

Demonstration of Fuel Cycle Closure including P&T towards Industrialization at multilateral scale

A game changer for the future of nuclear energy together with SMRs?

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International context evolution 2015 -> Today

- **Closing the fuel cycle and P&T beyond EU**

- As a result of the NI2050 initiative launched in 2015 by the **OECD/NEA** for accelerating the innovation in the nuclear energy sector one of the subject retained is "**Demonstration of Fuel Cycle Closure Including Partitioning and Transmutation (P&T) Towards Industrialization by 2050 (TF-FCPT)**"
- A dedicated Task Force under the Nuclear Science Committee has been created beginning 2021 and has been given a mandate for issuing the "High level report" meant for governmental authorities and decision makers for **launching large scale demonstration programmes**
- The report of the Task Force is expected for **end-2022/beginning 2023**
- The countries and international organisations represented in the task force are : **BE, EU/JRC, FR, JP, (RU suspended in may 2022), UK and USA**



Overview of the Task Force FCPT

Scope

- Existing and emerging **technologies** for **advanced transuranic (TRU) management strategies** – e.g. Pu multi-recycling and MA transmutation – such as advanced reprocessing and fuel fabrication, transmutation systems and cross-cutting issues

Main objectives

- Stress the need and the urgency to increase the Technology Readiness Level (TRL) in advanced fuel cycles and P&T technologies **to move from research and development (R&D) to pre-industrial scale demonstration**
- Identify **R&D and infrastructure needs and gaps** and provide recommendations on **priority actions** to be implemented
- Provide policy-makers with information for future decisions as regards technologies that would **enable the industrialisation** of fuel cycle closure and P&T **from 2050 on**
- **Provide guidance on establishing a Joint Undertaking on experimental demonstration**

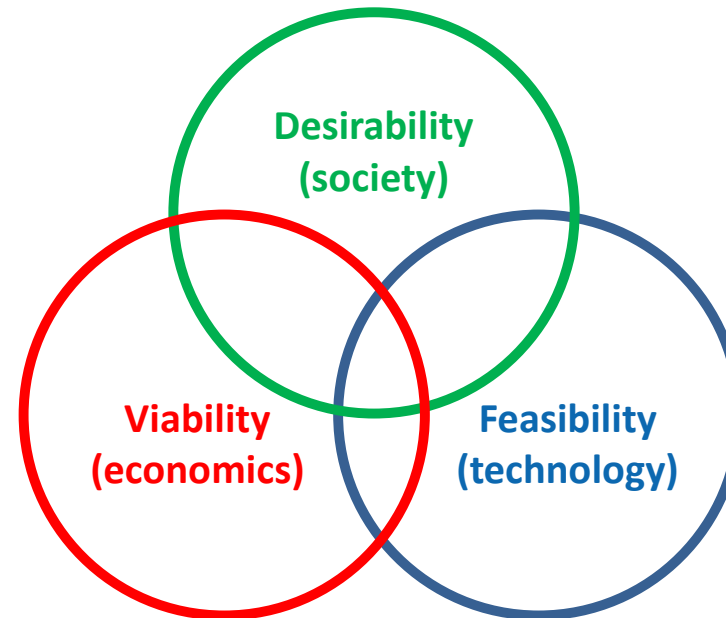
Deliverables

- A **“High-level Report”** aiming to be a comprehensive reference covering **technological, economic and societal aspects**
- A **library of documents** addressing the benefits of P&T, the technical challenges and developments in the field

Overview of the Task Force FCPT Report

Mandate and structure of the report

- Address the 3 dimensions that can be decisive for decision makers :
 1. Why ?
 2. What ?
 3. How much ?



