EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

Joint Research Centre

Five GIF criteria
Five International challenges

FR09 – Panel 2

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The Generation IV International Forum (GIF)

- **International initiative (currently 10 members)** to **support R&D**, within a time frame from 15 to 20 years and to reach **technical maturity by 2030**

- **The 5 GIF fundamental criteria :**
  - ✓ **Sustainability**
  - ✓ **Non-Proliferation and physical protection**
  - ✓ **Safety and reliability**
  - ✓ **Minimization of waste production**
  - ✓ **Economics**

The 5 GIF criteria

5 fundamental criteria

ECONOMICS
Competitiveness
Investment cost

SAFETY
Operation/Accidents
Severe conditions

Save natural resources (U, Th)
Reuse (U, Pu) from existing reactors

Minimize Waste production
Integral recycling of actinides

Enhance proliferation resistance
Pu burning,
Integration of fuel cycle

Missions and additional criteria

Electricity generation

Hydrogen production /HT process heat

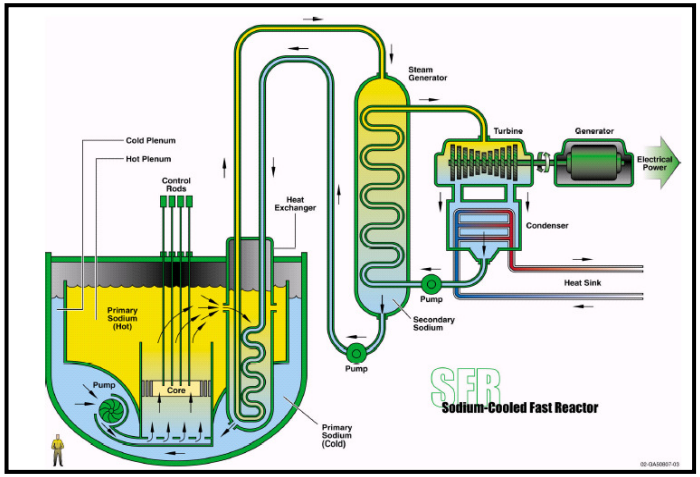
Long-lived radioactive waste burning

High sustainability

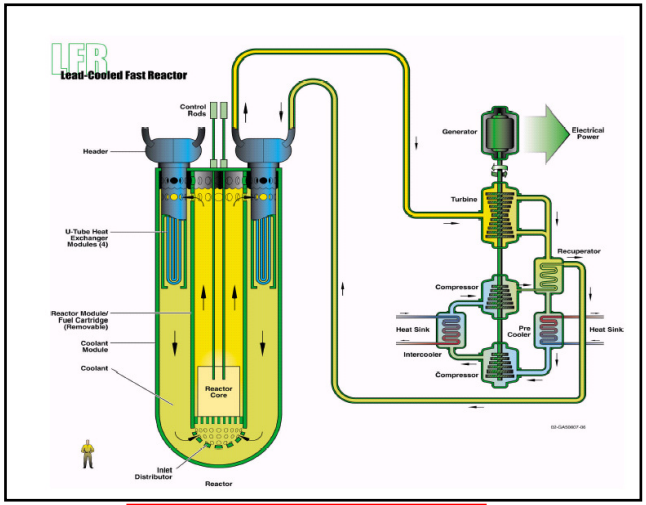
Symbiosis with existing LWRs

Flexible adaptation to diverse fuel cycles

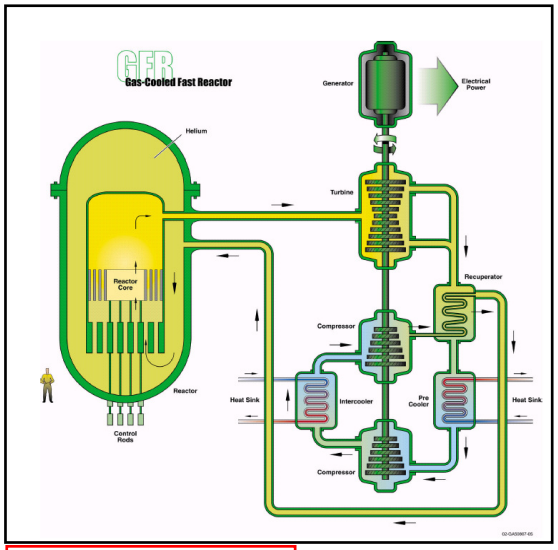
The 4 Generation IV fast systems



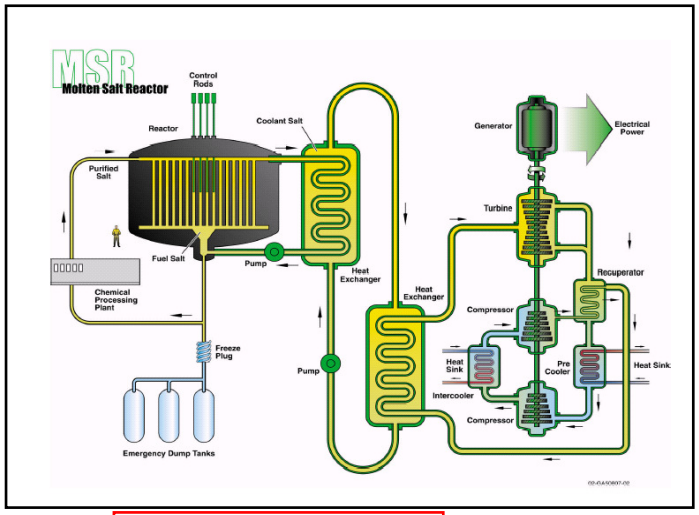
