DE LA RECHERCHE À L'INDUSTRIE

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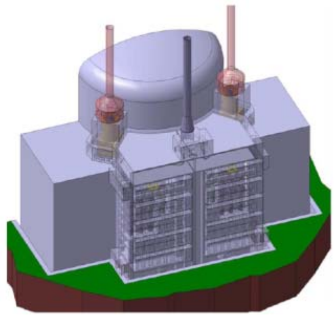
PRESENT STATUS OF FRENCH PROGRAM ASTRID

JAPAN FRANCE COOPERATION

EXPECTATIONS ON MONJU

MONJU



ASTRID

ALAIN PORRACCHIA

DIRECTOR FOR INNOVATION AND INDUSTRIAL SUPPORT

CEA/DEN

WHY TO CHOOSE A FAST NEUTRON REACTOR ?

Three main reasons:

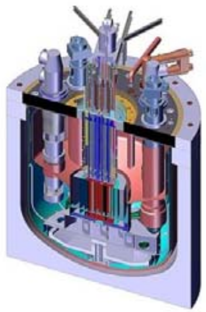
- Mastering, through recycling, the growth of Plutonium inventory

- Excellent use of uranium resource
  - Unlike reactors currently in operation or construction worldwide, that use only about 1% of natural Uranium, Fast neutron Reactors are able to use more than 80% of the Uranium resource.
  - The current stockpile of depleted Uranium available in France could feed the current needs of electricity production for several 1000 years.

- Ability to transmute and burn minor actinides

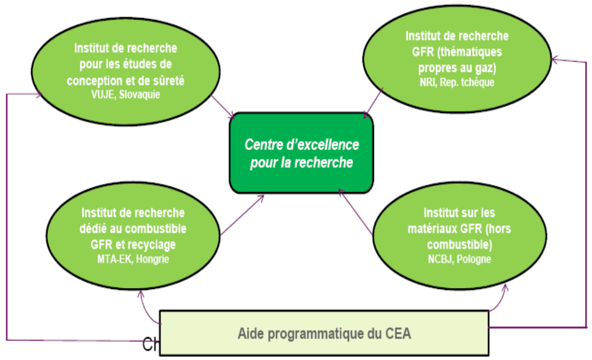
Two types of Fast Neutron Reactors have been selected in France:

- **Cooled by sodium** : the reference
  - The ASTRID Project

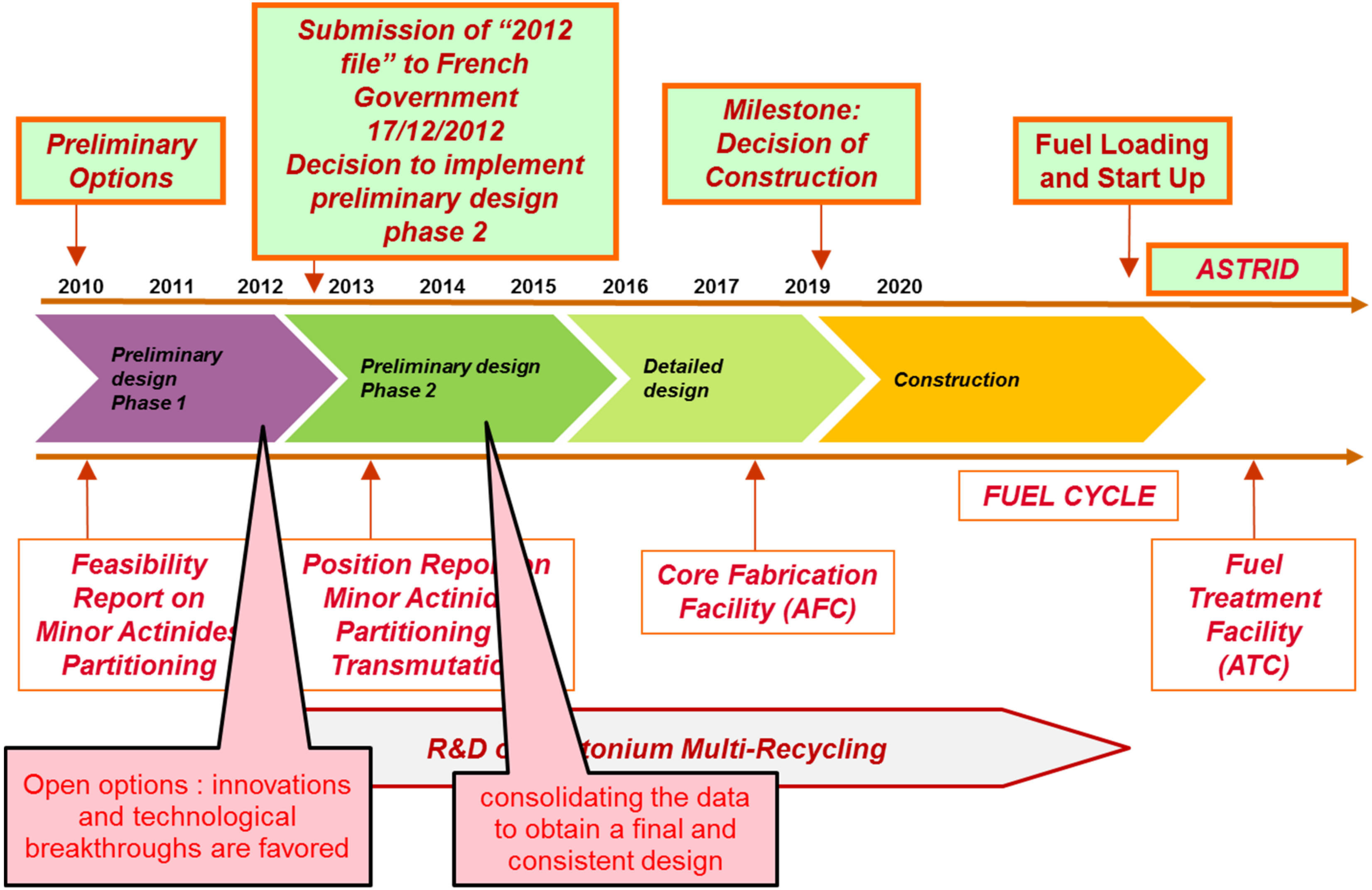


- **Integrated Technology Demonstrator**
- **600 MWe**
- **4^{th} generation reactor**

- **Cooled by gas** : the prospective route
  - The ALLEGRO Project, a project embodied through a consortium in central Europe
  - CEA Associated to the Consortium



ASTRID AND FUEL CYCLE SCHEDULE



2006 FRENCH ACT : *THE 2012 MILETSONE*

2006 ACT:

December 2012: CEA to issue a report to the French government *about "industrial perspectives" of advanced recycling options*

THE REPORT ISSUED BY CEA:

T1 : The guidelines for a sustainable management of nuclear material and waste (and gen4 systems)

T2 : Separation and transmutation of long-lived waste

T3 : The sodium-cooled fast reactor (and ASTRID demonstrator program)

T4 : Other fast neutron generation IV systems (and ALLEGRO experimental reactor project)

T5 : Executive summary

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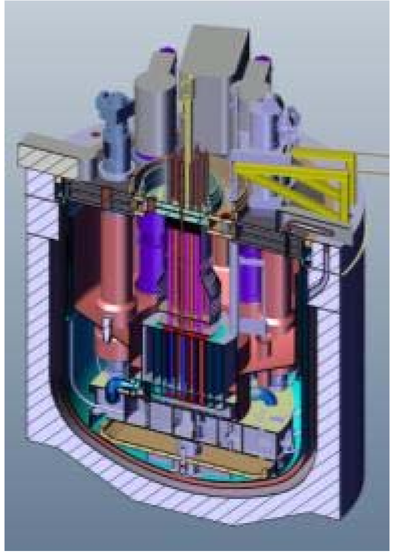
Executive Summary available in English end of May

GENERAL FRAME OF THE ASTRID DESIGN

- ASTRID will be designed using lessons learnt from the Fukushima-Daichi accident
- The design benefits of feedback of Sodium-cooled fast neutron reactors
  - Favorable intrinsic features to cool-down the reactor: Large thermal inertia; Diversified heat sinks; Natural circulation; Ability to guarantee a minimum sodium level.
- Safety objectives of ASTRID are derived from the WENRA* document "Safety objectives for new nuclear power plants".
  - It summarizes the highest safety standards, even for Fukushima-like initiators. Former ***Beyond Design Basis Accidents*** are included in the design.

