# Overview of IAEA Activities on Nuclear Fuel Cycle Options

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*TM on Proliferation Resistant Features of Fast Reactors and Advanced Fuel Cycles, 18 – 22 August 2025*

# IAEA's Organization

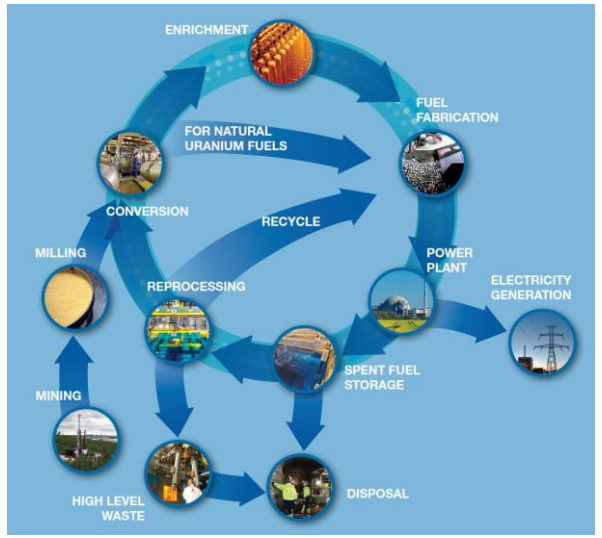
## Department of Nuclear Energy

NE | NS | NA | TC | SG | MT

**Division of Nuclear Fuel Cycle and Waste Technology (NEFW)**

- RRS
- WTS
- **NFCMS**
  - UPC Team
  - NFE Team
  - SFM Team
- DERS

### Nuclear Fuel Cycle and Materials Section (NFCMS)




- **Project 1.2.3.001 Spent fuel storage:** To support MSs in understanding and addressing the challenges of an effective and safe storage of their SNF (through wet and dry technologies), including anticipating those generated by SMRs
- **Project 1.2.3.002 Spent fuel recycling:** To facilitate discussion and information sharing among interested MSs on recent and future developments in nuclear fuel recycling processes and technologies for current and next generations of nuclear power reactors (e.g., LWRs, FRs, SMRs)
- **Project 1.2.3.003 Radioactive materials transportation:** To support MSs in understanding and addressing the challenges and issues related to the safe transportation of all kinds of radioactive and nuclear materials used or generated through nuclear fuel cycle activities, including SNF from current fleet of LWRs, Advanced Reactors and all different SMRs technologies

# NFCMS mandate

To support sustainable, safe, secure, reliable and economic Nuclear Fuel Cycles associated with current and future generations of nuclear power reactors, by providing Member States with relevant technical information (guidance) based on operational experience and best practices

- Through:
  - Organization of International conferences and workshops
  - Publication of technical documents and reports
  - Coordination of international research activities through Coordinated Research Projects (CRPs)
  - Management of specific databases
  - Issuance of e-Learnings





# Technical Working Group on Nuclear Fuel Cycle Options and Spent Fuel Management (TWG-NFCO)

**20 Member States** (Belgium, Canada, China, Finland, France, Hungary, India, Japan, RoK, Mexico, Netherlands, Romania, Russia, Spain, Sweden, Slovakia, UK, UAE, Ukraine, USA).

**Three International Organizations** (EC, OECD/NEA and WNA)

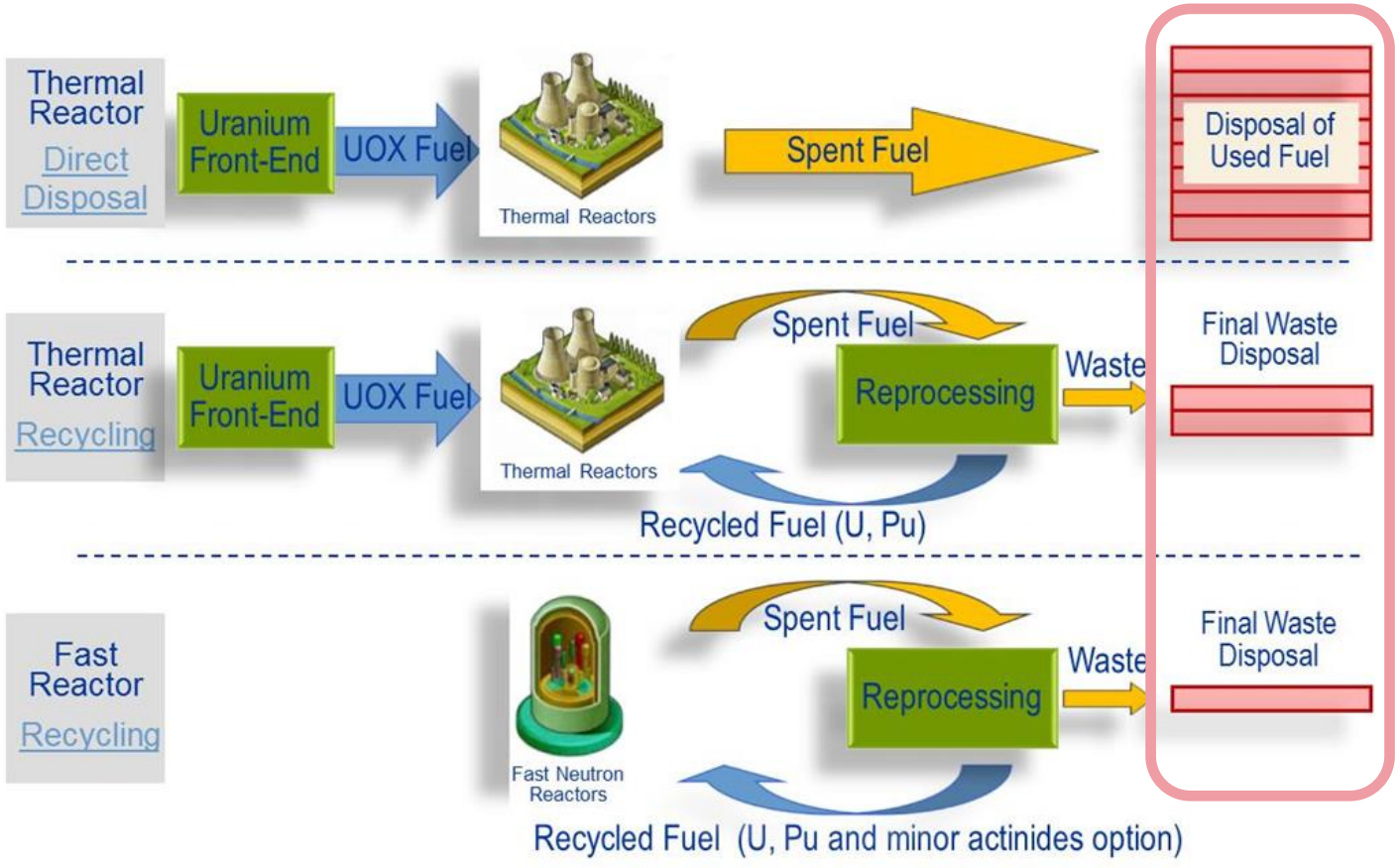
**TWG-NFCO focuses on nuclear fuel cycle options** with an emphasis on:

- **Spent fuel management** (storage, recycling and transportation)
- **Innovative fuel cycles** (multirecycling, minor actinides management and P&T of long-lived fission products)
- **Nuclear materials management**

**TWG-NFCO Meeting, 1-3 April 2025**

# Nuclear Fuel Cycle Options

- For Nuclear power to be sustainable, the nuclear fuel cycle must remain **economically viable and competitive** through the optimization of the use of fissile materials in reactor cores or the **recycling of valuable materials**
- This results in different fuel **cycle options**, some already implemented and others may be deployed in the future
- Potential future synergies between LWR-SMRs and AMRs will bring new spectrum of Nuclear Fuel Cycle Options

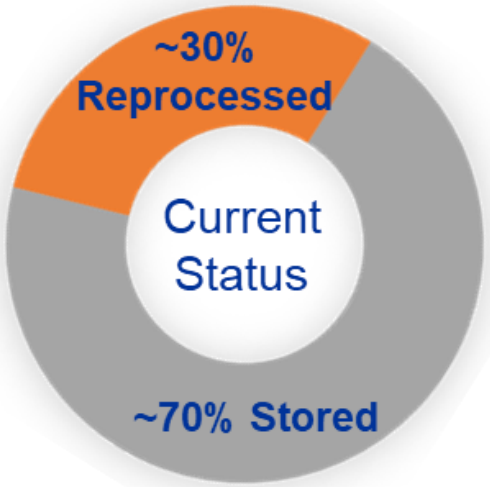


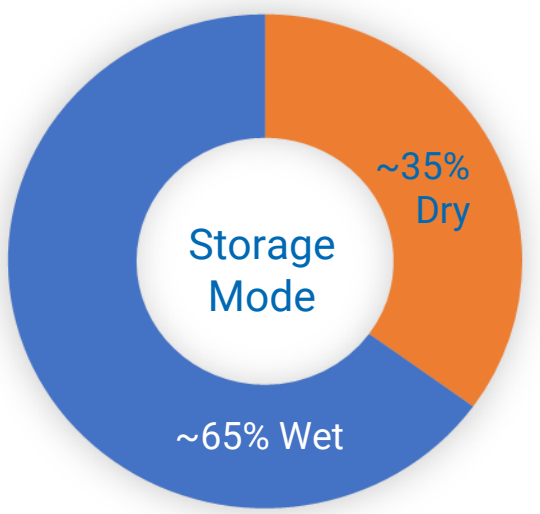

**Each Type of Reactor has an Associated Nuclear Fuel Cycle**

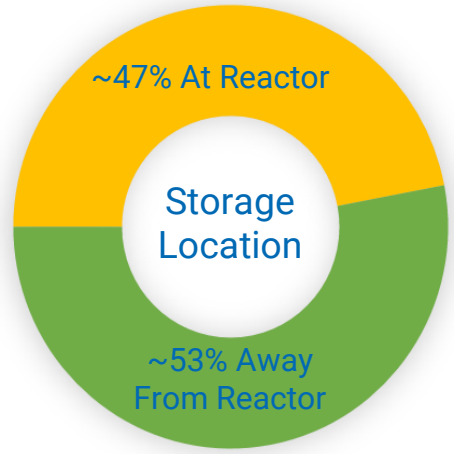
# Spent Fuel Management: Status and Trends

~ 416 NPPs* in 31 countries discharging ~ 10 000 tHM per year

Global Inventory by the end 2024, ~ **430 000 tHM**




(* August 2025, see PRIS database: https://pris.iaea.org/pris/)

- Global Inventory of spent fuel at the end 2023: **~ 430 ktHM**, among which **~ 301 ktHM are in Storage**
  - 47% at Reactor, 53% Away from Reactor (**33% Wet Storage** / **67% Dry Storage**)
- Selection of storage technology depends on many factors: Fuel, Economics, Stakeholders' preference

# Spent Fuel Management Strategies Worldwide

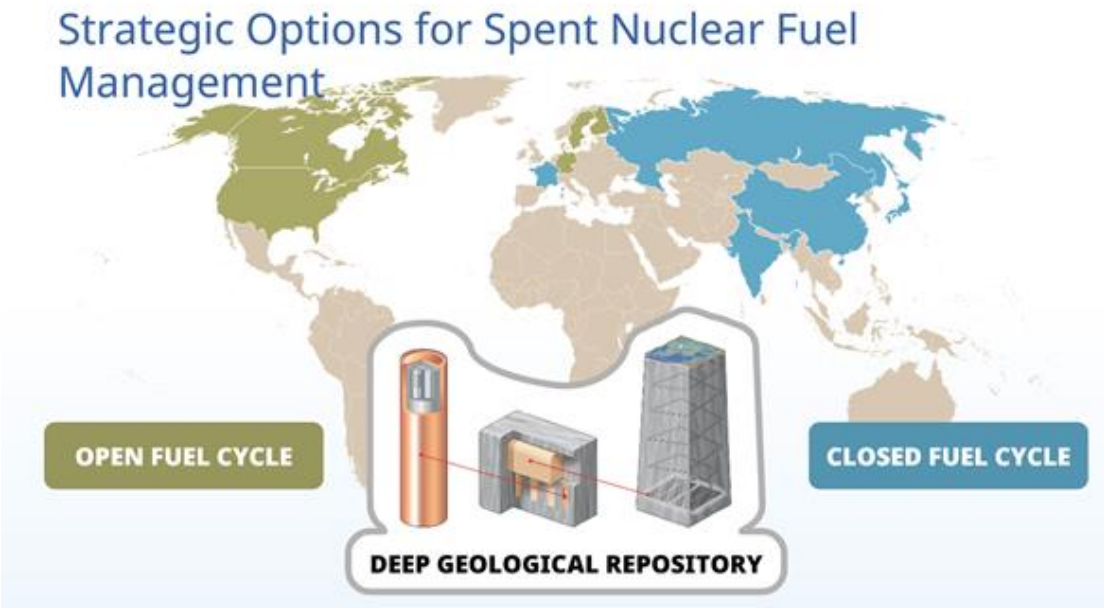
Today mainly countries with large nuclear power programmes recycle spent fuel: France, the Russian Federation, Japan, India and China.

Some countries have not yet made a final decision.

Most spent fuel is in interim storage.


