thermal treatment for radioactive waste minimisation and hazard reduction

theramin

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Safe management of radioactive waste is challenging to waste producers and waste management organisations. Thermal pre-treatment or immobilisation processes result in significant volume reduction, waste passivation and destruction of organic materials, which reduces risks during waste storage and supports development of safety cases for geological disposal.

Some thermal processes, such as induction melting, plasma melting or hot isostatic pressing, immobilise the waste into a disposable product, such as a glass, ceramic or metal. Other thermal processes, such as incineration, pyrolysis, calcination and gasification, are pre-treatment steps and the product may need further processing prior to disposal.

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Project summary

THERAMIN aims to identify which wastes could benefit from thermal treatment, which processes are under development in participating countries, and how these can be combined to deliver a wide range of benefits.

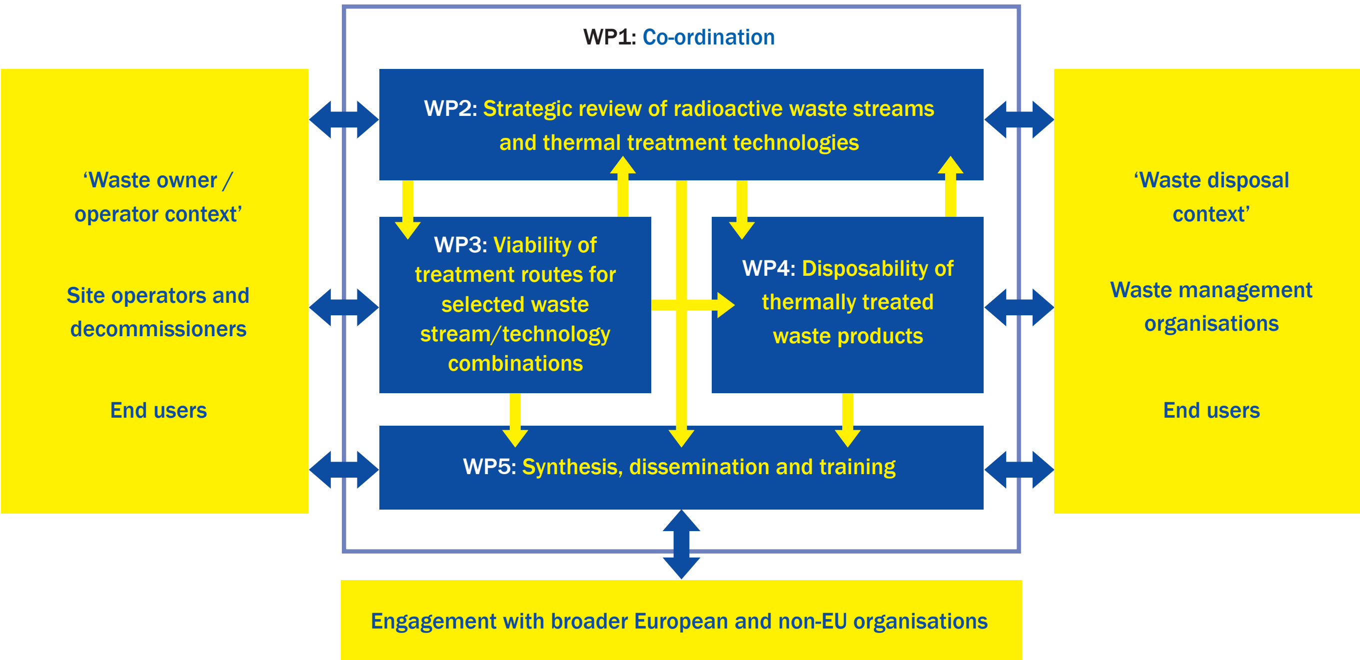
THERAMIN is being carried out by a consortium of 12 partners representing a European-wide community of experts on thermal treatment technologies and radioactive waste management and disposal. The project includes an advisory group of waste producers and management organisations to provide an end user view.

The THERAMIN project is:

- Providing an EU-wide strategic review and assessment of the value of thermal technologies applicable to a broad range of waste streams (e.g. ion exchange media, soft operational wastes, sludge, organics and liquids).
- Compiling a database of thermally treatable wastes in participant countries, documenting the strategic benefits of thermal treatment, and identifying the opportunities, synergies, challenges, timescales and cost implications to improve radioactive waste management.
- Evaluating the applicability and achievable volume reduction of the technologies through active and non-active pilot-scale and full-scale demonstration tests, and assessing the disposability of residues.

