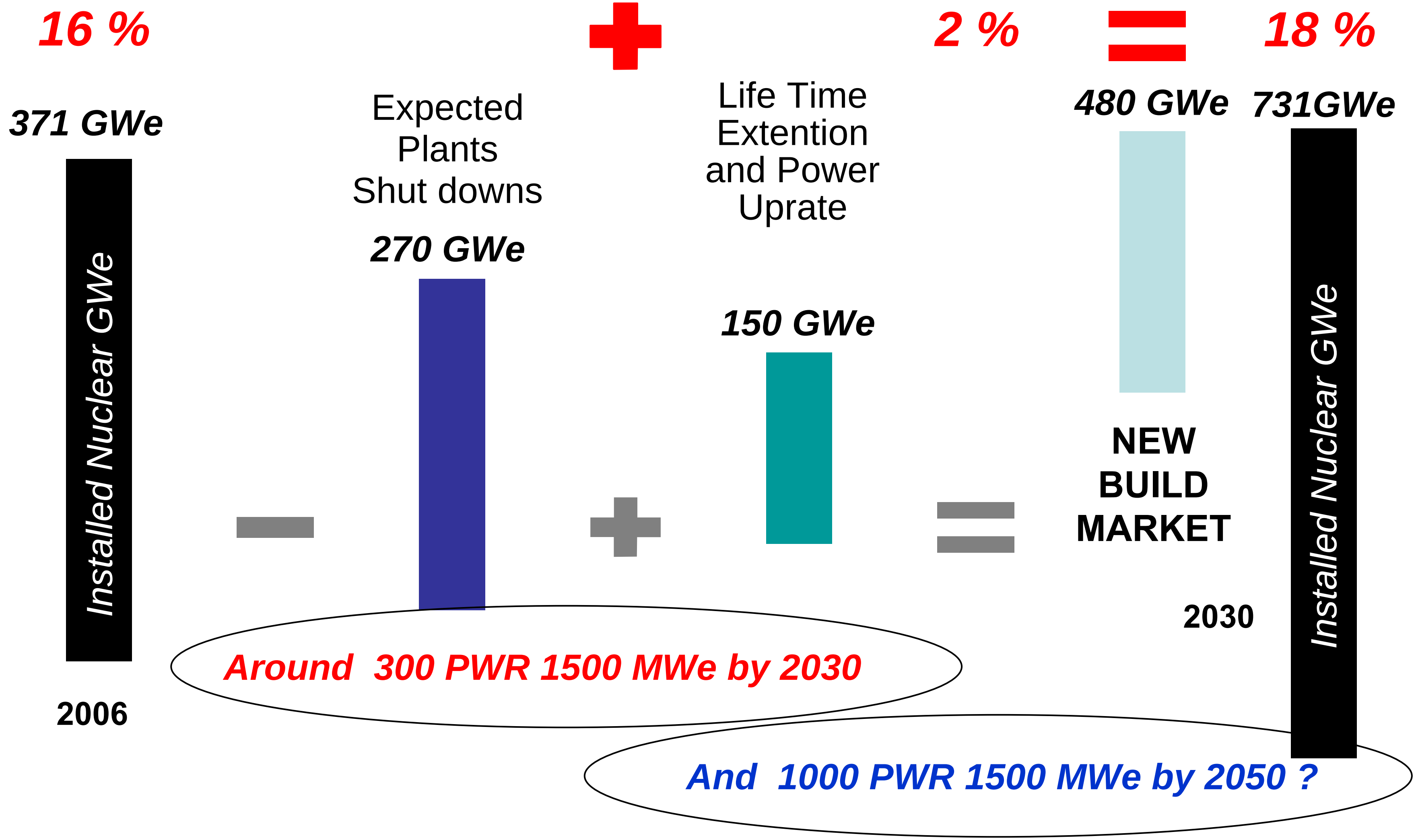
- 1st low carbon track : Electricity,



- 2nd low carbon track : transportation,

- 3rd low carbon track : residential and tertiary sector

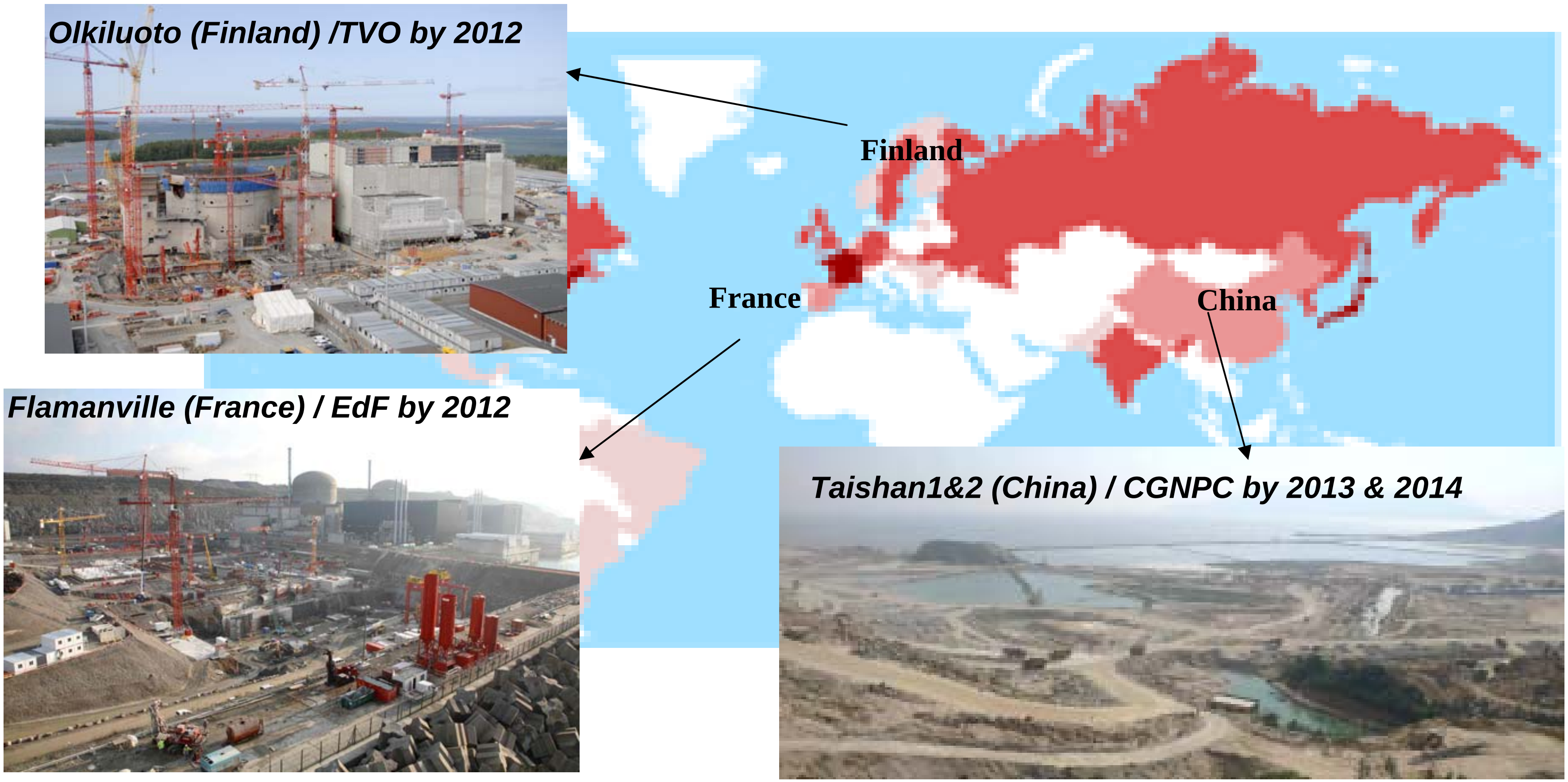
