EU Strategy in Partitioning & Transmutation and its Implementation within the EURATOM Framework Programmes

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SEVENTH FRAMEWORK PROGRAMME

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OUTLINE

- Introduction
- EU Strategy in P&T
- Implementation within the EURATOM Framework Programs
- Conclusions

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European Union (EU) Nuclear Research Activities

- EU nuclear energy research and training activities are carried out under the European Atomic Energy Community (EURATOM) treaty (Rome 1957)
- Implementation of EU nuclear energy strategy requires research and development of new technologies in a variety of areas.
- Framework Programs of the European Union have been a very fruitful tool to channel the 27 Member States' common research funds in areas of European–wide interest especially where European added-value dominates.
- International collaboration (outside EU) is an important policy element of the EU Framework Programs.

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Euratom Framework Programs

- European Community research has been organised in Framework Programmes (FP) of durations of 4-5 years since 1984.

- FP3: 1990-94, FP4: 1994-98, FP5: 1998-02
- FP6: 2002-06 FP7: 2007-11 (possibly to 2013)

- Organisation of Euratom Activities is as follows:
  - ➔ Fusion Energy Research
  - ➔ Nuclear Fission and Radiation Protection
  - ➔ Nuclear Activities of EC Joint Research Centre (JRC)*

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* Activities implemented by JRC are known as 'direct actions'.

EURATOM Framework (FP) Programs Budget

	FP6 (2002-06) M€	FP7 (2007-11) M€
• Fusion Energy Res	824	1947
• Fission & Rad Prot	209	287
• JRC's Nuclear Activity	319	517
Total	1352	2751

*FP research is only about 6 % of the entire EU effort

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Sustainable Nuclear Energy Technology Platform (SNE-TP)

(launched in September 2007)

- **A framework to unite all stakeholders (public-private partnership) around a common vision of sustainable nuclear energy technology research**
- **Mobilisation of a critical mass of research and innovation effort**
- **Definition of a Strategic Research Agenda**
- **Research directions:**
  - ➔ **Gen II and Gen III needs**
  - ➔ **Process Heat, Electricity and H_2**
  - ➔ **Advanced Fuel Cycle and Gen IV systems**

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EURATOM FP7 (2007-11)
Nuclear Fission & Radiation Protection

Radioactive Waste Management - **Geological disposal** of long-lived radioactive waste and the reduction of toxicity of radioactive waste through **partitioning & transmutation**

Reactor Systems- Operational safety of existing reactor systems and the potential of future reactor systems for safer, more efficient power plants and competitive nuclear industry

Radiation protection – especially risks from low doses, medical uses, emergency management etc.

Key cross-cutting activities:

- Support for **research infrastructures**
- **retaining competences and know-how** in all areas of nuclear science

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EU Strategy in P&T for Sustainability of Nuclear Energy

- **Once-through cycle** ('disposal of spent fuel as it is') does **not** appear to be **sustainable**!
- **Reprocessing** of the spent fuel and **transmutation** of Minor Actinides in **dedicated devices** reduces 'radio-toxic inventory' of the disposed waste in geological repositories.
- It has significant importance in **non-proliferation** strategy and radiological terrorism and reduces risks in case of an **inadvertent 'human intrusion'**.
- A **double-strata approach** with Sub-critical Accelerator Driven Systems (**ADS**) and/or Critical **Fast reactors** is being considered. A decision on the choice is planned in a couple of years.
- **Geological disposal** of the remaining waste (separation/transmutation losses) will be required

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Waste Management Strategy for sustainability of nuclear energy

- **Separation** of main heavy metals reduces the volume and thermal output and extraction of heat-bearing (Sr and Cs) components permits a **reduction** in the needed **size of the repository** except possibly in salt-media which does not need this separation.
- **Transmutation** can **reduce the half-life** of most of the waste to be disposed of to a couple of hundred years overcoming the concerns of the public related to the long-life of the waste thus aiding the GD community in securing a **'broadly agreed political consensus'** of waste disposal in geological repositories.
- **Additional cost, additional secondary waste, activation products and ILW and dose to workers** in the process of Reprocessing and Transmutation itself will contribute to defining an optimal transmutation scheme.
- P&T has an added value of **training many researchers** in nuclear science and contributes to retaining of competence.
- Though the maximum eventual **'dose'** to human beings from a geological repository **in normal scenarios** is likely to be due to **fission products**, some evidence is appearing that minor actinides are also mobile.