Sodium Fast Reactor



Lead Fast Reactor



Gas Fast Reactor



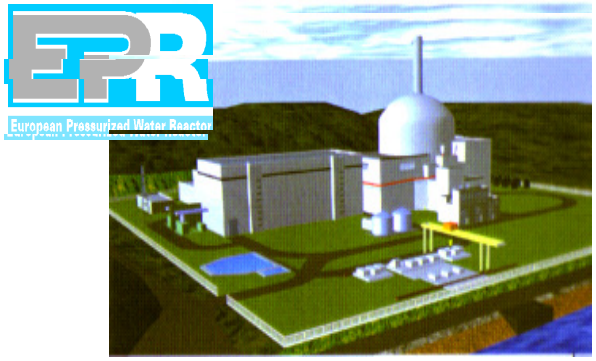
Molten Salt Reactor

The Evolution of Nuclear Power

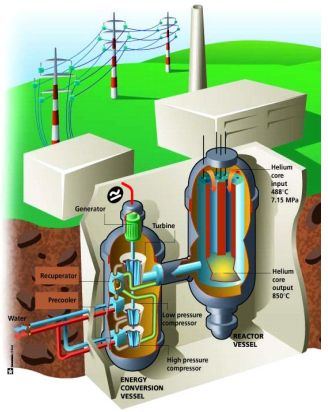
First Reactors (proto-types)

Current Reactors

Advanced Reactors



Future Systems



1950 1970 1990 2010 2030 2050 2070 2090

Generation I

Various types

Generation II

Pressurised Water Reactor
Boiling Water Reactor
900-1300 MW

Generation III

Evolutionary Pressurised Reactor

Generation IV

The sustainability in GIF

I. The Background

- Waste minimisation and better management of natural resources are two of the five GIF criteria.
- Four of the six selected systems are Fast Reactors associated with close cycle.
- Disposal of spent fuels and of long live radionuclides is not considered as sustainable and weakens the role of nuclear energy.

II. GEN IV will open new options

- A new partitioning : U / Pu + Actinides / “new” wastes (without long live radionuclides).
- The “new” wastes could be disposed for a duration of 2 to 300 years – which is technically feasible –their radioactivity should then be reduced at the natural level.
- Pu + Act could be burned in Fast reactors, mixed with depleted uranium. This will ensure an optimisation of natural resources and enhance proliferation resistance.
- Appropriate reprocessing facilities should be attached to Fast reactors.

