MSP-REFRAM

Coordination and Support Action (CSA)

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Report on knowledge identification and measurement

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Summary

Report on knowledge identification and measurement

Approval

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CONTENT

EXECUTIVE SUMMARY

An accurate plan for knowledge management is crucial in MSP-REFRAM, especially considering the project multi-actor approach, the cross-sectorial features of the information and the different areas where information will be handled (both inside the consortium at an internal level involving Expert Committees and project partners, and also outside the consortium involving target audiences). Therefore, MSP-REFRAM will implement a KM system as a set of infrastructures and tools that support project activities. They are more than information systems, since they must provide a context that facilitates the creation, transfer and application of knowledge. The knowledge will be retrieved from partners and External Expert Committees and also valuable knowledge will be generated through the first part of the project. All this information must be then processed in order to support the aimed Multi Stakeholder Platform so project objectives can be achieved. Two tools will support the KM: a Decision Support System (DSS) and a Document Management System (DMS), both of which will be hosted with a free open access on the PROMETIA website.

First step towards the creation of the aforementioned tools is knowledge mapping. Such action will allow MSP-REFRAM consortium to firstly identify the knowledge to be generated as project output and, secondly, to identify all the issues related to its generation (information sources, IPR issues, status and the partner responsible for its production). This way the knowledge map can be used as a guideline during the whole project, allowing to work in an effort-effective way, avoiding work duplication and ensuring that final project objective (delivering to EU society valuable information about refractory metals) will be met.

1 INTRODUCTION

Knowledge management is essentially about getting the right knowledge to the right person at the right time. This in itself may not seem so complex, but it implies a strong tie to project and consortium strategy, understanding of where and in what forms knowledge exists and creating processes that span organizational functions. Knowledge management may also include new knowledge creation, or it may solely focus on knowledge sharing, storage, and refinement.

The overall objective is to create value and to leverage, improve, and refine the EU competences and knowledge assets about refractory metals. To that end, the following set of steps has been envisaged as MSP-REFRAM strategy for an effective delivery of project results to EU society:

1. Identification and measurement of knowledge
2. Knowledge retrieval and storage
3. Knowledge transformation
4. Knowledge sharing: set-up of external Knowledge management tools.

This deliverable delves into the execution of the first step, providing information about the procedures that have been followed as well as about the results gathered, presented as the MSP-REFRAM Knowledge map. This map will be used during the whole project as it contains valuable details about the information to be produced.

2 KNOWLEDGE MANAGEMENT: BASIC DEFINITIONS

2.1 DATA, INFORMATION AND KNOWLEDGE

Before going into details about knowledge management definition there are three terms that have to be clarified in order to make easier the later knowledge mapping as several kind of information will be retrieved, handled and processed.

Part of the difficulty of defining knowledge arises from its relationship to two other concepts, namely data and information. These two terms are often regarded as lower denominations of knowledge, but the exact relationship varies greatly from one example to another. To illustrate, (Thiearauf, 1999) defines the three components as follows: data is the lowest point, an unstructured collection of facts and figures; information is the next level, and it is regarded as structured data; finally knowledge is defined as "information about information".

The following bullet-points summarise the definitions used through this deliverable:

- **Data:** Facts and figures which relay something specific, but which are not organized in any way and which provide no further information regarding patterns, context, etc. For example: unstructured data about production, demand, results from technical tests, datasheets, etc.
- **Information:** For data to become information, it must be contextualized, categorized, calculated and condensed. This refers for example to reports, scientific publications, MSc or PhD thesis, deliverables, etc.

- **Knowledge:** Knowledge is closely linked to doing and implies know-how and understanding. The knowledge possessed by each individual partner is a product of his experience, and encompasses the norms by which he evaluates new inputs from his surroundings. For instance, Knowledge is related to the know-how acquired in R&D projects, commercial activities or expertise that is inherent to each partner.

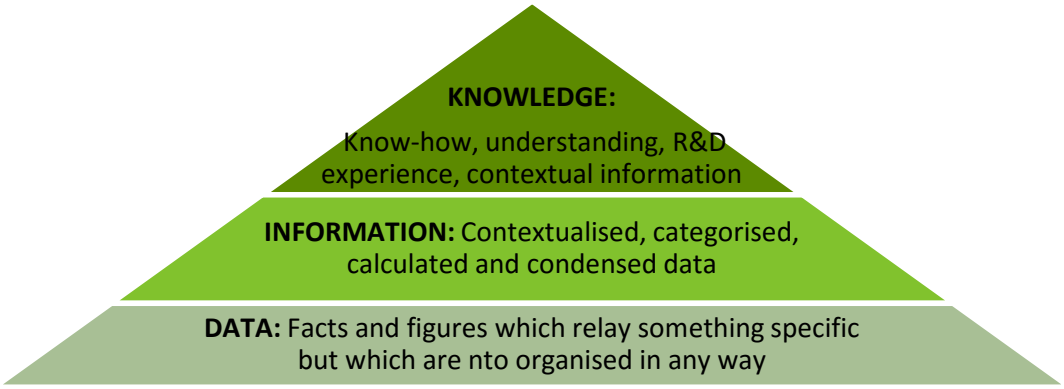

Figure 1. Data, information and knowledge definition

2.2 KINDS OF KNOWLEDGE

Understanding the different forms that knowledge can exist in, and thereby being able to distinguish between various types of knowledge, is an essential step for knowledge management. For example, it should be fairly evident that the knowledge captured in a document would need to be managed (i.e. stored, retrieved, shared, changed, etc.) in a totally different way than that gathered through the different workshops that MSP-REFRAM envisages.

A lot of definitions can be found in literature and Knowledge Management theories but for the present case only two kinds of knowledge will be considered for the sake of clarity.

