

PRE-DISPOSAL - TOPICAL SESSION 5

WP5 ICARUS, WP6 STREAM, WP7 L'OPERA

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ANNUAL EVENT N°2 – TOPICAL SESSION 5 - AGENDA

1. Presentation of **main achievements of each WP**: WPL - tot **25 min**
2. Presentation of a **topic common to the three WPs "Training Actions"**: T2Ls- tot **10 min**
3. **Interactive session** with discussion about two topics - tot **55 min**
 - **Introduction** to the topics and to the on-going efforts in the WPs to address the issues (WPL, **5 min**)
 - **Open discussion in small groups divided by role** (14-16 people/table). Each table will have a Facilitator and would address the topics within **30 min**
 - **Feedback from groups** - tot. **20 min**

MAIN ACHIEVEMENTS OF EACH WP



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WP5 ICARUS – OVERVIEW



Development, optimization and harmonization of innovative techniques for radiological, physical and chemical characterization of LLW/ILW-mixed waste which could be critical for the safe implementation of radioactive waste management programmes.

T2

Capture needs & KM

To obtain **fast**, **accurate**, and **non-destructive** characterization of complex large packages

T3

NON-DESTRUCTIVE
TECHNIQUES (NDT)

To overcome **expensive** and **time-consuming** conventional radiochemical analysis

T4

DESTRUCTIVE
TECHNIQUES (DT)

To improve **reliability** and lower **uncertainties** of Scaling Factors models

T5

SCALING
FACTORS (SF)



27 funded partners from 15 countries
2 Associated partners (IFE, PSI*)



Duration: 5 years
01.10.2024 – 31.09.2029



Budget:
5 years: 4.4 M€ total, of which
EC contribution of 2.2 M€

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WP5 ICARUS – MAIN ACHIEVEMENTS

★ NON-DESTRUCTIVE TECHNIQUES (NDT) for large waste volumes

- First population of datasets on the new **Data Management platform**
- Alignment of Working Groups on the identified use cases built on **real decommissioning scenarios**
 - Selection of the most promising techniques for real decommissioning applications

WP5 ICARUS – MAIN ACHIEVEMENTS

Deliverables and Milestones:

- D5.1: Initial State-of-the-Art
- M50: Identification of the most relevant radionuclides and WAC for SF
- M71: Selection of specific use cases to test the developed NDT and methods in relevant industrial conditions

Articles on peer-reviewed journals:

- Presentation of WP5 ICARUS
- Radiochemical method for ^{36}Cl in irradiated concrete
- Gamma spectrometric method for in-situ determination of surface and volume activity

Scientific conferences: 1 poster and 6 oral presentations

Large community: 31 End-Users and 22 Stakeholders (workshops, surveys, intercomparison)

Young professional: 11 PhD and MSc students (training, mobility, community)



WP6 STREAM - OVERVIEW



Development and optimization of new or existing treatment and conditioning methodologies for waste streams without industrially implemented management routes

Problematic waste

Metallic wastes, liquid organics, SIERs, sludges and evaporator concentrates

Sustainable design

Optimise treatment processes and conditioning matrices for further development

Upscaling pathway

Increase TRLs considering end-user constraints and industrial relevance

T2

Capture needs & KM

T3

Treat / condition

T4

Scale up

T5

Assess value



22 funded partners from **14** countries
2 Associated partners (UKNNL, NWS)



Duration: 5 years
01.10.2024 – 31.09.2029



Budget:
5 years: 4 M€ total, of which
EC contribution of 2 M€

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WP6 STREAM – MAIN ACHIEVEMENTS (TASK 3)

<50%

SIER residue after Fenton treatment

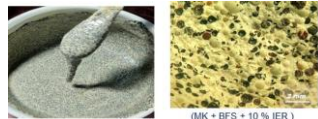


Organic waste treatment demonstrated

Fenton oxidation tests on spent ion exchange resins show significant residue reduction, supporting waste minimisation and lower secondary streams