Several other countries have opted for direct disposal: Finland, Sweden, Canada, Germany

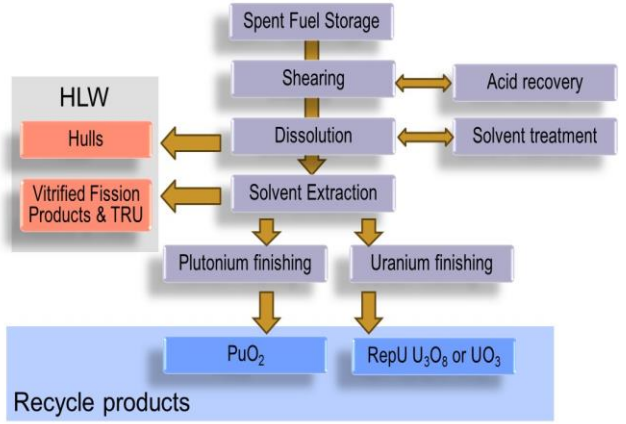
The Netherlands reprocess SNF from Borssele NPP abroad and stores High Level Waste at HABOG facility

# Spent Fuel Recycling through Reprocessing

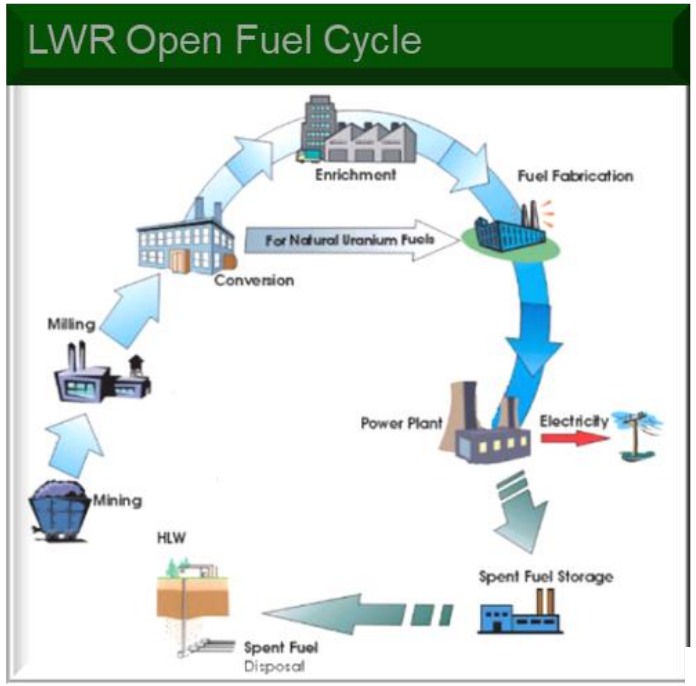
- Reuse of **Reprocessed Pu as MOX in Light Water Reactors**
  - More than **40 years** of experience worldwide (44 LWRs have used MOX fuel at industrial scale since 1986)
  - Loading cores partially with MOX (25-50%) and the remainder with UOX fuel
  - Recent reactor designs can accommodate 100% MOX cores
  - Demonstrating Multiple Recycling in LWRs contributes to transitioning to Fast Reactors
- Reuse of **Rep-Pu as MOX in Fast Reactors**: implemented in Russia in BN-800
- Reuse of **Rep-U** as **Enriched Reprocessed U (ERU)** in Thermal Reactors (PWRs, VVERs, RBMKs, AGRs, PHWRs)
  - More than **30 years** of experience worldwide (TRs can accommodate 100% Rep-U cores)

PUREX Process




- Recycling Spent Fuel is a **mature technology** (Pu recycling in LWRs saves up to 25% of natural uranium resources)
- Reference options exist worldwide (PUREX)
- Reprocessing capacities exist in **France**, **Russia**, **India**, **Japan** and **China**

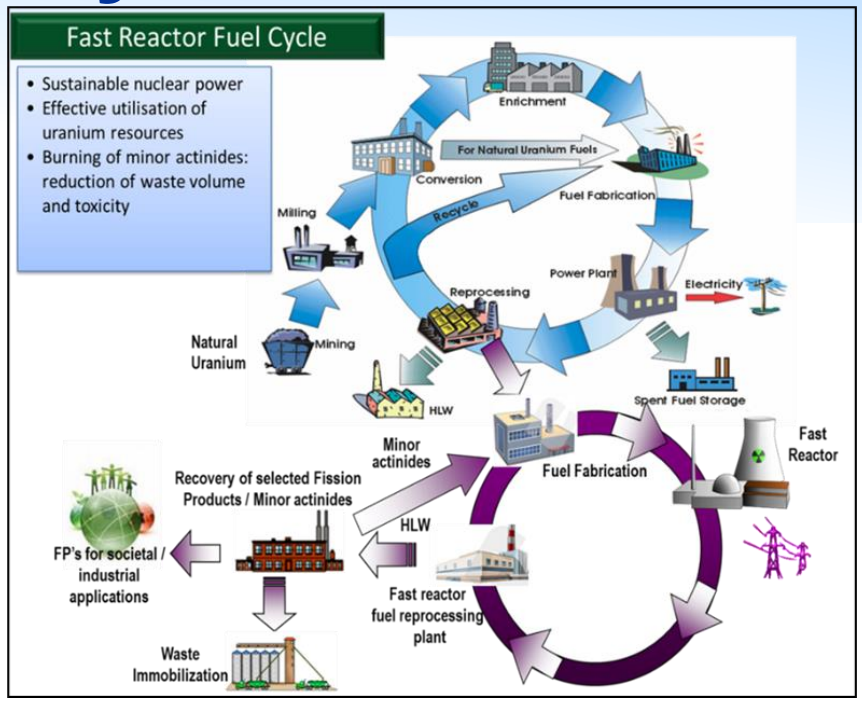
# Towards Enhanced Nuclear Energy Sustainability through Fast Reactor Systems




## Environment-friendly innovative fuel cycles:

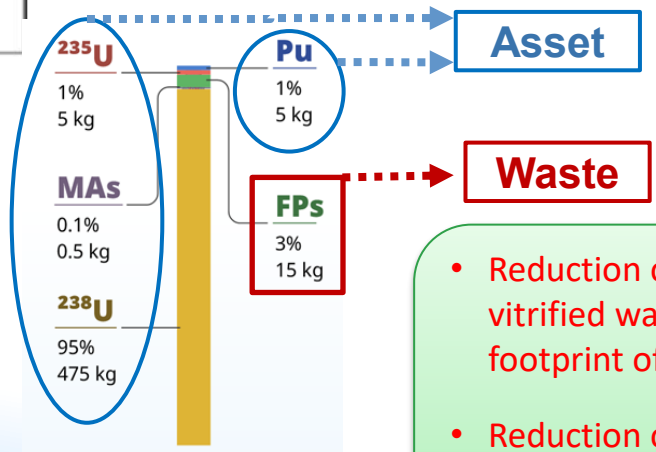
- Natural resources preservation
- Minimizing the burden of waste to be disposed of (reducing footprint of final repository)
- Economically viable fuel cycles through recycling valuable materials
- Enhance safety and security
- …

**Towards Fully Closed Cycle**



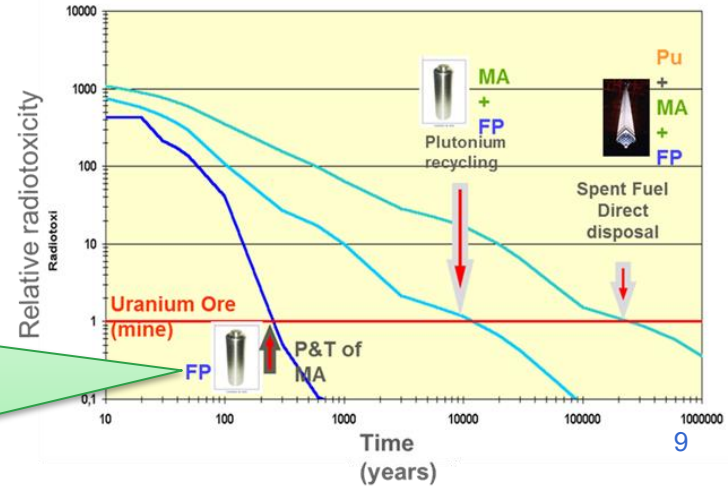

Multirecycling of valuable materials through innovative systems

- Breeding Pu
- Burning Pu
- Burning/Transmuting MAs



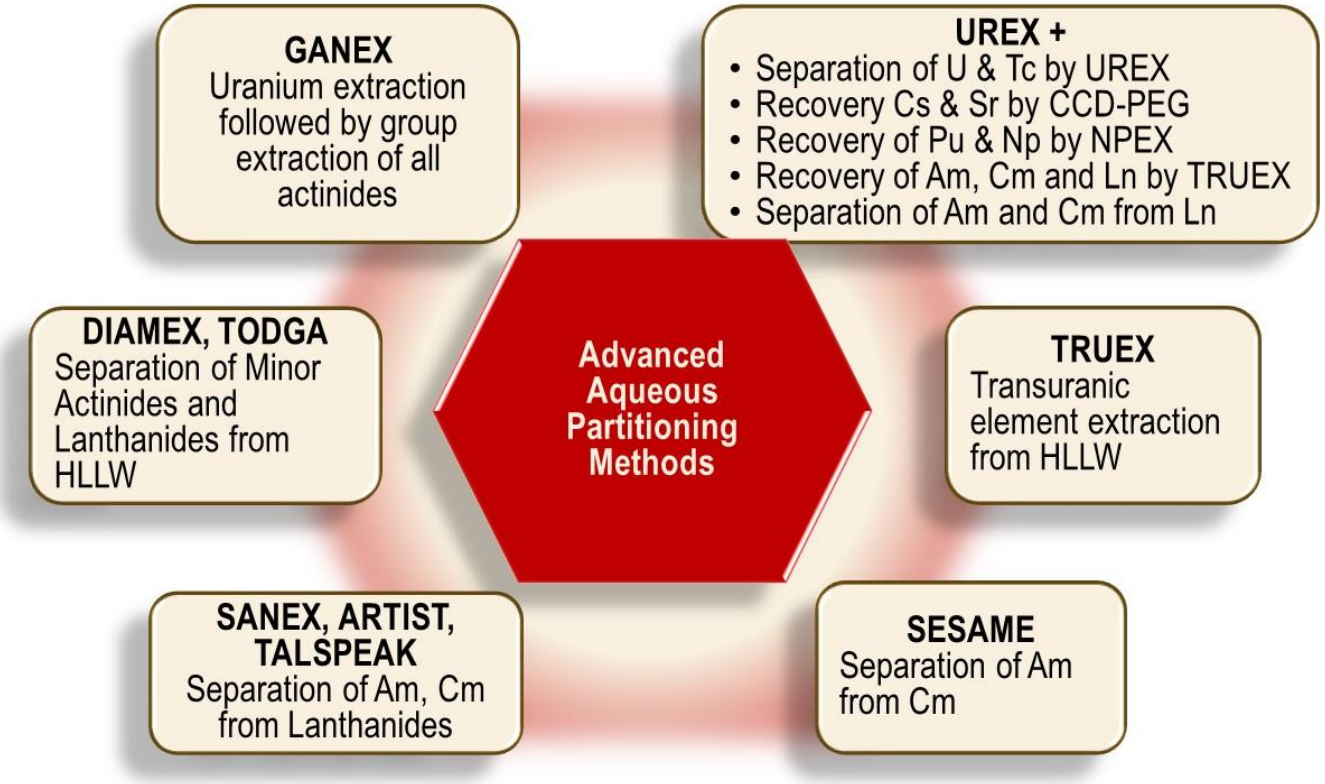

Spent Nuclear Fuel LWR
Fresh fuel 500 kg $UO_2$

- Reduction of heat generation of vitrified waste → Reduction of the footprint of geological repositories
- Reduction of potential hazard of vitrified wastes → Control of risk for future generations