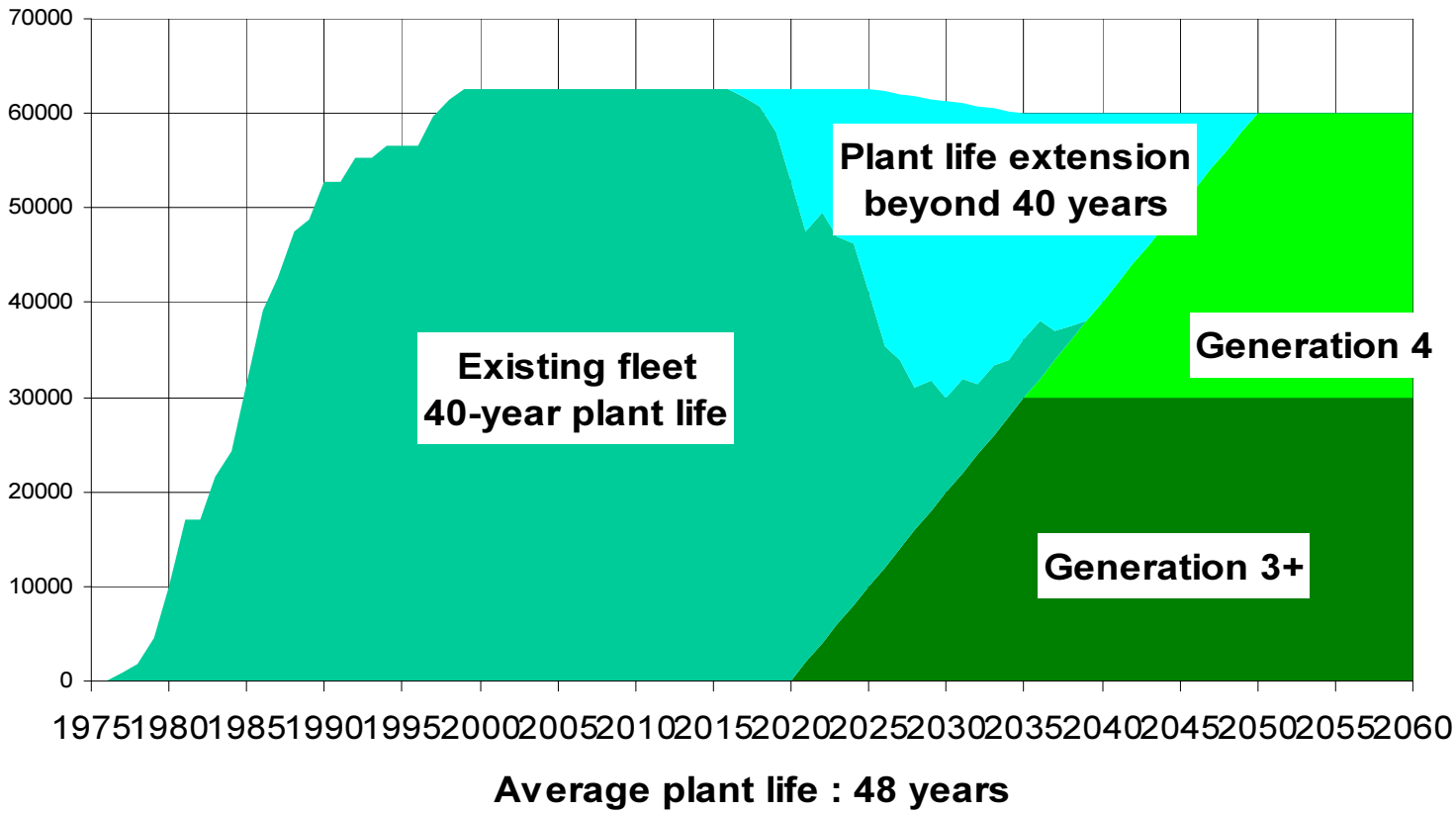
The sustainability in GIF

A possible long term nuclear strategy

- A combination of GEN III+ reactors or some GEN IV, such as VHTR (for hydrogen) or SCWR,
- with Fast reactors acting as both burners and electricity producers (if required breeders)
- and with appropriate reprocessing/recycling facilities

could guarantee a sustainable electricity production for at least the next centuries (probably more).

EDF: exemple de déploiement



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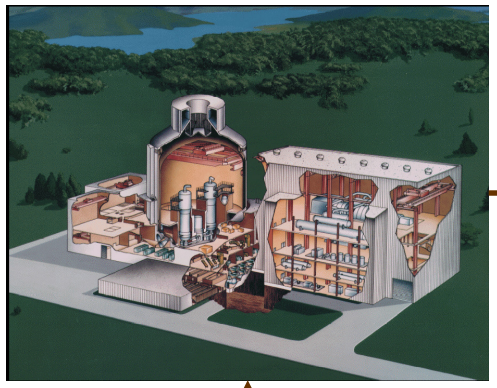
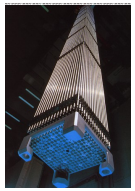
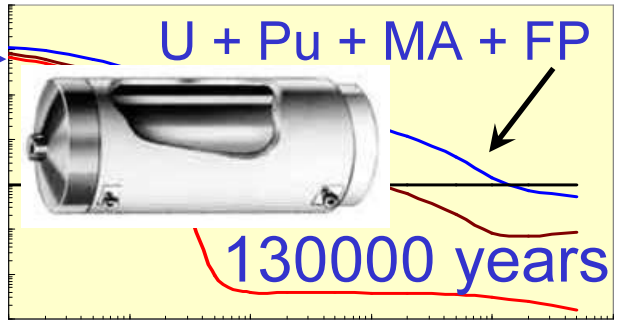
Sustainability, Minimisation and Proliferation Resistance