10–45%

Waste loading range



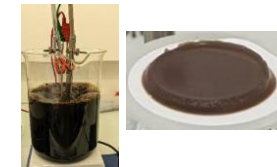
Alternative binders screened

AAM/geopolymer matrices reached 10–30% loading in several systems, with up to 30–45% in VBR/ash/metal cases under investigation

Corrosion products and H₂ generation investigated in MKPC+Al systems

>99%

Precipitation yield; DF ≈ 800

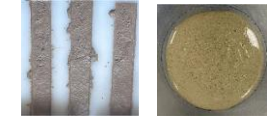


Reactive metal treatment progresses

Oxidation/decontamination trials for Mg and other reactive metals produced high precipitation yield and strong decontamination performance

11

Low Carbon Binder systems under study



Low-carbon matrix selection data

Tests identify workability, stability, corrosion and strength parameters for route selection

NEXT: evidence-based prioritisation for scale-up in Task 4 and LCA-LCC in Task 5

WP6 STREAM – MAIN ACHIEVEMENTS (WP6)

R&D pathways

Most promising treatment processes and conditioning matrices selected through MS62 and MS63

Capacity building

Geopolymer training course delivered
12 students involved in STREAM R&D activities
Pre-disposal Training portfolio built for Y3-Y4

Stakeholder engagement

Dedicated End-User & Stakeholder workshops strengthened practical relevance and feedback

24

end users

26

stakeholders

24

countries

Scientific excellence & Dissemination

Two open-access publications demonstrate scientific output and traceable progress
Strong participation in major scientific conferences

WP7 L'OPERA - OVERVIEW



Evaluate, understand, and improve the long-term performance, under **representative disposal conditions**, of the matrices used for the immobilization of low- and intermediate-level waste (LILW)



Waste forms

Metallic wastes, liquid and solid organics immobilized in geopolymers/AAM, MKPC and Nochar

Harmonization & Representativeness

Common teaching and characterization protocols. Defined parameters for accelerated ageing

Modelling

Predict long-term evolution of the waste forms and the impact on their performance

T2

Capture needs & KM

T3

Boundary conditions

T4

Inventory /
Characterization

T5

Durability /
Stability

T6

Implementation



27 funded partners from 12 countries



Duration: 5 years
01.10.2024 – 31.09.2029



Budget:
5 years: 4 M€ total, of which
EC contribution of 2 M€

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WP7 L'OPERA – MAIN ACHIEVEMENTS



➤ **Boundary conditions**

- Identification of the key parameters influencing the durability of the waste forms
- Geological parameters for leaching tests and environment conditions for ageing tests
- Recommendations for harmonized protocols

➤ **Inventory of the conditioned materials and complete characterization**

- Production of a large number of samples covering 11 different waste forms
- Common characterisation protocol: first screening achieved and will be completed as the work progresses
- Harmonized collection data template

➤ **Waste forms durability and stability testing**

- Long-term leaching tests in progress
- Leaching and radiation protocols for artificial ageing
- Harmonized data template for leaching results

WP7 L'OPERA – DISSEMINATION ACTIVITIES

➤ **Deliverables and Milestones:**

- D7.1: Initial State-of-the-Art
- D7.2 Representative conditions and identification of the key parameters influencing the long-term behaviour of LL-ILW
- M36: Delivery campaign of samples

➤ **Scientific conferences and papers:**

- 5 conferences of workshop
- 6 oral presentations or posters
- 2 published papers in peer-reviewed journal

➤ **We are**

- 27 beneficiaries from 11 countries,
- 8 PhDs and postdocs
- 23 End-Users and 22 Stakeholders



TOPIC COMMON TO THE THREE WPS "TRAINING ACTIONS "