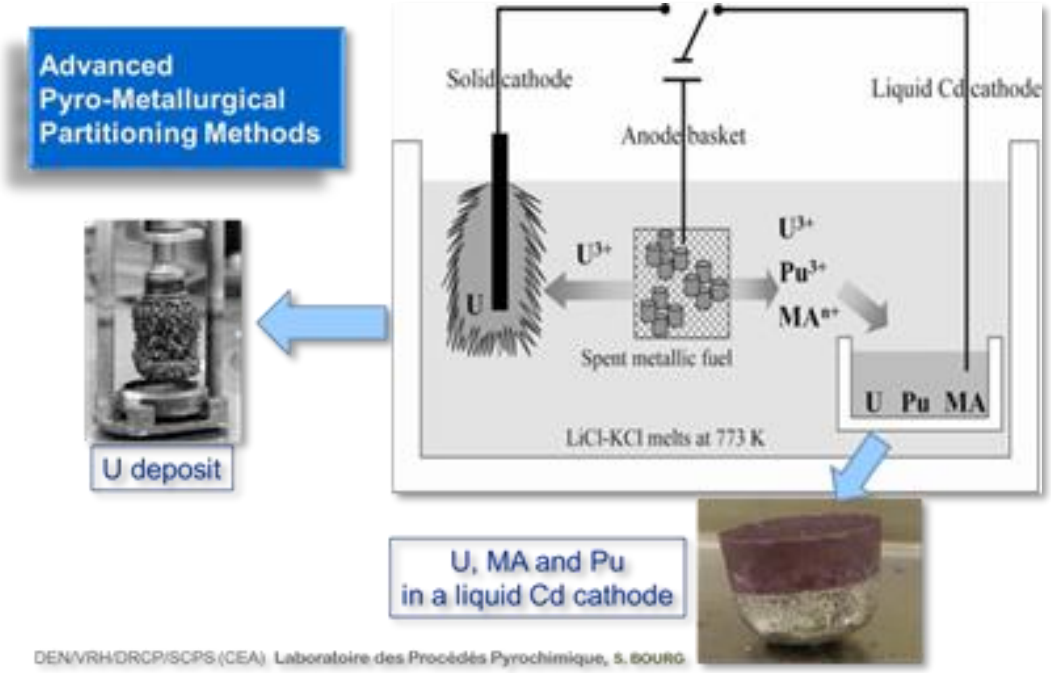


# Advanced Partitioning Processes

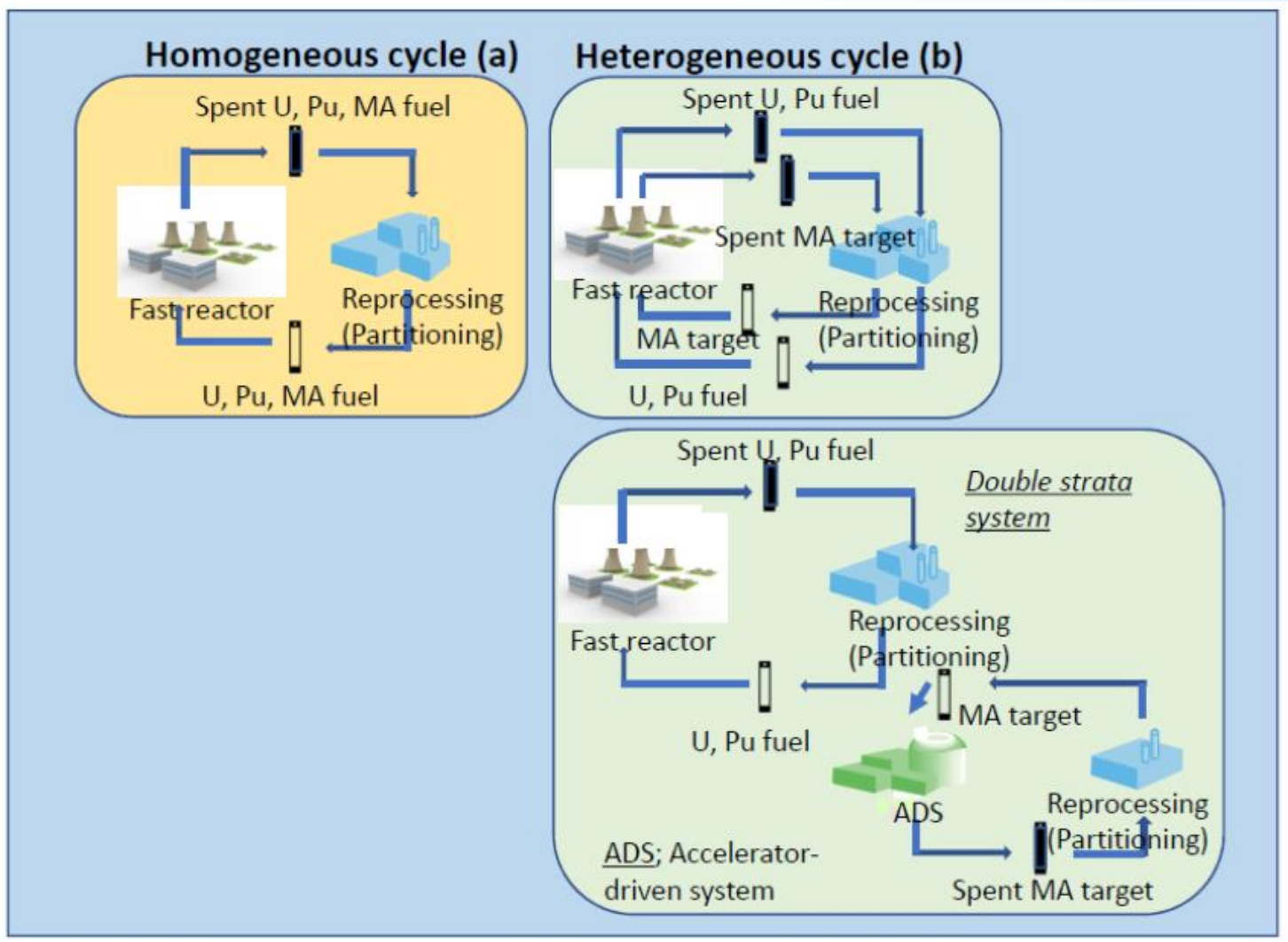
## Hydro-Metallurgical Processes



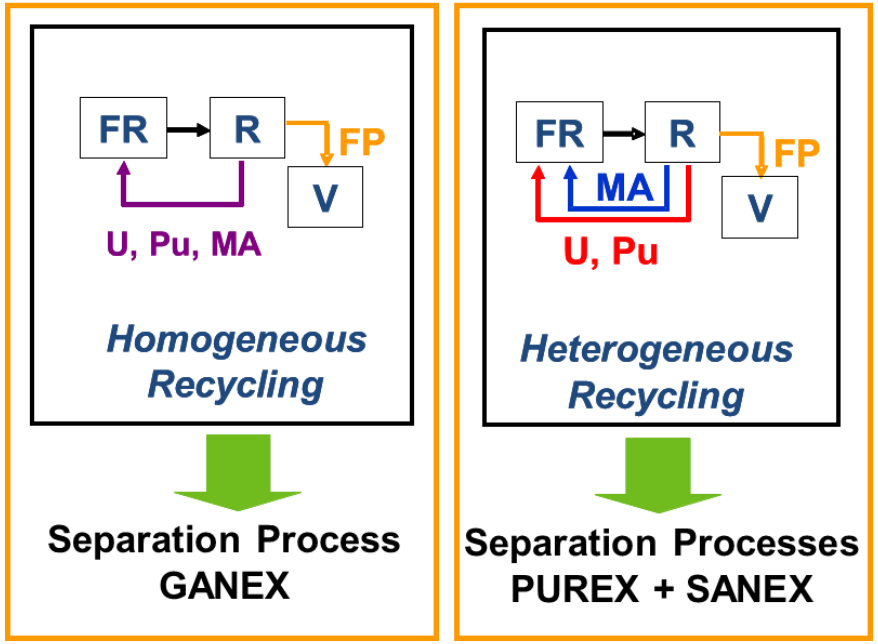

## Pyro-Metallurgical Processes



# Fully Closed Fuel Cycle Options




FR: Fast Reactor
R: Recycle plant
V: Vitrification




**Hydro-Metallurgical Processes**

Hydro and Pyro Processes still at a demonstration scale

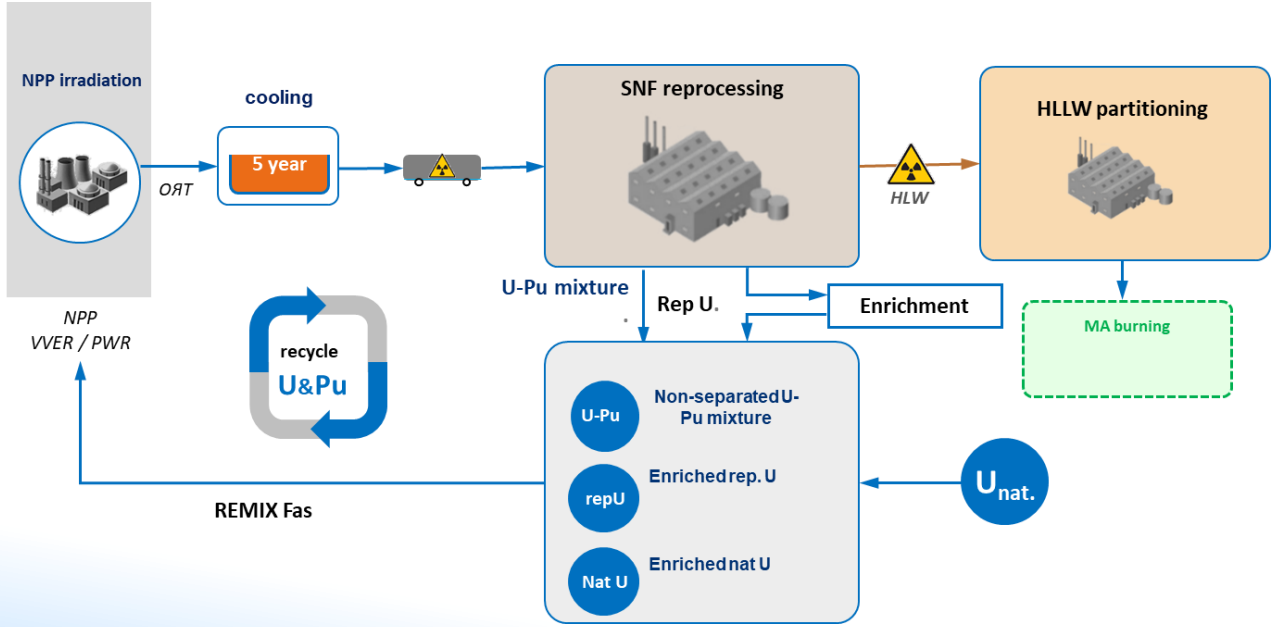
# Demonstrating Multiple Recycling in LWRs Contribute to Transitioning to Fast Reactors

## In France

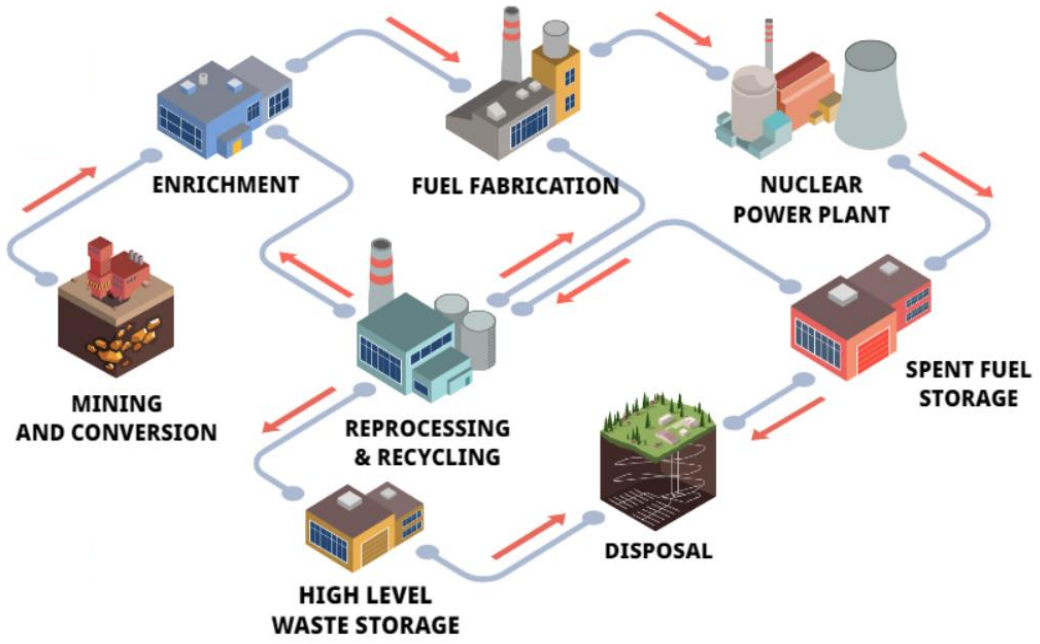
- MIX scheme is composed of MOX fuel rods with enriched uranium matrix (instead of depleted uranium as for current MOX fuel)
- MOX-MR scheme mixes plutonium batches coming from reprocessed spent UOX, current spent MOX fuels, and a minor amount of multi-recycled plutonium. Plutonium is then blended with depleted uranium.

## In Russia

- REMIX fuel is made up with:
  - Mixture of U+Pu, co-extracted from LWRs' SNF reprocessing
  - Enriched uranium (natural or RepU )



# Main Challenges for SNF Reprocessing and Recycling



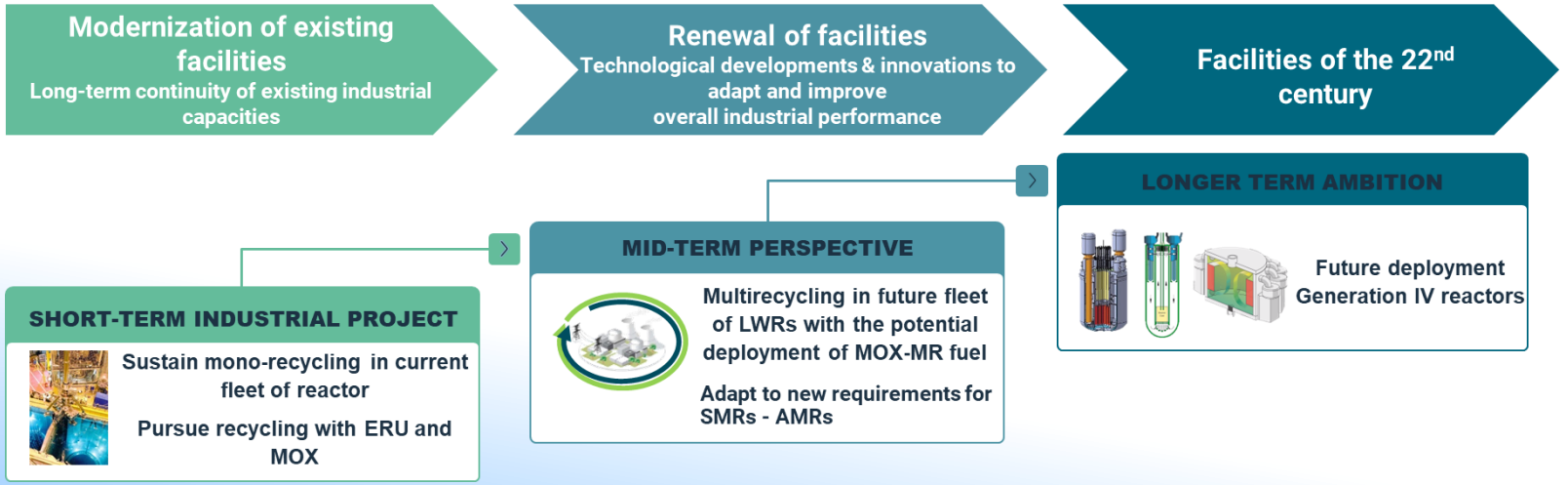

**Reprocessing and Recycling**

- Reprocessing is specialized on current fuels and capacities are limited
- Ageing of available Rep&Rec facilities, specially in Europe
- Accelerate implementation at industrial scale of Multi-recycling in LWRs as transition to AMRs
- Demonstrate and scale up multi-recycling through Advanced Fuel Cycles for innovative reactors

