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Study on Data Needs for a Full Raw Materials Flow Analysis

Final Report

prepared for

DG Enterprise and Industry

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Data Needs for a Full Raw Materials Flow Analysis

Final Report

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prepared for

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(under the Framework Contract ENTR/2008/006, Lot 1)

by

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EXECUTIVE SUMMARY

Background

The Communication 'Making raw materials available for Europe's future well-being: Proposal for a European innovation partnership on raw materials' was published on 29th February 2012. The proposed partnership aims to "*promote innovation along the entire value chain of raw materials*". For the successful implementation of the Innovation Partnership, there is a need for a robust and reliable evidence base on raw materials flows. This information is particularly important for the consideration of future options to support innovation in the entire raw materials value chain, including exploration, extraction, processing, recycling and substitution of materials as well as land use planning. While some data are already available, significant information gaps remain for many materials.

Aims

The objective of this study was therefore to support the European Commission in identifying the information and data needs for a complete raw materials flow analysis (MFA). More specifically, the aims of the study have been to:

- map, review and assess available data to establish a raw materials flow analysis (leading to the identification of current data gaps); and
- make recommendations for a future data strategy.

The focus of this study has been on the following 21 materials:

Aggregates	Germanium (Ge)	Rare Earths collectively (REEs)
Antimony (Sb)	Graphite (Gr)	
Beryllium (Be)	Indium (In)	
Cobalt (Co)	Lithium (Li)	Dysprosium (Dy)
Copper (Cu)	Magnesium (Mg)	Neodymium (Nd)
Fluorspar (Fl)	Niobium (Nb)	Tantalum (Ta)
Gallium (Ga)	Palladium (Pd)	Tungsten (W)
	Platinum (Pt)	Wood

The scope of this project has been somewhat broader than a simple MFA and the data assessed include indicators relating to current/past physical flows of the relevant materials across the whole value chain, other relevant indicators (such as the structure of the relevant industries) and information relating to potential supply and demand developments in the future. The main focus of this study (its "geographical system boundary") is the European Union, though where relevant, global information is presented.

Approach

The first stage of this study focussed on information collection for all the 21 materials. This study aimed to collect information on all lifecycle stages (potentially covering over 60 different aspects) for 21 materials. Information was collected from a wide range of sources including publicly accessible databases and reports as well as information requests submitted to Eurostat, a wide range of public authorities in each EU Member State, industry associations and companies. In addition, a review of commercially available market reports was conducted to identify the types of information potentially available from these sources. This report presents the data and information collected but given the time and budgetary constraints associated with the study, the information presented here is not exhaustive. It is therefore highly likely that additional information could be identified with additional research effort.

Subsequently, this study carried out an assessment of data availability and quality for ten selected materials (platinum, magnesium and wood, dysprosium and tungsten, fluorspar, cobalt, lithium, niobium and aggregates), leading to the identification of a number of issues and data gaps for these materials. Based on this analysis, this study has put forward a number of recommendations for a possible data acquisition strategy.

Results of Data Collection

The outcome of data collection is presented in this report by means of summary tables as well as graphically. In addition, detailed compilations of information collected for each material are presented in the annexes. While it is not possible to summarise the outcome of data collection for all 21 materials within the confines of this executive summary, an example of a flowchart is provided below.

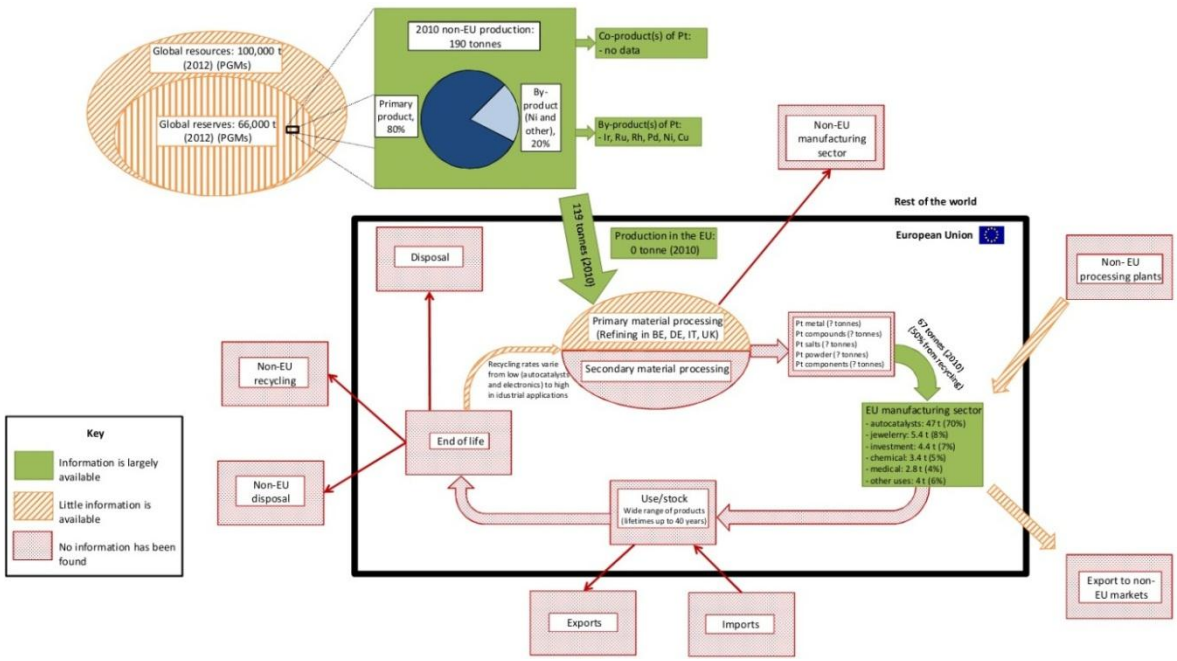

Figure 1: Flowchart presenting Platinum Flows into, from and within the EU

Recommendations

Based on the above, a number of recommendations for a future data acquisition strategy have been put forward, which focus on the most appropriate ways of addressing a selection of crucial (and often cross-cutting) issues.

The **problem areas and recommendations that relate cross-cutting issues common to all/several lifecycle stages** include:

- **Reliance on One-off and/or Non-EU Sources:** Much of the available information on the 21 materials can be found in one-off sources (i.e. studies that are not regularly updated) and in sources which have not been published in the EU and/or which do not provide data at the level of the EU27. It is therefore recommended that the European Commission further explores the feasibility of establishing EU-based structures to carry out or fund EU-specific data collation in a systematic manner. This might involve setting up a dedicated institution for this purpose.

- **Lack of Standardised Data:** There is a need for standardised use of terms, collection of information using standardised methods and indicators in order to facilitate aggregation of country level data at the EU level. It is therefore recommended that standards are developed for the use of the main terms as well as data categories and methods for data collection. This could be carried out utilising in-house capabilities at the European Commission (in collaboration with all affected stakeholders) or by means of mandating the body referred to under the previous bullet point.

- **Streamlining Currently Collected Trade Statistics:** There is a large pool of trade data available from Eurostat; however, these data are often not sufficiently detailed or cannot be easily assigned to a particular lifecycle stage. A two-stage strategy is proposed to address this problem. In the first instance, it is proposed to explore the potential for determining which data categories are relevant to each lifecycle stage and disaggregating data categories that are not sufficiently detailed. This could be carried out in-house by the Commission staff in collaboration with experts on each material. Should this not prove successful, it is recommended to explore the feasibility of organisations such as Eurostat working on adjusting their product category codes to better reflect MFA data needs.

In addition, the main **problem areas and recommendations that relate to specific lifecycle stages** include:

- **Exploration:** In order to address the identified lack of consistent and comprehensive information on entities involved in exploration activities and the associated investment, it is recommended that the European Commission funds a dedicated study or organises a workshop to assess the possibility of systematic collection of these data.

- **Extraction:** Overall, comparatively more information on extraction has been identified than for some of the other lifecycle stages, although significant data gaps remain, including data on mining waste, by-products/co-products, extractive methods, information on risks & hurdles to future development, etc.. It is recommended that the possibility of gaining access to additional paid-for data sources is investigated.

- **Processing:** Although some information on the main types of semi-processed and processed material forms that are produced and traded has been identified, this by no means amounts to a consistent, standardised overview across all materials on the output of the EU processing industries. It is therefore recommended to organise a workshop attended by experts from industry associations and public institutions to address this issue. Due to the complexity of the relevant supply chains, it is proposed to organise a workshop (or commission a study) dedicated specifically to this issue.