EXPLICIT KNOWLEDGE

This type of knowledge is formalized and codified, and is sometimes referred to as know-what. It is therefore fairly easy to identify, store, and retrieve. This is the type of knowledge most easily handled by Knowledge Management Systems, which are very effective at facilitating the storage, retrieval, and modification of documents and texts.

From a managerial perspective, the greatest challenge with explicit knowledge is similar to information. It involves ensuring that people have access to what they need; that important knowledge is stored; and that the knowledge is reviewed, updated, or discarded.

Explicit knowledge is found in: databases, memos, documents such as reports, thesis, deliverables, etc.

TACIT KNOWLEDGE

This type of knowledge is sometimes referred to as know-how and refers to intuitive, hard to define knowledge that is largely experience based. Because of this, tacit knowledge is often context dependent and personal in nature. It is hard to communicate and deeply rooted in action, commitment, and involvement.

Tacit knowledge is also regarded as being the most valuable source of knowledge. Knowledge Management systems have a very hard time handling this type of knowledge. An IT system relies on codification, which is something that is difficult/impossible for the tacit knowledge holder. This is way part of the MSP-REFRAM strategy in knowledge retrieving is based in carrying out workshops with main MSP members, allowing to translate this intangible know-how to written information in the way of reports and deliverables.

Tacit knowledge is found in skills, capabilities and expertise.

3 KNOWLEDGE MANAGEMENT DEFINITION

According to what has been discussed previously, the following definition could be provided: Knowledge management is the systematic management of knowledge assets for the purpose of creating value and meeting tactical & strategic requirements; it consists of the initiatives, processes, strategies, and systems that sustain and enhance the storage, assessment, sharing, refinement, and creation of knowledge.

3.1 KNOWLEDGE MANAGEMENT PROCESS DESCRIPTION

This section deals with knowledge management frameworks and models. At the most basic level, Knowledge management consists of the following steps:

1. Identification and measurement of knowledge
2. Knowledge retrieval and storage
3. Knowledge transformation
4. Knowledge sharing: set-up of external Knowledge management tools.

It is important to note that none of these processes are independent and all of them are affected by countless factors. This is why knowledge management frameworks are typically very different and can be presented in a wide variety of ways.

The case of MSP-REFRAM can be aligned with the knowledge management process model by (Botha, Kourie, & Snyman, 2008) presented next.

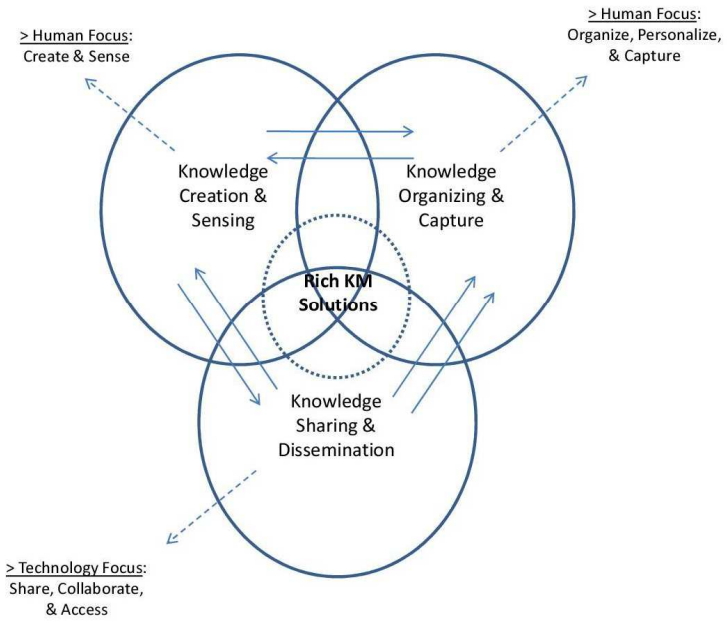

Figure 2. Knowledge management model

The three broad categories overlap and interact with one another. As for MSP-FRAM, knowledge will be created within the consortium at the same time that it's captured from information exchange during workshops. All the knowledge produced so far will be shared and disseminated thanks to the different dissemination events planned and the Knowledge management tools envisaged.

4 MSP-REFRAM KNOWLEDGE MAPPING

This section describes the procedure followed in order to accomplish the first step of knowledge management, i.e. knowledge identification and measurement. Then, the results of this action are presented.

The knowledge map to be produced is supposed to include basic information that will allow the product of project results. This information is:

- KNOWLEDGE STATUS: some information or knowledge will be currently available (mostly the explicit knowledge), while other information will have to be produced during the project. This information can be produced either from public explicit knowledge such as publications, literature surveys, etc. or from information exchanged and retrieved from the workshops.
- OWNER: the owner of the information and the source of it has to be specified in order to identify access availability as well as responsibilities and contact persons.
- RESPONSIBLE: within the consortium the partners will be responsible for producing, retrieving information. Having this item clearly defined will avoid work overlapping as well as will help ensure a proper contribution of all project partners
- IPR STATUS: definition of the information availability will be crucial when drafting reports and deliverables since MSP-REFRAM outputs are deemed to be used by EU society.