For further information, please see our website at http://www.theramin-h2020.eu or contact the project coordinator Matti Nieminen, VTT at Matti.Nieminen@vtt.fi

THERAMIN is divided into five work packages. The aim of each work package (WP) is summarised in the diagram below, which also shows how information flows between WPs.



CEA hosts General Assembly meeting, Marcoule

The second THERAMIN General Assembly meeting was held on 31st January 2018 in Bagnols-sur-Cèze, France, near the CEA Marcoule site. The meeting was attended by THERAMIN partners and End Users, and, as well as discussing administrative matters, an update on progress in each of the work packages was given, ensuring that all attendees had a good overview of work completed in the first six months of the project and work planned in the next six months.

THERAMIN participants outside the Val de Cèze Hotel (Jaana Laatikainen-Luntama)

THERAMIN participants enjoying the meeting dinner at the Val de Cèze hotel (Jaana Laatikainen-Luntama)

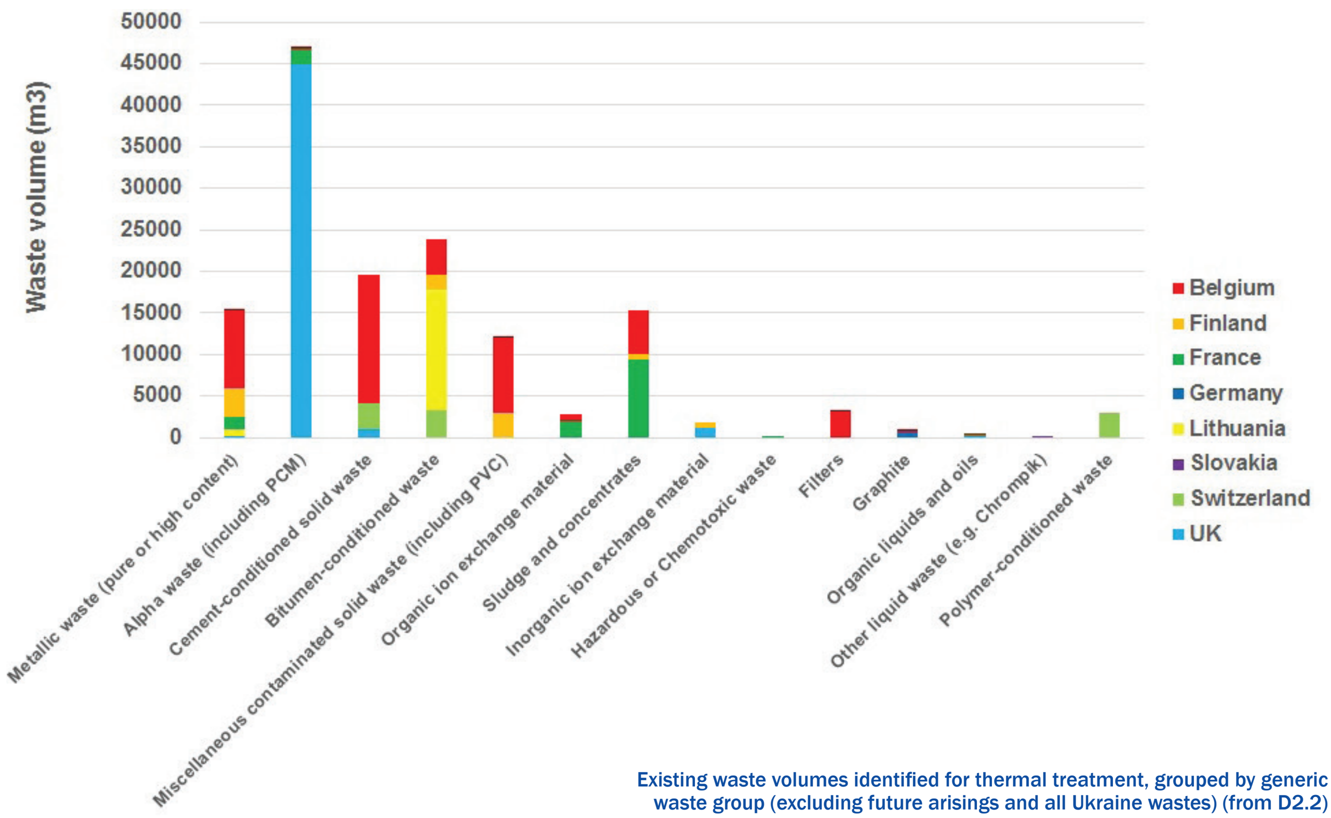
The meeting was followed by a tour of the CEA facilities used for R&D on waste treatment and conditioning, which included a tour of laboratories used to test the long-term performance of wasteforms and a visit to the hall containing pilot plants for a range of thermal treatment technologies (including IN CAN, PIVIC, SHIVA and PEV). A working dinner was held at the Val de Cèze Hotel, and this was followed by two further days of workshops focusing on WP2 and WP4.