2008 Vision : nuclear part in the energetic mix



A target for nuclear contribution in the energy mix by 2050:
30% such as in European Union ⟷ ***Around 2500 PWR 1500 MWe***

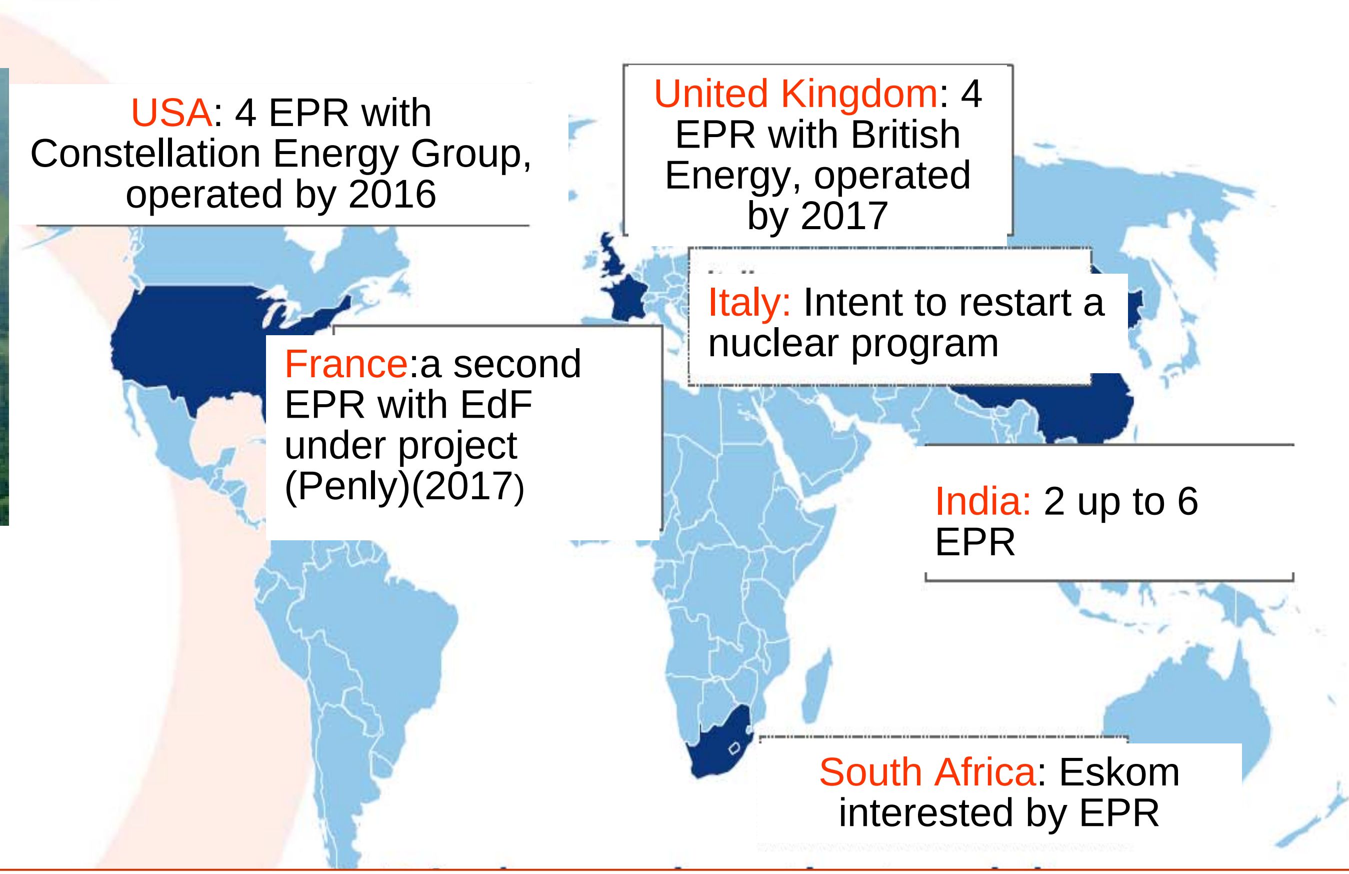
Gen III on the tracks with safety improved EPR