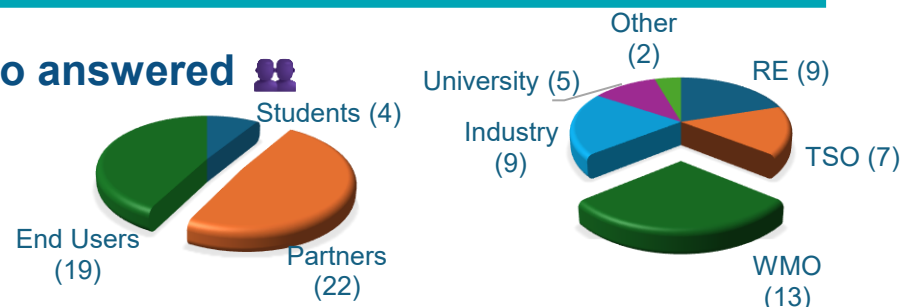


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TRAINING NEEDS – WHAT THE WP5-6-7 SURVEY TELLS US

Joint training-needs survey run by the Task 2 leads of WP5 ICARUS, WP6 STREAM and WP7 L'OPERA (export: 30 July 2025)

Who answered



Preferred training formats

on-line courses (4 h) 73%
on-site courses with practical sessions and technical visit (3–5 days) 60%
e-learning 56%

Practical, applied content preferred over theory



Fields of interest

Characterisation 76%
Waste Acceptance Criteria 64%
Conditioning 64%
Treatment 62%
End users rank characterisation highest (84%)

Community resources

9 partners and end-users ready to mentor
17 organisations open to host technical visits
Training material already exists many topics

Interest by WP (multiple answers possible):
WP5 ICARUS 69%
WP6 STREAM 53%
WP7 L'OPERA 31%

WP5-6-7 JOINT TRAINING

First successful case: Geopolymers Training Course

First joint WP5-6-7 course – on-site hands-on format asked by 60% of survey respondents
18–20 May 2026 · SCK CEN, Mol (BE) · lecturers from SCK CEN, PSI, SÚRAO and NRG Pallas

Programme highlights

Geopolymer science & chemistry · waste immobilisation
Lab sessions: formulation, casting, fresh, mechanical & mineralogical properties
Upscaling from lab to drum scale
NDT techniques

What worked well

Lab work · scaling up · NDT demonstration
· logistics · competition format

Takeaways: geopolymers as promising matrices; mix design, curing & testing matter; scaling and NDT challenges

3

days on site

20

participants

4

competing teams

Geopolymer competition

4 teams designed, cast and tested their own mix against a reference matrix
Scored on strength, viscosity, mini-slump, setting time, heat release

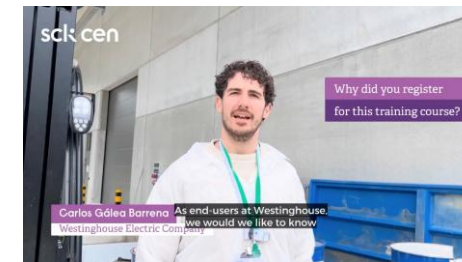
Lessons for the next courses

Prepare both sides in advance

- **Participants:** pre-reading and exercises sent beforehand to align prior knowledge
- **Lecturers:** a one-page brief – session scope, audience profile, course context, realistic time estimate

Format: shorter lectures, more breaks, theory tied to the practical sessions

See the full video here:
vimeo.com/1195901195



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WHAT COMES NEXT – INITIATIVES DRIVEN BY SURVEY PRIORITIES

Priority courses ranked by demand score in the survey – and how the WP5-6-7 initiatives now in development respond to them

Priority courses – demand score

P1 Radiological characterisation		33
P2 Novel conditioning matrices		23
P3 Pre-disposal data processing		23
P4 Isotope vector & scaling factors		22
P5 Radiolysis of radioactive waste		18
P6 Radiochemical separation & purification		17

Radiolysis training – on-line

Answers P4 in the most requested format – on-line courses (73%)
Applied focus: practical over theoretical content

Collection of available training materials

Makes existing material accessible – e-learning wanted by 56%
Targets the uncovered topics, incl. data processing & separation

