IAEA Scientific Forum
Energy for Development
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NUCLEAR ENERGY

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Energy : A major challenge of the 21st century

World Consumption:

10 Gtoe/year
1,7 toe/inh./year

Growth : 2 to 3% per year

Geopolitical tensions
Climate risks

The climate challenge

Reduce CO_2 emissions

while

Producing more energy

Nuclear Energy Today

In the world:

- 32 countries
- 440 power reactors
- 360 GWe
- 17% of electricity
- 6% of primary energy

Worldwide energy needs

- Energy needs are still increasing,
- Oil and gas are becoming scarce and expensive,
- Climate change due to CO_2 emissions is a concern

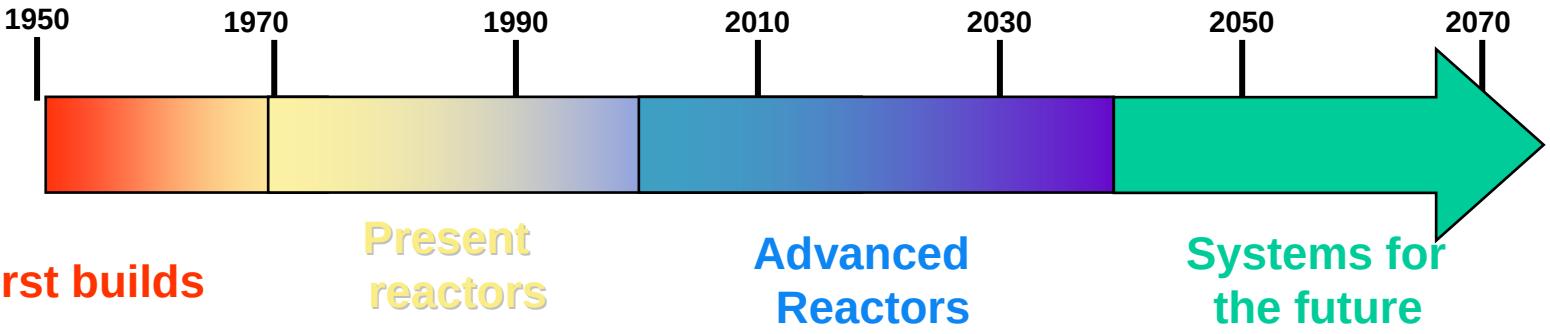
→ Nuclear energy is part of the solution

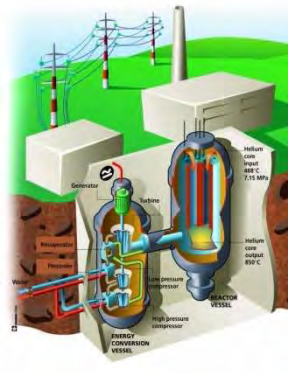
- Nuclear installed capacity could be multiplied by a factor 3 to 4 by 2050 (1200 - 1500 GWe) : It could be made possible with LWRs.
- The countries which will build reactors in the next decades, aimed at operating at least 60 years, will have to take into consideration uranium supply issues
- There is a need for a clear and proved vision of waste management

Nuclear Energy Development

- **To meet the requirements of the 21st century:**
  - **Safety**
  - **Economy**
  - **Waste management**
  - **Uranium resources**
  - **Proliferation resistance**
  - **Implementation in developing countries**