Initial results from WP2: Strategic review of radioactive waste streams and thermal treatment technologies

WP2 is divided into the following tasks:

- 2.1 Database of suitable waste streams
- 2.2 Strategic analysis of waste streams and thermal treatments
- 2.3 Availability and planned development of thermal treatment technologies
- 2.4 Viability matrix of waste streams and treatment processes
- 2.5 Value assessment

Task 2.1 has developed a database of waste streams in participant countries thought to be suitable for treatment or processing using thermal technologies, and Task 2.2 has developed a report and analysis of these wastes. In addition to participant countries, data has been included from Ukrainian contacts and from the EC project Microbiology in Nuclear Waste Disposal (MIND). Analysis of the data collected reveals the distribution of wastes with potential for being processed using thermal technologies. A summary diagram from the report is given below.



Existing waste volumes identified for thermal treatment, grouped by generic waste group (excluding future arisings and all Ukraine wastes) (from D2.2)

The waste streams identified by project partners and included in the database have been categorised into 14 generic waste groups. The categorisation into generic groups was based on commonalities in the waste stream properties and composition. Some types of waste occur in several countries, such as sludges, ion exchange materials, cement-conditioned wastes, and bitumen-conditioned waste, whilst others may be present in fewer countries (e.g. polymer-conditioned waste and non-organic liquid wastes).

Task 2.3 has been summarising the capabilities of thermal treatment technologies to treat and process radioactive wastes, and the availability of technologies to countries with significant waste arisings.

The information collected under Task 2.1 ▸

(wastes) and Task 2.3 (technologies) has been used in Task 2.4 to derive a viability matrix in which the suitability of particular technologies to treat particular waste types is shown. The waste types are organised in the same way as in the THERAMIN waste database (Task 2.2) so that they can be linked directly to specific countries and to specific waste streams. At this stage of THERAMIN, the viability matrix is draft and will not be finalised until the third year of the project.

A workshop was held in Bagnols-sur-Cèze, France, to carry out a draft value assessment of promising waste – technology combinations. The workshop identified promising waste stream technology combinations for value assessment (Task 2.5), discussed and identified criteria/attributes/factors to be used, assessed waste – technology combinations against attributes to determine key strengths and weaknesses, and derived key questions to be answered in WP3 and WP4 in order to improve the value assessment in Year 3.

Waste groups to be considered within the THERAMIN project

Based on the inventory developed in Task 2.1, the following waste groups are under consideration within the THERAMIN project.

High-level Group	Waste Group
Conditioned waste	Cement-conditioned solid waste (including concrete-lined drums, degraded packages etc.
	Bitumen-conditioned waste
	Polymer-conditioned waste
Unconditioned waste	Metallic waste (pure or high content, could include some decommissioning waste streams)
	Alpha waste (including plutonium-contaminated materials)
	Miscellaneous contaminated solid waste (including polyvinyl chloride)
	Inorganic ion exchange material
	Organic ion exchange material
	Sludge and concentrates
	Hazardous or chemotoxic waste
	Filters
	Graphite
Liquid waste	Organic liquids and oils
	Other liquid waste (e.g. Chrompik)

Waste groups identified in Task 2.1.

Technologies being investigated in WP3

WP3 was successfully kicked off at a meeting in Manchester in October 2017, following which the team visited the NNL R&D facilities at Sellafield. The first deliverable identified which waste groups would be processed using each technology. This deliverable sets the scene for thermal treatment demonstration in the THERAMIN project with a series of demonstrations on candidate waste groups due to be completed in 2018.

The technology demonstrators being considered (listed in the table below) cover a subset of the waste groups shown above; samples of the products will be provided for analysis in WP4.