- **End-product Manufacturing:** The assessments carried out demonstrate that for nearly all the raw materials analysed in more detail there are severe data gaps in relation to this lifecycle stage. It is therefore recommended that the European Commission organises a series of workshops bringing together industry experts to attempt to estimate some of the relevant information (such as average material content in main product categories) and makes use information that may become available on these materials within REACH registration and/or authorisation/restriction procedures and within reporting under Article 15 of the WEEE Directive (2012/19/EU).

- **Product Use:** There is a lack of data on the average lifetimes and product re-use potential, which hinders the temporal analysis of these materials' lifecycles and projections of waste arisings, thus limiting the understanding of the potential of urban mines. It is therefore recommended that a series of expert workshops to provide estimates of average product lifetimes is organised. These could be combined with those used to estimate average material content in main product categories.

- **Collection, sorting and recycling:** While there are data on overall levels of waste generation, collection, recycling, exports and imports, these are usually highly aggregated and not material specific. It is proposed that MFA needs should be taken into account when current EU legislation is revised or when new legislation is introduced and that there is monitoring of which data are being generated by existing legislation and structures. In addition, it is recommended that the Commission explores the feasibility of Eurostat adjusting currently reported data categories and/or establishing assumptions or developing models that would allow disaggregation of current data categories.

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1. INTRODUCTION

1.1 Background

Non-energy non-agricultural raw materials are a vital input to many industries within the European Union (hereafter referred to as the EU). They are an essential component of various consumer products including cars, computers and mobile phones, and the use of these materials is of increasing importance for the manufacture of many 'green' technologies, such as electric cars, solar photovoltaic cells and wind turbines. These are very diverse and range from aggregates and industrial minerals to metals used for high technology applications such as gallium, indium, and rare earths. With their demand ever increasing (mainly due to the growth of emerging economies and the increasing importance of new technologies), non-energy non-agricultural raw materials are highly important to the EU economy.

However, the supply of these materials from third countries on which the EU is dependent is increasingly being affected by market distortions. In addition, materials exploration and extraction in the EU is becoming more difficult due to competition between different land uses, regulation and technological limitations (European Commission (hereafter referred to as the EC), 2008[1] and 2011[2]). Other challenges include the need for greater resource efficiency and improved recovery of material from waste.

Such encumbrances were the reason for the launch of the EU Raw Materials Initiative (RMI) in 2008. The RMI was aimed at proactively addressing the multifaceted challenges facing the supply of non-energy non-agricultural raw materials to the EU economy. On 2 February 2011, the European Commission adopted a new Communication which sets out the current strategy to ensure secure access to raw materials for the EU. This strategy further pursues and reinforces the three-pronged approach initiated by the 2008 RMI:

- fair and sustainable supply of raw materials from international markets;
- fostering sustainable supply within the EU; and
- boosting resource efficiency and promoting recycling.

Innovation is the cornerstone of the Europe 2020 strategy for smart, sustainable and inclusive growth. The EU innovation strategy is set out in the 'Innovation

[1] More information is available from the EC communication COM(2008)699 final, available at, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0699:FIN:en:PDF

[2] More information is available from the EC communication COM(2011)25 final, available at, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0025:FIN:EN:PDF

Union' flagship initiative, proposed by the European Commission in October 2010. The EU raw materials strategy recognises the importance of an effective innovation policy which covers innovation along the entire supply chain as well as the demand side (including extraction, sustainable processing, eco-design, recycling, new materials, substitution, resource efficiency and land-use planning). For this reason, the Commission has proposed the Innovation Partnership on Raw Materials.

For the successful implementation of EU policies in this field (including innovation policy measures arising from the RMI), there is a need for a robust and reliable evidence base on raw materials flows. This information is particularly important for the consideration of future options to support innovation in the entire raw materials value chain, including exploration, extraction, processing, recycling and substitution of materials as well as land use planning. In order to identify with accuracy where innovation has the greatest potential, whether it should be supported, and what the levers are to do so, a more precise picture of the flow of the raw materials is required.

While some data are already available (for example, relatively advanced materials flow analyses are available for some base metals such as aluminium and copper[3]), significant information gaps remain for many materials.

1.2 Objectives of the Study

The objective of this study is to support the European Commission in identifying the information and data needs for a complete raw materials flow analysis (MFA). The aim of this study is, in particular, to provide the evidence base for future options to support innovation in the entire raw materials value chain including exploration, extraction, processing, recycling and substitution of these materials as well as land use planning.

More specifically, the aims of the study have been to:

- map, review and assess available data to establish a raw materials flow analysis (leading to the identification of current data gaps); and
- make recommendations for a future data strategy (Roadmap for action) covering both the improvement of data availability and quality.

[3] For aluminium see for example, http://www.alcoa.com/recycling/en/pdf/material_flow_analysis_in_the_aluminum_indudstry.pdf. For copper, a study on a global copper flow model was recently concluded by Fraunhofer ISI for the European Copper Institute.

1.3 Structure of this Report

The remainder of this report has been organised as follows:

- Section 2 summarises the relevant EU policy background leading the European Commission to commission this study;
- Section 3 provides an overview of the methodology and main steps under the study;
- Section 4 summarises the outcome of information collection for all 21 materials; and
- Section 5 provides a summary of the recommendations for a future data acquisition strategy.

2. POLICY BACKGROUND AND REQUIRED INFORMATION

2.1 Innovation Partnership on Raw Materials

The Communication on *'Making raw materials available for Europe's future well-being: Proposal for a European innovation partnership on raw materials'* was published on 29th February 2012.[4] The proposed partnership aims to "*promote innovation along the entire value chain of raw materials*"[5]. A number of concrete targets are proposed to be achieved by 2020 at the latest[6]. These include:

- *"up to 10 innovative pilot actions (e.g. demonstration plants) for exploration, extraction and processing, collection and recycling;*
- *substitutes for at least three key applications of critical and scarce raw materials;*
- *enhanced efficiency in material use and in prevention, re-use and recycling of valuable raw materials from waste streams, with a specific focus on materials having a potentially negative impact on the environment;*
- *a Network of Research, Education and Training Centres on Sustainable Mining and Materials Management (M³);*
- *European standardised statistical instruments for the survey of resources and reserves and a 3-D geological map;*
- *a dynamic modelling system linking trends in supply and demand with economically exploitable reserves and a full lifecycle analysis; and*
- *a pro-active strategy of the EU in multi-lateral organisations and in bilateral relations, such as the US, Japan, Australia in the different areas covered by the Partnership."*

It is further stated that in order for the Innovation Partnership to be successful, there is a need for *"standardised data on materials flows, covering production, reserves, resources, export and import and stocks (urban mining, heaps, tailings and landfills, materials in use)."*

2.2 Communication on Innovative and Sustainable Forest-based Industries in the EU

The Communication on innovative and sustainable forest-based industries in the EU – a contribution to the EU's Growth and Jobs Strategy[7] covers pulp, paper and paper packaging producers, woodworking industries (e.g. sawmills and wood-based panel producers), and specialised sectors such as the cork and printing industries. It reports

4 http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/communication_final_en.pdf

5 http://ec.europa.eu/enterprise/policies/raw-materials/innovation-partnership/index_en.htm

6 Ibid.

7 See Communication from the Commission to the Council and the European Parliament on innovative and sustainable forest-based industries in the EU – a contribution to the EU's Growth and Jobs Strategy, COM(2008)113, published 27th February 2008.

that forest-based industries, which provide more than 3 million jobs in 344,000 enterprises, have a production value of €365 billion and an added value of around €120 billion. However, it cautions that there are several challenges facing forest-based industries including:

- access to raw materials – competition for wood is increasing, partly due to growing demand for renewable energy;
- impact of climate change policies –a sustainable and efficient forest policy can help forests contribute towards reducing greenhouse gas levels. However, the pulp, paper and some wood panel industries involve energy intensive processes;
- innovation and R&D – the Forest-based Sector Technology Platform (FTP) has developed a Strategic Research Agenda to increase the EU's competitiveness;
- trade and cooperation with third countries – high tariffs and non-tariff barriers affect EU wood and paper products trying to access third country markets; and
- communication and information – the availability of information on forests, forest-based industries and forest products needs to improve.