**Western European Nuclear Regulators Association*

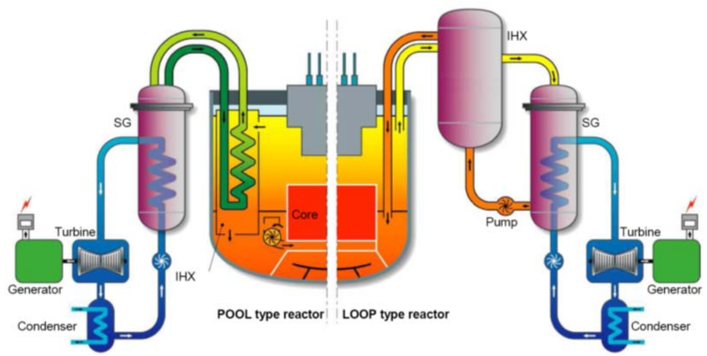


- Safety requirements are checked with the Generation IV International Forum Safety Design Criteria

PRELIMINARY DESIGN CHOICES / OPEN OPTIONS
(AS FOR APRIL 2013)

Main features

- 1500 thMW - ~600 eMW
- Sodium cooled pool type reactor
- 3 Primary pumps, 4 IHX
- 4 Secondary sodium loops with EMPs
- Oxide fuel UO_2-PuO_2
- High level expectations in terms of safety demonstration
  - Preliminary strategy for severe accidents (core catcher…)
  - Diversified decay heat removal systems
- Fuel handling in sodium
- ….