- **A 1600 MWe reactor, lifetime 60 years**
- ***A mature concept, based on current PWRs' experience***
- ***Significant improvements in safety and economy***



Gen III on the tracks with today envisaged EPR around the world

Calvert Cliffs (USA)

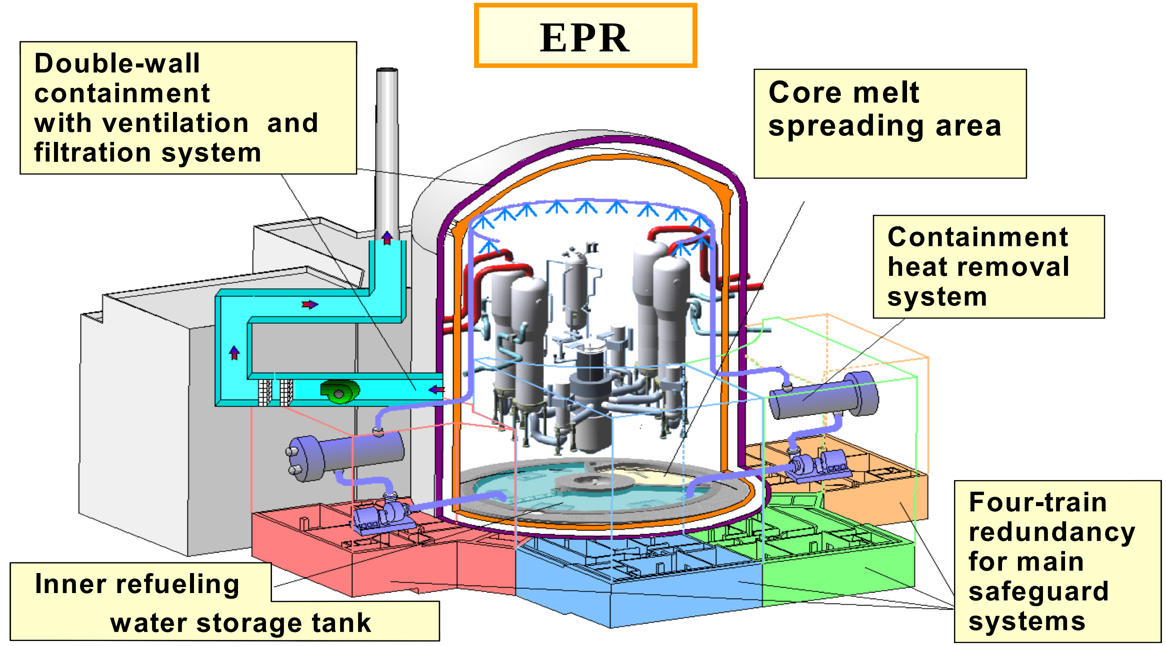


Development, investment & operation of more than 10 EPRs by 2020,
Potential Countries: United Arab Emirates, Jordan, Vietnam …

EPR Safety Objectives

- Enhanced defense in depth

  to reduce by a factor ten the number of significant incidents and global frequency of fusion core meltdown,



- Significant reduction of release and consequences

  in any situation (including fusion core meltdown),

- Improved resistance of the reactor containment to external impact and majored seism

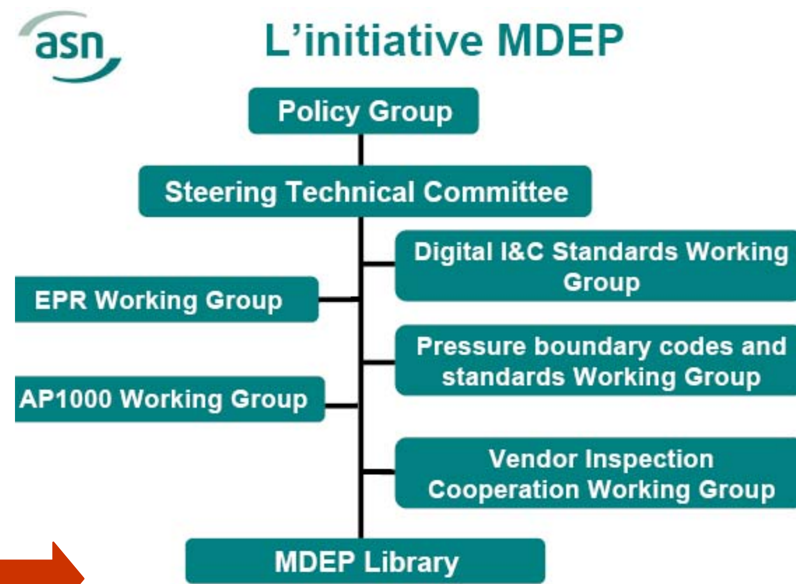
Towards a high safety level with the rising multinational safety initatives

- An International Nuclear Safety Harmonization, but:
  - Liabilities in regard to safety remain a national obligation, which can not be assigned to supra-national authorities,
  - Technologies are not the only one safety parameter, « Safety Culture » and an appropriate institutional framework are also necessary

- A long-standing Coopération (>50 years) between:
  - Institutional actors (IAEA ...),
  - Safety Authorities Cooperation (INRA, WENRA…),
  - And Operators (WANO …).