Generations of Nuclear Reactors

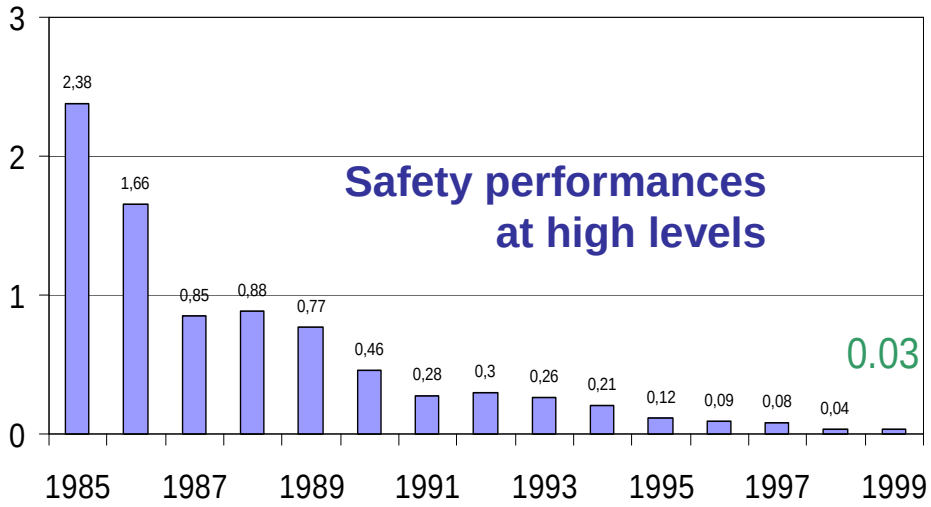




Nuclear : a safe and reliable energy

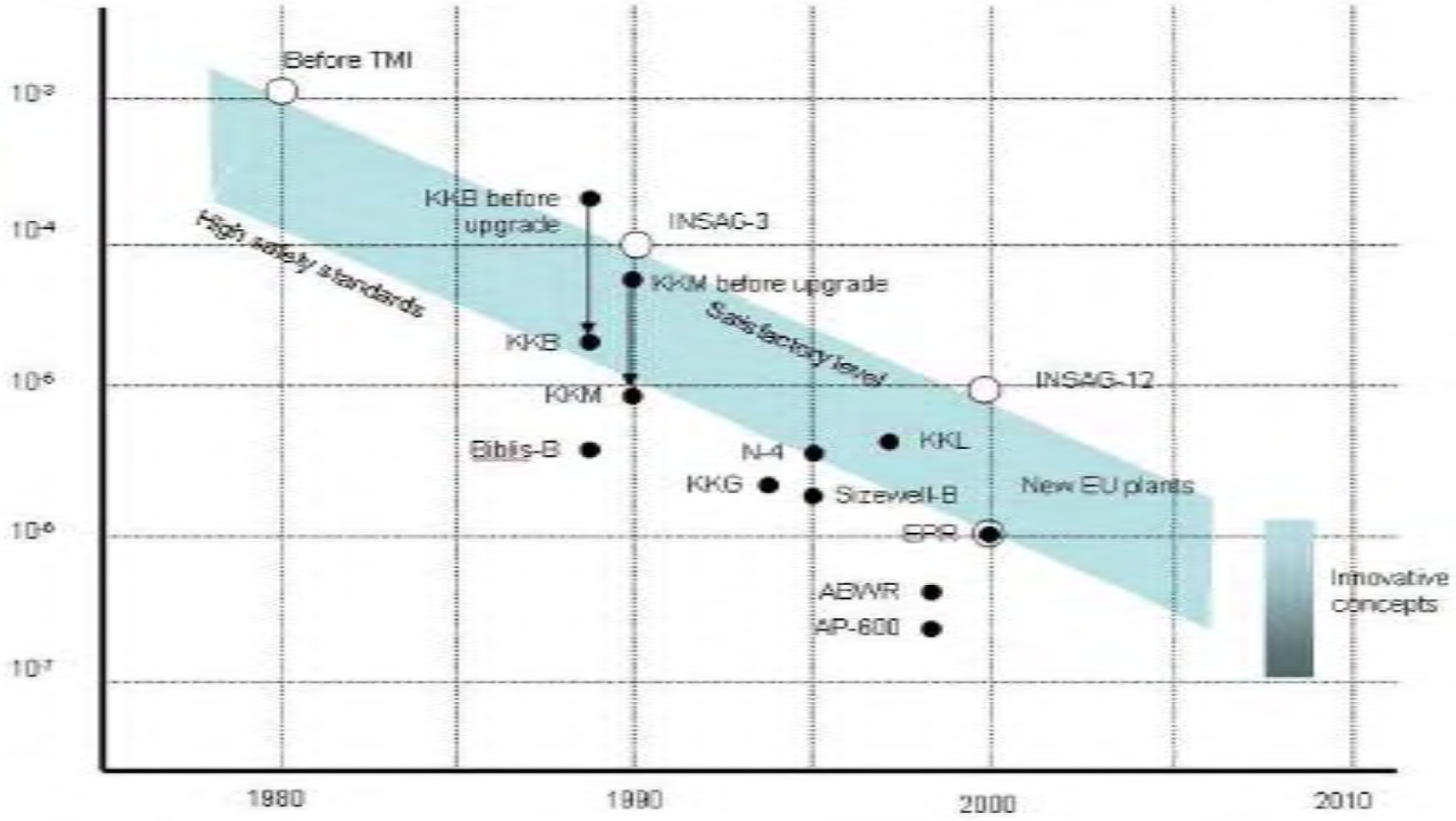
Safety :

- Gen II : satisfactory data for 20 years



- A new step with Gen III reactors
- Gradual improvements to be pursued for Gen IV reactors

Nuclear Safety is still improving



Evolution of the core damage frequency requirement for nuclear plants in Europe

Source: Hirschberg PSI 2005 :

Generation III : Advanced reactors

- A new generation of reactors, the conception of which is based on the feedback experience gained from the operation of Gen II and the Three Miles Island accident

- Light water reactors still predominant

- Main target: improve safety, all while preserving economic competitiveness

- Various approaches were studied and are still competing in the industrial offer: :
  - small vs. big reactors
  - passive safety systems vs. active ones