**Suspended following OECD Council's decision – effective 11 May 2022*

Content and structure of the “High-level Report”

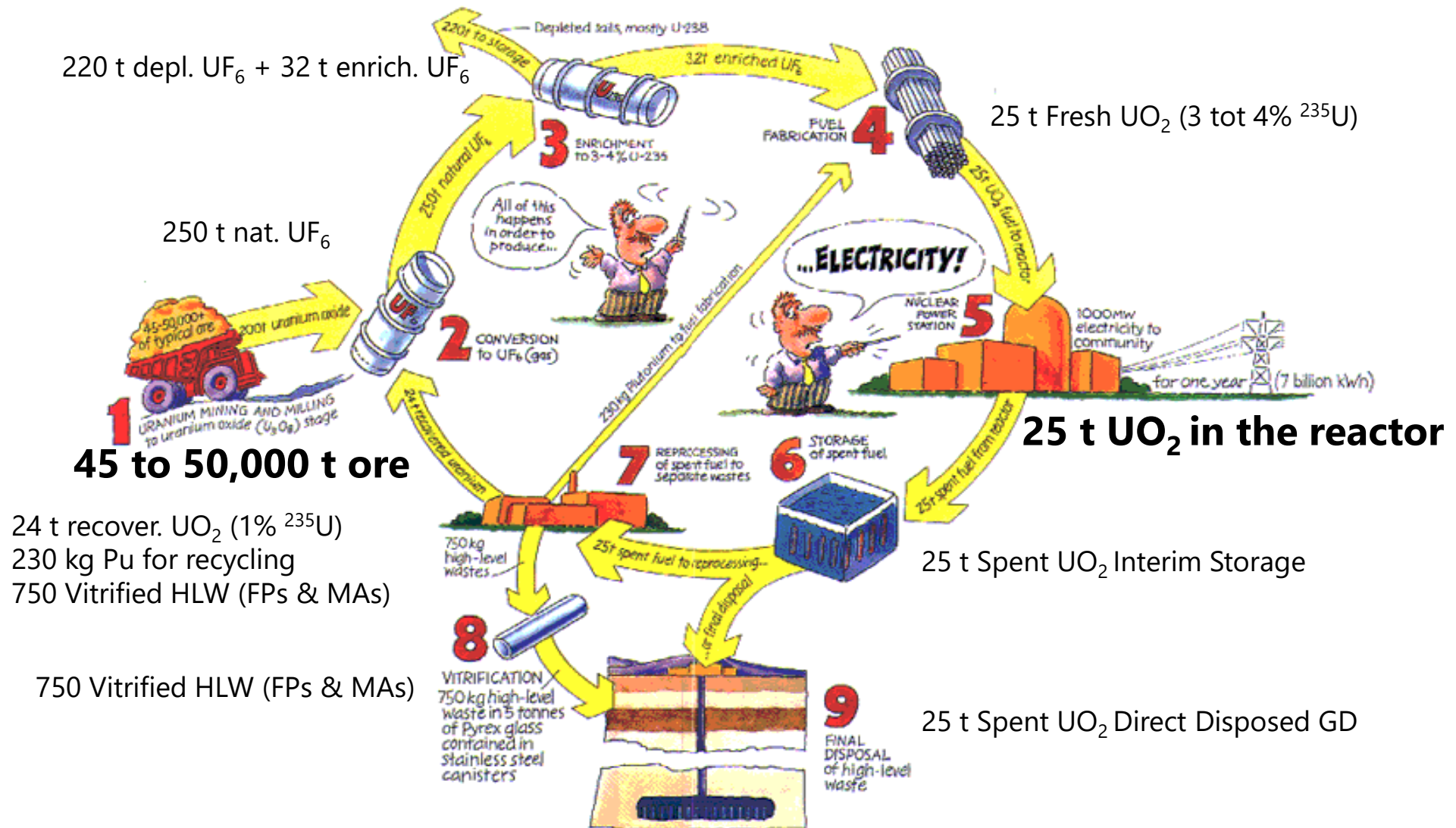
#	Section
	Foreword
	Executive Summary
1	Introduction
2	Advanced separation of conventional used fuels <i>Beyond PUREX for spent fuels – including MOX – from current NPP fleets (PWR/BWR)</i>
3	Advanced fuel fabrication and performance
4	Transmutation systems <i>Ensure overall consistency among systems considered</i>
	- Liquid Metal Fast Reactors (LMFRs) (SFR and LFR)
	- Accelerator-driven systems (ADSs)
	- Molten Salt Reactors (MSRs)
5	Advanced fuel reprocessing <i>For transmutation fuels</i>
6	Advanced fuel technological aspects <i>Cross-cutting aspects: transportation, cooling, and handling</i>
7	Economic aspects
8	Societal aspects
9	Recommendations and conclusions
	Glossary
	Appendices <i>Including accessible introductions to the technical areas discussed</i>
	References