4.1 KNOWLEDGE MAPPING WORKFLOW

In order to retrieve the information in a proper and organised way and to ensure that a good communication between all partners and MSP-REFRAM Knowledge manager is done, the following workflow has been followed

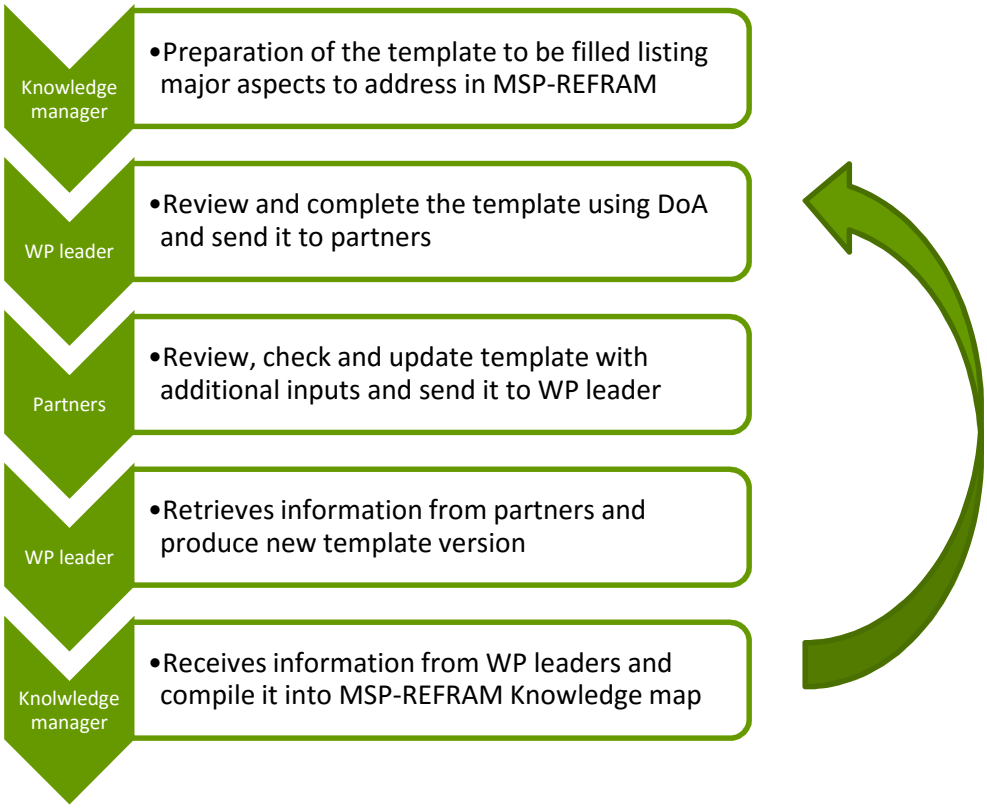

Figure 3. Knowledge mapping procedure within MSP-REFRAM

This process has been carried out in an iterative way in order to ensure that all knowledge to be potentially produced through the project is reflected in the map.

The template used for this procedure, as it was sent to WP leaders, can be found next (only one table per element is shown for the sake of brevity).

Please, for the following items select the actual status for each of the knowledge/information to be produced as project output.

- KNOWLEDGE STATUS: please select between,
  - ✓ Currently available within the consortium
  - ✓ Pending to elaborate
- OWNER: please detail who would own this knowledge (member of consortium or external expert) as well as information about the source, e.g.
  - o Owner: TUDelft, source: PhD thesis
  - o Owner: KGHM (external exp.), source: company publications
- RESPONSIBLE: please write the name of WP leader to be responsible of producing/retrieving the information
- IPR STATUS: please detail IPR status of the information, e.g. strictly confidential, only available for consortium members, public, etc.

Element								
					KNOWLEDGE STATUS	OWNER	RESPONSIBLE	IPR STATUS
Current Use								
Have applications in EEE?	YES	X	NO					
Current applications								
Current data on the production from primary sources	In 2015, x Mt produced.							
	Main producer: China, company Wang – coproduct of the YY mining.							
	Main technology for mineral processing: …							
	Main technology for extractive metallurgy: …							
	Economics from mineral processing main technology:…							
	Environmental impact from mineral processing main technology:…							
	Economics from extractive metallurgy main technology:…							
	Environmental impact from extractive metallurgy main technology:…							
Current data on the production from secondary sources	In 2015, y t produced from mine tailings, …							
	Main technology for waste processing:							
	Main technology for extractive metallurgy: …							
	Economics from waste processing main technology:…							
	Environmental impact from waste processing main technology:…							
Current data on the production by recycling	z kg from EoL vehicles by …							
	Economics from recycling process…							
	Environmental impact from recycling process							
Current demand	In 2015, ZZ Mt							
Current producers	Company X							
Current end-users	Company Y							

Current societal implications	Number of related jobs: XXX					
Future Use and trends						
Could have future applications in EEE?	YES	X	NO			
Potential future application						
Expected EU demand 2025						
Expected EU demand 2050						
Potential primary resource	Production estimation					
	Economics estimation from mineral processing main technology:…					
	Environmental impact estimation from mineral processing main technology:…					
	Economics estimation from extractive metallurgy main technology:…					
	Environmental impact estimation from extractive metallurgy main technology					
Potential secondary resource	Production estimation …					
	Economics estimation from waste processing main technology:…					
	Environmental impact estimation from waste processing main technology:…					
	Economics estimation from extractive metallurgy main technology:…					
	Environmental impact estimation from extractive metallurgy main technology					
Potential resources through recycling	z kg from EoL vehicles by …					
	Economics estimation from recycling process…					
	Environmental impact estimation from recycling process…					
Substitution	Nano-materials based on…					
	Could substitute XX in …					
	XX could substitute … in…					
Societal implications	Potential of job creation XXX					
Main related R&D activities	EU funded projects XXX					
Technology Gaps for future use						
mining	Low grade ores in deep sea mining					
processing	From radioactive minerals					
extractive metallurgy	Need development of a hydro process whereas currently produced by pyromet					
Substitution	High melting point combined with …					
recycling	Manual dismantling of …					
Policy Gaps for future use						
primary	…					
Secondary						
recycling						
substitution						

4.2 KNOWLEDGE MAPPING

After following the procedure stated before, the knowledge mapping within MSP-REFRAM has been completed. The knowledge map presented herein can be considered as a starting point for further work to be done within the project and as a guideline for WP leaders when coordinating and harmonising the work between partners.

Next tables (one per targeted refractory metal) present the knowledge map, which has been completed with information about the deliverable that tentatively will contain the information. Some abbreviations are included in the table in order to make it easy to understand and provide the opportunity of having at a glance a clear idea of knowledge current status and IPR characteristics.