2.3 Desired Information

2.3.1 Introduction to Material Flow Analysis

Material Flow Analysis (MFA) is an analytical tool that maps physical flows of natural resources and materials into, through and out of the economy (OECD, 2008).[8] According to OECD (2008), the term MFA refers to a family of tools which includes a wide variety of analytical approaches and measurement tools which can range in scope from economy-wide to substance or product-specific analyses. This study has attempted to compile what OECD (2008) terms a material system analysis, although the term material flow analysis will be used throughout the study as a synonym to this approach. A material system analysis is defined by OECD (2008) as follows:

> *"Material system analysis (MSA) is based on material specific flow accounts. It focuses on selected raw materials or semi-finished goods at various levels of detail and application (e.g. cement, paper, iron and steel, copper, plastics, timber, water) and considers life-cycle-wide inputs and outputs. It applies to materials that raise particular concerns as to the*

[8] OECD (2008): **Measuring Material Flows and Resource Productivity Volume 1**, available at www.oecd.org/dataoecd/46/48/40485853.pdf

sustainability of their use, the security of their supply to the economy, and/or the environmental consequences of their production and consumption."

2.3.2 Outline of Desired Information

The focus of this study is on the materials which are listed below (alongside an acronym or symbol which may be used when referring to the material):

Aggregates	Germanium (Ge)	Rare Earths collectively (REEs)
Antimony (Sb)	Graphite (Gr)	
Beryllium (Be)	Indium (In)	
Cobalt (Co)	Lithium (Li)	Dysprosium (Dy)
Copper (Cu)	Magnesium (Mg)	Neodymium (Nd)
Fluorspar (Fl)	Niobium (Nb)	Tantalum (Ta)
Gallium (Ga)	Palladium (Pd)	Tungsten (W)
	Platinum (Pt)	Wood

This study focuses on collecting information relevant to the flows of the above materials across the whole lifecycle, with the desired outcome being an account of material flows throughout the different stages of the material lifecycle. However, the scope of this project is somewhat broader than a simple MFA and the list of main research questions given in the service request requires the consideration of information that is not directly related to an MFA. For this reason, we have classified the data and information presented in the Annexes to this report into three distinct groups:

- Group 1: Indicators relating to current/past material flows and stocks;
- Group 2: Other relevant current and past indicators relating to policy objectives (such as industry structure); and
- Group 3: Indicators relating to future supply and demand changes.

The main focus of this study (its "geographical system boundary") is the European Union, though where relevant global information is presented.

Table 2.3 overleaf lists the types of data that are of interest to this study.

Table 2.3: List of Indicators for Each Stage in the Material Life Cycle (LC)			
Lifecycle Stage and Indicator Group		**Data category**	**Description of indicator**
Exploration/ Availability	1	Explorative activities	New resources and reserves
			Availability of wood and growth rates of wood
	2	Industry structure	Number of companies
	3	Future trends	Investment in exploration
Extraction/ harvesting	1	Mining production	Mining production as primary material (EU vs. non-EU)
			Mining production as by-product (EU vs. non-EU)
		Harvested quantity	Roundwood production as raw material
		Mining waste	Quantities of relevant material in mining waste; if in EU, number of Category A sites (Directive 2006/21/EC)
		Time required for mining production	Time required for initial processing or for materials that are mined as by-products, time required to extract them from the main product
		Imports/ exports to/ from the EU	Amounts of primary material (ores, concentrates, roundwood) imported/exported
		Intra EU-trade	Where mined in the EU, trade between Member States
	2	Industry structure	Number of companies (or mines) and their location (EU vs. non-EU)
		Extractive methods	% of production produced by each main extractive method (open cast, underground, artisanal and small-scale mining)
	3	Future supply of ores/ concentrates	Published projections of future supply
		Factors affecting future mining output	Summary of available information on risks, hurdles to the development of the relevant sectors/ activities (such as sustainable forest management plans for wood)
Processing	1	Processing output	Quantities processed and resultant material forms
		Processing waste	Quantities of the material going into the waste stream following processing
		Time required for processing	Length of time required to process the material
		Imports/ exports to/ from the EU	Amounts of processed material imported/exported
			Amount of basic wood types imported/exported
		Intra EU-trade	Where processed in the EU, trade between Member States
	2	Industry structure	Number of each type of facility and location (EU/non EU)
	3	Future supply of processed materials	Published projections of future supply
		Factors affecting future processing output	Summary of available information on risks, hurdles to the development of the relevant sectors/ activities
Manufacture of end-products	1	Main uses	Main uses and amounts required for each application in physical units per year (EU level). Also a description of grades required, if available
		Raw material waste from the manufacturing process	Quantities of raw materials that enter the manufacturing process that are not used in end products
		Time required for manufacture	Length of time required to manufacture the end product
		Exports and imports of manufactured products	Exports and imports of products or product categories that contain the relevant raw materials
		Intra EU-trade	Where manufactured in the EU, trade between MSs

Table 2.3: List of Indicators for Each Stage in the Material Life Cycle (LC)			
Lifecycle Stage and Indicator Group		**Data category**	**Description of indicator**
	2	Availability of substitutes	List of potential substitutes for each technical function of the material and their market shares, if available
		Characteristics of substitutes	Environmental and energy impacts of substitute materials
		Industry structure (manufacturing sectors)	Number of companies, % of SMEs (but turnover and number of employees are also relevant for policy making purposes)
	3	Forecasts of future demand for these materials	Amounts demanded at various points in time in the future (each source may use different reference periods); if available, forecasts for substitute materials
		Factors affecting future demand	Summary of available information on risks, hurdles to the development of the relevant sectors/activities
Use	1	Average product lifetime	Average lifetime of products that contain the relevant material in years
		Re-use potential	Existence of a second-hand market or potential for re-use
Collection and sorting	1	Total post-consumer wastes generated	Quantities of material contained in post-consumer waste generated each year (products coming to the end of their useful life)
		Proportion of total waste collected	Quantities of waste collected (i.e. excluding products after the end of useful life that are not collected)
		Proportion of waste collected and entering the recycling process	Old scrap collection rate/wood waste collection rate (material collected for recycling/material content in end-of-life products)
		Proportion of waste collected but not recycled	% of collected waste landfilled or incinerated (with or without energy recovery)
		Exports of collected wastes	% of collected wastes exported
	2	Industry structure	Number of companies, % of SMEs (but turnover and number of employees are also relevant for policy making purposes)
Recycling	1	Recycling rate measure 1	Recycling process efficiency rate (recycled material/end-of-life material collected for recycling)
		Recycling rate measure 2	End-of-life recycling rate (recycled material/material in collected products)
		Exports of end-of-waste materials	% of recycled material exported to countries outside the EU
		Intra EU-trade	Where recycled in the EU, trade between Member States
		Downcycling	% of material that is downgraded/moved down the value chain (wood)
	2	Industry structure	Number of companies, % of SMEs (but turnover and number of employees are also relevant for policy making purposes)
		Future supply of recycled materials	Published projections of future supply
		Factors affecting future recycling output	Summary of available information on risks, hurdles to the development of the relevant sectors/activities
Landfill	1	Quantities mined	Quantities mined from landfills (note this is not applicable to wood)

3. OVERVIEW OF METHODOLOGY AND ACTIONS TAKEN

The approach adopted by the study is described below.

3.1.1 Information Collection for 21 Materials

The outcome of information collection for the 21 materials is summarised in Section 4 of this report and in Annexes B to E.

This study adopted a three-pronged approach to information collection.

Information collection focused on the following two types of published sources:

- publicly accessible databases; and
- published research reports and websites.

In addition, requests for information were sent to both public authorities in EU Member States, Eurostat as well as industry associations and companies. The overview of information identified and collected as well as of stakeholders contacted is given in Annexes B and C.

In addition, a review of commercially available market reports was conducted to identify the types of information potentially available from these sources. The approach to data collection was therefore broad and resource intensive.

This report and its Annexes present the data and information collected but given the time and budgetary constraints associated with the study, the information presented here is not exhaustive. It is therefore highly likely that additional information could be identified with additional research effort.

3.1.2 Assessment of Data Availability and Quality for 10 Materials

This study undertook a more detailed assessment of data availability and quality for ten selected materials, with the outcome presented in Annex A. The first step was to identify ten materials to undergo detailed analysis of data availability and quality.

The raw materials for in-depth analysis have been selected on the basis of the following criteria (among others):

- selected raw materials were to represent varying degrees of data availability/quality – the selection was therefore to include several materials from each of the following groups: five highest and five lowest scoring materials on the data availability criterion, and from the group of eleven materials scoring between the extremes; and

- materials selected for in-depth analysis were to reflect a range of material types (e.g. metals vs. non-metals); for this reason, the selection was to include at least two non-metallic materials.