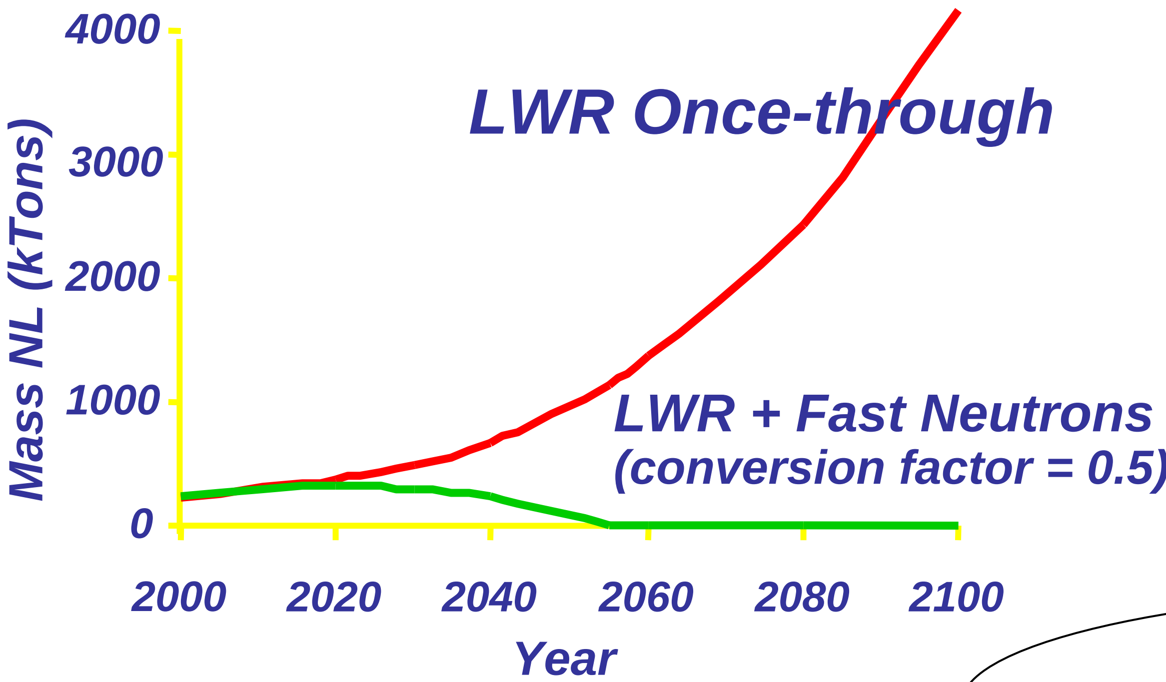
- The 2 driving forces behind harmonization:
  - MDEP (Multinational Design Evaluation Prog.) Initiative

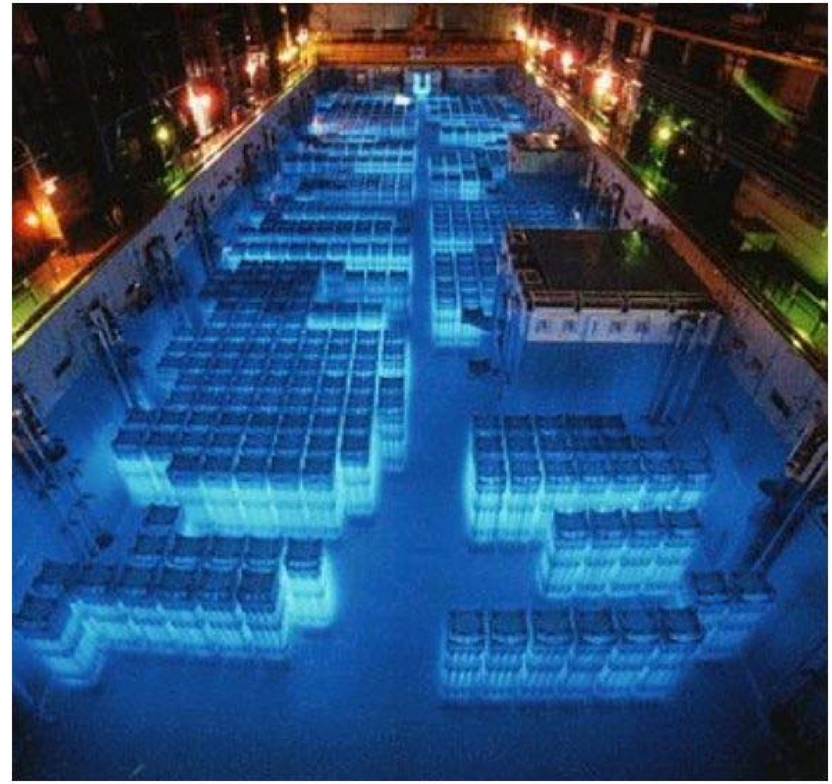
    to assess the new reactors the safety authorities
  - European Construction