STATUS:

	Currently available within the consortium
	Pending to elaborate
	Part of the knowledge is currently available within the consortium but there are some gaps that will be filled

IPR:

PU	Public
Co-Av	Confidential at this moment but can be available with permission from its authors
COCO	Confidential, available only to consortium members

MSP-REFRAM will strongly work in order to deal with confidentiality issues so as to deliver as project results information that is completely public and free from IPR constraints.

Element	TUNGSTEN					
		STATUS	OWNER/SOURCE	RESPONS.	IPR	DELIV
Current Use						
Have applications in EEE?	YES/NO		Literature survey	BRGM	PU	D1.2
Current applications			VTT, IMN, ICCRAM knowledge	IMN	PU	D1.2
Current data on the production from primary sources	In 2015, x Mt produced.		Available in public reports + BRGM publications	BGRM	PU	D2.1
	Main producer: China, Russia, Canada		Available in public reports + BRGM publications	BGRM	PU	D2.1
	Main technology for mineral processing		Available in public reports + BRGM publications	BGRM	PU	D2.2
	Main technology for extractive metallurgy		Available in public and mining companies reports + Amphos 21 and MEFOS knowledge	MEFOS	PU	D2.2
	Economics from mineral processing main technology		Information from workshops, literature survey	GTK	PU/CO	D2.2
	Environmental impact from mineral processing main technology		Available in public and mining companies reports + Amphos 21 knowledge	Amphos 21	PU	D2.4
	Economics from extractive metallurgy main technology		Information from workshops, literature survey	GTK	PU/CO	D2.2
	Environmental impact from extractive metallurgy main technology		Available in public and mining companies reports + Amphos 21 knowledge	Amphos 21	PU	D2.4
Current data on the production from secondary sources	In 2015, y t produced from mine tailings……		Open information, Collaboration with organizations and industry, UNIKL, ICCRAM, GTK Knowledge	ICCRAM	PU	D3.1
	Main technology for waste processing:		Available in public reports + BRGM publications + GTK, UNIKL, BRGM, MEFOS	GTK	PU	D3.2
	Main technology for extractive metallurgy		Open information + Knowledge from MEFOS (Pyro), UNIKL, Chalmers (Hydro), TUDelft	TUDelft	PU	D3.2
	Economics from waste processing main technology		Information from workshops, literature survey	MEFOS	PU/CO	D3.2
	Environmental impact from waste processing main technology		Open information, collaboration with organizations and industry, Knowledge from MEFOS, CARTIF, NTUA	CARTIF	PU	D3.4
Current data on the production by recycling	z kg from EoL vehicles by …		IMN (projects, publications and own materials)	IMN	PU	D4.1
	Economics from recycling process…		Information from workshops, literature survey	IMN	PU/CO	D4.2
	Environmental impact from recycling process		NTUA Knowledge	NTUA	PU	D4.4
Current demand	In 2015, ZZ Mt		Knowledge from MSP workshops	CEA	PU	D1.3
Current producers	Company		IMN (projects, publications and own materials)	IMN	PU	D1.2
Current end-users	Company Y		VTT (own projects), ICCRAM	VTT	PU	D1.2
Current societal implications	Number of related jobs: XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	Amphos21	PU	D1.4
Future Use and trends						
Could have future applications in EEE?	YES/NO		Literature survey	BRGM	PU	D1.4
Potential future application			IMN: R&D, University of Padova: DECORE Project (W as catalyst in Bioetanol oxidation)	IMN	CO - av	D1.4
Expected EU demand in 2025			Knowledge from MSP workshops	CEA	PU	D1.4
Expected EU demand in 2050			Knowledge from MSP workshops	CEA	PU	D1.4

Potential primary resource	Production estimation		Open information	MEFOS	PU	D2.3
	Economics estimation from mineral processing main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.3
	Environmental impact estimation from mineral processing main technology:		NTUA Knowledge	NTUA	PU	D2.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.3
	Environmental impact estimation from extractive metallurgy main technology:…		NTUA Knowledge	NTUA	PU	D2.3
Potential secondary resource	Production estimation …		Developments based on state-of the art and "family" metals + Knowledge from UNIKL, ICCRAM and GTK	ICCRAM	PU	D3.3
	Economics estimation from waste processing main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from waste processing main technology:…		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF, NTUA	CARTIF	PU	D3.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from extractive metallurgy main technology:…		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF, NTUA	CARTIF	PU	D3.3
Potential resources through recycling	z kg from EoL vehicles by new materials in Poland		IMN (own materials)	IMN	COCO	D4.3
	Economics estimation from recycling process…		Information from workshops, literature survey	IMN	PU/CO	D4.3
	Environmental impact estimation from recycling process…		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF	CARTIF	PU	D4.3
Substitution	Nano-materials based on…		VTT and IMN knowledge	VTT	CO	D5.1
	Could substitute XX in …		VTT and IMN knowledge	VTT	CO	D5.1
	W-based coatings could substitute bulk materials in …		IMN: R&D	IMN	CO - av	D5..2
Societal implications	Potential of job creation XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	ICCRAM	PU	D1.7
Main related R&D activities	EU funded projects XXX		Literature survey + Knowledge from workshops	ICCRAM	PU	D1.4
Technology Gaps for future use						
mining	Low grade ores in deep sea mining		Information from workshops, literature survey	GTK	PU	D1.4
processing	From radioactive minerals		Available in public reports + BRGM publications	BGRM	PU	D1.4
extractive metallurgy	Need development of a hydro process whereas currently produced by pyromet		Information from workshops, literature survey	MEFOS	PU	D1.4
Substitution	High melting point combined with …		IMN: R&D	IMN	CO - av	D1.4
recycling	Manual dismantling of …		Information from workshops, literature survey	IMN	PU	D1.4
Policy Gaps for future use						
primary	…		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
Secondary	...		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
recycling	...		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
substitution	...		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1