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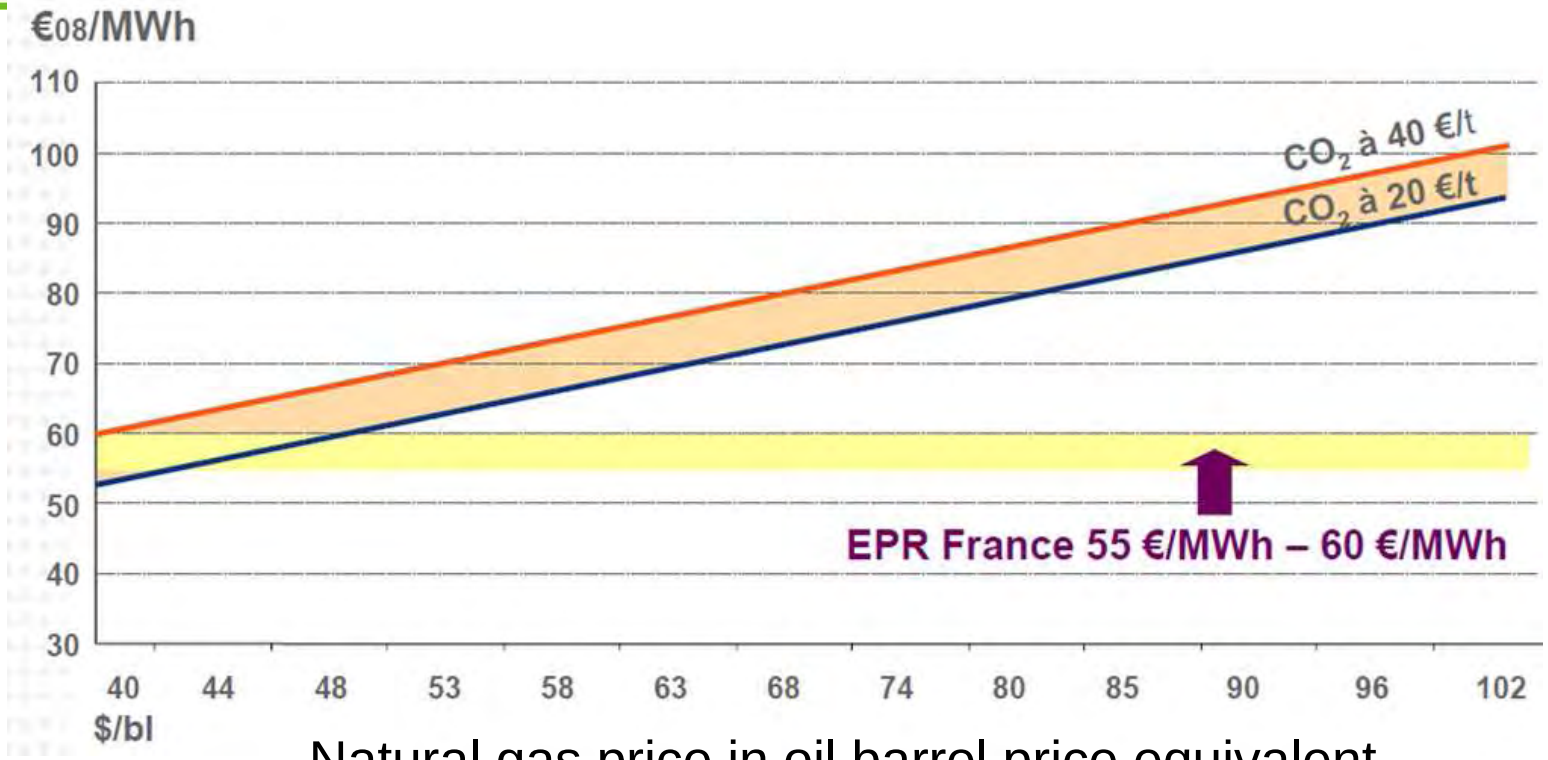
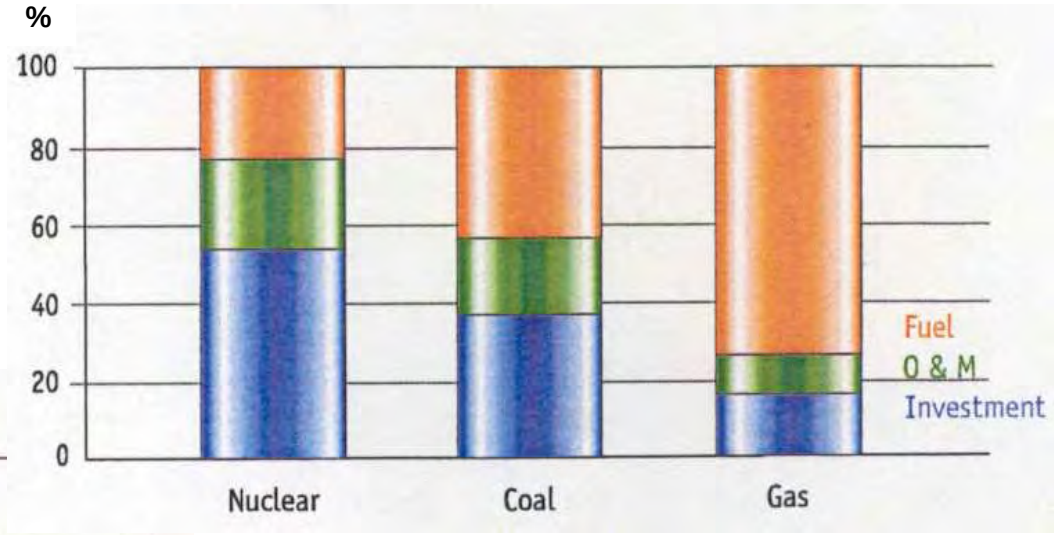
A Competitive Source of Energy