- Review technology “building blocks”
- Identify of R&D needs and priority actions to increase the TRL up to pre-industrial demonstration
- One specific working subgroup for each “building block” with topical leader(s) to coordinate work and ensure interconnection with other chapters

- Perform an economic analysis of the pre-industrial phase needed for the closure of the nuclear fuel cycle, focusing on the need for and the benefit of a pre-industrial demonstration (reducing uncertainties, and option value, informing a decision...)
- One specific working subgroup, gathering experts from NDC/NTE and Task Force members

- Provide an overview of societal aspects of the closure of the nuclear fuel cycle, addressing the public perception, worries and concerns, hence acting on decision-makers
- To be reviewed by the Forum on Stakeholder Confidence

Quantities at different stages for 1GWe PWR

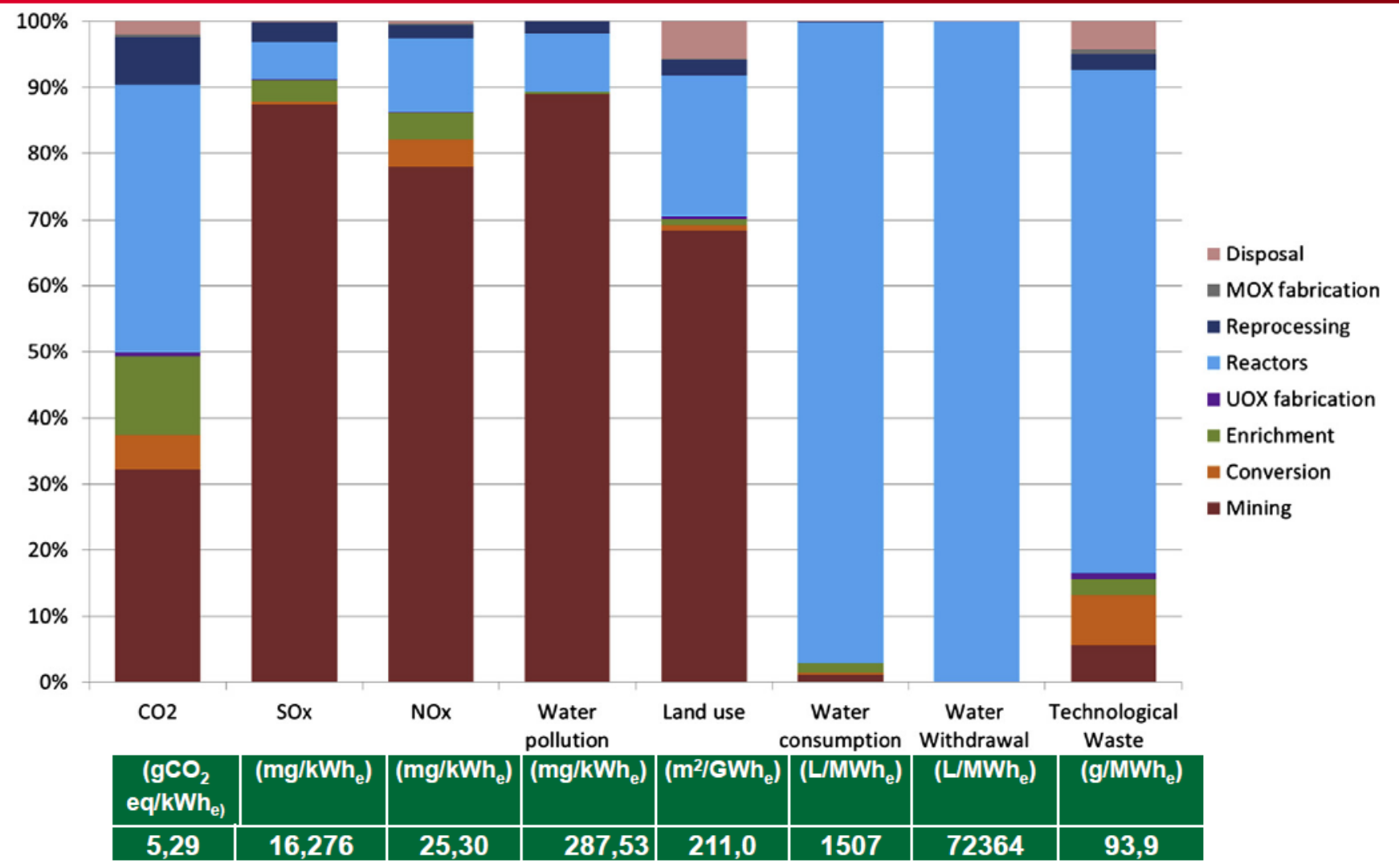


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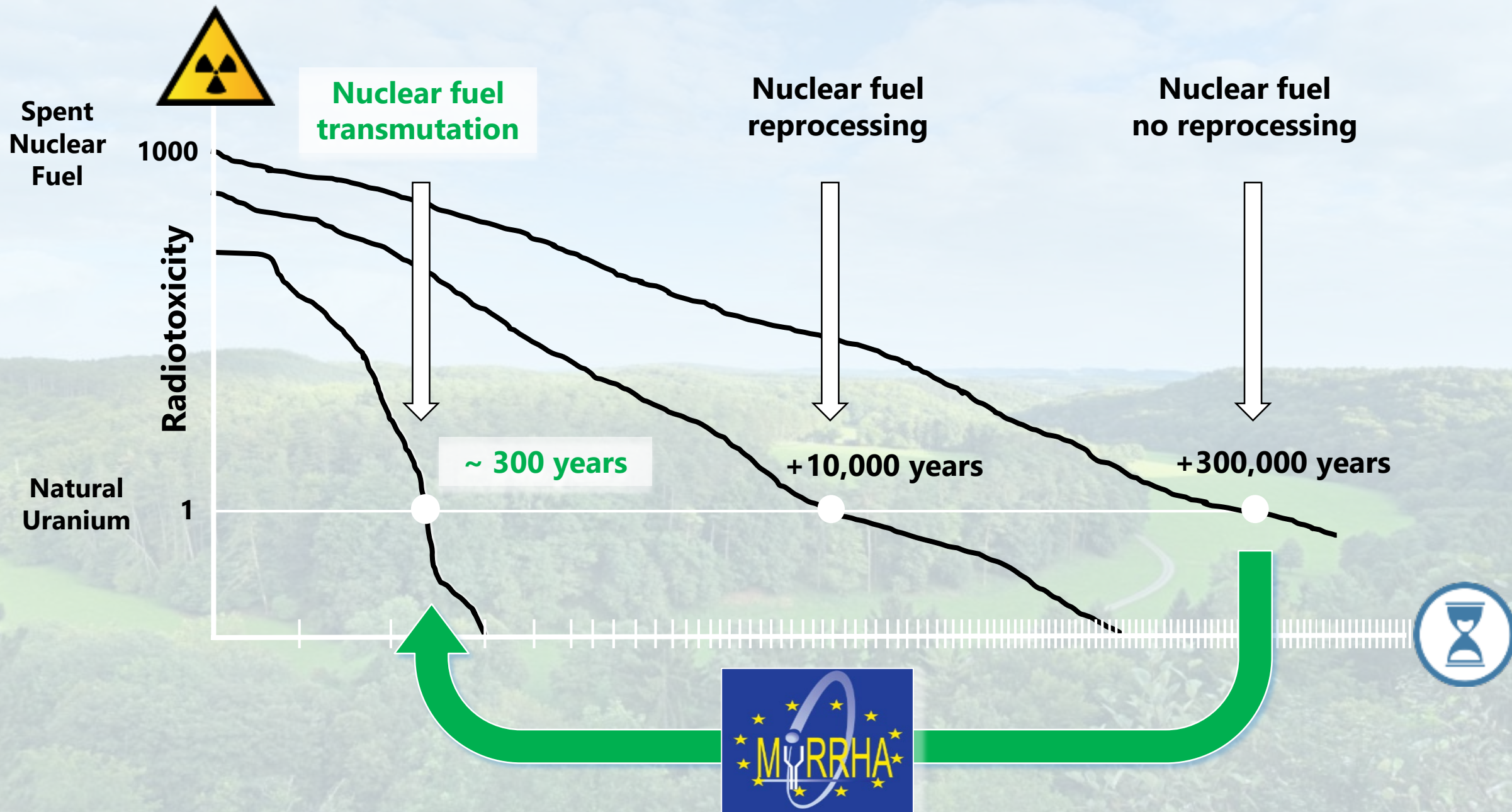