From the group of materials scoring highly on the data availability criterion**, platinum, magnesium and wood**[9] have been selected. These materials are preferable to copper which was included in this study chiefly to act as an example of a material for which an MFA has already been completed. The selection of wood appears to be advantageous as wood provides an example of a non-metallic material. Due to similarities between the supply chains of platinum and palladium, it was decided not to select palladium. From the group of materials scoring low on the data availability criterion, the focus is on **dysprosium and tungsten.** These are complemented by **fluorspar** which also received a low score and is an industrial mineral, not a metal. From the list of remaining materials, the selection comprises **cobalt, lithium, niobium and aggregates**.

The in-depth assessment focused both on data availability (thus identifying the main data gaps) as well as data quality. It is based on the analysis conducted by the core study team and supported by the judgement of three external experts in relation to their specialist areas of expertise. These experts were:

- Andrew (Gus) Gunn (British Geological Survey) in relation to exploration, extraction and processing;
- Dirk Jepsen (Ökopol) in relation to ecodesign; and
- Mike Van Acoleyen (ARCADIS Belgium) in relation to waste management and recycling.

The analysis of data availability and quality took into account the following factors:

- Are recent data available for each material and for each data indicator and category?
- Is it possible to establish a reference year or period for an MFA?
- Are data from different sources consistent?
- Does a cross-comparison of data from different sources reveal large disparities between the values recorded and what are the main reasons for these?
- Are the data sources one-off publications or are they likely to be updated in the future?
- What is the geographic scope of the data and if data are not at the level of the EU, can they be applied/adapted to the EU?
- What is the reliability of the sources of the data?
- If the data have a limited coverage can these data be extrapolated onto the EU-27?

In addition, requests were sent out to relevant stakeholders (usually industry associations) to review draft annexes for the 10 selected materials (with the exception of wood), as well as annexes for antimony, copper, palladium and tantalum. Comments on draft annexes were received for antimony, cobalt, copper, fluorspar,

[9] Note, however, that although overall wood information may be good relative to other materials, information for recovered and recycled wood is limited.

magnesium, and wood. These included comments provided by the European Aggregates Association, the Cobalt Development Institute, the International Copper Study Group, the European Copper Institute, Comité Technique Européen du Fluor (Cefic), the International Magnesium Association/Europäische Forschungsgemeinschaft Magnesium/Magnesium Metal and the International Platinum Group Metals Association. A number of other consultees not named here also kindly provided comments in relation to antimony, fluorspar and wood.

3.1.3 **Recommendations**

The final task of this study was to put forward recommendations for possible ways for addressing any identified data gaps. These recommendations are presented in Section 5 of this report and are based on analysis carried out by the core study team and the three external experts.

4. OUTCOME OF DATA COLLECTION FOR 21 MATERIALS

This section summarises the information collected for each of the 21 materials. The full information collected is presented in material specific annexes to this report. Throughout this report and its annexes, the term material is used to refer to the raw materials that are the subject of this report. This section provides a brief summary of collected data by means of:

- a summary table comparing the 21 materials as regards data availability; and
- flowcharts and summary tables for each of the 21 materials.

Table 4.1 provides a summary of data availability for the 21 materials.

Table 4.1: Comparison of Data Availability for the 21 Materials

Comparative Data Availability	**Materials**
Five Highest	Copper, Magnesium, Palladium, Platinum, Wood
Medium	Aggregates, Antimony, Beryllium, Fluorspar, Gallium, Germanium, Indium, Lithium, Niobium, Tantalum
Five Lowest	Graphite, Rare Earth Elements, Dysprosium, Neodymium, Tungsten

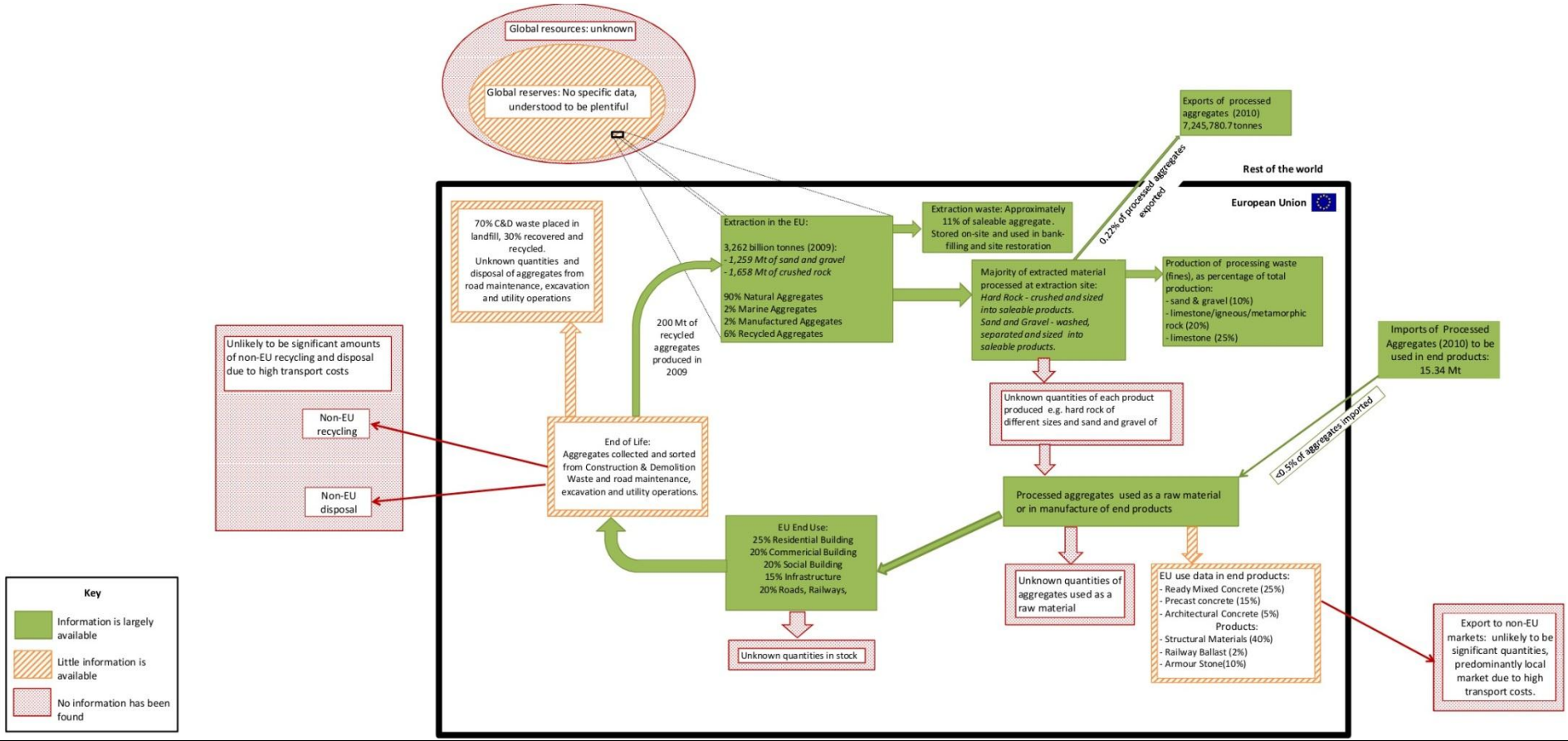
Note: Under each data availability category, materials are listed in alphabetical order.

The flowcharts that follow provide a simplified overview of the flows of each of the materials in a recent year for which data are available and with a specific focus on the EU. The flowcharts are complemented by a brief overview of the structure of the relevant sectors and potential future trends. The summary tables are presented in the same order as annexes to this report. Information in the flowcharts is colour coded as follows (they are also pattern coded for those wishing to print out the report in black and white):

- green colour indicates that data are largely available
- orange indicates that some (little) data are available (e.g. global use patters instead of EU specific data); and
- red indicates that insufficient information is available.