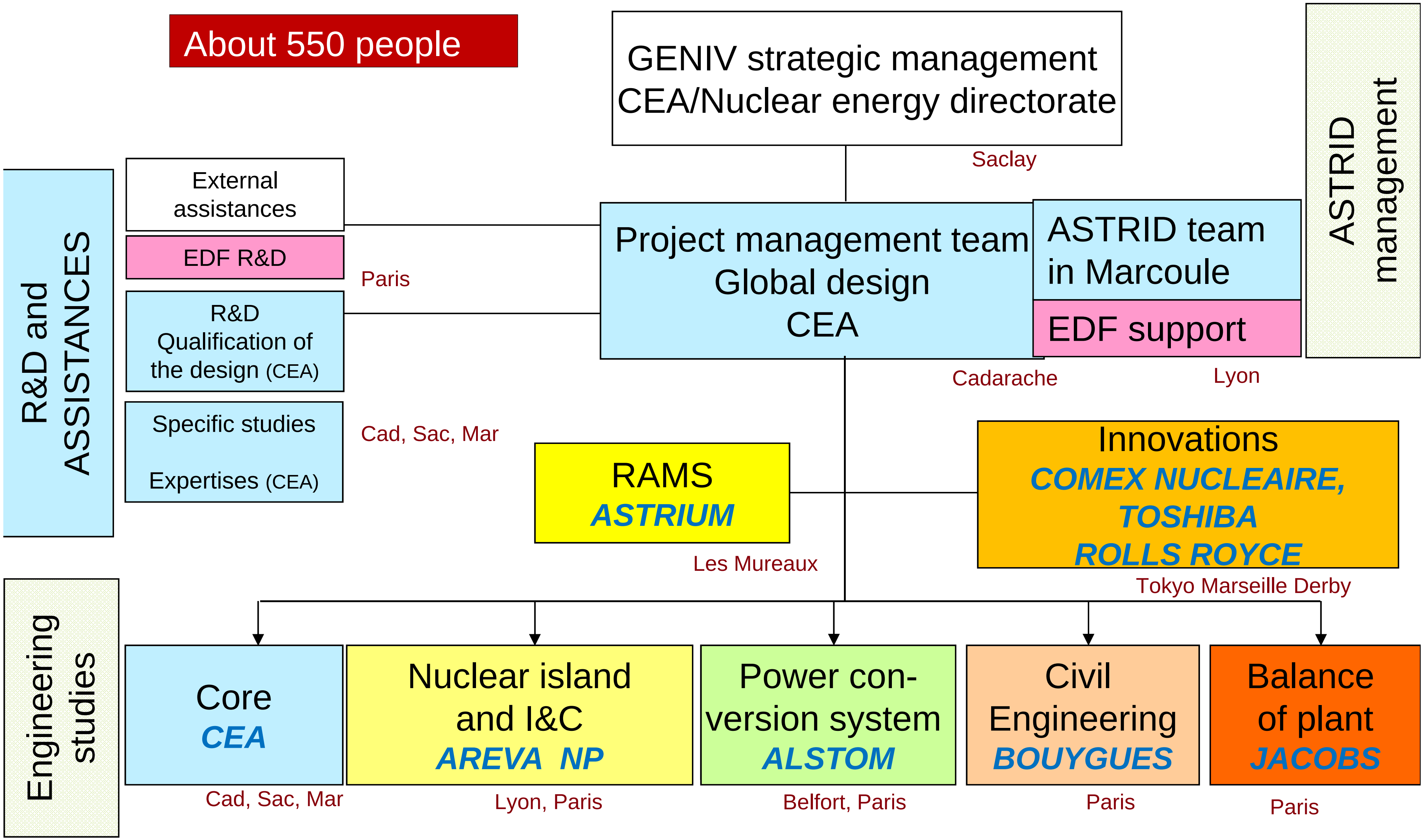
Open options

- Core design
- Energy conversion system
  - water/steam or
  - N2 (reference today)
- Complementary devices for improved prevention of severe accidents (i.e. 3rd shutdown level)
- Core catcher design and materials
- SGs or Sodium-Gas HX design and materials
- Innovative technologies for Na fires detection and mastering
- Type of I&C

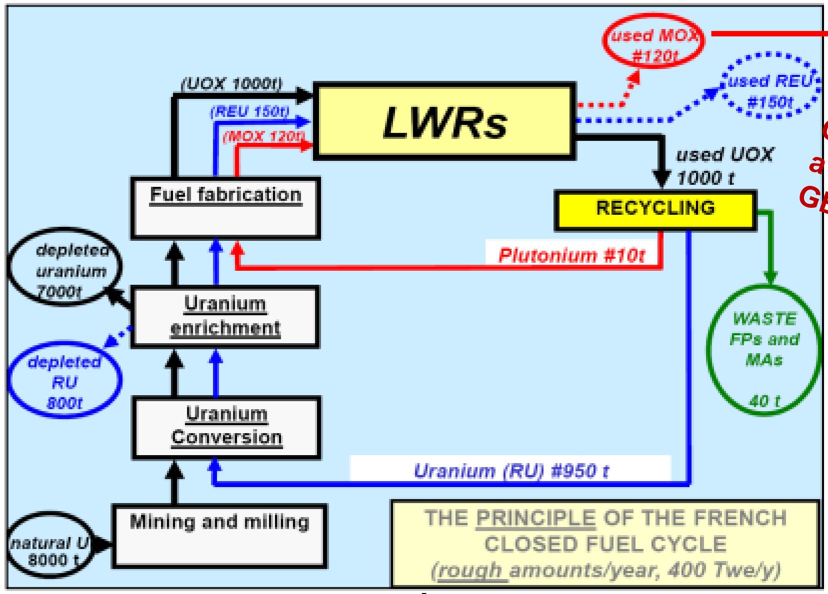
Innovative options to be tested

- Carbide fuel
- SiC-SiC materials
- …

ASTRID PROJECT INDUSTRIAL ORGANIZATION

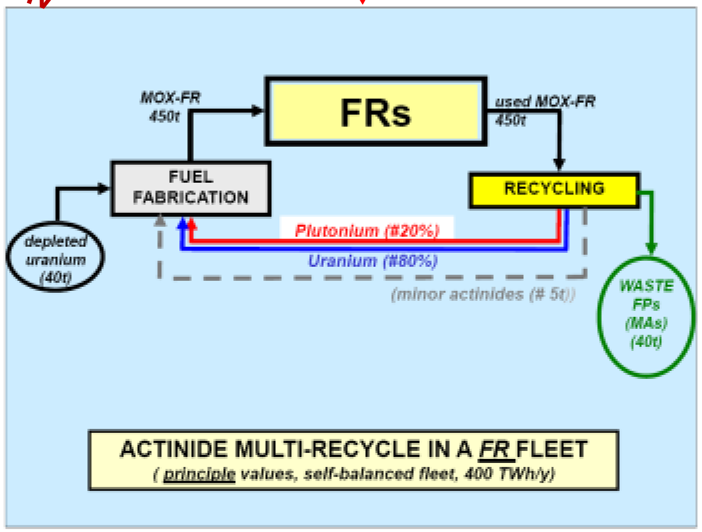


FROM LWRs RECYCLING TO FRs RECYCLING



Current technologies: a bridge between GEN II/III and GEN IV

Pu stored in MOX Spent Fuel recycled in MOX SFR to start the SFRs deployement



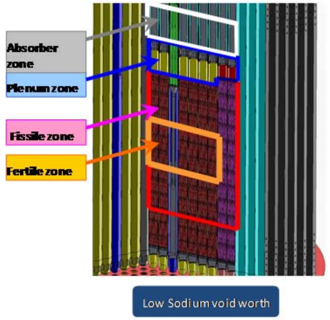
Scenario can be flexible

Both systems can coexist during a transition phase

- FNR merits as regards to fuel cycle
  - No front end steps and no enrichment technology
  - Use depleted U; **Use Pu included in MOX Spent Fuel**
  - **Multi-recycling of Pu**
  - **Possible recycling of Minor Actinides**

Possible irradiation in Monju ?