Course materials reaching a wider audience

Theory collecting and developing for the courses re-used as recorded e-learning modules (30–40 min), 4-h on-line lectures and lunch-and-learn sessions – formats wanted by 56–73%
Shared via EURAD School, EURAD Wiki, course videos and summary sheets

Characterisation – top demand (P1)

Partially will be covered by WP5 ICARUS T2.3 demonstrations & workshops:
NDT prototype training, DT radionuclide workshop, SF workshop

TRAINING PORTFOLIO 2027

Two on-site courses, complemented by **digital learning** and **reusable resources**



The aim is to combine **specialised training**, **broad access** and **long-term reuse**

TREATMENT, CONDITIONING & NEW MATRICES



Scan for full
programme



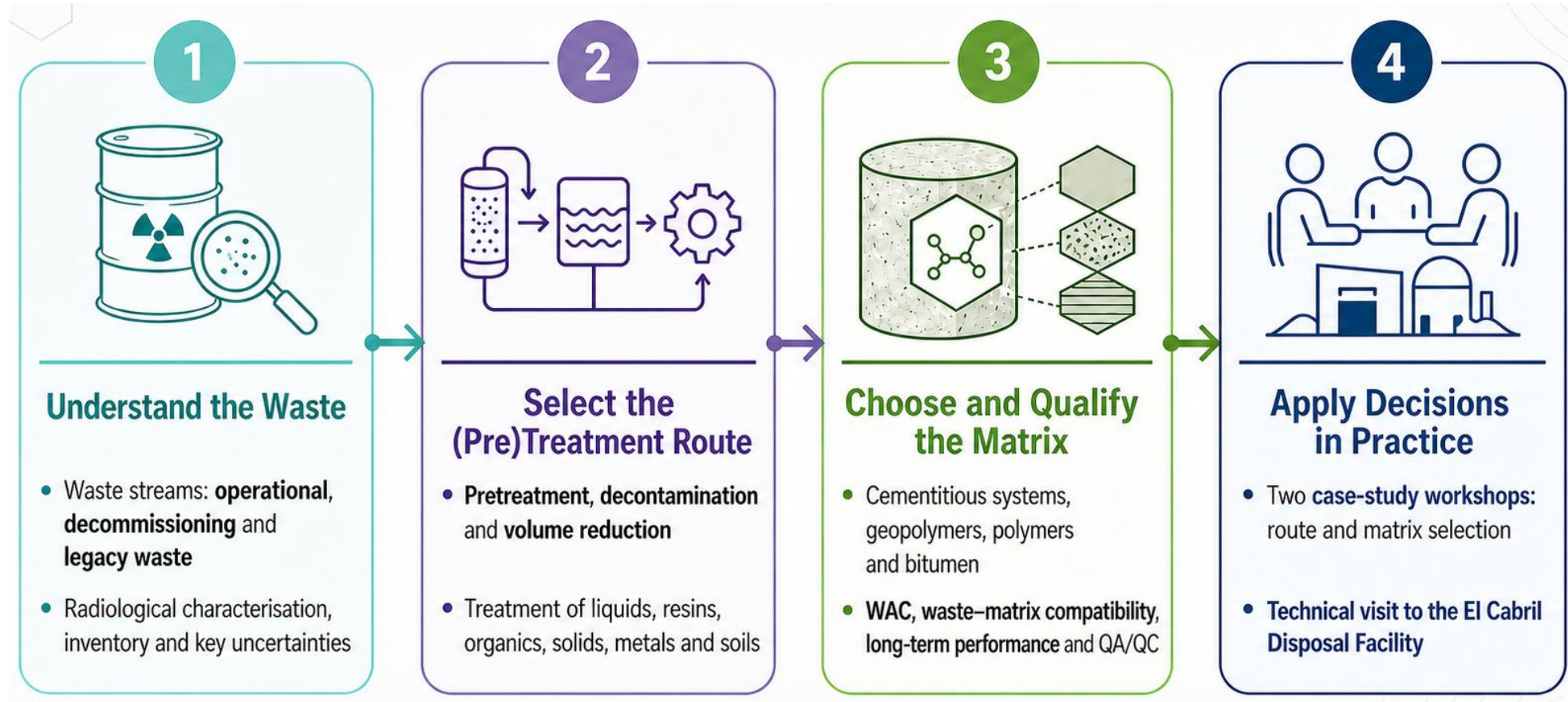
17-19 May 2027



CIEMAT, Madrid



Organized by Enresa & CIEMAT



CHARACTERIZATION OF LARGE WASTE PACKAGES



Scan for
programme

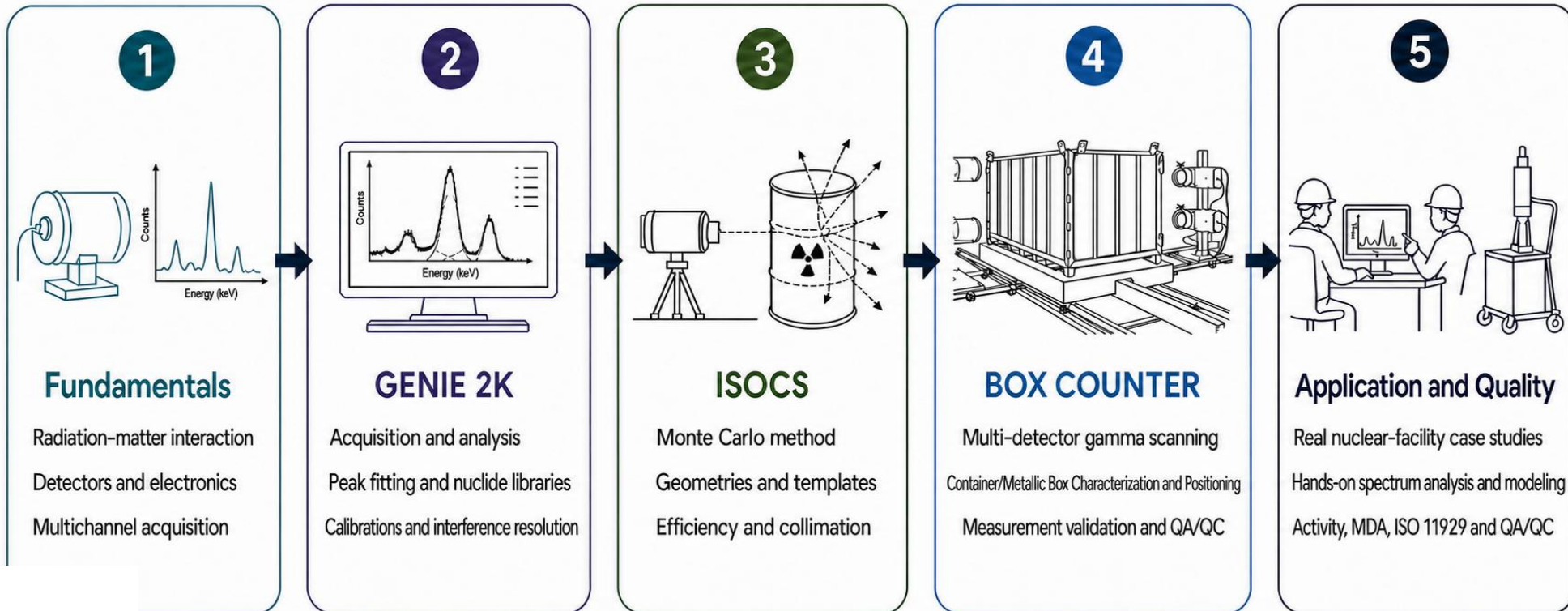