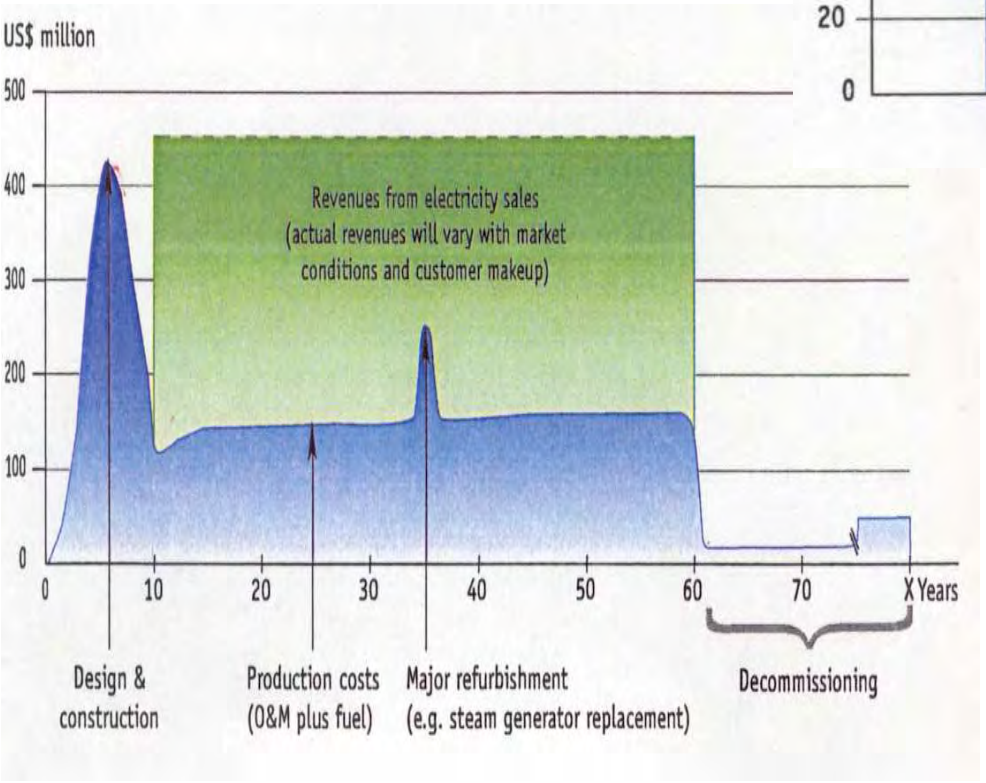
Nuclear energy compared to gas combined cycle
(2015 – base load production)



Natural gas price in oil barrel price equivalent

Nuclear Energy : Economy – capital cost





Nuclear energy :

- **High capital investment costs**
- **Long planning horizons**
- **Low Fuel and O&M costs**