- Present International Safety Initiative such as MDEP to be forsted

2008 Vision: world spent fuel amount





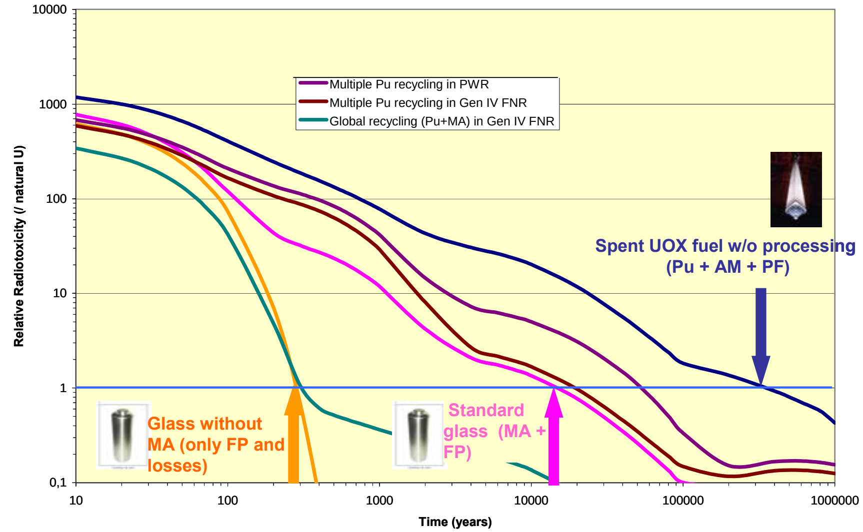
	2030	2050
World spent fuel production / year	10 000 t	20 000 t

700 000 t by 2050,
Around 400 EPR spent fuel pits,
+ 2 pits / year

Closing the fuel cycle, towards sustainability …

- First step: Pu recycling in LWRs,
  Conditionning of waste

  Continuous progress has been made in the processing of spent fuel, recycling of nuclear material and conditioning of waste

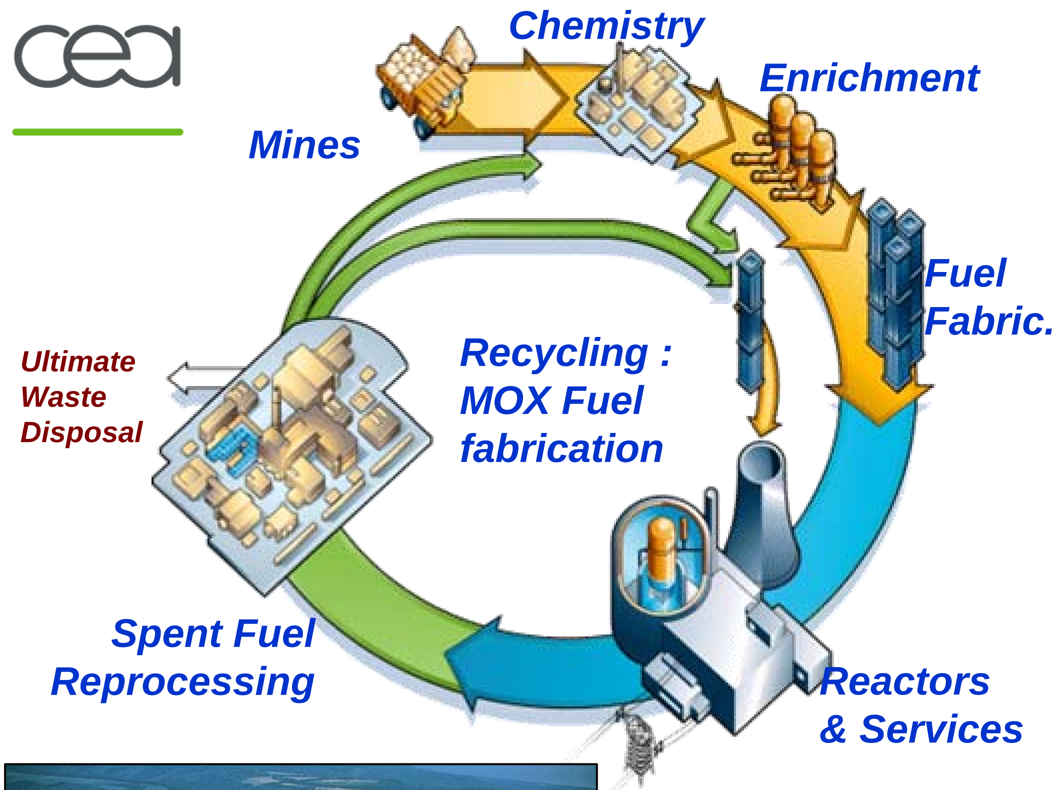


- Next step: Recycling of minor actinides to reduce thermal load and radio-toxicity of waste is the object of on-going research

• **Recycles**	**96%**	**of spent fuel materials**
• **Saves**	**30%**	**of natural resources**
• **Costs less than**	**6%**	**of the kWh total cost**
• **Reduces by**	**5**	**the amount of wastes**
• **Reduces by**	**10**	**the waste radiotoxicity**

Adapted technologies allow a safe conditioning of wastes to guarantee their long term confinement and stability,for dozens of thousands of years

Closing the Fuel cycle… and an industrial reality



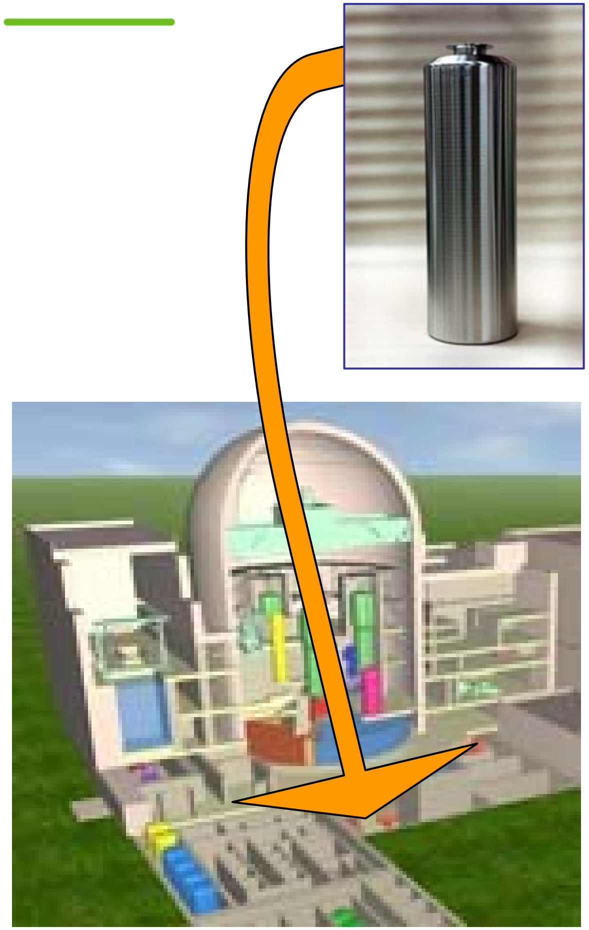
More than 25 years of unequalled experience in France :