***Integration of existing and new fuel cycles is key for sustainability***

# French decision to pursue the reprocessing/recycling strategy till 2100

- The 4th Nuclear Policy Council chaired by the French President of 17th March 2025, confirmed **the programme to renew the back-end nuclear fuel cycle facilities at La Hague**, as well as the policy guidelines for **achieving closure of the nuclear fuel cycle in France** in the second half of the century
- On March 7th, 2024, the Minister of Economy and Finance, publicly announced at Orano La Hague, the decision to pursue the reprocessing-recycling strategy beyond 2040 with:
  - La Hague and Melox plants operational life extended beyond 2040
  - **New MOX fuel fabrication plant, new wet storage capacities** at La Hague site by 2040 to meet the needs of the existing nuclear fleet and the EPR2s
  - **New spent fuel reprocessing plant** at La Hague site, by 2045/2050

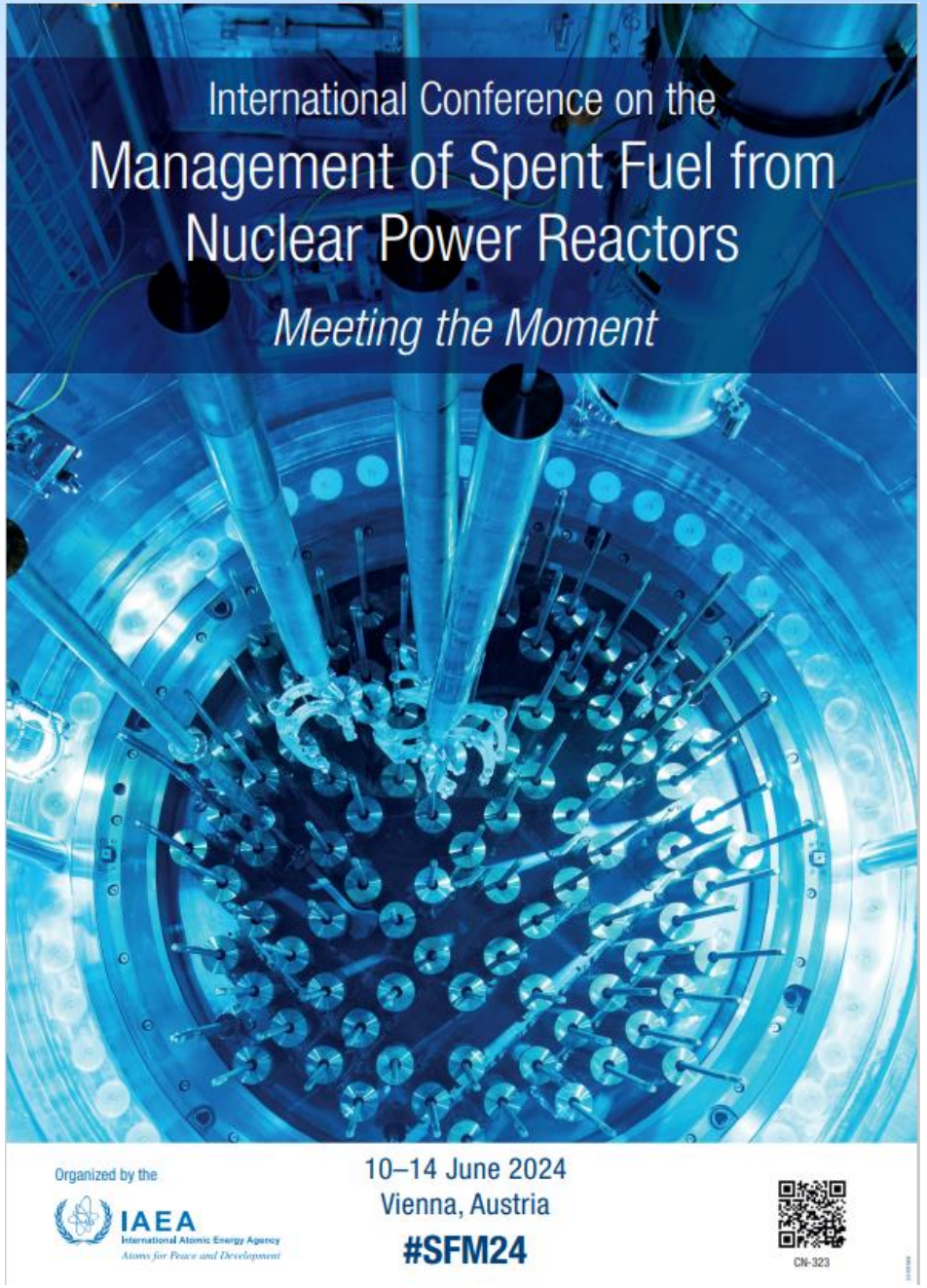


# IAEA’s Activities in Support of Spent Fuel Management

- Publications
- Scientific/Technical Events
- Coordinated Research Projects
- e-Tools

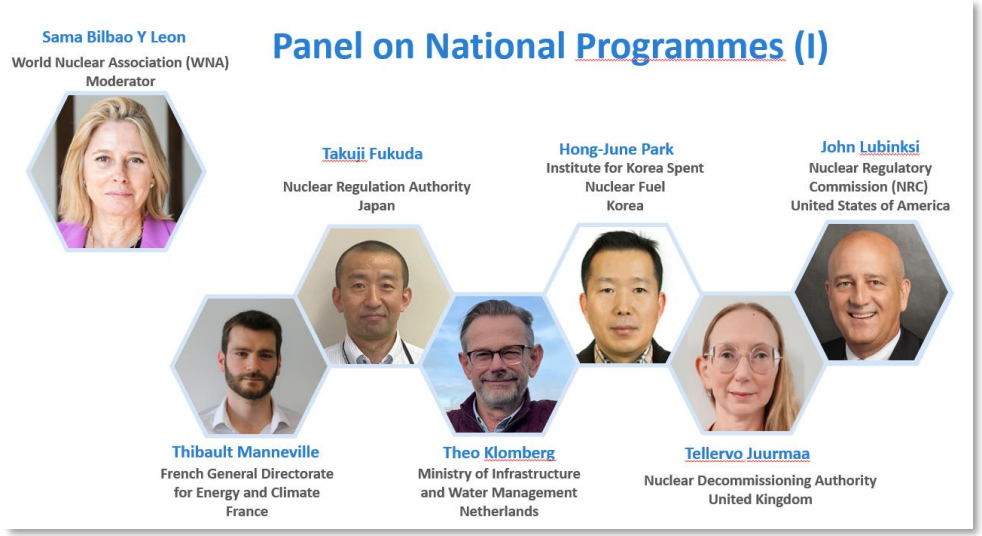
# Scientific/Technical Events

- **Conference SFM'24, 10-14 June 2024**
  - In cooperation with NEA-OECD, WNA, EC, WNTI
  - 300 in person participants from 58 countries and 6 Int Org
    - 86 women and 214 men present
    - About 220 participants online
  - **Proceedings** in progress

# #SFM24 Panel Discussions

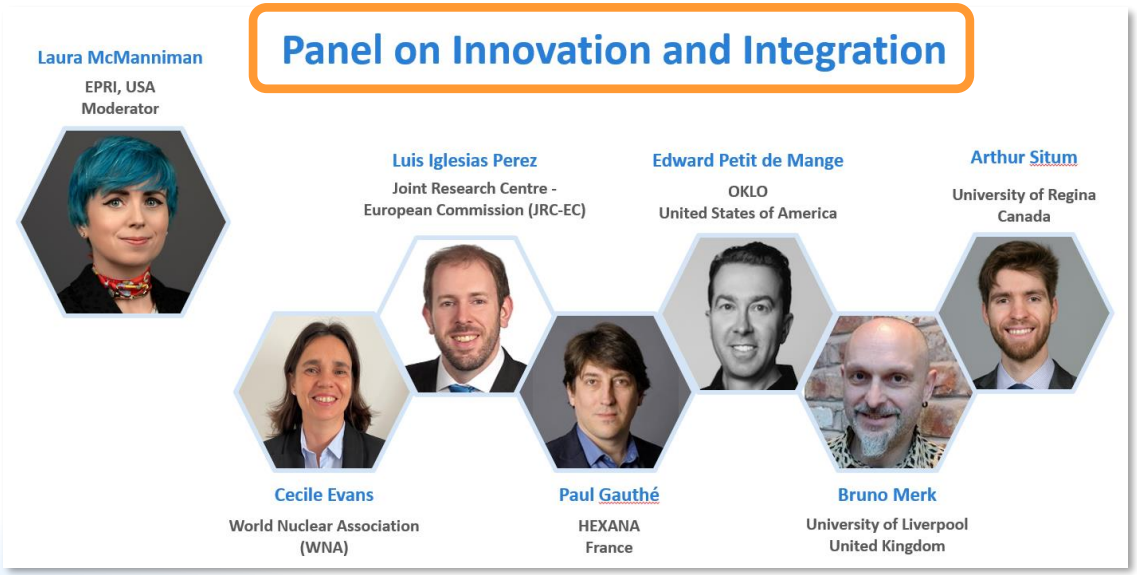
## Panel on National Programmes (I)




## Panel on National Programmes (II)


## Panel on Stakeholders Involvement


## Panel on Innovation and Integration



# Scientific Conference Programme from 8:30h to 18:30h

**Monday, 10 June**

09:00-10:30 — **Opening Session**
*R. M. Grossi*, Director General International Atomic Energy Agency (IAEA)
*W. D. Magwood*, Director General OECD Nuclear Energy Agency (OECD/NEA)
*S. Bilbao y León*, Director General World Nuclear Association (WNA)
*U. Engelmann*, Director for Nuclear Safety and Security Joint Research Centre - European Commission (JRC-EC)
*P. Buchan*, Managing Director of Shipping Nuclear Transport Solutions (NTS), Board Member World Nuclear Transport Institute (WNTI)
*J.A. Gago*, Conference Chairman, Spain

10:30-11:00 — Coffee/Tea Break

11:00-13:15 — P1 — **Panel on National Strategies for Spent Fuel Management (I)**
*T. Mamelvile*, French General Directorate for Energy and Climate, FRA
*T. Fukuda*, Nuclear Regulation Authority, JPN
*T. Klomberg*, Ministry of Infrastructure and Water Management, NET
*B. Sosnik*, Polskie Elektrownie Jądrowe, POL
*H.-J. Park*, Institute for Korea Spent Nuclear Fuel, ROK
*T. Ausmus*, Nuclear Decommissioning Authority, UK (ID#81)
*J. Lubinski*, Nuclear Regulatory Commission, USA

13:15-14:45 — Lunch Break

14:45-16:00 — P2 — **Panel on National Strategies for Spent Fuel Management (II)**
*B. Nős*, Public Limited Company for Radioactive Waste Management (PURAM), HUN
*U. Dani*, Bhabha Atomic Research Centre (BARC), IND
*M. Shoaib*, Pakistan Atomic Energy Commission (PAEC), PAK (ID#19)
*A.L. Chichelin*, ROSATOM, RUS

16:00-16:30 — Break

16:30-18:30 — S6.1 — ADV — **Poster Session 1 NAT**
ID#26 Characterization of Spent Fuel for Selected Small Modular Reactors and Implications for the Back End Fuel Cycle, *X. Wang, CAN*
ID#88 A Tool to Estimate Isotopic Evolution for Actinides Transmutation Dedicated to Fast Molten Salt Reactors: A Comparative Study of Evolving In-core Key Parameters for the Preliminary Design of a Fast Molten Salt Reactor (F-MSR), *P.-E. Dufour, FRA*
ID#51 Assessing the Potential for Molten-Salt Reactor (MSR) Technology in EU's Sustainable Nuclear Energy Futures, *L. Van den Durpel, BEL*
ID#37 The French R&D Collaborative Project ISAC on Fast MSR Dedicated to Actinides Transmutation, *M.-S. Cheveaud, FRA*
ID#142 NRC Research Activities in Spent Fuel Storage and Management of Advanced Fuels for Advanced Reactors, *T. Boyce, USA*
ID#21 The Implementation of SMR and the Back End Issue of the Fuel Cycle in Ukraine, *B.P. Zhukovskyi, UKR*

18.30-20:00 — **Official Reception**

**Tuesday, 11 June**

08:30-10:30 — S6.2 — ADV
ID#64 Challenges and Opportunities of Advanced Nuclear Reactors for the Back End of the Fuel Cycle, *C. Evans, FRA*
ID#94 The WISARD Project - Starting with the End in Mind: Exploring How Innovative Nuclear Systems Require Innovative Waste Management Solutions, *L. McManniman, USA*
ID#95 Potential Impacts of SMR Deployment on Multinational Cooperation at the Back End of the Fuel Cycle, *J. Kinghorn-Mills, UK*
ID#119 Safeguards by Design: Supporting Sustainable Spent Fuel Management Strategies, *J.J. Whitlock, IAEA*
ID#93 HTGR Spent Fuel Management Strategy in the UK, *L.E. Kissick, UK*
ID#123 Assessment of Performance and Spent Fuel Characteristics of a Generic 100-MWe-Class SFR-SMR, *D.T. Wojtaszek, CAN*

10:30-11:00 — Coffee/Tea Break

11:00-12:40 — S2.1 — STO — **Poster Session 6 ADV**
ID#76 Characterization of the Swiss SNF Radionuclide Inventory for DGR Planning, *E. Vassopoulos, SWI*
ID#59 Computational Spent Fuel Characterization at VTT Finland, *S. Häkkinen, FIN*
ID#127 EURAD - Spent Fuel Characterization - Report from a Recently Finished European Project, *E. Vassopoulos, SWI*
ID#132 Overview of Decay Heat Measurements at Ciab Facility: Description of Decay Heat Measurements from 2003-2021 Under EPRI-SKB Collaboration, *N. Akkurt, USA*
ID#144 New Calorimeter Concept for the Measurement of Decay Heat from Spent Fuel Assemblies: A Gösgen NPP Project, *S. Caruso, SWI*