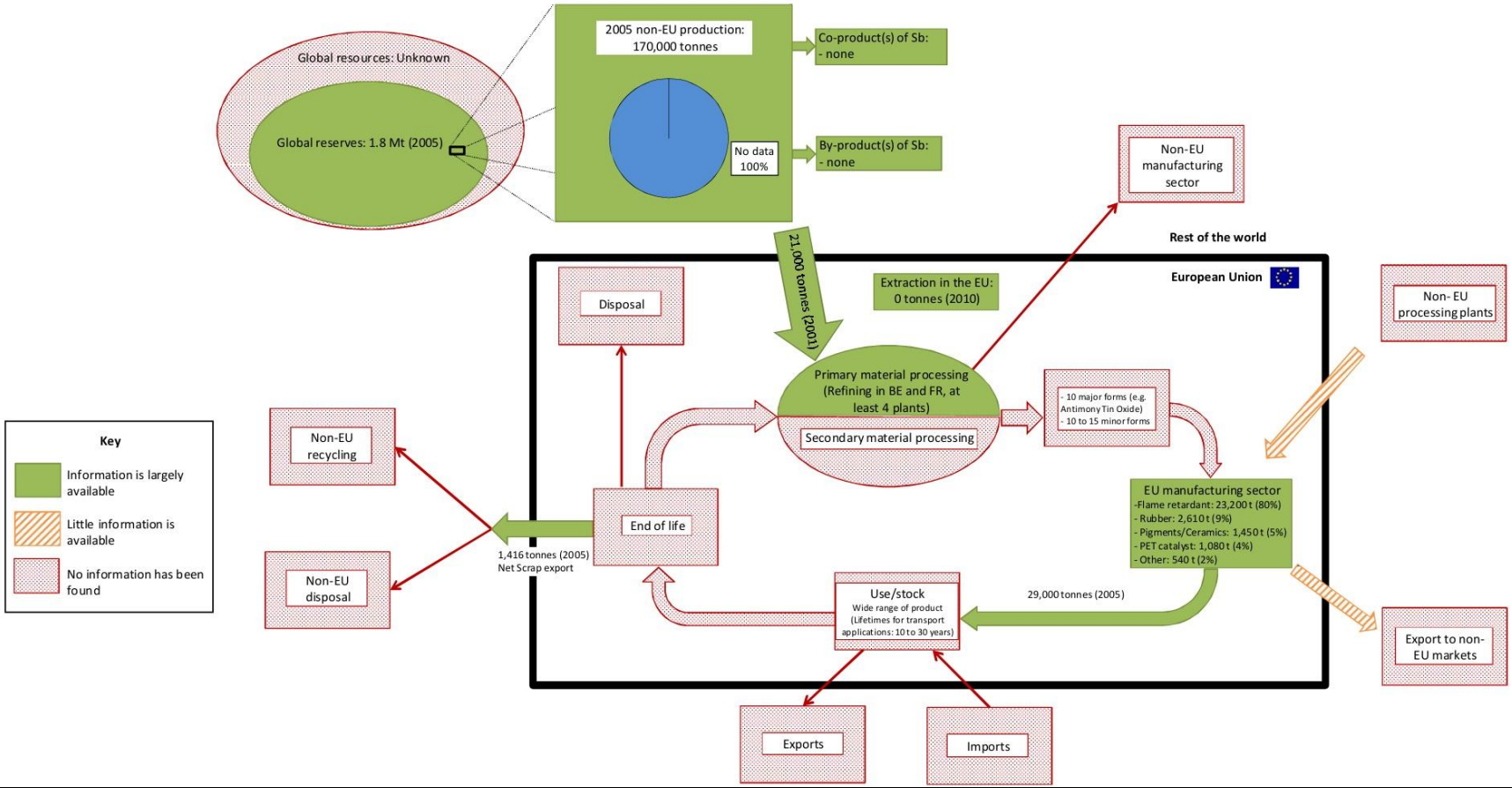
The flowcharts aim to primarily present information for the EU which is given within the black boundary and interactions with regions outside the EU are presented by means of an arrow at relevant stages in the lifecycle. Where information is available, the thickness of the arrows has been adapted to reflect the magnitude of the flows. However, the size of the boxes is standardised throughout, mainly reflecting paucity of information necessary for their differentiation.

Table 4.2: Overview of Aggregate Flows in the EU



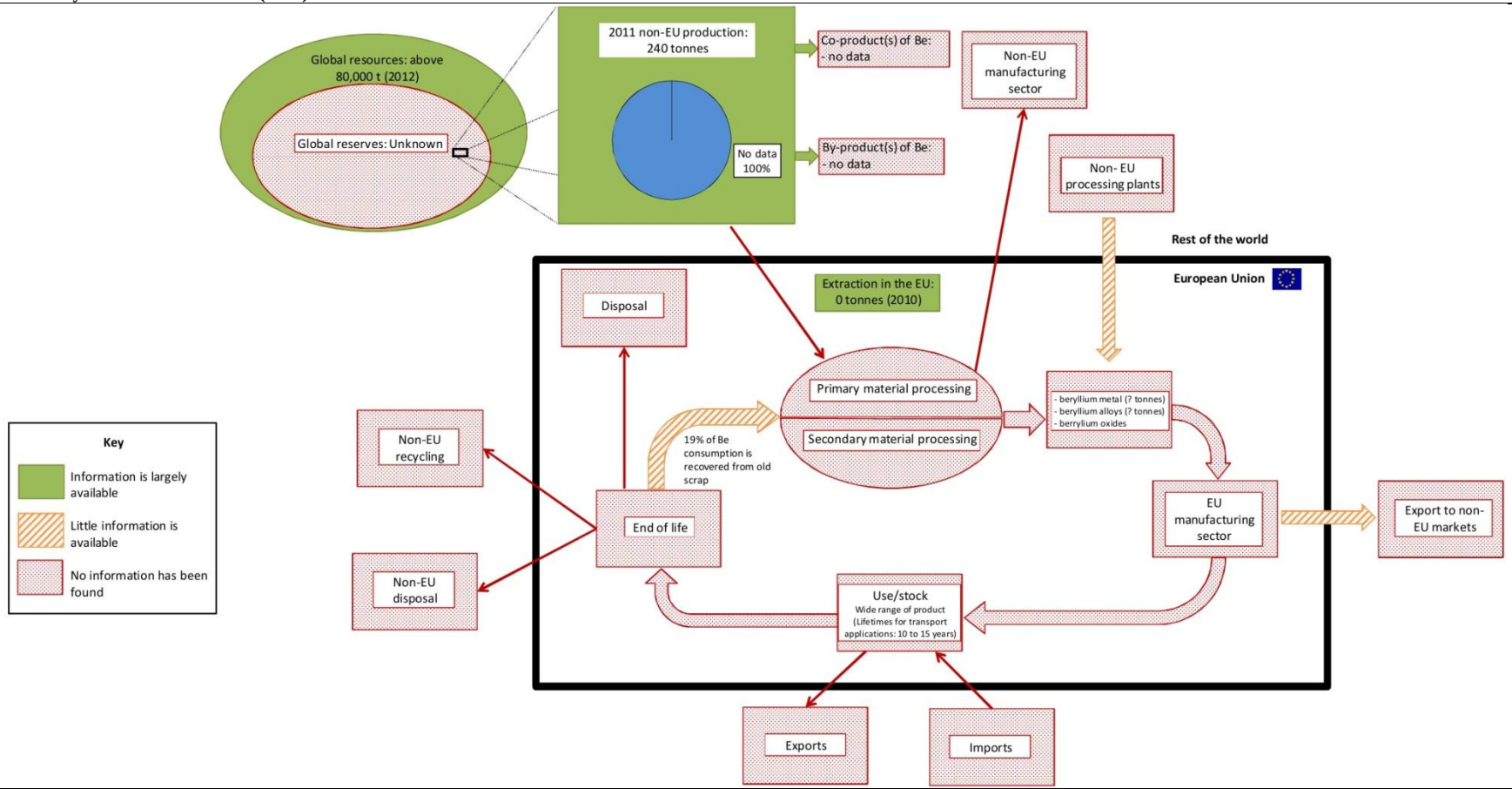
Structure of the relevant sectors		*Future trends*	
Exploration	Expected same as extraction.	**Exploration**	Exploration carried out to ensure 20-50 years of future reserves.
Extraction	2009: 15,904 aggregates producers in EU, majority SMEs	**Extraction**	Gradual increase in production
Refining	Conducted by extraction companies	**Refining**	Environmental measures
Manufacturing	Independent companies and those that extract. Majority SMEs.	**Manufacturing**	None identified
Collection	Insufficient information	**Recycling**	Expected increase in EU
Recycling	Insufficient information		

Table 4.3: Overview of Antimony Flows in the EU (2005)