- **Until now: ~ 20 000 Mt_{HM} spent fuel reprocessed and more than 1200 Mt_{HM} MOX fuel recycled**
- **1100 Mt_{HM} /yr of spent fuel discharged from the French PWRs**
- **Up to 1 700 Mt_{HM} /yr of spent fuel reprocessed (domestic + foreign)**

Rokkasho-Mura

La Hague

Nuclear Plants for new comers: reactor + Fuel services + Education & training



- To address the expectations of customers interested in developing nuclear energy production plants *(power range, design for site flexibility and various grid conditions...)*,
- Combining reliable and proven nuclear technologies, including fuel cycle facilities
(glass canister storage…)
- Answering non proliferation criteria,
- Setting an ambitious training offer

RR21 Characteristics:

Power range 10 MW,

Pool type reactor

Inherently safe fuel (no fuel melting),

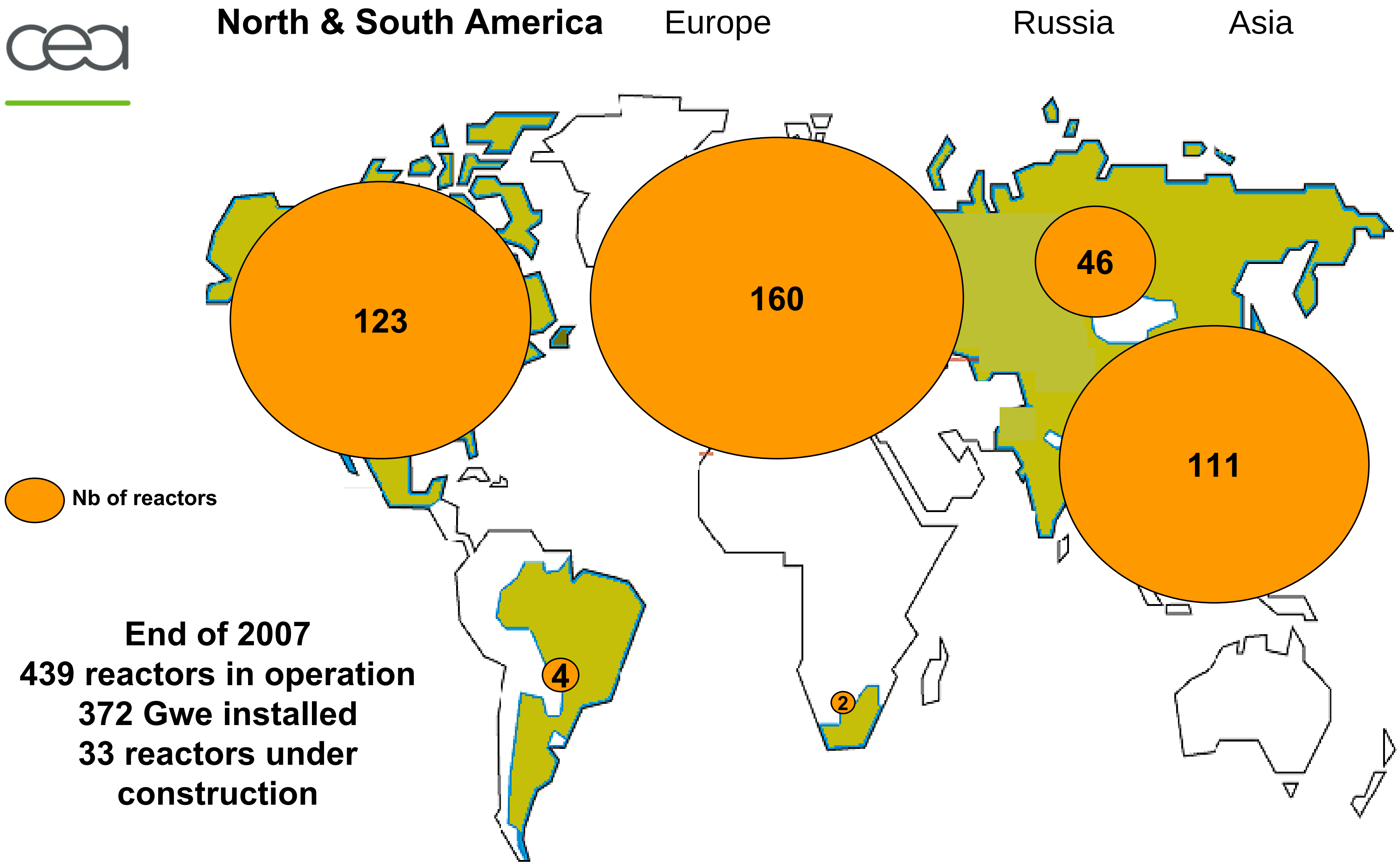
Spend Fuel recovered for treatment and recycling,