Three areas of cooperation



-1. Astrid Fuel

-2. Sharing Programs and Infrastructures

-3. Participation to Astrid R&D and Studies


Monju


Joyo


RJH

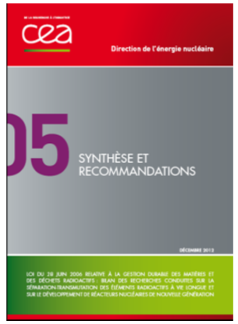
A Comprehensive Cooperation Program under construction

And already long term story beween Japan and France on Sodium Fast Reactors

MONJU ROLE / FRANCE VIEW

NEEDS

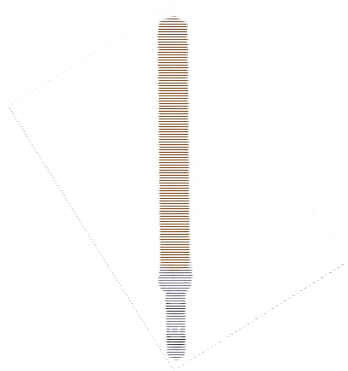
- ASTRID DRIVER FUEL QUALIFICATION
- PLUTONIUM MULTIRECYCLING QUALIFICATION
- MINOR ACTINIDES TRANSMUTATION
  Trilateral Framework with US (GACID and New GACID)



Mentioned in the national report released end 2012

Strong Expectations on Large Scale Irradiations Programs

- Full Size Pin
- Bundle
- Sub-Assembly



Thank you

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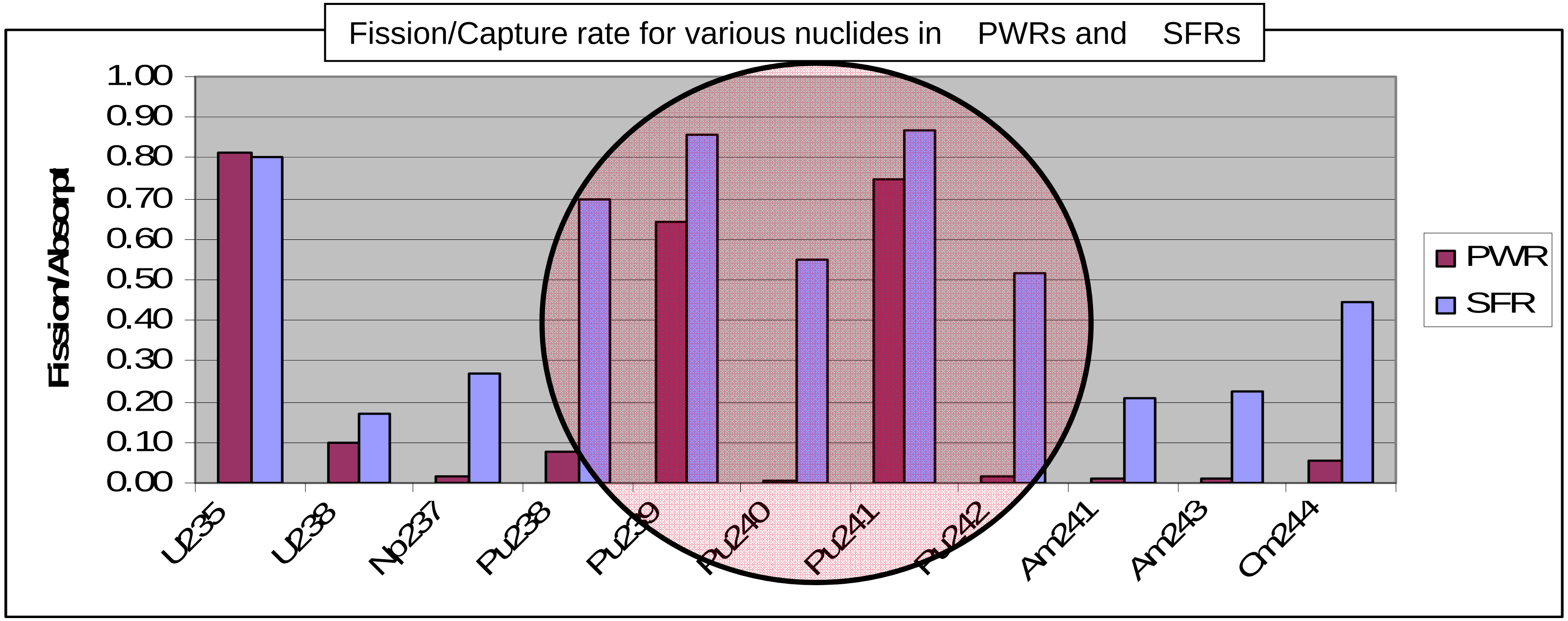
Nuclear Energy Division