Gen II / III



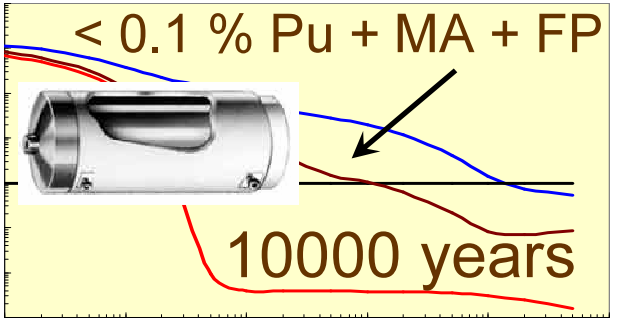
Once Through
Spent Fuel

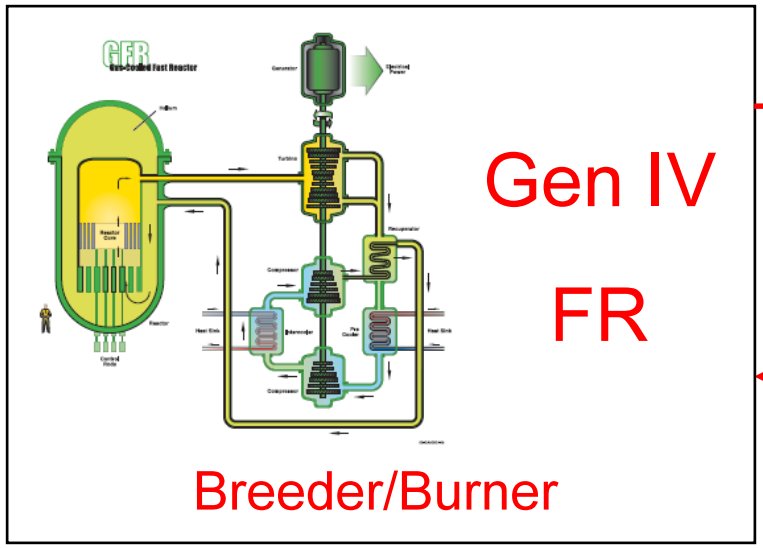




Reprocessing
Vitrification

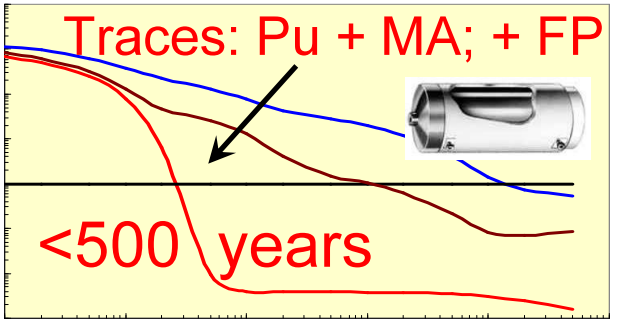
U, Pu





Partitioning
U, Pu + MAs

Fuel Fabrication
Pu + MAs



U consumption ↓

Proliferation Resistance ↑

Radiotoxicity
Volume
Safe Storage Time ↓

Security and non proliferation challenges

Political Action required

- Adherence to NPT with additional protocol to become norm
- Clear consequences for non adherence or withdrawal
- Creation of regional/global security systems for regions with strong tensions
- Develop regime to assure fuel supply and fuel cycle services on non-discriminatory basis
- Support design of future nuclear systems: no weapons usable materials, ease of safeguardability, early provision of information

Institutional (Legal Action)

- Extend IAEA's responsibility to cover weaponisation programmes?
- Strengthen role of IAEA in assurance of supply

Verification system / technological issues

- Maintain integrity and impartiality of IAEA verification system.
- Pursue integrated safeguards
- Detection of clandestine activities in countries remains major challenge

A major challenge: Human capital

All challenges described here above could be taken up if the political will exists, the financial means are available, the necessary staff is available, recruited, educated and trained. The two first conditions are beyond our competence. We can only hope that they will be fulfilled. The last one remains the most challenging

Last but not least: Nuclear Safety

The Convention on Nuclear Safety:

- Ensuring that the use of nuclear energy is safe, well regulated and environmentally sound;
- Reaffirming the necessity of continuing to promote a high level of nuclear safety worldwide
- Affirming the importance of international co-operation for the enhancement of nuclear safety
- **Recognizing the usefulness of further technical work in connection with the safety of other parts of the nuclear fuel cycle, and that this work may, in time, facilitate the development of current or future international instruments**

GIF in the "Nuclear Renaissance"

Once again, Human capital remains a major challenge

Most of countries willing to use nuclear energy have either not built any NPP since many years or have never built any NPP. In the EU, Italy and UK belong to the first group. It might be the case to morrow for Germany or Sweden, while Poland belongs to the second. In all such countries education and training are key issues. Attracting young scientists is essential and GIF should offer opportunities.

Another significant challenge: towards a "Regional" approach

The Euratom Treaty since 50 years, but also ABACC have demonstrated the interest and efficiency of a regional safeguards system. WENRA is the framework of an enhanced cooperation and harmonised approach among European Regulatory Authorities. A careful examination of each GIF criteria is likely to show that the same applies to each of them: **neighbours working with neighbours** (e.g waste minimisation, waste management, etc)… but to this end minds need to be changed and this is probably the most challenging issue.