Element	TANTALUM					
		STATUS	OWNER/SOURCE	RESPONS.	IPR	DELIV
Current Use						
Have applications in EEE?	YES/NO		Literature survey	BRGM	PU	D1.2
Current applications			VTT (CRM InnoNet reports and background materials, BRGM Report Panorama 2011 sur le marché du Tantale	VTT	PU	D1.2
Current data on the production from primary sources	In 2015, x Mt produced.		European project Polinares EU policy on natural resources	BRGM	PU	D2.1
	Main producer: China, company Wang – coproduct of the YY mining.		BRGM Report (in French)	BRGM	PU	D2.1
	Main technology for mineral processing: …		Literature survey	BRGM	PU	D2.2
	Main technology for extractive metallurgy:		Literature survey	BRGM	PU	D2.2
	Economics from mineral processing main technology:…		BRGM Report (in French)	BRGM	PU	D2.2
	Environmental impact from mineral processing main technology:…		Available in public reports + Amphos 21	Amphos 21	PU	D2.4
	Economics from extractive metallurgy main technology:…		BRGM Report Panorama 2011 sur le marché du Tantale	BRGM	PU	D2.2
	Environmental impact from extractive metallurgy main technology:…		Available in public reports + Amphos 21	Amphos 21	PU	D2.4
Current data on the production from secondary sources	In 2015, y t produced from mine tailings,…		Open information, Collaboration with organizations and industry	VTT	PU	D3.1
	Main technology for waste processing:		Open information, Collaboration with organizations and industry, GTK and IDENER contributions	GTK	PU	D3.2
	Main technology for extractive metallurgy		Available in public reports or in the scientific literature BRGM, ERAMET (Pyro), CEA, LGC, Chalmers(Hydro), TUDelft	TUDelft	PU	D3.2
	Economics from waste processing main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.2
	Environmental impact from waste processing main technology:…		Open information, Collaboration with organizations and industry, Amphos 21 and NTUA knowledge	NTUA	PU	D3.4
Current data on the production by recycling	z kg from EoL vehicles by …		VTT, own studies + Literature survey (BRGM)	VTT	PU	D4.1
	Economics from recycling process…		Information from workshops, literature survey	IMN	PU/CO	D4.2
	Environmental impact from recycling process		NTUA Knowledge	NTUA	PU	D4.4
Current demand	In 2015, ZZ Mt		Knowledge from MSP workshops	CEA	PU	D1.3
Current producers	Company X		Knowledge from MSP workshops	ERAMET	PU	D1.2
Current end-users	Company Y		VTT (CRM InnoNet reports and background materials)	VTT	PU	D1.2
Current societal implications	Number of related jobs: XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	Amphos21	PU	D1.4
Future Use and trends						
Could have future applications in EEE?	YES/NO		Literature survey	BRGM	PU	D1.4
Potential future application			Knowledge from MSP workshops	ICCRAM	PU	D1.4
Expected EU demand in 2025			Knowledge from MSP workshops	CEA	PU	D1.4
Expected EU demand in 2050			Knowledge from MSP workshops	CEA	PU	D1.4
Potential primary resource	Production estimation		Literature survey and Knowledge from MSP workshops	BRGM	PU	D2.3
	Economics estimation from mineral processing main technology:…		Information from workshops, literature survey		PU/CO	D2.3

	Environmental impact estimation from mineral processing main technology:…		NTUA Knowledge	NTUA	PU	D2.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.3
	Environmental impact estimation from extractive metallurgy main technology:…		NTUA Knowledge	NTUA	PU	D2.3
Potential secondary resource	Production estimation …		Developments based on state-of the art and "family" metals	VTT	PU	D3.3
	Economics estimation from waste processing main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from waste processing main technology:…		Open information, Collaboration with organizations and industry, Knowledge from Amphos 21 and CARTIF	Amphos 21	PU	D3.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from extractive metallurgy main technology:…		Open information, Collaboration with organizations and industry, Knowledge from Amphos 21 and CARTIF	Amphos 21	PU	D3.3
Potential resources through recycling	z kg from EoL vehicles by …		Literature survey + Knowledge from workshops	VTT	PU	D4.3
	Economics estimation from recycling process…		Information from workshops, literature survey	IMN	PU/CO	D4.3
	Environmental impact estimation from recycling process…		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF	CARTIF	PU	D4.3
Substitution	Nano-materials based on…		Literature survey and Knowledge from workshops	VTT	PU	D5.1
	Could substitute XX in …		Literature survey and Knowledge from workshops	VTT	PU	D5.1
	XX could substitute … in…		Literature survey and Knowledge from workshops	VTT	PU	D5..2
Societal implications	Potential of job creation XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	ICCRAM	PU	D1.7
Main related R&D activities	EU funded projects XXX		Literature survey + Knowledge from workshops	ICCRAM	PU	D1.4
Technology Gaps for future use						
mining	Low grade ores in deep sea mining		Information from workshops, literature survey	GTK	PU	D1.4
processing	From radioactive minerals		Information from workshops, literature survey	GTK	PU	D1.4
extractive metallurgy	Need development of a hydro process whereas currently produced by pyromet		Available in the scientific literature, Eramet patents and intern reports	ERAMET	PU	D1.4
Substitution	High melting point combined with …		Information from workshops, literature survey	VTT	PU/CO	D1.4
recycling	Manual dismantling of …		Available in the scientific literature, VTT (from several research projects)	VTT	PU	D1.4
Policy Gaps for future use						
primary	…		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
Secondary	...		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
recycling	...		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
substitution	...		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1