Demonstrator	Waste group	Partner
SHIVA	Organic ion exchange material	CEA/ORANO
IN CAN	Sludges	
Geomelt	Cement-conditioned waste	NNL
	Heterogeneous sludges	
Thermal gasification	Organic ion exchange material	VTT
VICHR	Chrompik	VUJE
HIP	Uranium-containing feeds	USFD
	Uranium surrogate-containing feed	NNL

Image: VTT thermal gasification rig (Jaana Laatikainen-Luntama)

Pre-trials have already been carried out by VTT in Finland. VTT has developed, constructed and tested a thermal gasification treatment method, especially for spent ion exchange resins. Technically the method can also be used for volume reduction of low-level operational waste containing organic matter, but waste has to be crushed before treatment. The existing test facility has been designed for treatment of spent ion exchange resins and the feeding systems would need to be modified in order to enable treatment of other types of waste.

in THERAMIN, the VTT rig (picture) will be used to demonstrate the treatment and immobilisation of organic ion exchange resins.

Identification of Waste Acceptance Criteria in WP4

WP4 is dedicated to the study of the impacts of thermal treatment on the disposability of radioactive waste. The outputs of WP4 will feed the final value assessment carried out in WP2. WP4 will be achieved through different steps. The first one is the identification of Waste Acceptance Criteria (WAC).

Eight European countries contributed to the WAC report: Belgium, Finland, France, Germany, Lithuania, Slovakia, Switzerland and the United Kingdom. Depending on the country, WAC could be generic and/or qualitative, or quantified and/or precise criteria. All of the gathered WAC have been compiled in a report.

Characterisation test phase in WP4

Image: PIVIC glass sample
(S. Catherin)

Some thermally treated waste products will be produced in WP3 while some others, produced outside the project, will be shared by partners. Most of these treated wastes are glass-like products, but some of them are also ceramic or contain mixed phases. The products of some thermal technologies may be unconditioned waste such as ash powders, etc.

The main objective of WP4 is to study the impacts of thermal treatment on the disposability of radioactive waste. As a consequence, one of the key steps of the project is to evaluate the behaviour of the thermally treated waste products with regard to disposal safety. A WP4 workshop was held in Marcoule in February 2018 to identify the characterisation tests needed to understand the behaviour of the waste products. At this stage of the project, some common tests have been defined, such as X-Ray Fluorescence and diffraction, scanning electron microscopy and leaching tests. Additional tests may also be carried out by some of the partners.

More than 15 samples will be studied within WP4. Characterisation tests are scheduled to start in March 2018.

WP5: First call for training placements related to demonstration and testing within THERAMIN WP3 and WP4

WP5 aims to disseminate the outcomes of the project within the technical community and more widely. This includes provision of placements that are intended to support training and enable technical exchange between technical experts. These placements are aligned with the demonstration activities in WP3 and the characterisation/testing activities in WP4.

An application form and a list of 2018 placements are on the project website (http://www.theramin-h2020.eu/); completed applications must be submitted by end March 2018. Placements may be between three days and three weeks in duration, and funding is available to contribute towards travel and subsistence costs. Applications for funding are invited from both participants in the THERAMIN project and non-participants.

Project participants

The THERAMIN project benefits from participation from waste management organisations, waste producers, and research organisations, with input from technology specialists. It therefore offers a "joined-up" perspective of the advantages and disadvantages of using thermal treatment within the waste management lifecycle.

THERAMIN partners:

- **Technical Research Centre of Finland Ltd (VTT)**, Finland
- **Agence Nationale pour la Gestion des Déchets Radioactifs (Andra)**, France
- **Orano**, France
- **Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA)**, France
- **Galson Sciences Limited (GSL)**, United Kingdom
- **Forschungszentrum Jülich GmbH (FZJ)**, Germany
- **Lithuanian Energy Institute (LEI)**, Lithuania
- **National Nuclear Laboratory Limited (NNL)**, United Kingdom
- **Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS)**, Belgium
- **Studiecentrum voor Kernenergie/Centre d'Etude de l'Energie Nucléaire (SCK•CEN)**, Belgium
- **University of Sheffield (USFD)**, United Kingdom
- **VUJE a.s. (VUJ)**, Slovakia

End users:

- **National Cooperative for the Disposal of Radioactive Waste (Nagra)**, Switzerland
- **Radioactive Waste Management (RWM)**, UK
- **Sellafield Limited**, UK
- **Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP)**
- **Électricité de France (EDF)**, France
- **Fortum**, Finland
- **Teollisuuden Voima Oy (TVO)**, Finland
- **Agence Nationale pour la Gestion des Déchets Radioactifs (Andra)**, France - Project Partner as well
- **Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA)**, France - Project Partner as well
- **Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS)**, Belgium - Project Partner as well

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European Commission