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Waste Management Strategy for sustainability of nuclear energy

- Generation IV safe advanced nuclear reactor concepts that burn waste and produce fuel for further use are gaining increased attention as a possible future course of action.
- It is clear that reprocessing of the spent fuel for a sustainable nuclear energy and fuel cycle would be required no matter what path of transmutation is followed.
- Efforts for the advanced partitioning processes should be reinforced towards pilot and test facilities for optimised separation processes in close cooperation with fuel fabrication teams and geological disposal (GD) community.
- The GD community should embrace the opportunity offered by P&T to ease the acceptance of geological repositories by society and make the best use of accepted sites by removal of long-lived and heat producing radio-nuclides from the waste.
- The GD community should especially take into account the requirements and accommodate the waste streams emanating from the advanced (minor-actinide) reprocessing systems with a view to transmutation whether in sub-critical or critical devices.

Implementation of P&T

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FP6 Projects

P&T Roadmap
- PATEROS

Transmutation of High Level Nuclear Waste in an ADS
- EUROTRANS
  - System Analysis of an ADS:
    - Integrated design
    - Cost, safety and licensing issues
    - Reliability of accelerators for ADS
  - Experiment: Coupling of ADS components
  - Materials and coolant technologies
  - Advanced fuel and Targets
  - Basic nuclear data
  - Education and Training

Impact of P&T on Waste Management
- RED-IMPACT

Critical Systems & Technologies
- ELSY-LFR
- PUMA-HTR

Partitioning Technologies
- EUROPART

Innovative Fuels
- LWR-DEPUTY

Nuclear Data
- EFNUDAT
- CANDIDE
- NUDAME

Networking HLM EU Infrastructures
- VELLA

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EURATOM FP6 P&T Projects Underway

SN	Acronym	Abbreviated Title	Budget (M€)		Co-ordinator	Start Date End date	Remarks
			Tot	EC			
1	PATEROS	P&T European Road-map	0.8	0.6	SCK/CEN (BE)	01/09/2006 31/08/2008	
2	RED-IMPACT	Impact study of P&T on Waste management	3.9	2.0	KTH (SE)	31/03/2004 30/09/2007	
3	EURO-PART	Partitioning techniques and processes	11.2	6.0	CEA (FR)	01/01/2004 30/06/2007	A new project ACSEPT has started
4	EURO-TRANS	All Aspects of Transmutation by sub-critical ADS	45.0	23.0	FZK (DE)	01/04/2005 31/03/2010	A new project GETMAT has started
5	ELSY	Waste transmutation in Lead Cooled critical system	6.9	2.95	ANSA-LDO (IT)	01/09/2006 31/08/2009	
6	PUMA	Pu and MA Management by thermal Gas-cooled system	3.7	1.85	NRG (NL)	01/09/2006 31/08/2009	
7	VELLA	Networking of lead loop infrastructures in Europe	3.3	2.3	ENEA (IT)	01/10/2006 30/09/2009	
8	LWR-DEPUTY	LWR fuels for deep burning of Pu in thermal systems	2.4	1.25	SCK/CEN (BE)	01/08/2006 31/07/2009	
9	EFNUDAT	Networking of EU facilities for nuclear data	3.0	2.4	CNRS (FR)	01/11/2006 31/10/2010	
10	CANDIDE	Networking of Nuclear data for EU Industrial Development	0.8	0.8	UU (SE)	01/01/2007 31/12/2008	
11	NUDAME	Trans-national access for nuclear data	0.2	0.2	EC-JRC (IRMM)	01/04/2005 31/03/2008	
		Totals	81.0	43.5			