12:40-14:00 — Lunch Break

12:50-13:50 — **Side Event 1:** "The French Fuel Cycle: An Integrated System for a Sustainable Low-Carbon Energy", sponsored by France

14:00-15:40 — S2.3 — STO
ID#72 Preparing for Extended Storage of SNF in Germany from the Point of View of the Licensing Authority, *J. Palmes, GER*
ID#87 Experience of Regulatory Oversight for the Construction, Commissioning and Operation of Spent Fuel Storage Facilities in Ukraine, *A. Shepitchak, UKR*
ID#108 Regulatory Framework for Spent Fuel Management for Ghana's Nuclear Power Programme, *M. Asamoah, GHA*
ID#65 Environmental Justice and Public Engagement in the US Consent-Based Siting Process, *M.Z. Ball, USA*
ID#138 Spent Fuel Management in the Slovak Republic, *J. Vaclav, SLR*

15:40-16:00 — Break

16:00-17:20 — S4.1 — REC — **Poster Session 2.1 STO**
ID#106 Solvent Extraction Experiments for Uranium, Plutonium, and Neptunium Co-Recovery with Dissolver Solutions Derived from Irradiated Nuclear Fuels, *M. Nakahara, JPN*
ID#43 Recycling of PWR Spent Fuel in a Fast Reactor, *C.-B. Lee, ROK*
ID#112 MOX and UOX Fuel Recycling in Pressurized Water Reactors, *G. Vaast, FRA*
ID#7 Fundamental Approaches to HTGR SNF Reprocessing Technology Development, *E.D. Filimonova, RUS*

17:20-18:40 — S4.2 — REC
ID#9 Technological Approaches to Spent Accident Tolerant Nuclear Fuel Processing, *L.N. Podmoova, RUS*
ID#61 Outlines for Building the Future of French Recycling Facilities, *H. Vincenti, FRA*
ID#131 The ASOF Project - Advanced Separation for the Optimal Management of Spent Fuel, *K. Lemmens, BEL*
ID#3 Sustainable Fuel Cycle as Basis for Successful Development of Nuclear Power Programmes for Embarking Countries, *T.A. Aleksandrova, RUS*

**Wednesday, 12 June**

08:30-10:30 — S2.2 — STO
ID#36 Progression and Challenges in Technically Underpinning the United Kingdom's Strategy for the Management of Spent AGR Oxide Fuel, *R. Veazey, UK*
ID#156 Assessment of the Effects of Long-Term Wet Storage on Canadian Spent Nuclear Fuel, *G. Cota-Sanchez, CAN*
ID#17 Observation on Slow Cooling Rate Effect of Unirradiated Zircaloy-4 Hydride Reorientation Under Dry Storage Condition, *D.H. Kook, ROK*
ID#57 Investigating Drying and Dry Storage Options for Stainless-Steel Clad Advanced Gas Reactor Spent Fuel, *C. Gallagher, UK*
ID#90 Brittle Failure Limits of Spent Fuel Claddings Subjected to Long-Term Dry Interim Storage Conditions, *U. Zencker, GER*
ID#134 Re-Examining Spent Fuel Cladding Integrity Limits, *J. Faldowski, USA*

10:30-11:00 — Coffee/Tea Break

11:00-12:40 — S2.4 — STO — **Poster Session 4 REC**
ID#6 New Dual-Purpose Casks for Spent Fuel of Foreign WWER NPPs and High Level Waste from Spent Fuel Reprocessing, *M.E. Kuchi, RUS*
ID#33 Modifications of the Interim Spent Fuel Dry Storage Facility for the Storage of Fresh Fuel, *A. Smaižys, LIT*
ID#109 Performance Enhancement of the NUHOMS EOS Dry Storage System and the TN EAGLE Transportation Cask for Used Fuel Management, *P. Narayanan, USA*
ID#77 Complementary Facility for Cask Recovery at ISFSI, *F. Lantijo, SPA*
ID#52 Spent Nuclear Fuel Management for Holtec International's SMR-300, *R. Marin, SPA*

12:40-14:00 — Lunch Break

14:00-16:00 — P3 — **Panel on Navigating Stakeholders Engagement**
*L. Frizzell*, Nuclear Waste Management Organization (NWMO), CAN
*M. Kaija*, Lappeenranta-Lahti University of Technology (LUT), FIN (ID#79)
*R. Zinovik*, Association Nationale des Comités et Commissions Locales d'Information (ANCCLI), FRA
*J. Boelen*, Centrale Organisatie Voor Radioactief Afval (COVRA), NET
*M. Pérez Fernández*, Empresa Nacional de Residuos Radiactivos, S.A. (ENRESA), SPA
*T. Vietor*, Nationale Gesellschaft für die Lagerung radioaktiver Abfälle (NAGRA), SWI

16:00-16:30 — Break

16:30-18:30 — S5.1 — DIS — **Poster Session 2.2 STO**
ID#120 CIGEO, Readiness of the French DGR Project at the Construction Licence Examination Stage, *M. Maertens, FRA*
ID#80 Recent Progress within the United Kingdom R&D Programme for the Geological Disposal of High Heat Generating Wastes, *J.J. Dunsford, UK*
ID#124 Challenges in Collecting and Preserving Sufficient Spent Nuclear Fuel Information Before the Fuel is Placed in the Final Repository, *F. Johansson, SWE*
ID#111 Cost Estimations for Disposal of Radioactive Waste in Switzerland: An Established Framework Takes the Next Step, *D. Mignone, SWI*
ID#71 Adaptation of Current Final Disposal Strategy and Methods in Finland for Spent Fuel from SMRs, *P. Keto, FIN*
ID#63 Spent Nuclear Fuel and the ConfinAR Geo Project, *L. Kniznik, ARG*

**Thursday, 13 June**

08:30-10:30 — S5.2 — DIS
ID#35 An Overview of the United Kingdom Strategy for Management of Spent Nuclear Fuel, Focusing on Metallic Uranic Fuels and Challenges Presented for Geological Disposal, *M.J. Austin, UK*
ID#16 Design and Evaluation of a Korean-Style High-Efficiency Disposal System for Domestic Waste, *K.-L. Lee, ROK*
ID#40 Exploring Encapsulation Envelopes for Disposal of Spent Nuclear Fuel, *K.J. Robinson, UK*
ID#38 Predicting Decay Heat by Combining Fuel Parameters with Gamma and Neutron Data Using Machine Learning, *V. Solans, SWE*
ID#78 Developing Waste Acceptance Criteria for Advanced Reactor Waste Forms in the Universal Canister System, *J. Sloane, USA*
ID#11 Effect of the Host Rock Thermal Properties on the Disposal Area Requirements for Spent Fuel and Vitrified High Level Waste in a Geological Repository, *B. B. Acar, TUR*

10:30-11:00 — Coffee/Tea Break

11:00-13:00 — P4 — **Panel on Innovation and Integration**
*C. Evans*, World Nuclear Association (WNA) (ID#53)
*L. Iglesias Pérez*, Joint Research Centre - European Commission (JRC-EC)
*P. Gauthé*, HEXANA, FRA
*E. Petit de Mange*, OKLO, USA (ID#91)
*B. Merk*, University of Liverpool, UK (ID#103)
*A. Sillim*, University of Regina, CAN

13:00-14:20 — Lunch Break

13:10-14:10 — **Side Event 2:** "Meeting the Moment: Paving the Way for Tomorrow's SFM Workforce" (Co-organized by NEI, NWC and IAEA-WIN, sponsored by NEI (USA))

14:20-15:40 — S7.1 — INT
ID#34 Addressing Nuclear Spent Fuel Management Challenges: A Key to Alleviating Nigerian Skepticism Towards Nuclear Power Generation, *J. Sunmi, NIR*
ID#73 An IRSN Augmented Expertise Tool Helping for Continuous Monitoring of the Consistency of the Fuel Cycle, F. Ledrot, FRA
ID#151 Updated Status of Spent Fuel Removal at Fukushima Daiichi NPP, *Y. Ishii, JPN*
ID#162 Findings from the RPV and PCV Internal Investigation for Fuel Debris Retrieval at the Fukushima Daiichi NPP, *K. Sawada, JPN*

15:40-16:10 — Break

16:10-17:50 — S7.2 — INT — **Poster Session 7 INT**
ID#45 About Spent Nuclear Fuel in Argentina: Should We Worry? *L. Gringauz, ARG*
ID#55 The Value of an Integrated View on Spent Nuclear Fuel and Radioactive Waste Management Strategies Reducing Financial Risks to Stakeholders, *L. Van den Durpel, BEL*
ID#74 ROWO: A Holistic Approach to the Optimization of Deep Geological Disposal of High Level Waste, *E. Vassopoulos, SWI*
ID#113 Advances in Developing a LWR Multirecycling System, *C. Evans, FRA*
ID#116 Study of Scenarios for Spent Fuel Management in Mexico, *J.L. François, MEX*

**Friday, 14 June**

08:30-10:10 — S3.1 — TRA
ID#114 Preparing Safe and Efficient Loading and Transport Operations of Spent Nuclear Fuel, *Y. Soligna, FRA*
ID#20 Experience and Perspectives of SNF Transportation in Russia: Organization of Shipments, Safety Requirements and Justification, Emergency Response, New Tasks, *V.N. Enshin, RUS*
ID#110 Spent Nuclear Fuel Management at KKM Nuclear Power Plant: Spent Nuclear Fuel Storage Away from the Plant, *F. Hotzgrewe, SWI*
ID#32 Transportation of Spent Nuclear Fuel Conducted in Poland - Lessons Learned, *L. Bak, POL*
ID#141 Packaging, Safety, Security, and Safeguards (3S) for Nuclear Fuel Cycle Materials in Storage, Transportation, and Disposal, *Y. Liu, USA*

10:10-10:35 — Coffee/Tea Break

10:35-11:55 — S3.2 — TRA
ID#42 Demonstration of a Risk-Informed Approach for Regulatory Approval for Shipping a Microreactor Transportation Package, *M.E. Adkins, USA*
ID#41 Microreactor Transportation Emergency Planning Challenges, *S.J. Maheras, USA*
ID#148 Transportation and/or Interim Storage of SMR/AMR Spent Fuel: Solutions and Challenges, *C. Alastar, FRA*
ID#67 Development of a Functions and Requirements Document for a SNF Transportation Package Performance Demonstration, *L. Hay, USA*

12:00-13:00 — **Closing Session**
*J. A. Gago*, Conference Chairman, Spain
*L. Evrard*, Deputy Director General and Head of the Department of Nuclear Safety and Security, IAEA
*M. Chudakov*, Deputy Director General and Head of the Department of Nuclear Energy, IAEA

**Track titles**

1. **NAT** - National Strategies for Spent Fuel Management
2. **STO** - Storage of SNF and Vitrified HLW and Subsequent Transportability
3. **TRA** - Transportation in the Back End of the Fuel Cycle
4. **REC** - Recycling of Spent Fuel
5. **DIS** - Disposal of SNF, HLW and Other Waste Forms in Deep Geological Repositories (DGR)
6. **ADV** - Impacts of Advanced Nuclear Energy Systems on the Back End of the Fuel Cycle
7. **INT** - Achieving Integrated Spent Fuel Management

**Panel titles**

**P1** - Panel on National Strategies for Spent Fuel Management (I)

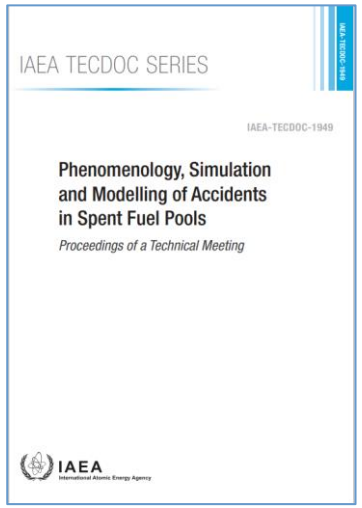
**P2** - Panel on National Strategies for Spent Fuel Management (II)

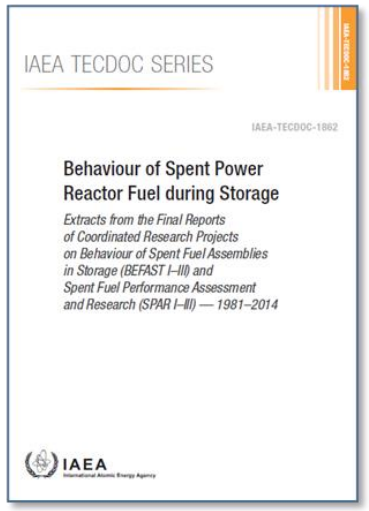
**P3** - Panel on Navigating Stakeholders Engagement: Sharing Insights and Lessons Learned in Spent Fuel Management Strategy Implementation in Member States

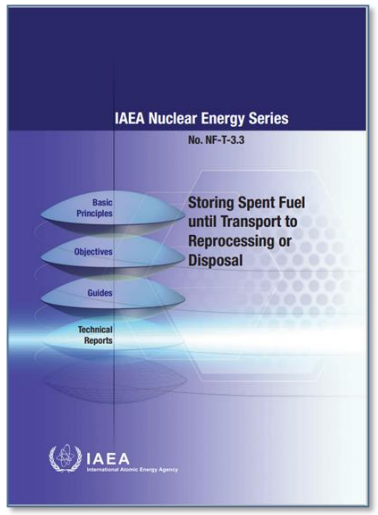
**P4** - Panel on Innovation and Integration: Approaches for Managing Spent Fuel from Advanced Reactors (e.g. SMRs, …)

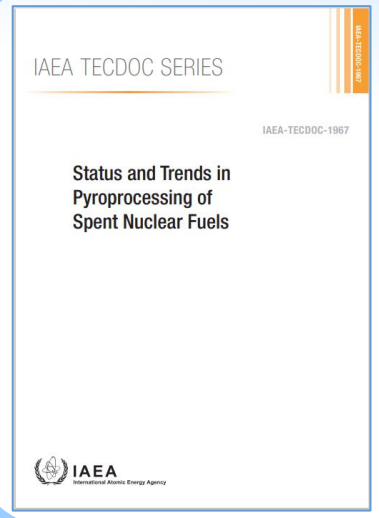
- **14** Sessions in **7** Tracks
- **77** contributed oral presentations **13** E-posters, **21** posters from **29** Member States and **2** international organizations