Easy handling,

Easy experimental work

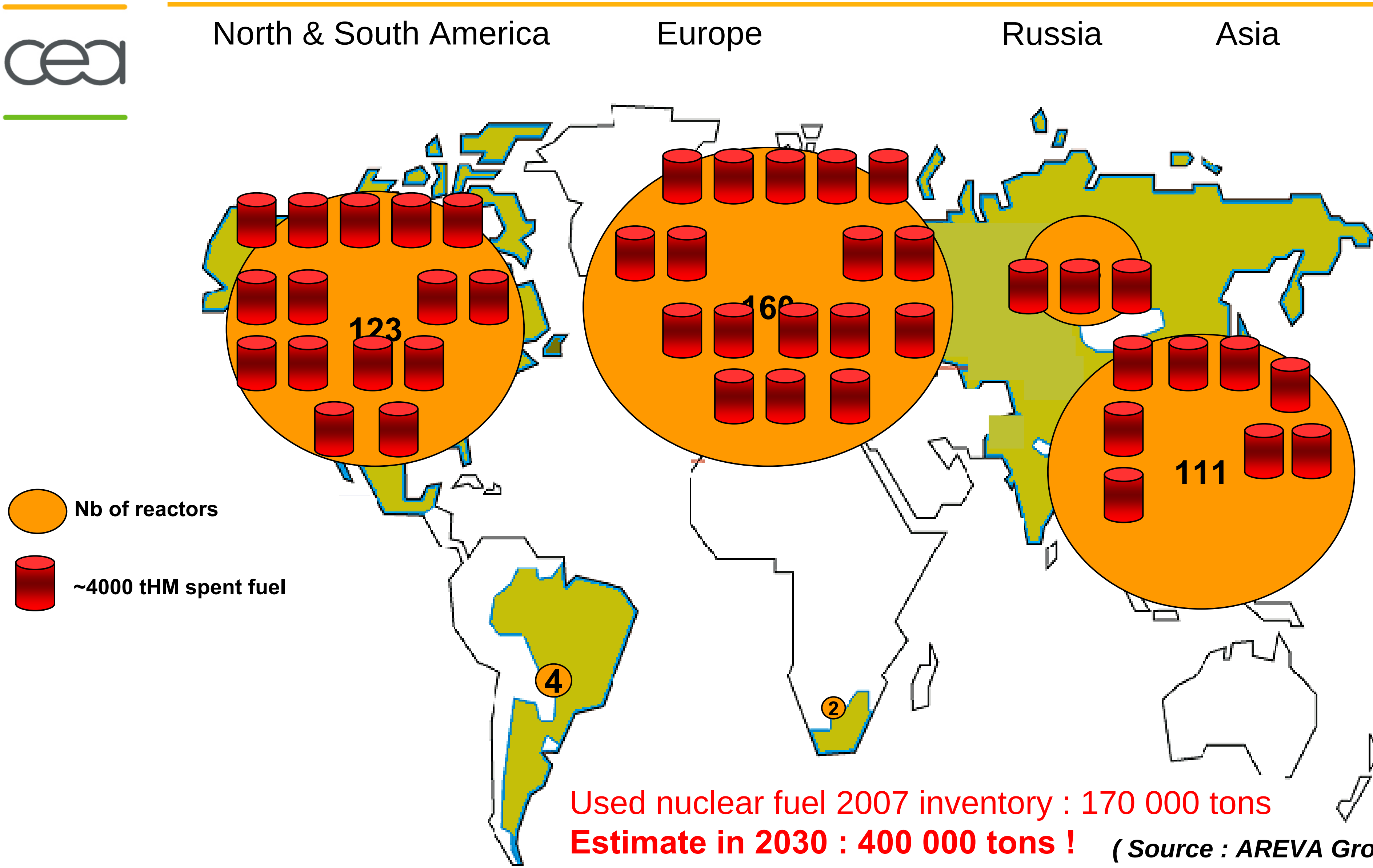
A specific research and training reactor

Nuclear renaissance in the world



End of 2007
439 reactors in operation
372 Gwe installed
33 reactors under construction