Fall 2027



Garoña NPP, Burgos, Spain

From gamma-detection fundamentals to *in situ* characterisation

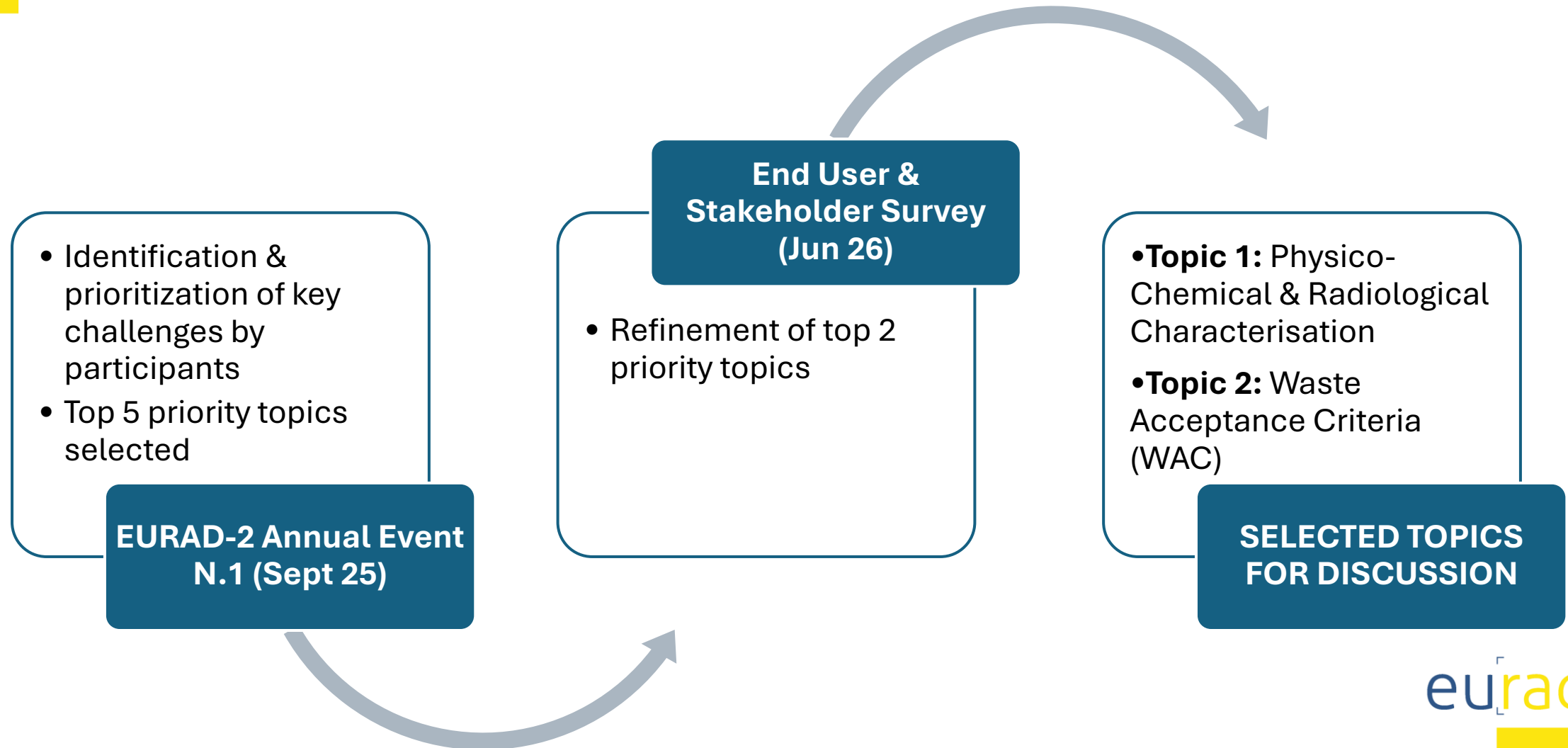


INTERACTIVE SESSION



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TOPICS FOR THE INTERACTIVE SESSION – SELECTION PROCESS



HOW ICARUS, STREAM AND L'OPERA ADDRESS TOPIC 1 (CHARACTERISATION)

Level and quality of characterisation needed to support decision-making across the waste management lifecycle