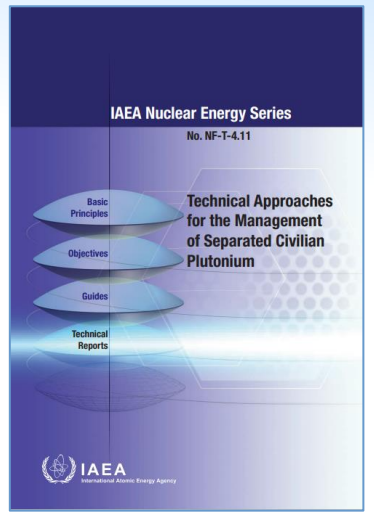
# IAEA Publications on Spent Fuel Management

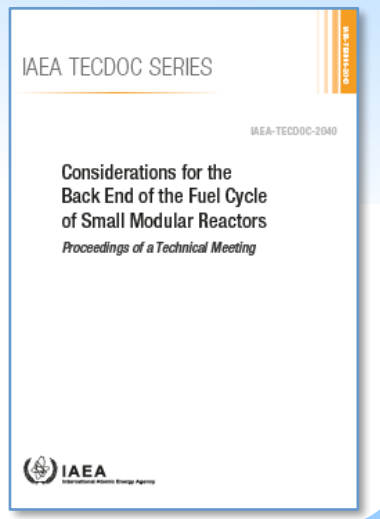


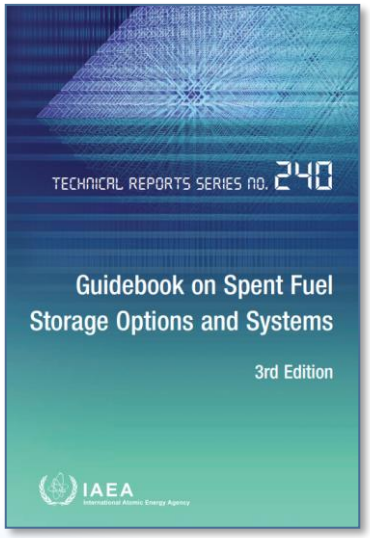



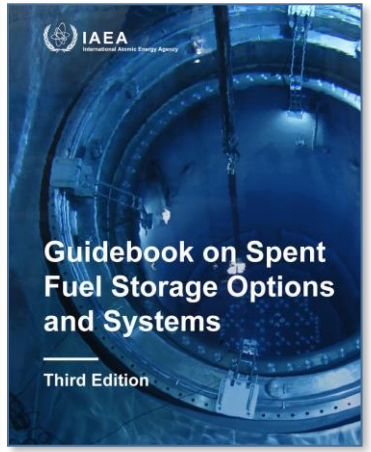



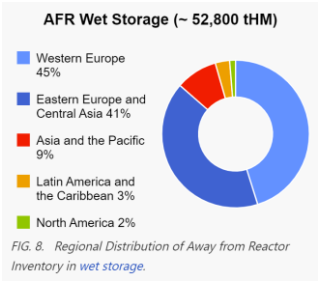




**INTERACTIVE**
Available ON-LINE



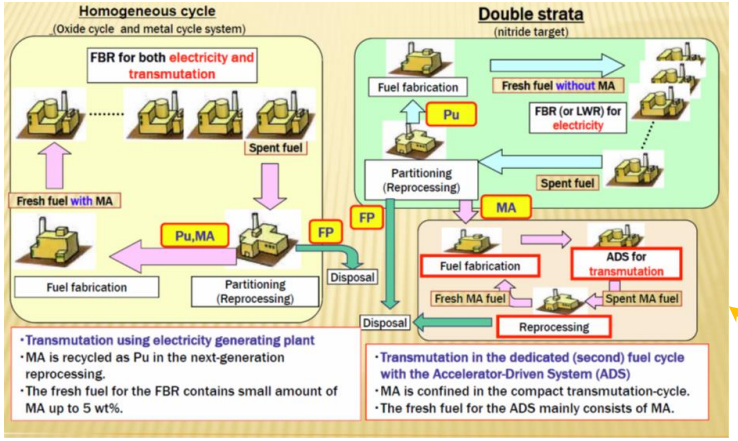


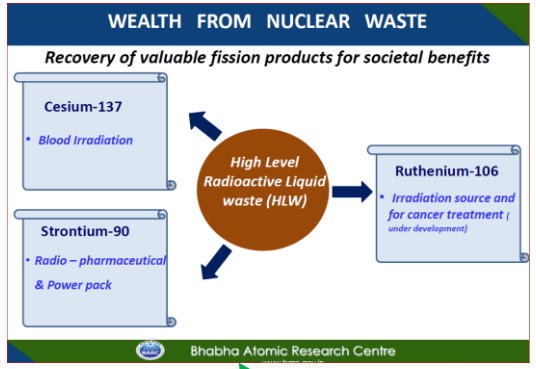
https://www.iaea.org/publications

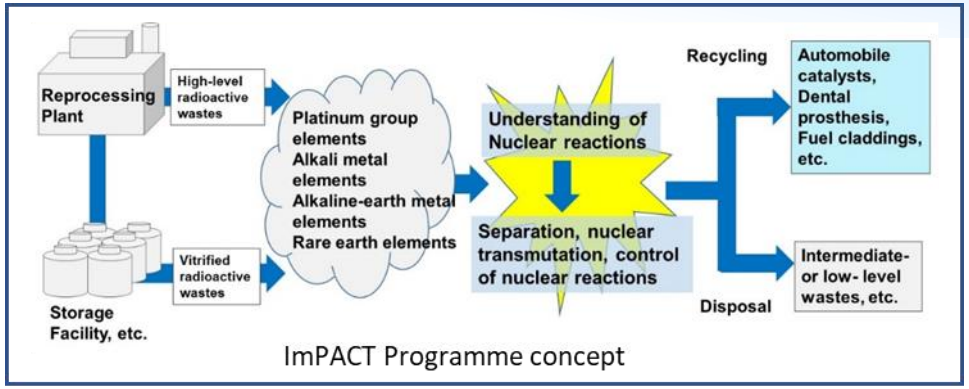
- **TECDOCs**
- **NE Series publications**
- **Interactive Books** with pictograms, animations and downloadable pictures and charts

# IAEA activities on Advanced Fuel Cycles

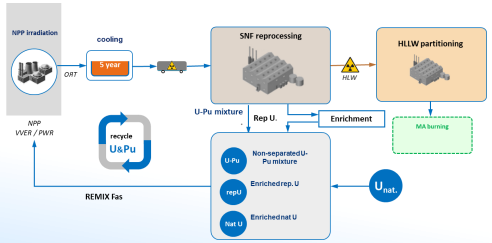
**Nuclear Energy Series** on "*Existing and Advanced Nuclear Fuel Cycle Technical Options for Waste Burden Minimization*": To describe relevant information on Nuclear Fuel Cycle Options in terms of nuclear materials and wastes involved and nuclear fuel cycle facilities and infrastructures required



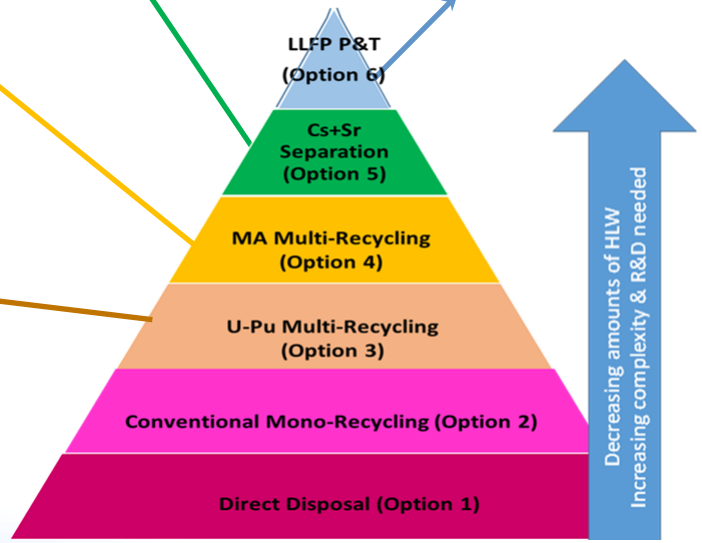



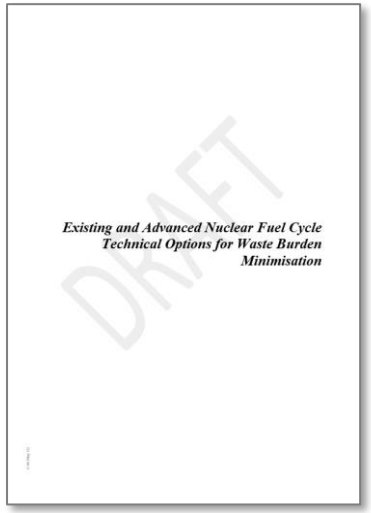




- LWRs multirecycling to enable transition to FRs
  - MIX and MOX-MR processes (France)
  - REMIX process (Russian Fed.)




- FRs multirecycling



# IAEA Technical Meeting (EVT2105850) on Backend of the Fuel Cycle Considerations for Small Modular Reactors, 20-23 September 2022

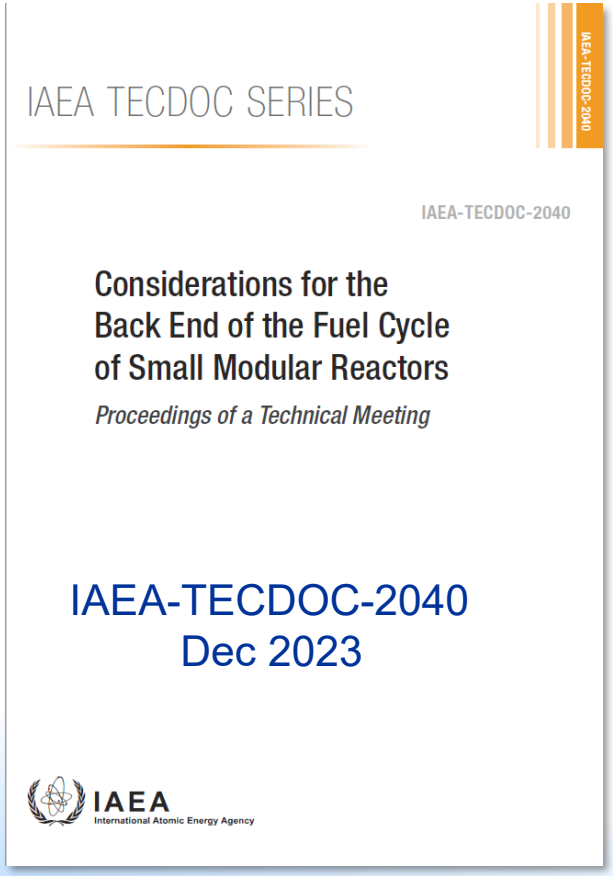
**107** Participating Experts from
**32** Member States

**3** International Organizations

40 people in person and 67 on-line


**~ 40** Presentations and
Extended Abstracts

# IAEA Technical Meeting on Backend of the Fuel Cycle Considerations for SMRs

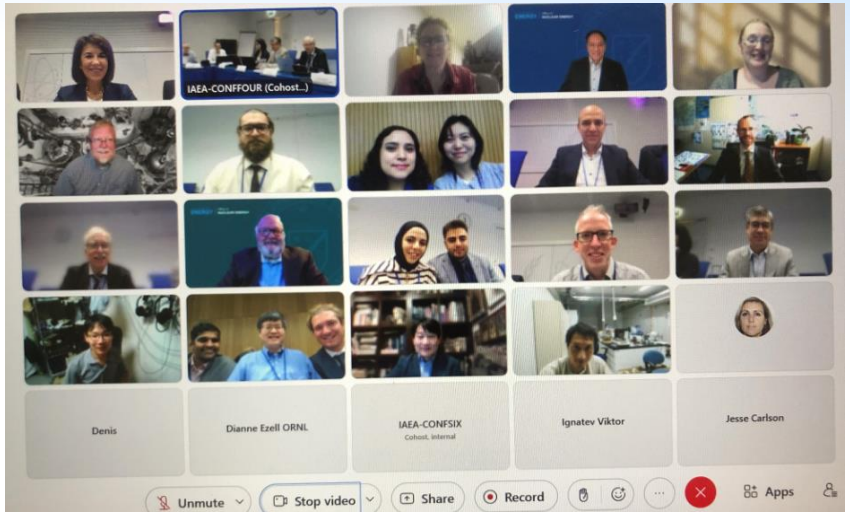



## Summary of Presentations and Discussions during the Technical Sessions on

- IAEA Activities
  - SMR Developments and Associated Nuclear Fuel Cycle Options, Fuel Designs, Safety, Security, Safeguards, Economics, Transportation
- International Organization's Activities and Perspectives
  - EC/JRC, OECD/NEA and ERDO
- Member States' Activities and Perspectives
- Three Breakout Sessions (Storage, Reprocessing&Recycling, Transportation, Disposal)
  - LWR type
  - HTGR type
  - **AMRs (LMFRs and MSRs) type**
- General Discussion
- Conclusions and Future Areas of Work

# **International Workshop on the Chemistry of Fuel Cycles for Molten Salt Reactor Technologies, 2-6 Oct. 2023**, in cooperation with the OECD/NEA