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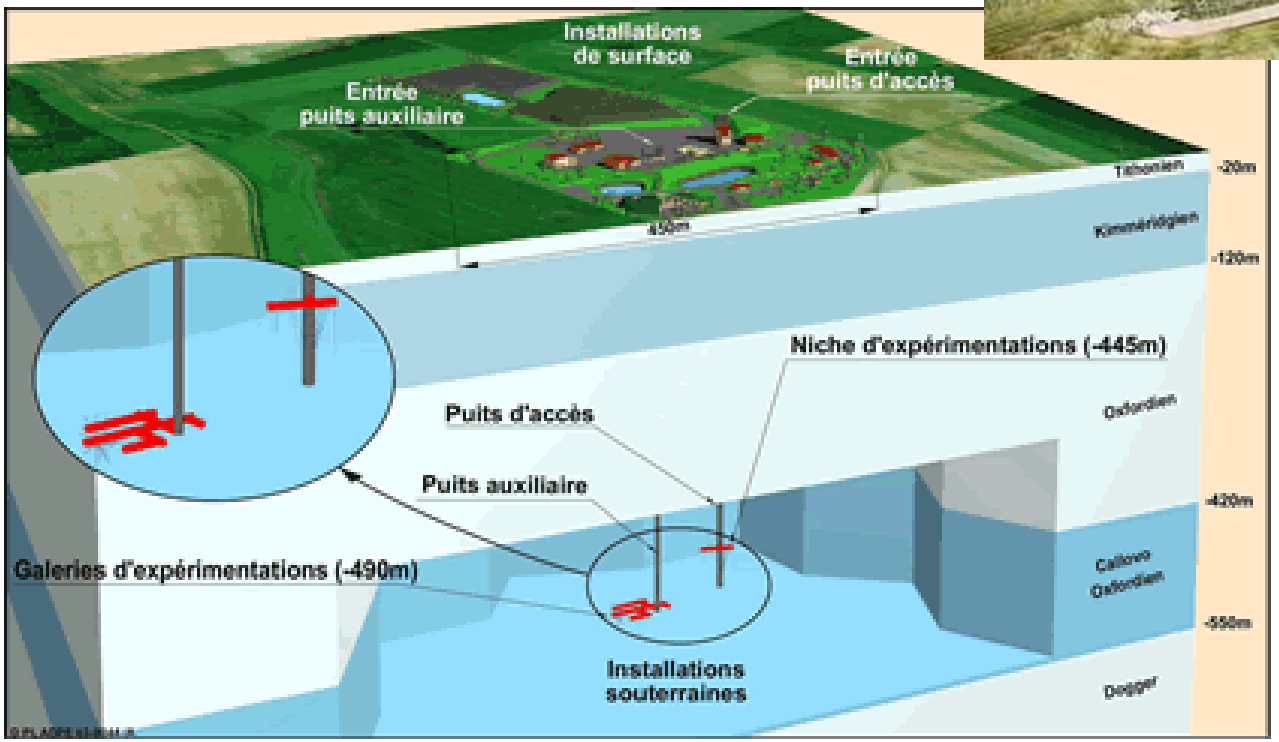
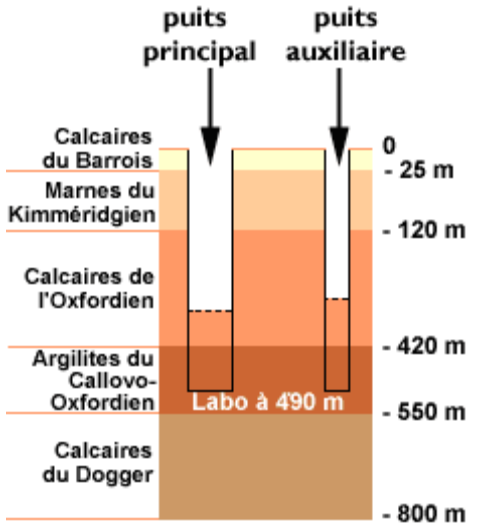
Back End of the Fuel Cycle : Three options

	OPEN CYCLE	CLOSED CYCLE	SNF Interim Storage
PROS	Assumed to be cheaper	Sustainable option	"Wait & See" Policy Easy for immediate decision
	Limits the immediate risk of proliferation	Reduces volume and radiotoxicity of waste	Limits the short term costs
	No immediate release of radioactivity	Industrial experience of reprocessing and recycling	Could be easier for public acceptance
CONS	Non sustainable option	Assumed to be more expensive	"Wait & See" Policy A burden for next generation
	High quantities of long life elements in the waste	Needs improved processes to limit the proliferation risk	Everything remains to be done in the future
	Increased long term risk of proliferation (Pu mine)	Large size plants necessary for economy	The total cost will be much higher