Chap.II – results of the current French cycle

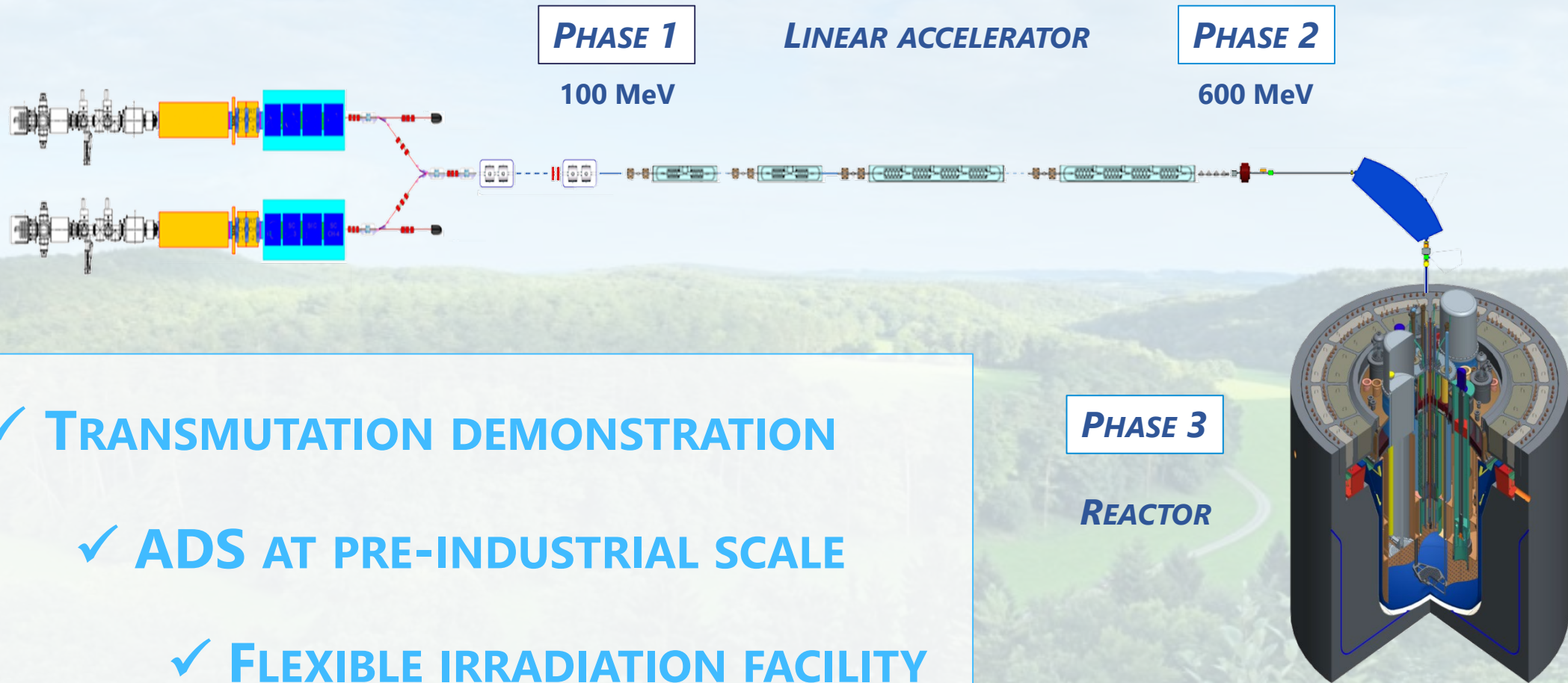
The general environmental indicators of the TTC