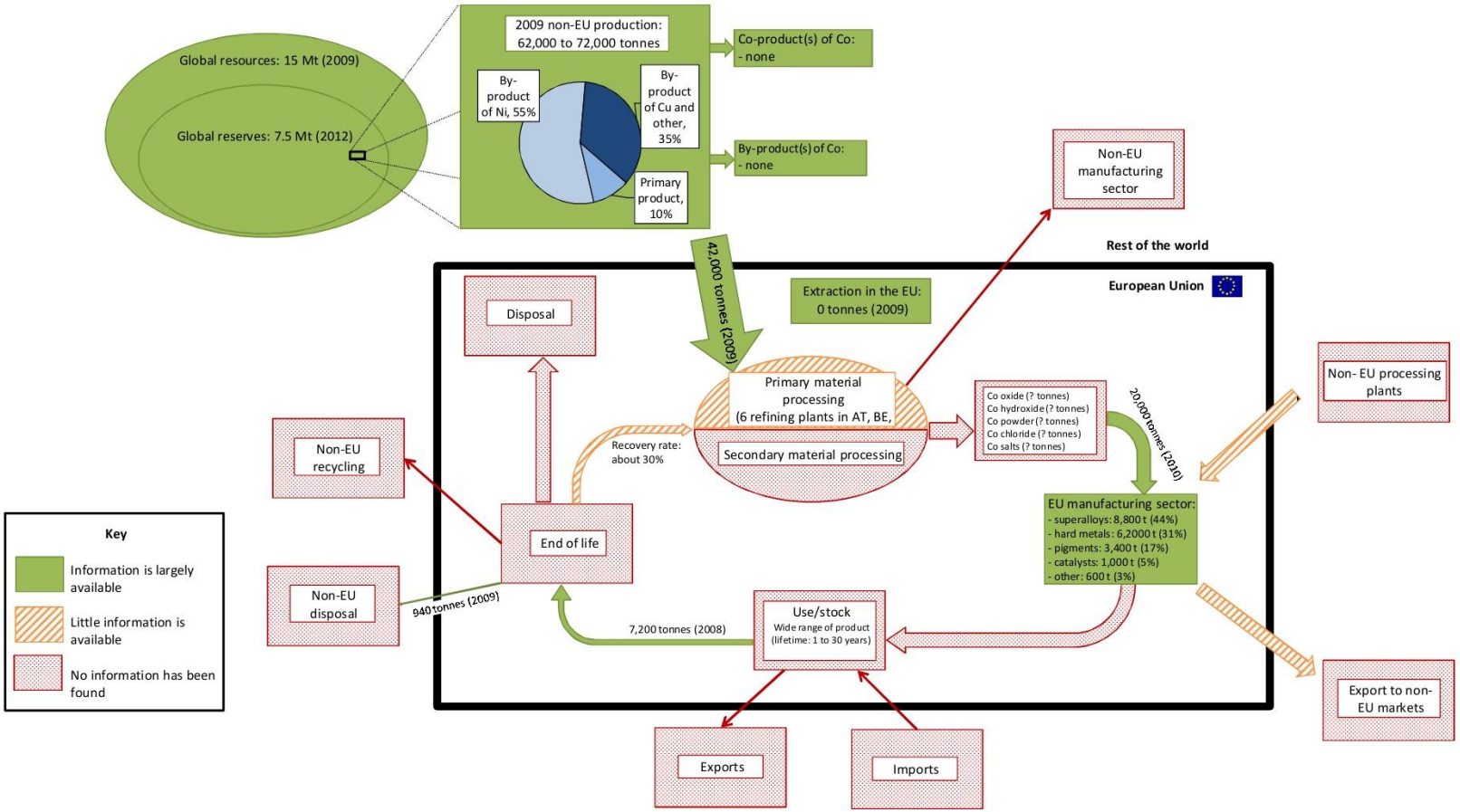
Structure of the relevant sectors		*Future trends*	
Exploration	Insufficient information (2 EU firms involved in exploration and extraction)	**Exploration**	Insufficient information
Extraction	Insufficient information	**Extraction**	Insufficient information
Refining	4 ATO in EU	**Refining**	Insufficient information
Manufacturing	Insufficient information	**Manufacturing**	Qualitative assessment
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	2 largest ones but total Insufficient information	**Recycling**	Insufficient information

Table 4.4: Overview of Beryllium Flows in the EU (2005)



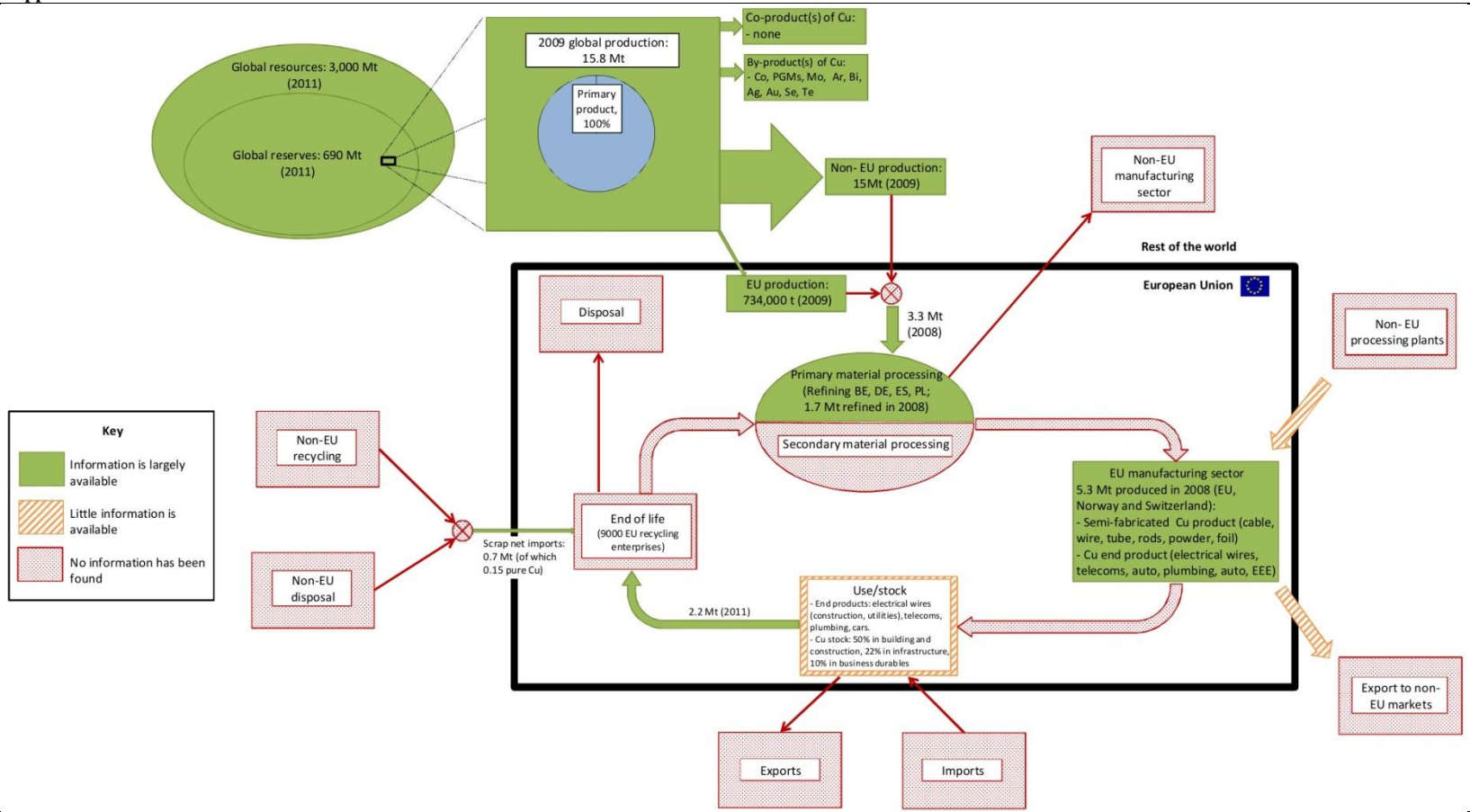
Structure of the relevant sectors		*Future trends*	
Exploration	No mining in the EU	**Exploration**	Insufficient information
Extraction	One US and one Chinese company	**Extraction**	Insufficient information
Refining	Processing plants in France and Germany	**Refining**	Less beryllium metals and more beryllium alloys
Manufacturing	Wide range of end products	**Manufacturing**	Growth of the demand to 465 tonnes in 2015
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Insufficient information	**Recycling**	Insufficient information