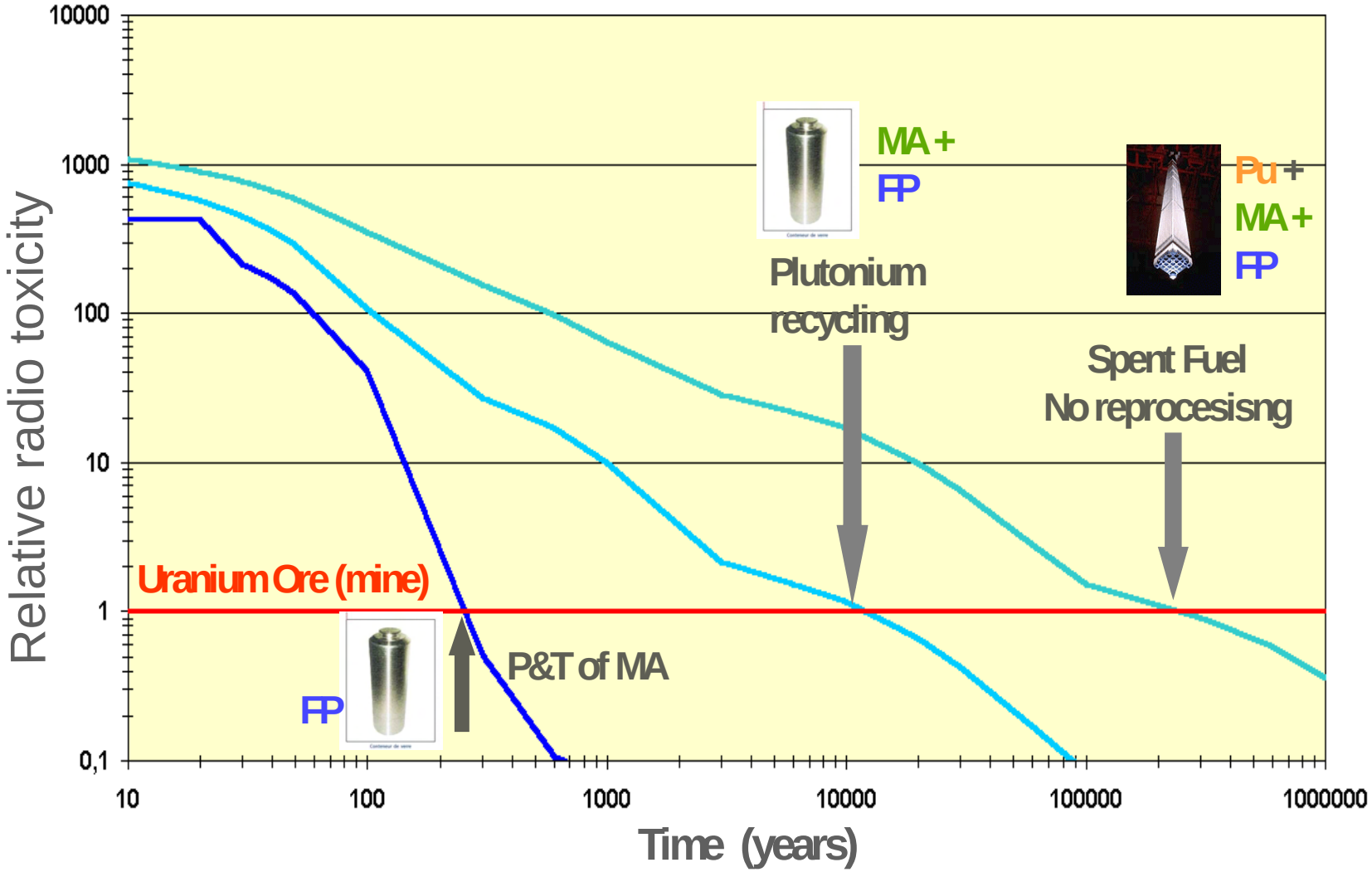
HLLW : Geological Disposal

Underground Laboratory
Bures (France)





Burning Actinides for minimizing waste



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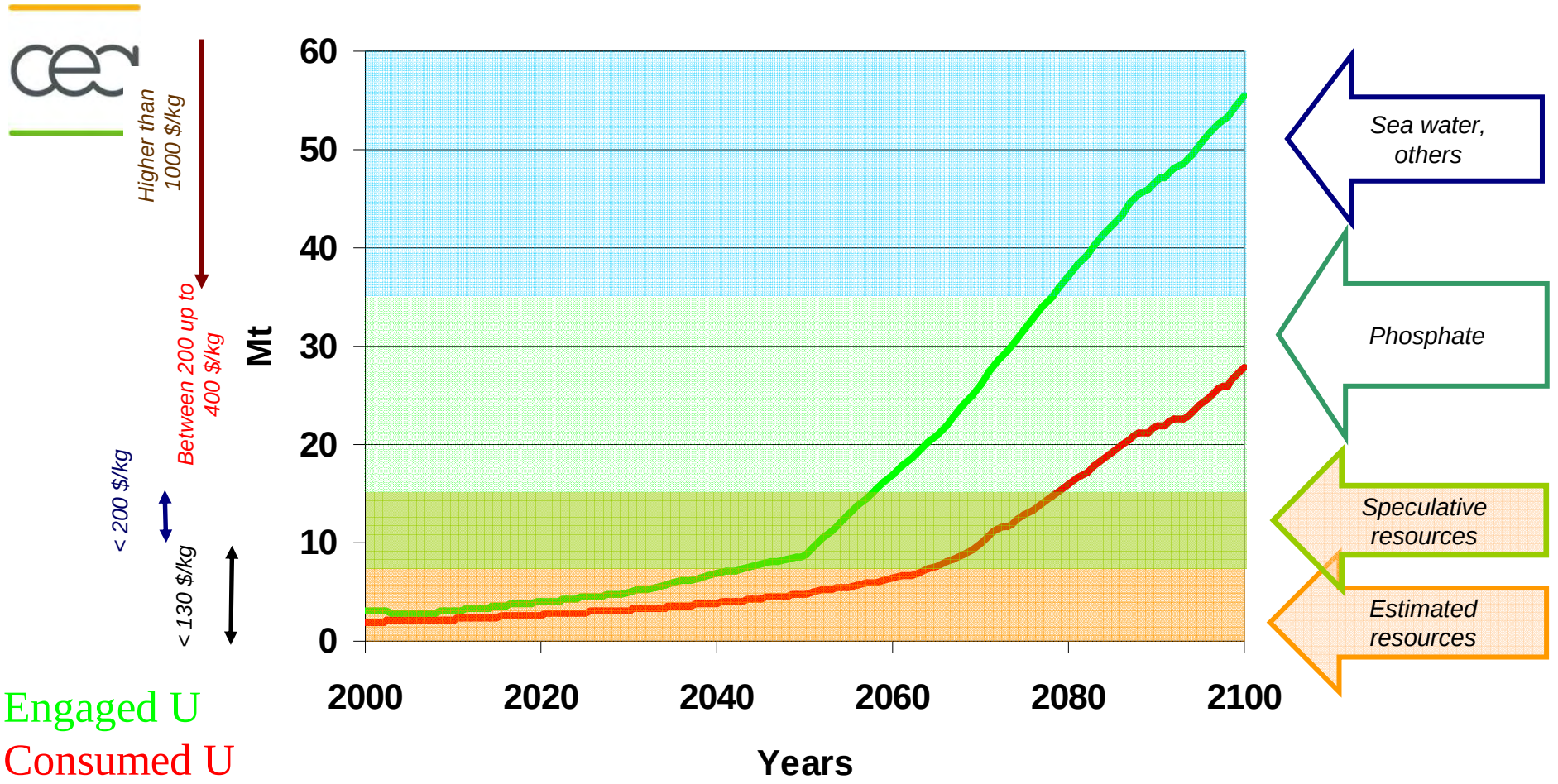
Uranium Needs