EURATOM FP7 P&T and Advanced Reactor Systems Projects

SN	Acronym	Title	Budget (M€)		Coordinator	Start Date End Date
			Total	EC		
	FP7-2007 Call					
1	ACSEPT	Actinide Recycling by Separation and Transmutation	23.8	9.0	CEA (FR)	01/04/2008 31/03/2012
2	GETMAT	Gen IV and Transmutation Materials	14.0	7.5	FZK (DE)	01/03/2008 29/02/2013
3	F-BRIDGE	Basic Research for Innovative Fuel Design for Gen IV Systems	10.2	5.4	CEA (FR)	01/03/2008 29/02/2012
4	CARBOWASTE	Treatment and Disposal of Irradiated Graphite and other Carbonaceous Waste	12.0	6.0	FZJ (DE)	01/04/2008 31/03/2012
5	EUFRAT	European Facility for Innovative Reactor and Transmutation Neutron Data	0.5	0.5	JRC-IRMM (Mol-BE)	01/10/2008 30/09/2012
6	JHR-CP	Jules Horowitz Reactor-Collaborative Project	3.4	1.75	CEA (FR)	01/09/2008 31/08/2009
	FP7-2008 Call					
7	ACTINET-I3	ACTINET Integrated Infrastructure Initiative	~6.0	~3.0	CEA (FR)	Under Negotiation
8	CP-EFSR	Collaborative Project on European Sodium Fast Reactor	~11.5	~5.8	CEA (FR)	Under Negotiation
9	FAIRFUELS	Fabrication and, Irradiation and Reprocessing of Fuels and Targets for Transmutation	~6.5	~3.0	NRG (NL)	Under Negotiation
10	CDT	Central Design Team for a Fast Spectrum Transmutation Experimental Facility	~5.0	~2.0	SCK/CEN (BE)	Under Negotiation
		Totals	~92.9	~44.0		

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P&T and Advanced Systems Planned Topics for FP7-2009 and 2010 Call for Proposals

- **FP7-2009 Call**
  - ➔ Improved Nuclear Data for Advanced Reactor Systems
  - ➔ Thermal Hydraulic Issues and Computational Fluid Dynamics Codes for Advanced Reactors
  - ➔ Conceptual Design for Lead and Gas Cooled Fast Reactor Systems

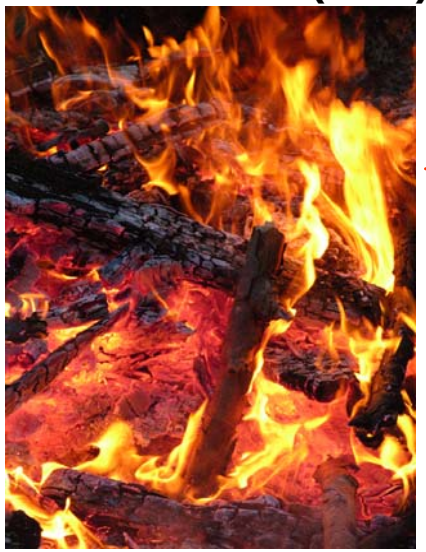
- **FP7-2010 Call**
  - ➔ Reliability and Efficiency of High-Power Proton Accelerator Components and System Design for Continuous Operation of Transmutation Devices
  - ➔ Support Experiments for Validation of Design Activities of Critical and Sub-critical Lead-Cooled Fast Spectrum Transmutation Facilities
  - ➔ Fuel and Cladding for Advanced Reactors and Transmutation Devices

Conclusions

Debate on Waste Management Strategy for sustainability of nuclear energy

'BURN or BURY' ?

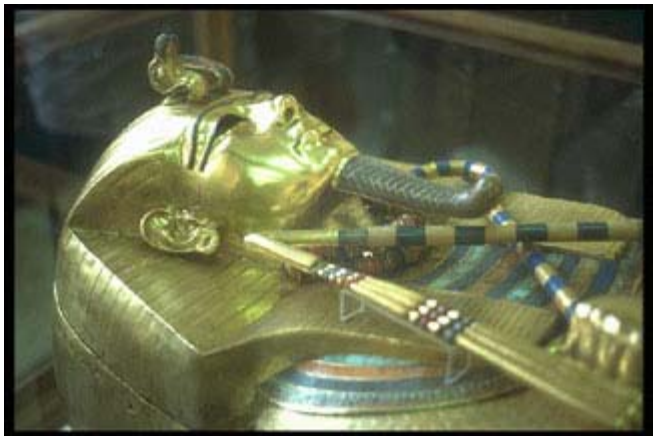
Partitioning and transmutation (P&T)



←P&T

GD→

Geological disposal (GD)



- P&T is essential for the sustainability of nuclear energy
- GD is indispensable for radioactive waste management
- Both communities should work together for the future of nuclear energy