Source: Christophe POINSSOT (CEA)



MYRRHA: ACCELERATOR DRIVEN SYSTEM



- ✓ **TRANSMUTATION DEMONSTRATION**
- ✓ **ADS AT PRE-INDUSTRIAL SCALE**
- ✓ **FLEXIBLE IRRADIATION FACILITY**

Belgian Government decision of 7 September 2018

Confirmed on 23 July 2021 (+ creation of MYRRHA NPO)



Decision to build MYRRHA as large new research infrastructure in Mol, Belgium

Belgium **allocates** € 558 m for 2019-2038

- 2019-2026: construction of MINERVA (linac 100 MeV + PTF & FTS)
- 2019-2026: design, R&D and licensing for Phases 2 (extended linac 600 MeV) & 3 (reactor)
- 2027-2038: MINERVA operations (linac 100 MeV)

Establishment of **international non-profit organisation**

MYRRHA AISBL/IVZW

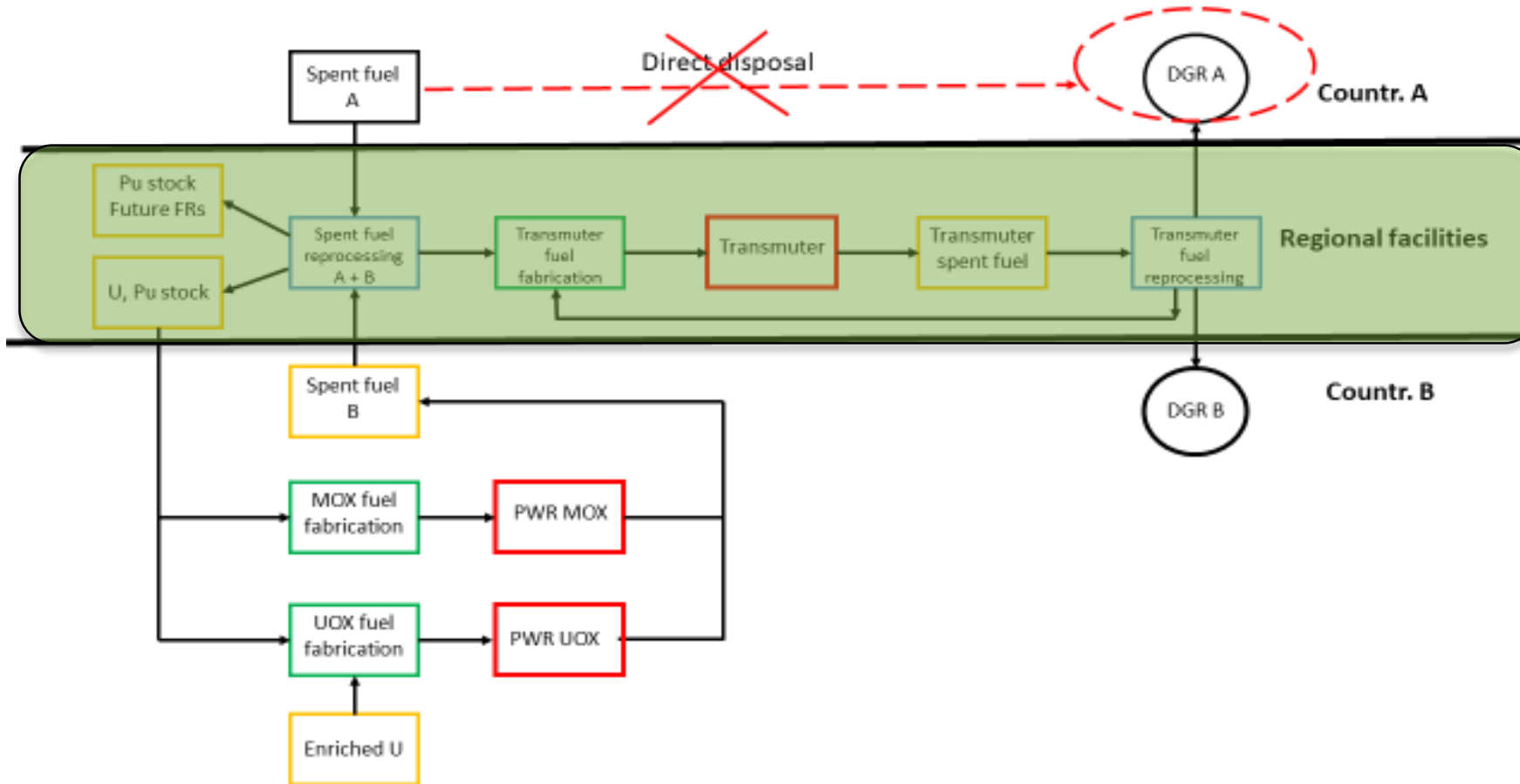
Decided 23.07.2021

Created 17.09.2021

Government support for establishing MYRRHA partnerships

Belgium appoints tutorship ministers to promote and negotiate international partnerships

Even with completely different national NE policies European solution for HLW works with ADS