IAASA A2 Scenario - PWR only - open cycle

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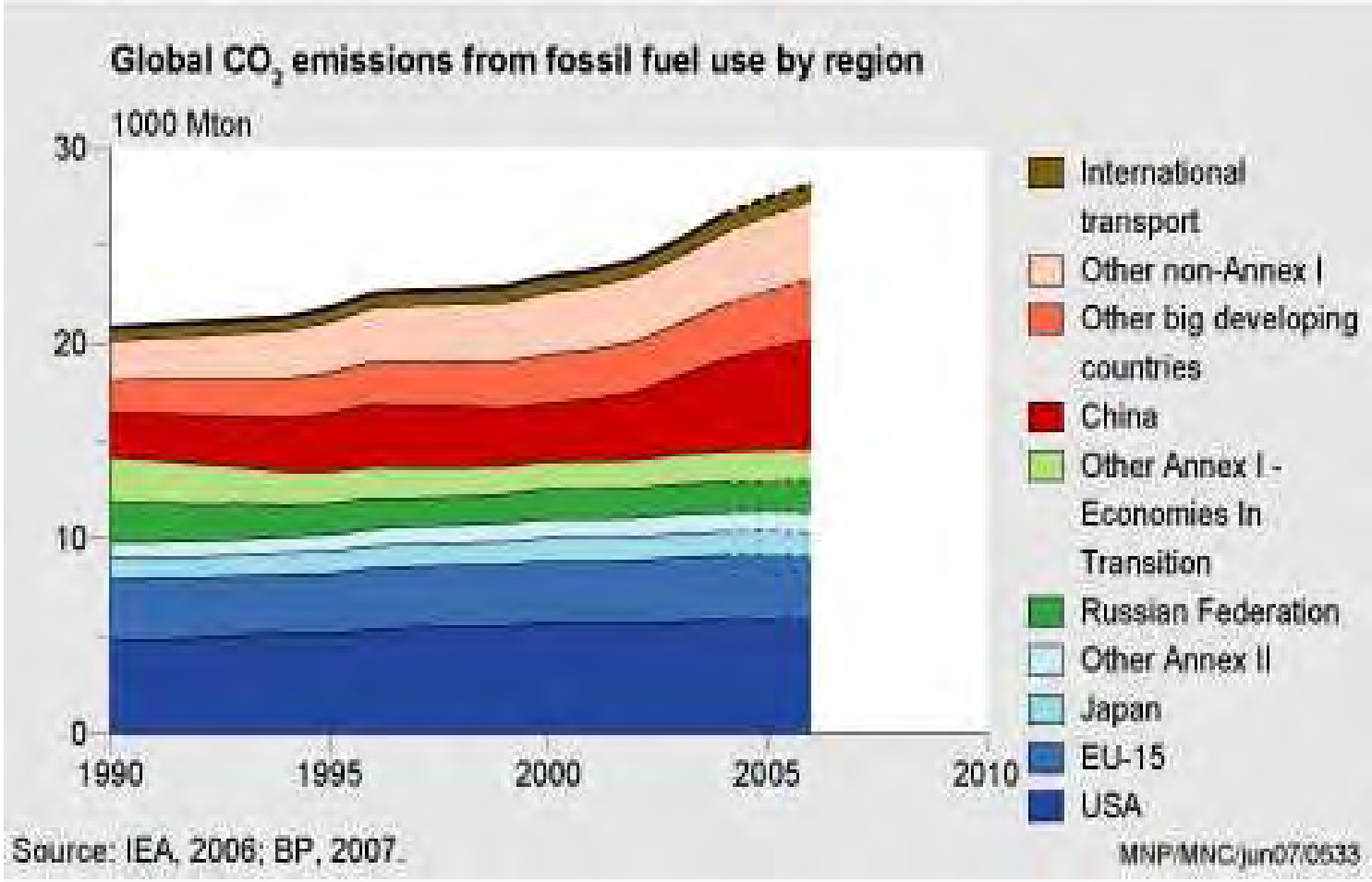
Implementation of Nuclear Energy