Table 4.5: Overview of Cobalt Flows in the EU



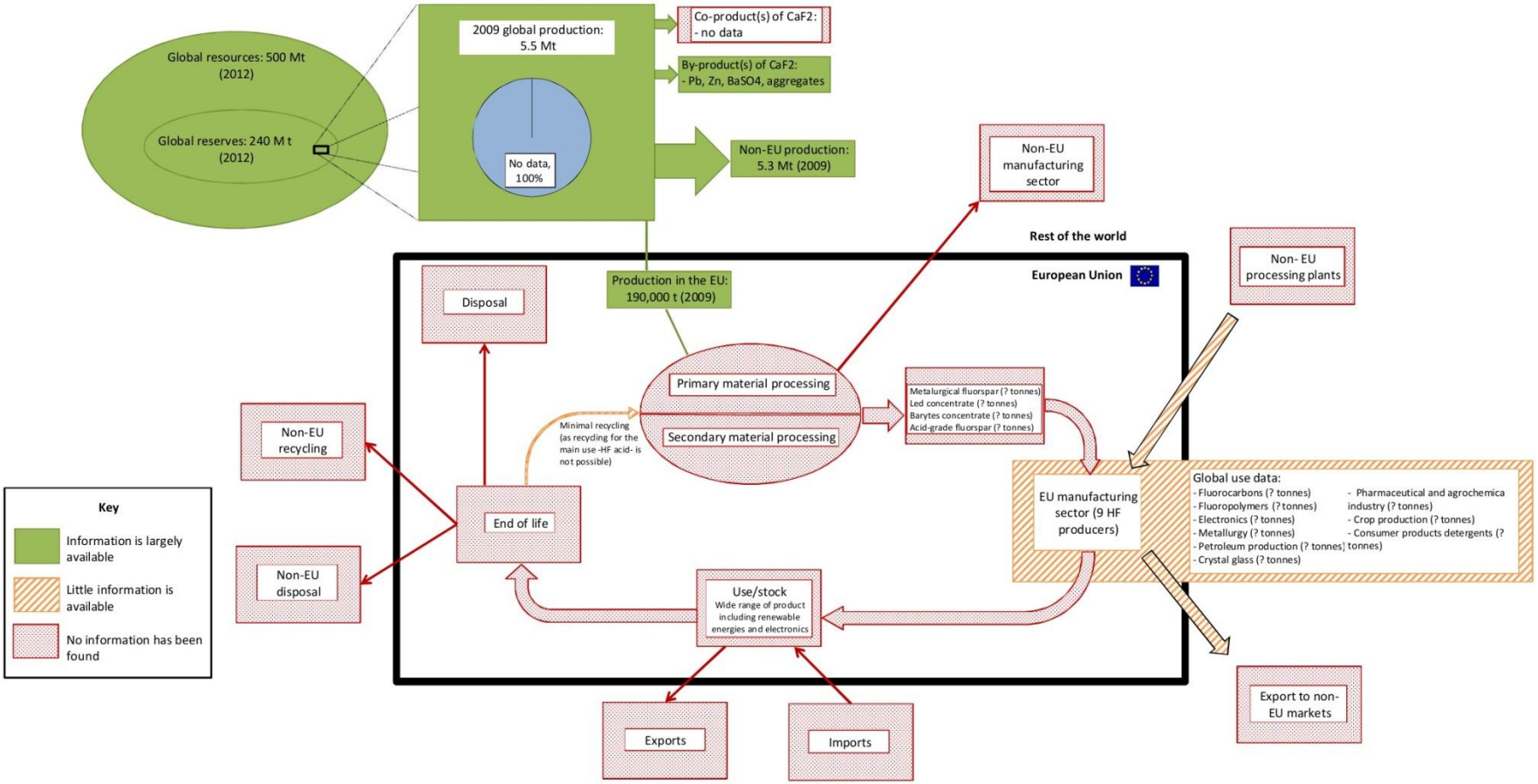
Structure of the relevant sectors		*Future trends*	
Exploration	Large number	**Exploration**	Insufficient information
Extraction	None in the EU, Insufficient information globally	**Extraction**	Dependent on Ni and Cu
Refining	Max. 6 in the EU	**Refining**	Increase in non-EU processing
Manufacturing	Insufficient information	**Manufacturing**	Insufficient information
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Known for specific sub-sectors	**Recycling**	Known for specific sub-sectors

Table 4.6: Overview of Copper Flows in the EU



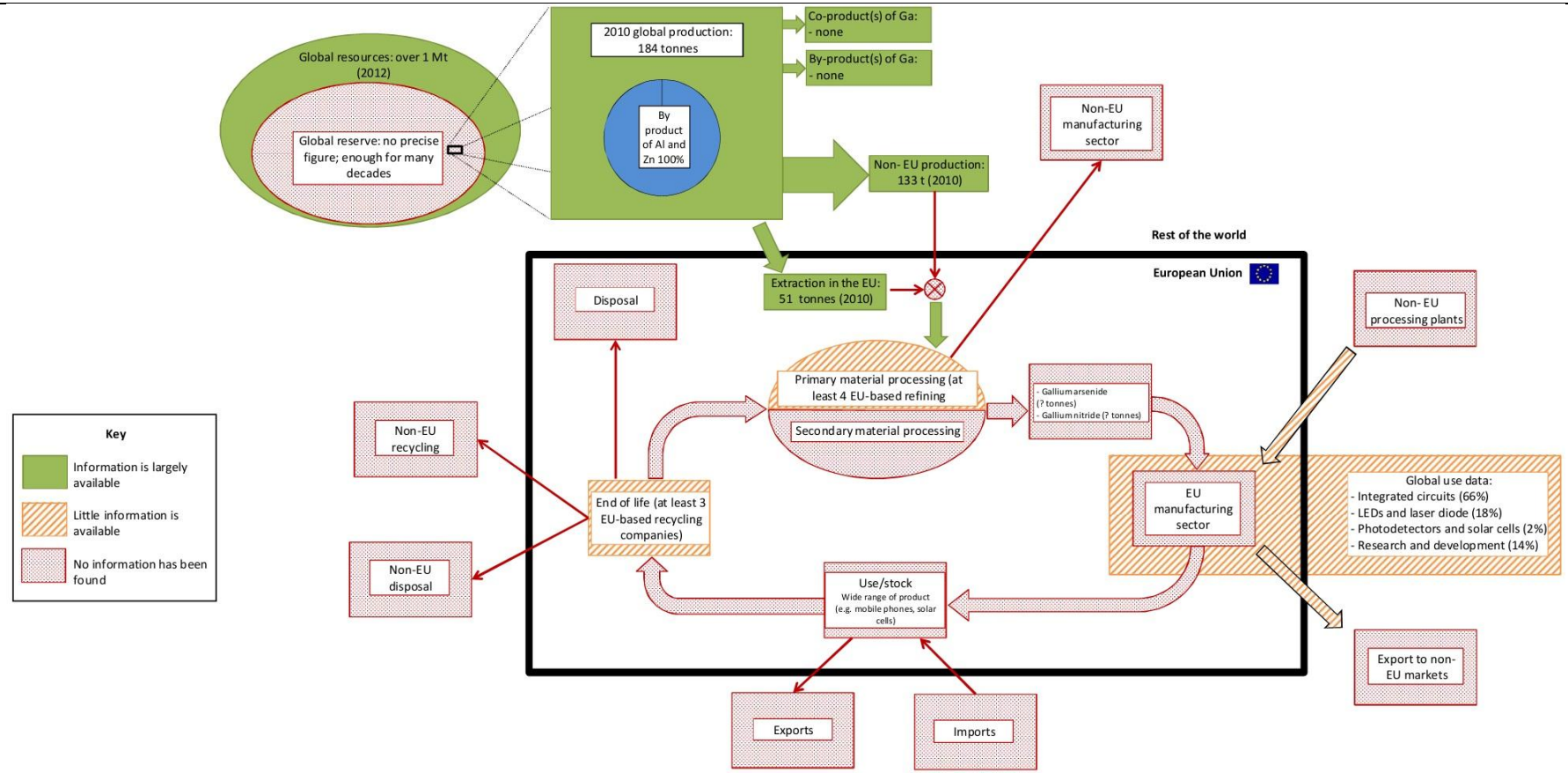
Structure of the relevant sectors		*Future trends*	
Exploration	5 EU companies in top 20 producers/explorers	**Exploration**	Expected increase, but declining ore grades
Extraction	5 EU companies in top 20 producers	**Extraction**	Expected increase
Refining	2 EU companies in top 20 refiners	**Refining**	Expected increase
Manufacturing	EU has 22% of semis production capacity	**Manufacturing**	Expected increase
Collection	Insufficient information, thought substantial	**Collection**	Expected increase
Recycling	9000 EU enterprises	**Recycling**	Expected increase