ICARUS

Radiological, physical and chemical data

Data quality & uncertainty

Development, optimization and harmonization of innovative techniques

STREAM

Waste data needed for treatment and conditioning

Challenging waste streams and waste-form characterization

Data needed for process optimization and scale-up

L'OPERA

Waste form data needed for long-term performance assessment

Long-term relevance of characterization data

Modelling and extrapolation of characterization data

Together we contribute to:

- ✓ Define what needs to be characterised, at what quality level, and for which decision throughout the waste lifecycle

HOW ICARUS, STREAM AND L'OPERA ADDRESS TOPIC 2 (WAC)

How existing regulatory frameworks, safety expectations and repository requirements influence the acceptance of innovative characterization, treatment and conditioning solutions.

ICARUS

Improve waste inventory and uncertainty management

Radiological, physical, and chemical data to demonstrate compliance with WAC

Fit-for-purpose characterisation

STREAM

Innovative waste treatment routes and conditioning matrices

Waste form optimisation, scale-up and demonstration

Disposability assessment

L'OPERA

Long term behaviour

Durability and ageing

Leaching and degradation studies

Modelling the long-term evolution

Together we contribute to provide the evidence needed to:

✓ Build confidence in innovative solutions & Support regulatory acceptance

WHAT WE EXPECT FROM THE DISCUSSION

TOPIC 1 - CHARACTERISATION

"Focus on the **level & quality of characterisation needed to support decision-making** throughout the waste management lifecycle"

TOPIC 2 - WAC

"Focus on how **regulatory frameworks, safety expectations and repository requirements influence the acceptance** of innovative characterisation, treatment and conditioning"

What are **the greatest challenges** (barriers, gaps, uncertainties or unmet needs) in relation to the topic?
Consider issues related to:

- *the type, quality, completeness and reliability of the data required*
- *limitation of the existing methods, tools, and technologies*
- *regulatory requirements and approval processes*
- *safety expectations and the evidence needed to demonstrate compliance and build confidence*
- *industrial feasibility, scalability, costs and operational integration*
- *public trust, risk perception and societal acceptance*

- ✓ Discuss **how these challenges influence decision-making** and the **development, demonstration, qualification and acceptance of innovative solutions**
- ✓ Agree on **two concrete, realistic and useful actions** that ICARUS, STREAM and/or L'OPERA could initiate to address the priority challenges

ROLE-PLAY EXERCISE

Same challenge – Different Realities

Objective

To compare how **different stakeholders** perceive the **same challenge**, identify conflicts and convergences, and extract **guidance** for the future orientation of the WP.

 **Roles** - Each table represents one stakeholder perspective:

1. Waste Management Organisation (WMO)
2. Regulator / Safety Authority (REG)
3. Technical Support Organisation (TSO)
4. Research Entity (RE)
5. Industry / Facility Operator (IN)
6. Public & Civil Society (CS)



6 Tables identified by color

Check your **badge color** / find your name on the participant list and **join the corresponding table**



TABLES AND ROLES

30 min discussion

- Discuss the assigned topics
- Your facilitator will guide the discussion and capture key points
- Identify **2 challenges and 2 actions**

20 min feedback session

- 1 slide (3 min) each table to briefly present the outcomes – *we will take them all into account for our future activities and on-line follow-up meetings with EU-SH!*

Stay in role

-  Represent the **interests and priorities of your assigned stakeholder**. Argue from your stakeholder's perspective, not your personal opinion.

Table	Primary topic	Secondary topic (if time allows)
CS	Topic 2: WAC	Topic 1: CHAR
IN	Topic 1: CHAR	Topic 2: WAC
RE	Topic 1: CHAR	Topic 2: WAC
REG	Topic 2: WAC	Topic 1: CHAR
TSO	Topic 1: CHAR	Topic 2: WAC
WMO	Topic 2: WAC	Topic 1: CHAR



THANK YOU FOR YOUR ATTENTION

.... ENJOY THE DISCUSSION!!



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