- A structuring choice for a country
- A large industrial offer for today and many projects for tomorrow
- **Climate change issues demands that recourse to nuclear energy concern as many countries as possible, within satisfactory limits:**
  - **Large countries already equipped with a nuclear program**
  - **New comers/small countries**

Large Countries already Nuclear

Most countries emit huge amounts of CO2

➔ Urgent Need for Wider Use of Nuclear Energy



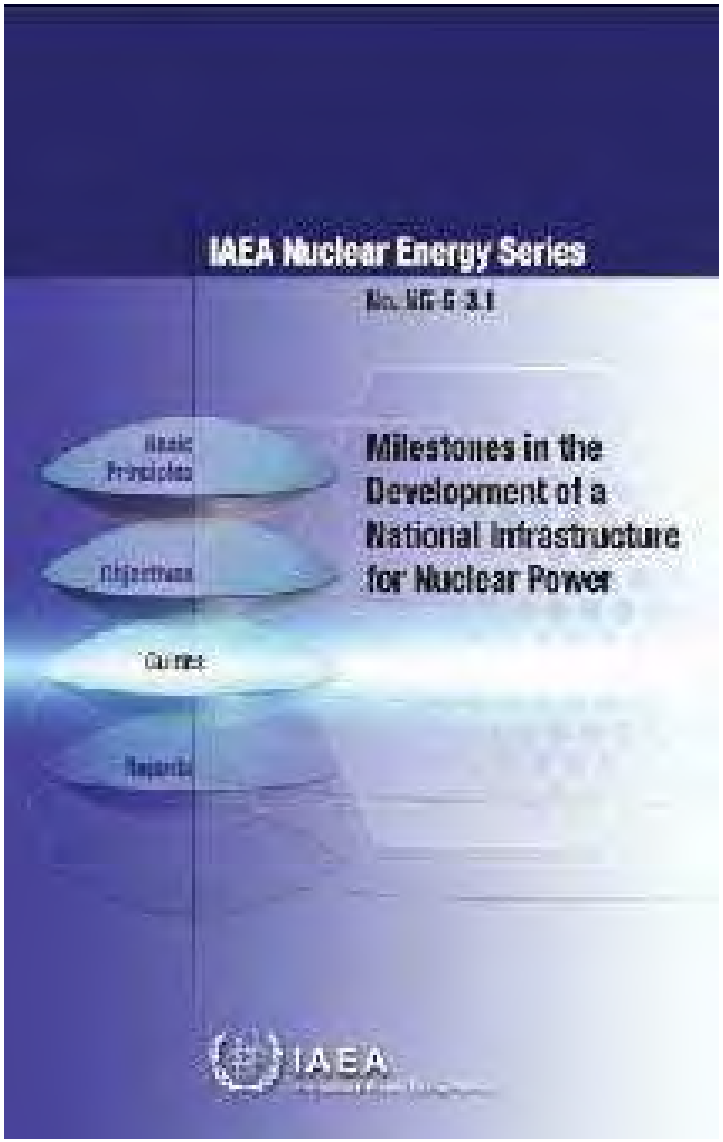
Nuclear Energy for New Comers

- The use of nuclear energy should be extended to allow for economical development while limiting the burning of fossil fuels.

- For its use in new countries, several conditions should be considered:
  - The development of skills and appropriate infrastructures,
  - A clear organization of safety authority,
  - The choice of reactor power adapted to the grid,
  - A robust financial engineering for the entire project.

- A partnership with countries which have already experience in nuclear energy could be worthwhile.

The IAEA Milestones Document



National Position
Legal Framework
Regulatory Framework
Radiation Protection
Financing
Human Resource Development
Safeguards
Security and Physical Protection
Emergency Planning
Nuclear Fuel Cycle
Nuclear Waste
Environmental Protection
Nuclear Safety
Sites & Supporting Facilities
Stakeholder Involvement
Electrical Grid
Management
Industrial Involvement
Procurement