Advantages for A

- ADS shared with B
- ADS burn A's Pu & MA
- Smaller Fu-Cycle units & shared

Advantages for B

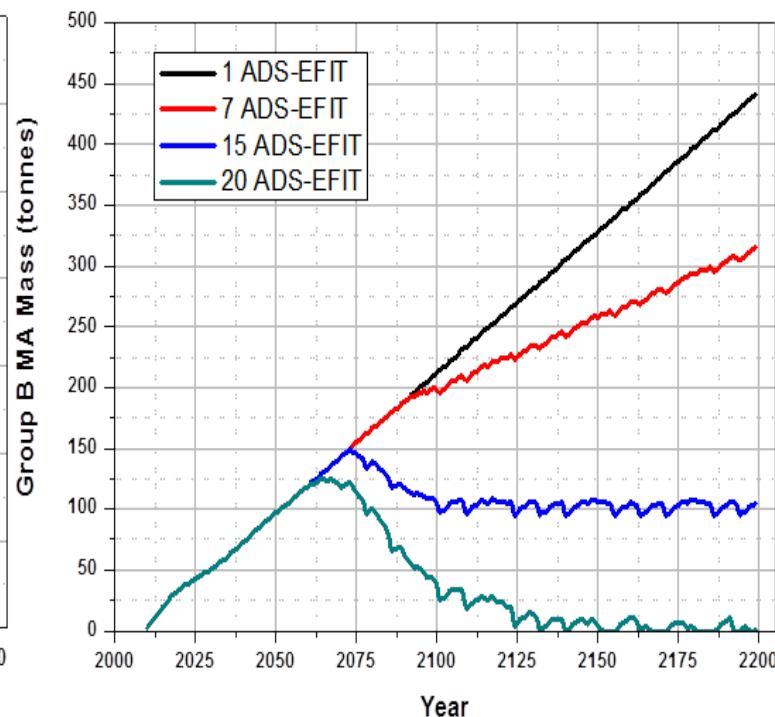
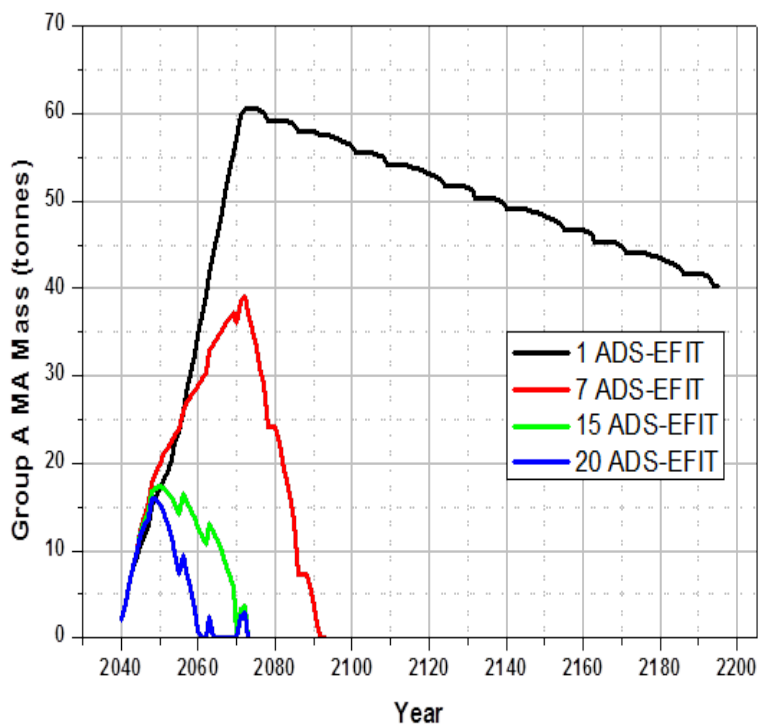
- ADS shared with B
- ADS burn B's MA
- A's uses B's Pu (part) as resource in FR
- FR fleet not contam with MA's
- Smaller Fu-Cycle units & shared

FP6 PATEROS project: Scenario 1 objective: elimination of A's spent fuel by 2100
A = Countries Phasing Out, B = Countries Continuing

Shared & efficient solution for Minor Actinides management

EU case with 144 power reactors using EFIT 400 MWth

- **Europe should go for a regional approach for legacy** (see PATEROS, ARCAS)
- **Countries with different nuclear energy policies to collaborate together**
 - Countries willing to continue Nuclear Energy
 - Countries willing to develop fast reactor systems
 - Countries in nuclear phase out, interested in Partitioning & Transmutation (P&T)



15 EFIT * 400 MWth = 6000 MWth
For all EU HLW treatment

Doel (BE) = 9000 MWth
Tihange (BE) = 9000 MWth

Gravelines (FR) = 17118 MWth

Zaporizhzhya (UA) = 18000 MWth

Bruce (CND) = 18702 MWth

Kashiwazaki-Kariwa = 23895 MWth

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Where is the link to SMRs ?

- SMR-SFR
- SMR-LFR
- Link ADS ⇔ SMR-LFR
- SMR-MSR

Link ADS ⇔ SMR-LFR in Belgium

celebration of 70th anniversary of SCK CEN on May 24, 2022



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