- **Held in Vienna on 2-6 October 2023, co-organised by the NEA and the IAEA**
- **44 participants** (28 onsite + 16 online) including **4 developers of MSRs** (Copenhagen Atomics, Seaborg Technologies, Naarea and Terrapower)**, R&D organisations, regulators and industry experts** from **13 countries** and the EU
- Several **technical sessions** including technical presentations, “thoughts from the floor” sessions and panel discussions with all the presenters
- **Breakout sessions** for the participants to engage in further discussion and work together to identify gaps and needs: experimental underpinning; irradiations; monitoring and operation; irradiated fuel treatment (material and waste streams)




***Publication gathering Main Findings, Topical Discussions, Break Out Sessions, Conclusions and Recommendations is under preparation***

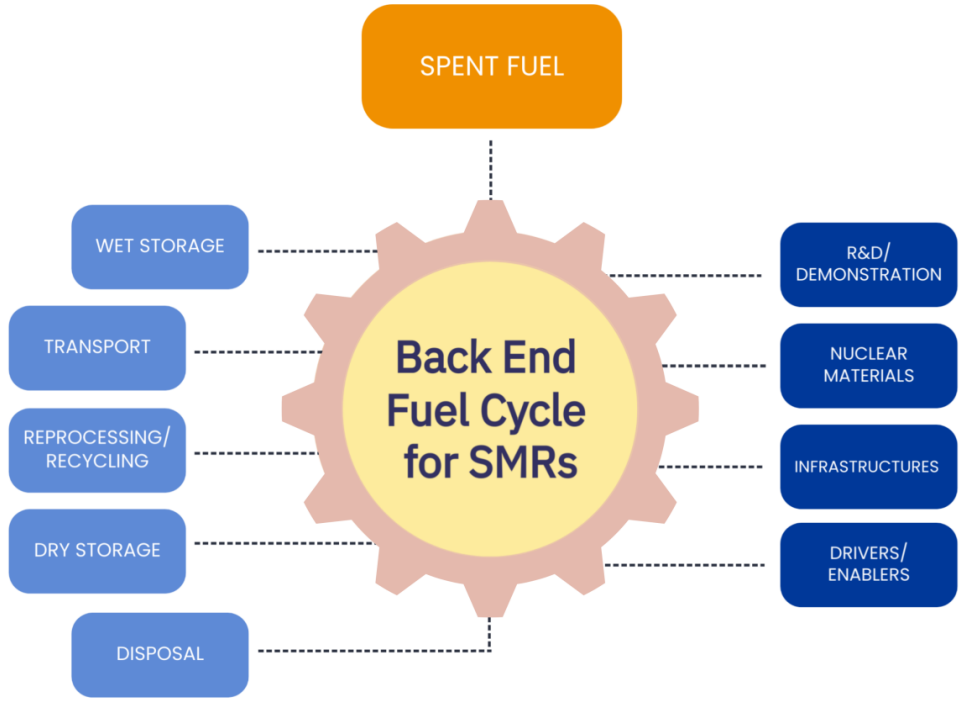
# Coordinated Research Project on *Challenges, Gaps and Opportunities for Managing Spent Fuel from SMRs*

Understanding the implications of the management of new spent fuels is paramount to make informed decisions

**SMR-COGS, CRP T13021**

**MAIN OBJECTIVES:**

- To identify viable nuclear fuel cycle options for the different SMR technologies
- To identify common technologies/similarities for various reactor types and/or significant differences
- To prepare a list of generic key parameters for countries to perform their analysis incorporating their specific context
- Development of **specific roadmaps** for managing spent fuel from the different SMR technologies, identifying what can be derived, optimized or adapted from existing practices, or what needs to be fully developed



# First Research Coordination Meeting of SMR-COGS CRP held on 11 to 15 November 2024 in Vienna

## STATUS of the Coordinated Research Project SMR-COGS

- 14 Research Contracts from ARG, ARM, CPR, CZR, EGY, INS, LIT, MEX, POL, ROM(2), UKR(3)
- 18 Research Agreements from CAN(2), CPR, DEN, EGY, JOR, NOR, SIN, SPA, SWE, TUR, UK(2), USA(5)

Industry, Operators, Researchers, Regulators, etc.

Nuclear Energy Programmes: Embarking (Phase 1, 2 and 3), Expanding, Mature and Not Nuclear (DEN and NOR)

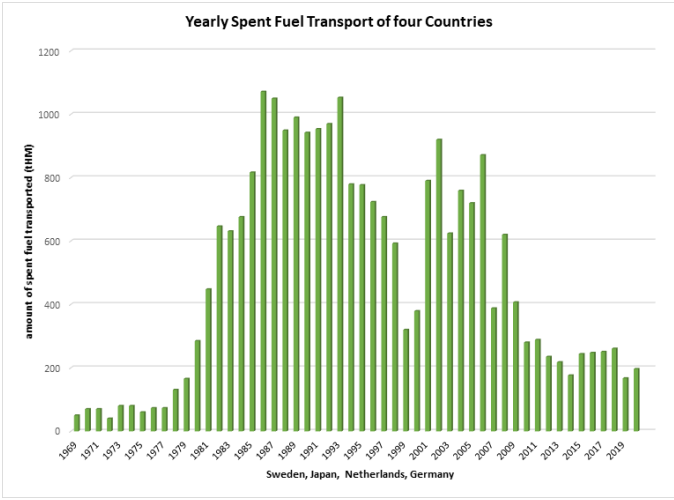
Observers: OECD/NEA, FIN, FRA, NET, RUS

**45+ participants from 25 countries**

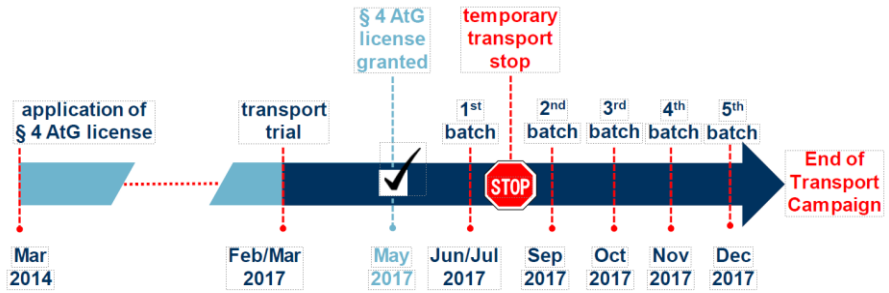
# Transportation of Spent Fuel

## Technical Meeting on Operational Experiences on Spent Fuel and High Level Waste Transportation, 17-21 October 2022

- Spent fuel has been regularly transported for decades
- TM will review draft TECDOC on Operational Experience containing case studies from seven countries
- Will be opportunity to gather and discuss further information
- Tecdoc is under Drafting Process, gathering country cases








Detailed regulations require long preparation times

# Upcoming and Recent IAEA Events on Spent Fuel Management (1/2)

1. Technical Meeting on Operating Experience and Lessons-learned on Managing Non-standard/Exotic Legacy Power and Research Reactor Spent Fuels, **18 – 21 February 2025, Vienna** (Material accessible at https://conferences.iaea.org/event/399 )

2. Technical Meeting on Spent Fuel Behaviour and Performance of Storage Systems**, 23-27 June 2025, Seoul, RoK**

3. Technical Meeting on the Management of Spent Fuel (Pebbles and Compacts) from High Temperature Reactors, **7 – 11 July 2025, Vienna** (Material accessible at *https://conferences.iaea.org/event/414 )*

7. Technical Meeting on Proliferation Resistant Features of Fast Reactors and Advanced Fuel Cycles, **18 – 22 August 2025, Vienna**

8. Workshop on Molten Salt Taxonomy (In collaboration with the OECD/NEA and EC-JRC), **November 2025, Vienna**

# **Joint IAEA-NEA-EC/JRC Workshop** on the Taxonomy and Related Terminology of Fuel Cycles for Molten Salt Reactors

3 - 7 November 2025

IAEA International Atomic Energy Agency

NEA NUCLEAR ENERGY AGENCY

European Commission

## Objectives

- To identify and establish a taxonomy for the fuel cycle options related to molten salt reactor technologies.
- To draft a suitable terminology for the different stages of the fuel cycles to facilitate communication on this complex topic.

## Topics

- **MSR Fuel Cycle Scenarios**
  - MSR fuel cycle scenario modelling: covering once-through to full recycling options
  - Flowsheet studies
  - Safeguards and MC&A considerations
- **MSR Fuel Cycle Technologies**
  - Clean-up and chemical control of fuel salt (with focus on fission products and contaminants removal)
  - Recycling of actinides
  - Influence of waste streams on fuel cycle options
  - Off-gassing techniques
  - Online, inline, offline, at-line, onsite, and offsite treatment options
  - How fuel cycle technologies affect the coupling of chemistry and physics
- **Impacts of the input streams on the fuel cycle**
  - Fuel source (e.g.: fresh fuel, recycled from spent fuel from other reactors)
  - Fuel and blanket salts
  - Fissile/fertile material (e.g.: U/Pu, Th/U, fuels with minor actinides)

# Spent Fuel Management Meetings in 2025 (2/2)

9. Technical Meeting on Status and Trends for SNF and RW Management, **28 – 31 October 2025, Vienna**

10. Technical Meeting on Policies and Strategies for Managing Spent Fuel and Radioactive Waste, **1 – 5 December 2025, Vienna**

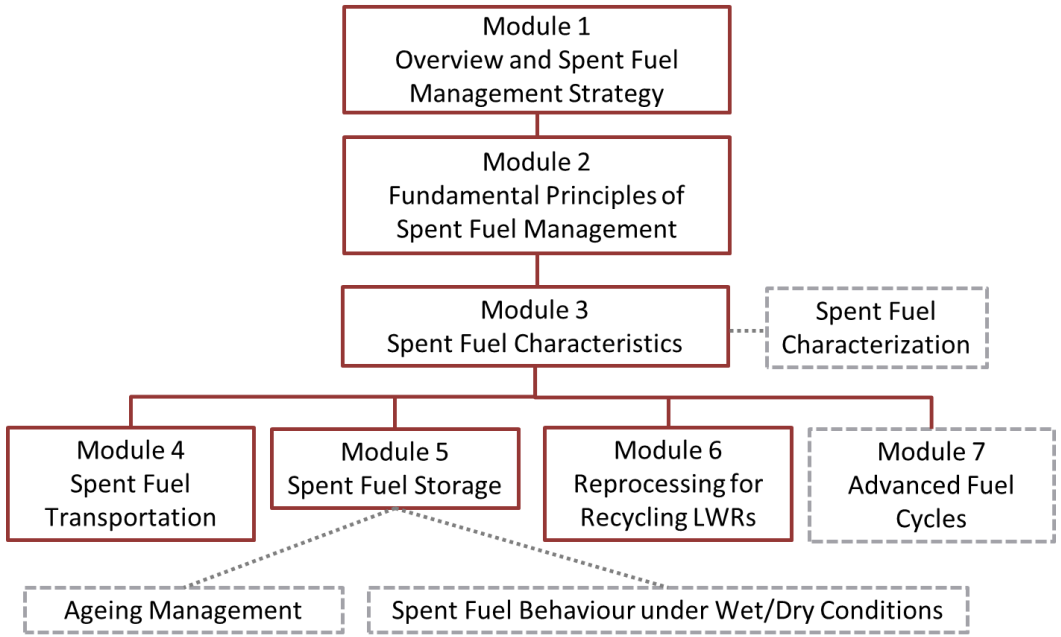
# International Conferences in 2026

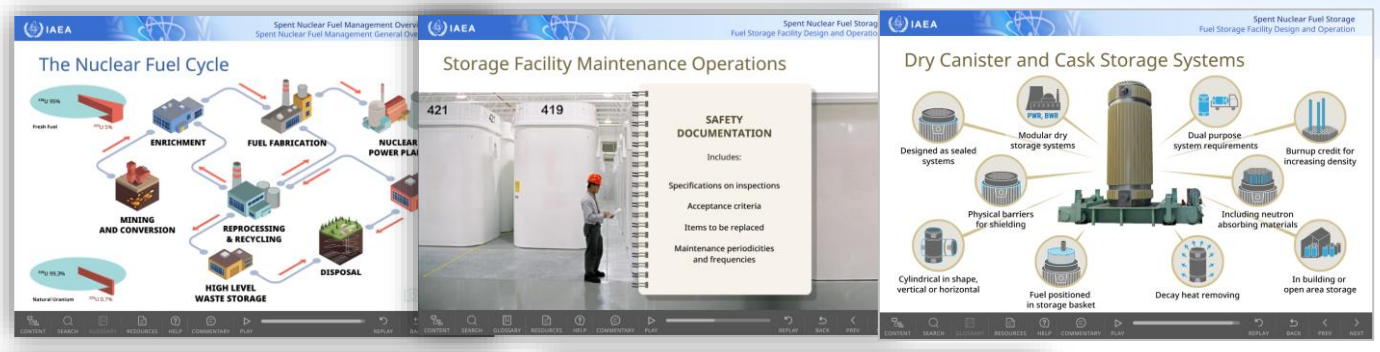
- International Conference on Fast Reactors and Related Fuel Cycles (FR26) in Beijing (China) from **18 to 21 May 2026** (In collaboration with IAEA/NPTDS)

- International Conference on Fuel Supply Chain for Sustainable Nuclear Power Development in Vienna from **13 to 15 October 2026** (IAEA/NFCMS)
  - Topic 1. Industry Prospects and Challenges Facing Raising Fuel Supply Demand
  - Topic 2. Supply and demand of raw materials for nuclear fuel supply
  - Topic 3. Advanced nuclear fuels for innovative reactor technologies
  - Topic 4. Industrial and Innovative technologies for recycling nuclear materials