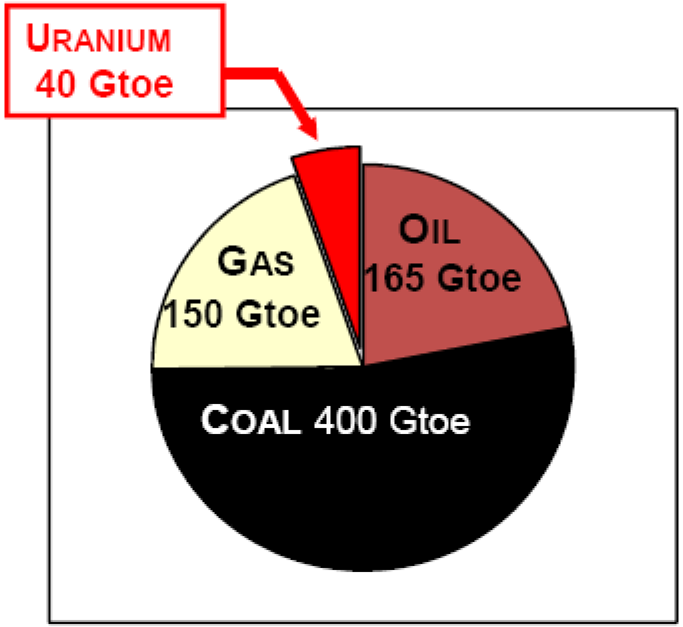
1. KEEP ON RECYCLING in NUCLEAR SYSTEMS
2. IN FAST REACTORS

Because of these main merits :

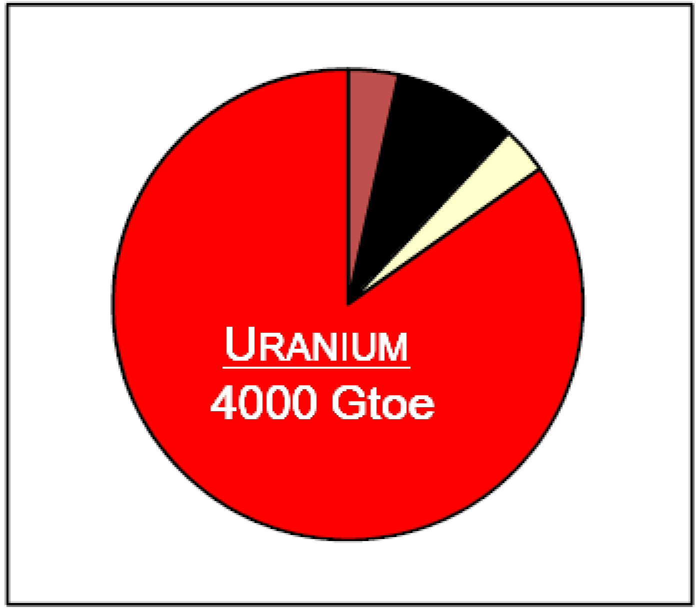
- EFFICIENT BURNING OF PLUTONIUM
- NO NEED FOR NATURAL URANIUM
- POTENTIAL FOR IMPROVING WASTE MANAGEMENT



A BETTER USE OF URANIUM 238



Uranium use in
<u>current reactors</u>



Uranium use in
<u>4th generation reactors</u>

Source : WEC, 2010 Survey of Energy. (Coal: 860 Gt, Oil: 163 Gt, Gas: 185 Tm3, Uranium : 3,5 Mt)

RADIOACTIVE WASTE OF GENERATION IV SYSTEMS