Element	RHENIUM					
		STATUS	OWNER/SOURCE	RESPONS.	IPR	DELIV
Current Use						
Have applications in EEE?	YES/NO		Literature survey	BRGM	PU	D1.2
Current applications			IMN: R&D	IMN	PU	D1.2
Current data on the production from primary sources	In 2015, x Mt produced.		Available in public reports + EMINES Knowledge	EMINES	PU	D2.1
	Main producer:		Available in public reports + EMINES Knowledge	EMINES	PU	D2.1
	Main technology for mineral processing:		Lietrature survey	GTK	PU	D2.2
	Main technology for extractive metallurgy: ion exchage		LUT (publications), IMN, KGHM process	LUT	PU/CO	D2.2
	Economics from mineral processing main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.2
	Environmental impact from mineral processing main technology: beneficial for gas and liquid treatment plants		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF, NTUA	NTUA	PU	D2.4
	Economics from extractive metallurgy main technology:		Information from workshops, literature survey	GTK	PU/CO	D2.2
	Environmental impact from extractive metallurgy main technology:…		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF, NTUA	NTUA	PU	D2.4
Current data on the production from secondary sources	In 2015, y t produced from		Open information, Collaboration with organizations and industry	ICCRAM	PU	D3.1
	Main technology for waste processing:		Open information, Collaboration with organizations and industry, Knowledge from VTT, LUT, IMN	VTT	PU	D3.2
	Main technology for extractive metallurgy		LUT (publications), KGHM process, Chalmers, (Pyro) Chalmers, IMN (Hydro), TUDelft	TUDelft	PU/CO	D3.2
	Economics from waste processing main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.2
	Environmental impact from waste processing main technology:…		Open information, Collaboration with organizations and industry + Knowledge from Amphos 21, NTUA, LUT	CARTIF	PU	D3.4
Current data on the production by recycling	z kg from EoL vehicles by …		KGHM	IMN	PU	D4.1
	Economics from recycling process…		Information from workshops, literature survey	IMN	PU/CO	D4.2
	Environmental impact from recycling process		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF	CARTIF	PU	D4.4
Current demand	In 2015, ZZ Mt		IMN (projects, publications and own materials)	IMN	COCO	D1.3
Current producers	Company in Estonia, France, Germany and Poland		IMN (projects, publications and own materials)	IMN	COCO	D1.2
Current end-users	Company Y: aerospace, superalloys and alloys, catalysts, coatings		IMN (projects, publications and own materials)	IMN	COCO	D1.2
Current societal implications	Number of related jobs: XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	Amphos21	PU	D1.4
Future Use and trends						
Could have future applications in EEE?	YES/NO		Literature survey	BRGM	Public	D1.4
Potential future application			IMN: R&D, consortium in CuBR R&D programme funded by KGHM and NCBR	IMN	CO - av	D1.4
Expected EU demand in 2025			Knowledge from MSP workshops	CEA	PU	D1.4

Expected EU demand in 2050			Knowledge from MSP workshops	CEA	PU	D1.4
Potential primary resource	Production estimation		Literature survey and Knowledge from MSP workshops	BRGM	PU	D2.3
	Economics estimation from mineral processing main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.3
	Environmental impact estimation from mineral processing main technology:…		NTUA Knowledge	NTUA	PU	D2.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.3
	Environmental impact estimation from extractive metallurgy main technology:…		NTUA Knowledge	NTUA	PU	D2.3
Potential secondary resource	Production estimation …		IMN (projects, publications and own materials), Developments based on state-of the art and "family" metals by ICCRAM	ICCRAM	COCO	D3.3
	Economics estimation from waste processing main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from waste processing main technology:…		Open information, Collaboration with organizations and industry + Knowledge from Amphos 21, LUT, CARTIF	CARTIF	PU	D3.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from extractive metallurgy main technology:…		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF	CARTIF	PU	D3.3
Potential resources through recycling	z kg from EoL vehicles by …		IMN (projects, publications and own materials)	IMN	COCO	D4.3
	Economics estimation from recycling process…		Information from workshops, literature survey	MEFOS	PU/CO	D4.3
	Environmental impact estimation from recycling process…		Open information, Collaboration with organizations and industry + Knowledge from Amphos 21, NTUA, LUT	Amphos 21	PU	D4.3
Substitution	Nano-materials based on…		IMN,KGHM Knowledge	IMN	CO - av	D5.1
	Could substitute XX in …		IMN,KGHM Knowledge	IMN	CO - av	D5.1
	XX could substitute … in…		IMN,KGHM Knowledge	IMN	CO - av	D5..2
Societal implications	Potential of job creation XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	ICCRAM	PU	D1.7
Main related R&D activities	EU funded projects XXX		IMN information	IMN	PU	D1.4
Technology Gaps for future use						
mining	Low grade ores in deep sea mining		Information from workshops, literature survey	GTK	PU	D1.4
processing	From radioactive minerals		Information from workshops, literature survey	GTK	PU	D1.4
extractive metallurgy	Need development of a hydro process whereas currently produced by pyromet		IMN (projects, publications and own materials)	IMN	COCO	D1.4
Substitution	High melting point combined with …		IMN: R&D	IMN	PU	D1.4
recycling	Manual dismantling of …		IMN (projects, publications and own materials)	IMN	COCO	D1.4
Policy Gaps for future use						
primary	…		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
Secondary	new intermediates, waste		IMN (projects, publications and own materials) + Knowledge from MSP workshops and WP7 surveys	IMN	COCO	D7.1
recycling	New superalloys, new materials,		IMN (projects, publications and own materials) + Knowledge from MSP workshops and WP7 surveys	IMN	COCO	D7.1
substitution	…		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1