Nuclear renaissance in the world

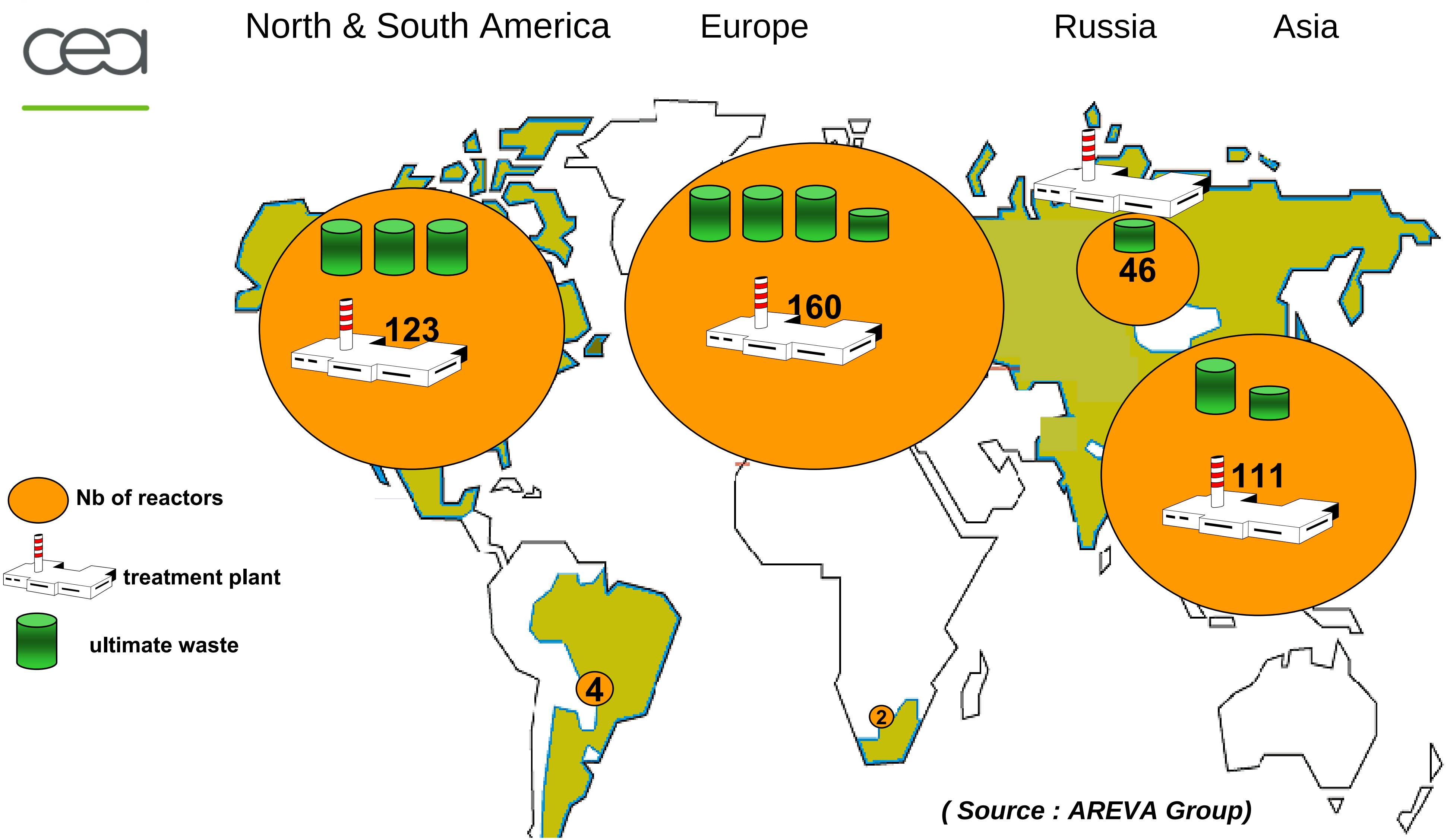


Used nuclear fuel 2007 inventory : 170 000 tons

Estimate in 2030 : 400 000 tons !

(Source : AREVA Group)

Nuclear renaissance in the world



➔ Drastic waste reduction with only few recycling plants

Commitments and international obligations with regard to safety, security and non proliferation standards, shall be strictly observed.

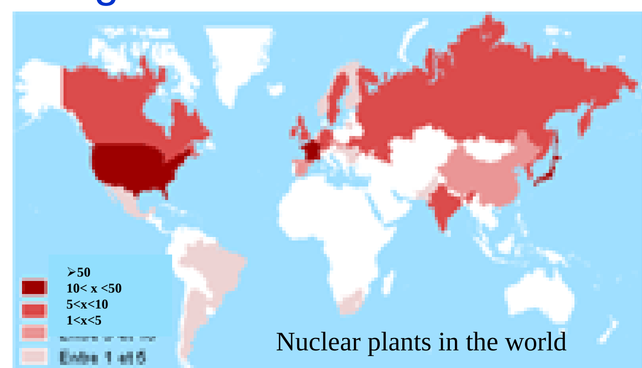
1. The stockpiling in undefinite interim storage is not a responsible management of the fuel back-end, in the perspective of a wide nuclear renaissance,
2. Spent fuel recycling shall be carried out vitrified waste sended back to countries of origin, to be safely and economically storaged, waiting for final disposal: for a safer, a more secure and a more proliferation resistant spent fuel management
3. A global service offer for spent fuel reprocessing and recycling shall be set up with the appropriate international framework, i.e; the IAEA umbrella
4. Supply of recycling plants based on best available proven technologies:

by current La Hague / Rokkasho and future facilities

operated bymajor players

Distribution of the recycling facilities on a regional basis

with respect of commercial contracts



Nuclear plants in the world

Bridging Technologies from the Renaissance to Sustainability

Adapted initiatives taking into account the best available technologies, towards the emerging economies

↓

to enlarge the access to the nuclear energy in terms of

- **electricity production without green gas emission (up to 40-50% in 2050),**
- **natural ressources conservation,**
- **waste minimisation,**
- **potential for new applications (hydrogen, desalination, heat…)**

RENAISSANCE

Spent fuel

new fuel (MOX)

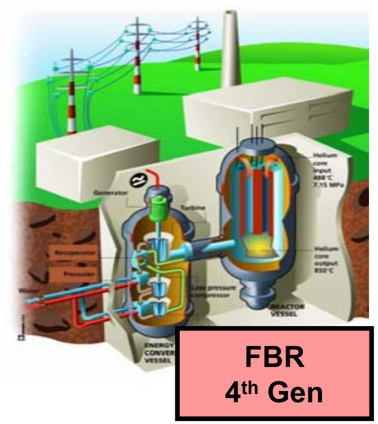
BRIDGING TECHNOLOGIES

Proven advanced recycling technologies

Spent fuel

new fuel

SUSTAINABILITY



Durability

- R & D (2000)
- Prototypes (2015 – 2030)
- Industrial deployment (by 2040)

R&D sharing
in GEN IV Forum

International harmonization of prototypes

In a bi or trilatéral framework
Example (USA-Japon-France)
of the Sodium FBR

INPRO

- *Dialogues between technologies suppliers and operators,*
- *Clarification of user's needs*

Atoms for Prosperity