# IAEA e-Learnings on Spent Fuel Management

## 6 Modules (11 Lectures) already available in



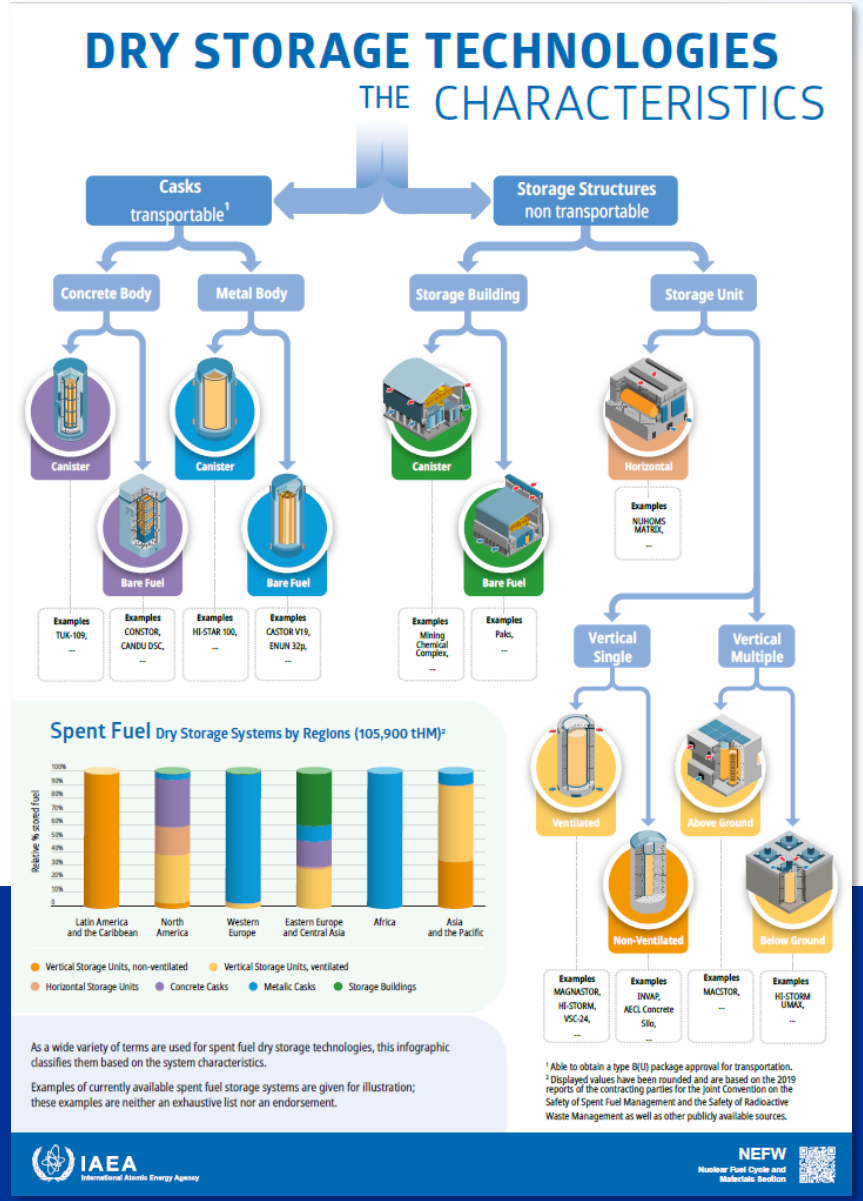



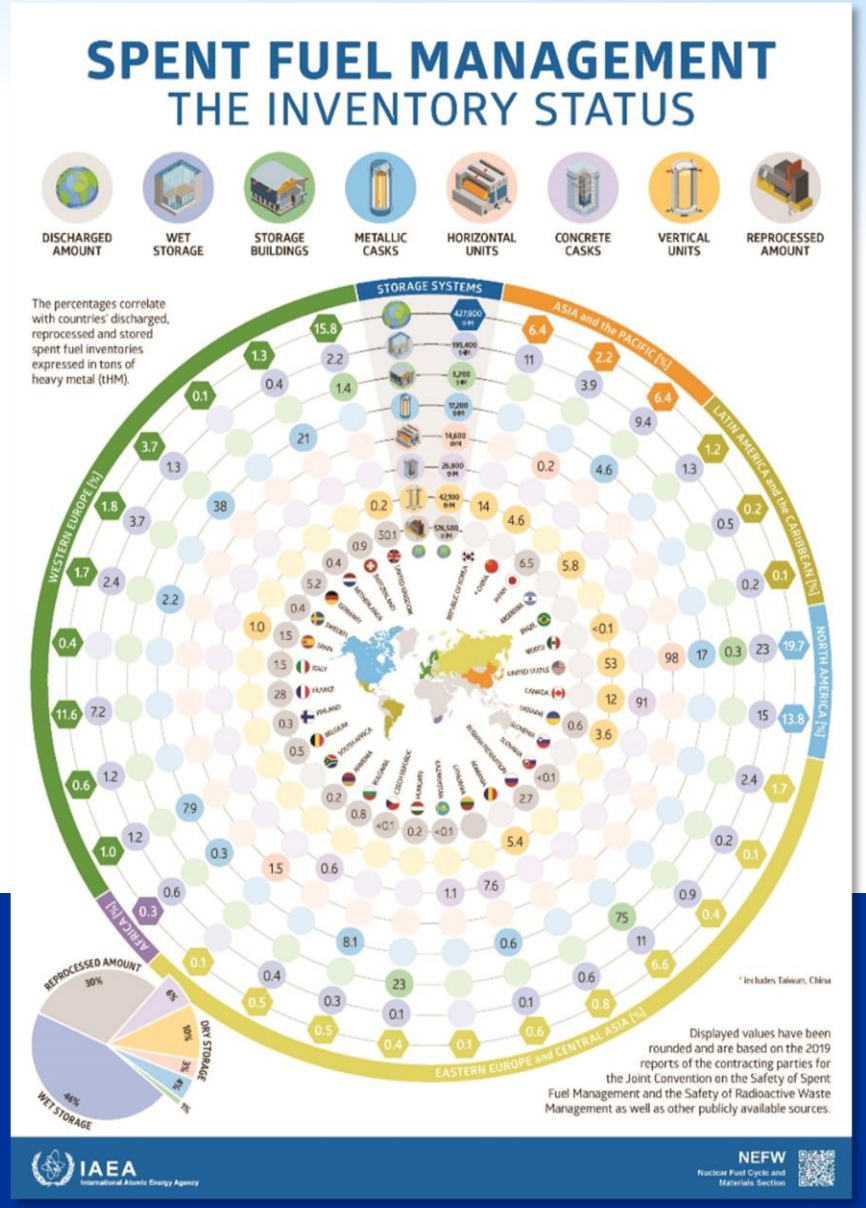





https://www.iaea.org/services/education-and-training/online-learning

# IAEA Infographics on Spent Fuel Management




https://www.iaea.org/topics/spent-fuel-management

# Nuclear Fuel Cycle Simulation System


## Integrated Nuclear Fuel Cycle Information System (iNFCIS)

INFCIS is a resource for technical and statistical information about nuclear fuel cycle activities worldwide, as reported to the IAEA.

The system includes four databases and one computer simulation system:

**Nuclear Fuel Cycle Facilities Database (NFCFDB)**

NFCFDB covers civilian nuclear fuel cycle facilities around the world. It contains information on operational and non-operational, planned, and cancelled facilities. All stages of nuclear fuel cycle activities are covered, starting from uranium ore production to spent fuel storage facilities. Nuclear Fuel Cycle can be defined as the set of processes to make use of nuclear materials and to return it to normal state. It starts with the mining of unused nuclear materials from the nature and ends with the safe disposal of used nuclear material in the nature.

**World Distribution of Uranium Deposits Database (UDEPO)**

UDEPO is a database of uranium deposits in the world. It contains information on the classification, geological characteristics, geographical distribution and technical characteristics of the uranium deposits worldwide. The website provides filtering and search capabilities that include the geological classification of the deposits, current status and country. UDEPO also provides tools to create dynamic summary reports.

**Post Irradiation Examination Facilities Database (PIEDB)**

PIEDB is a catalogue of post irradiation facilities (hot cells) worldwide. It includes a complete survey of the main characteristics of hot cells and their PIE capabilities.

**Nuclear Fuel Cycle Simulation System (NFCSS)**

NFCSS, formerly known as VISTA, is a scenario-based computer model for the estimation of fuel cycle material, service requirements and actinide arisings. The NFCSS is a computer simulation system that uses simplified approaches to calculate fuel cycle requirements. The site provides a detailed description of the simulation system, an example scenario with results, and a simple calculation tool that can be used to calculate annual material flow in a selected nuclear fuel cycle option.

**World Thorium Deposits and Resources (ThDEPO)**

Access NFCFDB

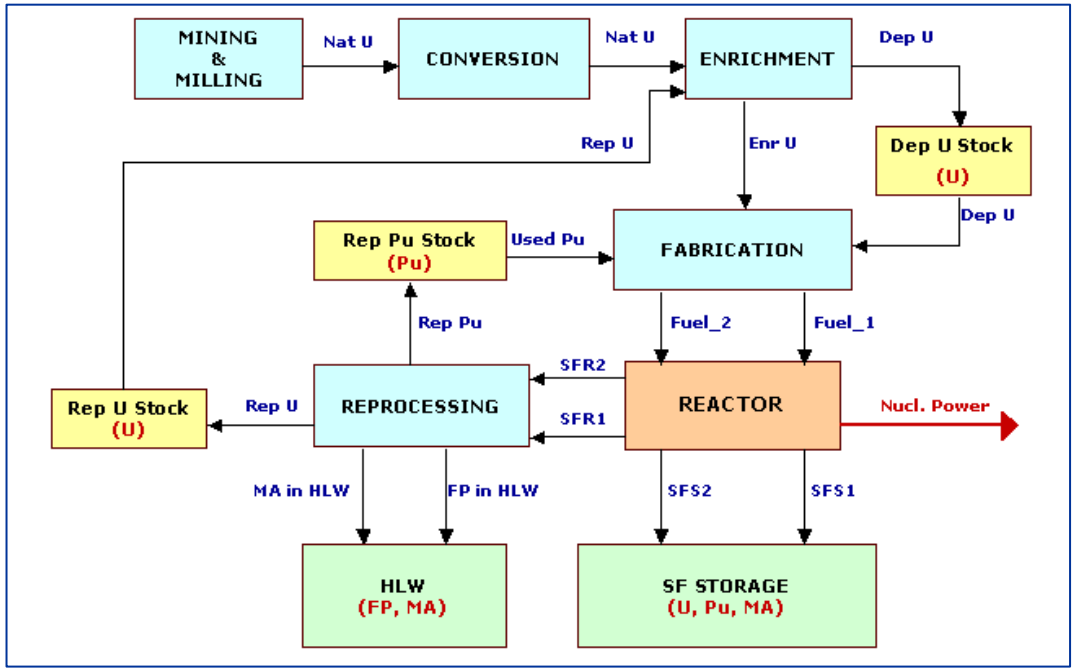
Access UDEPO

Access PIEDB

Access NFCSS

Access ThDEPO

## Overall Fuel Cycle Material Flow Diagram



# Spent Fuel Management Network

SFM.Contact-Point@iaea.org

## Welcome to the IAEA International Network on Spent Fuel Management - SFM Net

The spent fuel management (SFM) network is a forum for the sharing of practical experience and international developments on spent fuel management.

Its main objectives are to facilitate the efficient exchange of information, communication and cooperation amongst professionals working in the back end of the fuel cycle – from its removal from a reactor core to its final disposition (i.e. SNF wet and dry storage, transportation, handling and retrieval, reprocessing and recycling, economics of the back-end of nuclear fuel cycle, damaged SNF management, stakeholder involvement, communication issues, etc.)

The establishment of the SFM Net is aimed at fostering safe, sustainable and efficient spent nuclear fuel management practices across all IAEA Member States.

For further information or questions please contact SFM.Contact-Point@iaea.org.

### Featured Publications

SEE ALL

Spent Fuel Performance Assessment & Research (SPAR-IV) | Status and Trends in Pyroprocessing of Spent Nuclear Fuels | Phenomenology, Simulation & Modelling of Accidents in Spent Fuel Pools | Management of Spent Fuel from Nuclear Power Reactors Learning from th... | Demonstrating Performance of Spent Fuel & Related Storage System... | Management of Spent Fuel from Nuclear Power Reactors

### Events 2025

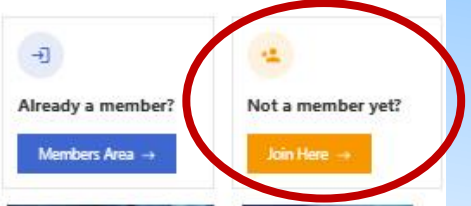
- Technical Meeting on Operating Experience and Lessons Learned on Managing Non-Standard Legacy Spent Fuels from Power and Research Reactor (18 – 21 February 2025) *EVT2304628*
- Third Coordination Research Meeting on Spent Fuel Research and Assessment (24 – 28 March 2025) *EVT2404557*
- 23rd Meeting of the Technical Working Group on Nuclear Fuel Cycle Options and Spent Fuel Management (01 – 04 April 2025) *EVT2403024*
- Technical Meeting on the Behaviour of Spent Fuel and Cladding During Storage and the Performance of Spent Fuel Storage Systems (23 – 27 June 2025) *EVT2406873*
- Technical Meeting on the Management of Spent Fuel (Pebble Beds and Prismatic) from High Temperature Gas Cooled Reactors (7 – 11 July 2025) *EVT2404558*
- Joint IAEA-NEA Workshop on the Taxonomy and Related Terminology of Fuel Cycles for Molten Salt Reactors (29 September – 03 October 2025) *EVT2404560*
- Workshop on the Challenges in Managing Spent Evolutionary Advanced Technology Fuels (10 – 14 November 2025) *EVT2205116*
- Technical Meeting on the Operation and Maintenance of Storage and Transportation Casks (09 – 12 December 2025) *EVT2404726*

### Latest News

**NEW CRP: Challenges, Gaps and Opportunities for Managing Spent Fuel from Small Modular Reactors (T13021)**

**IAEA's Learning Management System!**

With the addition of 3 new modules, the course on Spent Fuel Storage is available on IAEA's Learning







New infographics now available!



# Thank You

A.Gonzalez-Espartero@iaea.org