Element	MOLYBDENUM					
		STATUS	OWNER/SOURCE	RESPONS.	IPR	DELIV
Current Use						
Have applications in EEE?	YES/NO		Literature survey	BRGM	PU	D1.2
Current applications			IMN: R&D	IMN	PU	D1.2
Current data on the production from primary sources	In 2015, x Mt produced.		Available in public reports + EMINES Knowledge	EMINES	PU	D2.1
	Main producer: China, USA, Chile		Available in public reports + EMINES Knowledge	EMINES	PU	D2.1
	Main technology for mineral processing:		Company publications	GTK	CO	D2.2
	Main technology for extractive metallurgy:		Available in public and mining companies reports + Amphos 21, MEFOS knowledge	MEFOS	PU	D2.2
	Economics from mineral processing main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.2
	Environmental impact from mineral processing main technology:…		Available in public reports + Amphos 21	Amphos 21	PU	D2.4
	Economics from extractive metallurgy main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.2
	Environmental impact from extractive metallurgy main technology:…		NTUA Knowledge	NTUA	PU	D2.4
Current data on the production from secondary sources	In 2015, y t produced from mine tailings…		Open information, Collaboration with organizations and industry	ICCRAM	PU	D3.1
	Main technology for waste processing		Open information, Collaboration with organizations and industry + Knowledge from GTK, UNIKL, BRGM, MEFOS	GTK	PU	D3.2
	Main technology for extractive metallurgy:		Open information, Collaboration with organizations and industry + Knowledge from MEFOS (Pyro) LUT, UNIKL, Chalmers (Hydro), TUDelft	TUDelft	PU	D3.2
	Economics from waste processing main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.2
	Environmental impact from waste processing main technology:…		Open information, Collaboration with organizations and industry + Knowledge Amphos 21 and NTUA	Amphos 21	PU	D3.4
Current data on the production by recycling	z kg from EoL vehicles by …		IMN (publications and own materials)	IMN	PU	D4.1
	Economics from recycling process…		Information from workshops, literature survey	IMN	PU/CO	D4.2
	Environmental impact from recycling process		NTUA Knowledge	NTUA	PU	D4.4
Current demand	In 2015, ZZ Mt		Knowledge from MSP workshops	CEA	PU	D1.3
Current producers	Company X		Knowledge from MSP workshops	ERAMET	PU	D1.2
Current end-users	Company Y		Knowledge from MSP workshops	ERAMET	PU	D1.2
Current societal implications	Number of related jobs: XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	Amphos21	PU	D1.4
Future Use and trends						
Could have future applications in EEE?	YES/NO		Literature surve	BRGM	Public	D1.4
Potential future application			IMN: R&D, University of Padova: DECORE Project (Mo as catalyst in Bioetanol oxidation)	IMN	CO- av	D1.4
Expected EU demand in 2025			Knowledge from MSP workshops	CEA	PU	D1.4
Expected EU demand in 2050			Knowledge from MSP workshops	CEA	PU	D1.4
	Production estimation		Open information	MEFOS	PU	D2.3

Potential primary resource	Economics estimation from mineral processing main technology:…		Information from workshops, literature survey		PU/CO	D2.3
	Environmental impact estimation from mineral processing main technology:…		NTUA Knowledge	NTUA	PU	D2.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.3
	Environmental impact estimation from extractive metallurgy main technology:…		NTUA Knowledge	NTUA	PU	D2.3
Potential secondary resource	Production estimation …		Developments based on state-of the art and "family" metals	ICCRAM	PU	D3.3
	Economics estimation from waste processing main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from waste processing main technology:…		Open information, Collaboration with organizations and industry + Knowledge from Amphos 21 and CARTIF	CARTIF	PU	D3.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from extractive metallurgy main technology:…		Open information, Collaboration with organizations and industry + Knowledge from Amphos 21 and CARTIF	CARTIF	PU	D3.3
Potential resources through recycling	z kg from EoL vehicles by …		Open information	MEFOS	PU	D4.3
	Economics estimation from recycling process…		Information from workshops, literature survey	IMN	PU/CO	D4.3
	Environmental impact estimation from recycling process…		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF	CARTIF	PU	D4.3
Substitution	Nano-materials based on…		IMN: R&D	IMN	CO- av	D5.1
	Could substitute XX in …		IMN and other consortium partners within national PBSI project (NCBR): R&D	IMN	CO - av	D5.1
	XX could substitute … in…		Literature survey and Knowledge from workshops	VTT	PU	D5..2
Societal implications	Potential of job creation XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	ICCRAM	PU	D1.7
Main related R&D activities	EU funded projects XXX		Literature survey + Knowledge from workshops	ICCRAM	PU	D1.4
Technology Gaps for future use						
mining	Low grade ores in deep sea mining		Information from workshops, literature survey	GTK	PU	D1.4
processing	From radioactive minerals		Information from workshops, literature survey	GTK	PU	D1.4
extractive metallurgy	Need development of a hydro process whereas currently produced by pyromet		Information from workshops, literature survey	MEFOS	PU	D1.4
Substitution	High melting point combined with …		Information from workshops, literature survey	VTT	PU	D1.4
recycling	Manual dismantling of …		Information from workshops, literature survey	IMN	PU	D1.4
Policy Gaps for future use						
primary	…		Information to be drafted from MSP workshops	ADE	PU	D7.1
Secondary	…		Information to be drafted from MSP workshops	ADE	PU	D7.1
recycling	…		Information to be drafted from MSP workshops	ADE	PU	D7.1
substitution			IMN, source: R&D, Knowledge from MSP workshops and WP7 surveys	ADE	CO- av	D7.1

Element	NIOBIUM					
		STATUS	OWNER/SOURCE	RESPONS.	IPR	DELIV
Current Use						
Have applications in EEE?	YES/NO		Literature survey	BRGM	PU	D1.2
Current applications			Knowledge from MSP workshops	ERAMET	PU	D1.2
Current data on the production from primary sources	In 2015, x Mt produced.		Available in public reports + EMINES Knowledge	EMINES	PU	D2.1
	Main producer: China, company Wang – coproduct of the YY mining.		Available in public reports + EMINES Knowledge	EMINES	PU	D2.1
	Main technology for mineral processing:		Company publications	GTK	CO	D2.2
	Main technology for extractive metallurgy: …		Available in public and mining companies reports + Amphos 21 and MEFOS Knowledge	MEFOS	PU	D2.2
	Economics from mineral processing main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.2
	Environmental impact from mineral processing main technology:…		Available in public reports + Amphos 21	Amphos 21	PU	D2.4
	Economics from extractive metallurgy main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.2
	Environmental impact from extractive metallurgy main technology:…		Available in public reports + Amphos 21	Amphos 21	PU	D2.4
Current data on the production from secondary sources	In 2015, y t produced from mine tailings…		Open information, Collaboration with organizations and industry	ICCRAM	PU	D3.1
	Main technology for waste processing:		Open information, Collaboration with organizations and industry + Knowledge from GTK, UNIKL, MEFOS	GTK	PU	D3.2
	Main technology for extractive metallurgy: …		Open information, Collaboration with organizations and industry + Knowledge from ERAMET, MEFOS (Pyro), CEA, LGC, Chalmers (Hydro), TUDelft	TUDelft	PU	D3.2
	Economics from waste processing main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.2
	Environmental impact from waste processing main technology:…		Open information, Collaboration with organizations and industry + Knowledge from Amphos 21 and NTUA	AMPHOS 21	PU	D3.4
Current data on the production by recycling	z kg from EoL vehicles by …		Literature survey + Knowledge from workshops	VTT	PU	D4.1
	Economics from recycling process…		Information from workshops, literature survey	IMN	PU/CO	D4.2
	Environmental impact from recycling process		NTUA Knowledge	NTUA	PU	D4.4
Current demand	In 2015, ZZ Mt		Knowledge from MSP workshops	CEA	PU	D1.3
Current producers	Company X		Knowledge from MSP workshops	ERAMET	PU	D1.2
Current end-users	Company Y		Knowledge from MSP workshops	ERAMET	PU	D1.2
Current societal implications	Number of related jobs: XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	Amphos21	PU	D1.4
Future Use and trends						
Could have future applications in EEE?	YES/NO		Literature survey	BRGM	Public	D1.4
Potential future application			Knowledge from MSP workshops	ICCRAM	PU	D1.4
Expected EU demand in 2025			Knowledge from MSP workshops	CEA	PU	D1.4
Expected EU demand in 2050			Knowledge from MSP workshops	CEA	PU	D1.4
Potential primary resource	Production estimation		Open information	MEFOS	PU	D2.3
	Economics estimation from mineral processing main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.3

	Environmental impact estimation from mineral processing main technology:…		NTUA Knowledge	NTUA	PU	D2.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	GTK	PU/CO	D2.3
	Environmental impact estimation from extractive metallurgy main technology:…		NTUA Knowledge	NTUA	PU	D2.3
Potential secondary resource	Production estimation …		Developments based on state-of the art and "family" metals	ICCRAM	PU	D3.3
	Economics estimation from waste processing main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from waste processing main technology:…		Open information, Collaboration with organizations and industry + Knowledge from Amphos 21 and NTUA	AMPHOS 21	PU	D3.3
	Economics estimation from extractive metallurgy main technology:…		Information from workshops, literature survey	MEFOS	PU/CO	D3.3
	Environmental impact estimation from extractive metallurgy main technology:…		Open information, Collaboration with organizations and industry + Knowledge from Amphos 21 and CARTIF	CARTIF	PU	D3.3
Potential resources through recycling	z kg from EoL vehicles by …		Literature survey + Knowledge from workshops	VTT	PU	D4.3
	Economics estimation from recycling process…		Information from workshops, literature survey	IMN	PU/CO	D4.3
	Environmental impact estimation from recycling process…		Open information, collaboration with organizations and industry, Knowledge from Amphos 21, CARTIF	CARTIF	PU	D4.3
Substitution	Nano-materials based on…		Literature survey and Knowledge from workshops	VTT	PU	D5.1
	Could substitute XX in …		Literature survey and Knowledge from workshops	VTT	PU	D5.1
	XX could substitute … in…		Literature survey and Knowledge from workshops	VTT	PU	D5..2
Societal implications	Potential of job creation XXX		Information exchanged in workshops, Amphos 21 and ICCRAMM	ICCRAM	PU	D1.7
Main related R&D activities	EU funded projects XXX		Literature survey + Knowledge from workshops	ICCRAM	PU	D1.4
Technology Gaps for future use						
mining	Low grade ores in deep sea mining		Information from workshops, literature survey	GTK	PU	D1.4
processing	From radioactive minerals		Information from workshops, literature survey	GTK	PU	D1.4
extractive metallurgy	Need development of a hydro process whereas currently produced by pyromet		Eramet patents and intern reports	ERAMET	PU	D1.4
Substitution	High melting point combined with …		Information from workshops, literature survey	VTT	PU	D1.4
recycling	Manual dismantling of …		Information from workshops, literature survey	IMN	PU	D1.4
Policy Gaps for future use						
primary	…		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
Secondary	…		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
recycling	…		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1
substitution	…		Knowledge from MSP workshops and WP7 surveys	ADE	PU	D7.1

5 CONCLUSIONS

A deep and extensive exercise of knowledge identification and measurement has been carried out as the first step in knowledge management within MSP-REFRAM. The procedure that has been followed has required a strong cooperation between the Knowledge manager and WP leaders, all supervised by the project coordinator and the Project Management Office, i.e. a strong cooperation between the different WPs of the project. This has ensured that no information is out of the picture of the whole information to be produced as result of MSP-REFRAM.

Finally, the knowledge map presented herein can be considered as a preliminary map of all the knowledge to be generated during the project, and can be used by WP leaders as a guideline in organising duties and responsibilities related to information generation, retrieval and production.

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