Table 4.7: Overview of Fluorspar Flows in the EU



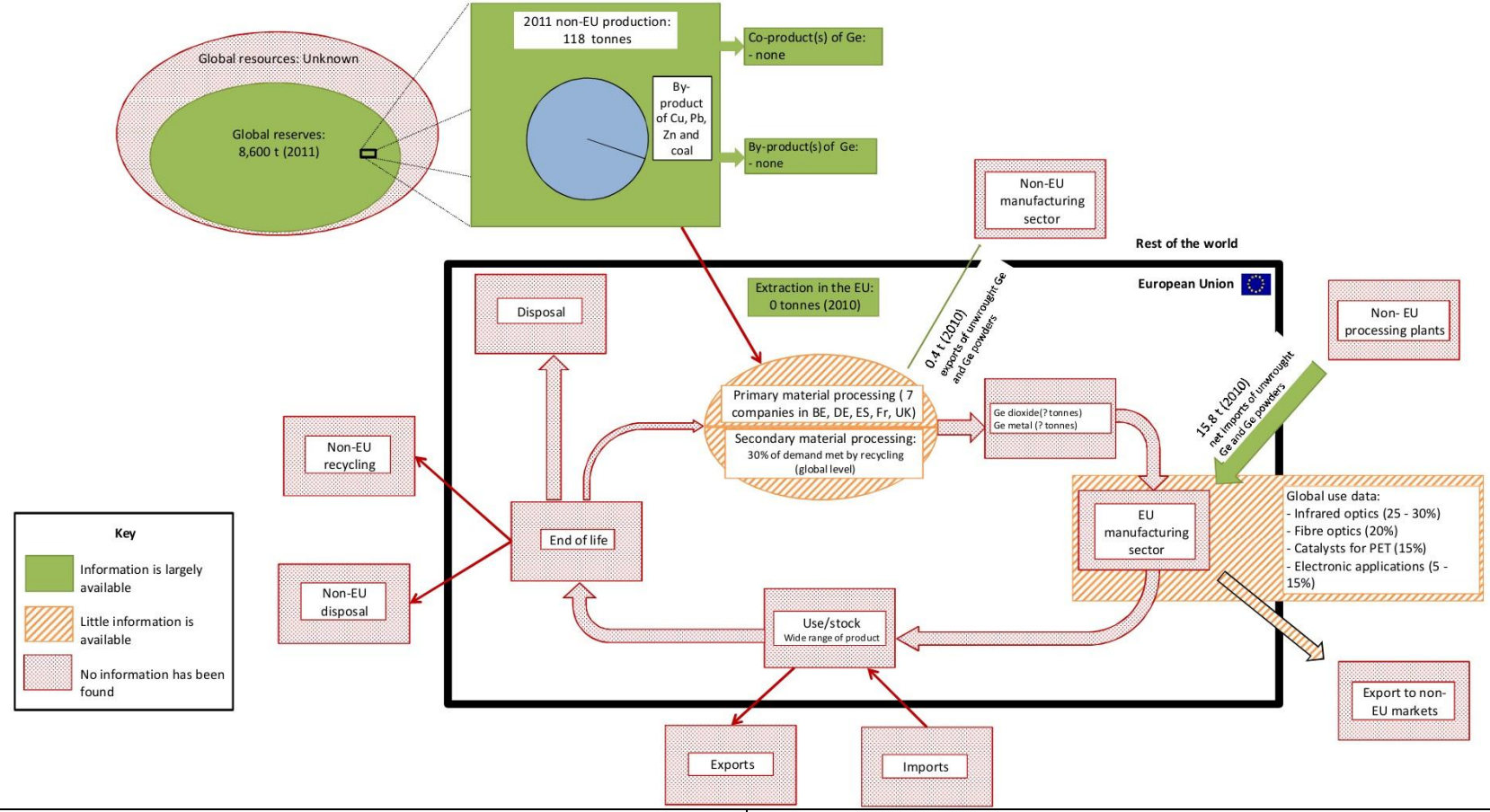
Structure of the relevant sectors		*Future trends*	
Exploration	5 EU headquartered firms exploring and extracting	**Exploration**	Insufficient information
Extraction	Insufficient information	**Extraction**	New projects planned in the EU
Refining	Insufficient information	**Refining**	Insufficient information
Manufacturing	9 HF producers	**Manufacturing**	Insufficient information
Collection	Not relevant	**Collection**	Not relevant
Recycling	Currently not practiced	**Recycling**	Insufficient information

Table 4.8: Overview of Gallium Flows in the EU



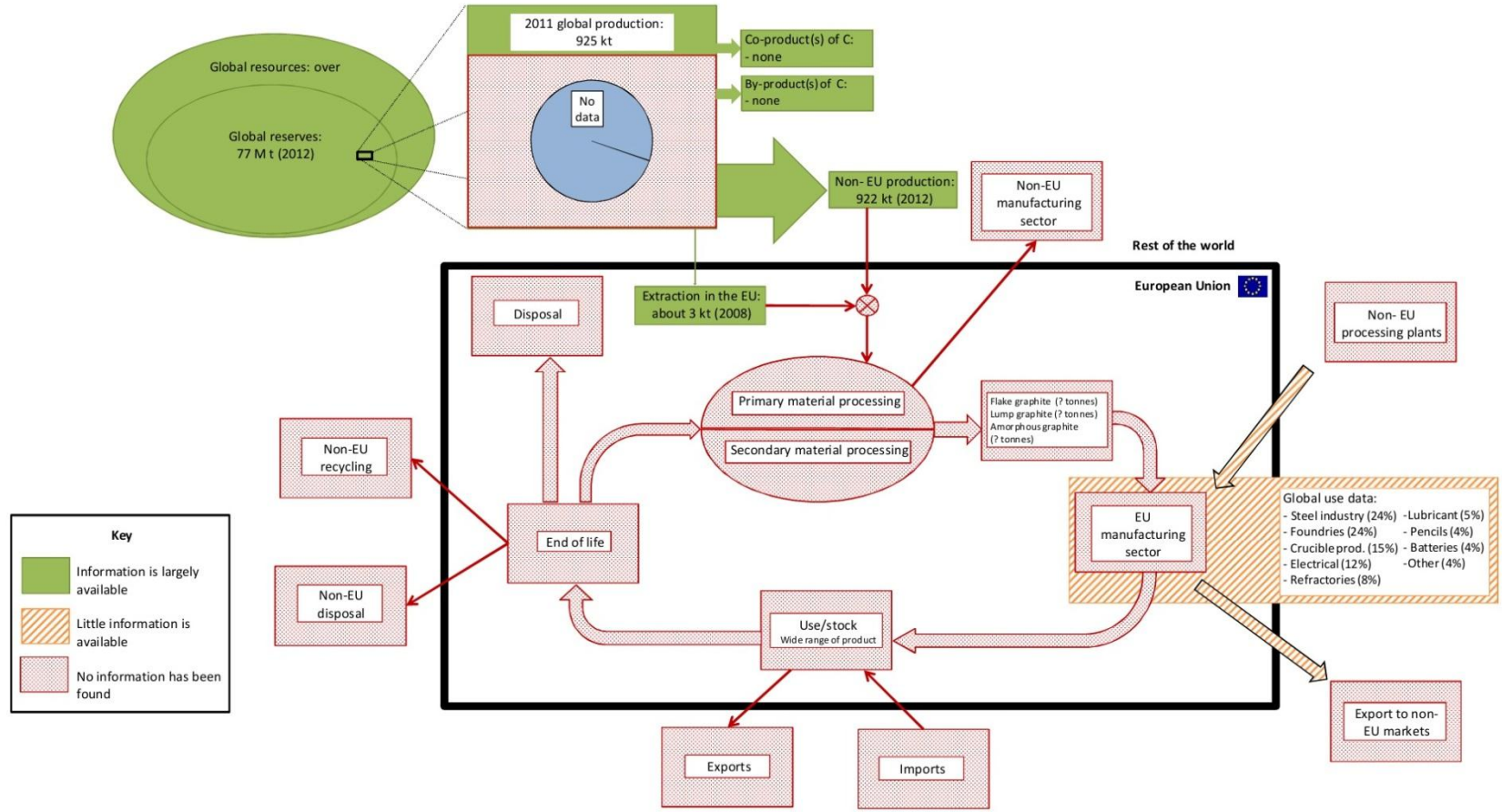
Structure of the relevant sectors		*Future trends*	
Exploration	3 EU firms involved in exploration and extraction (includes producers as by-product)	**Exploration**	Insufficient information
Extraction	7 firms in the EU	**Extraction**	Insufficient information
Refining	At least 7 globally, at least 4 in the EU	**Refining**	Insufficient information
Manufacturing	Insufficient information but potentially large	**Manufacturing**	Sharp increase from solar cells, IC, WLED expected
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	At least 5 globally, at least 3 in the EU	**Recycling**	Insufficient information

Table 4.9: Overview of Germanium Flows in the EU



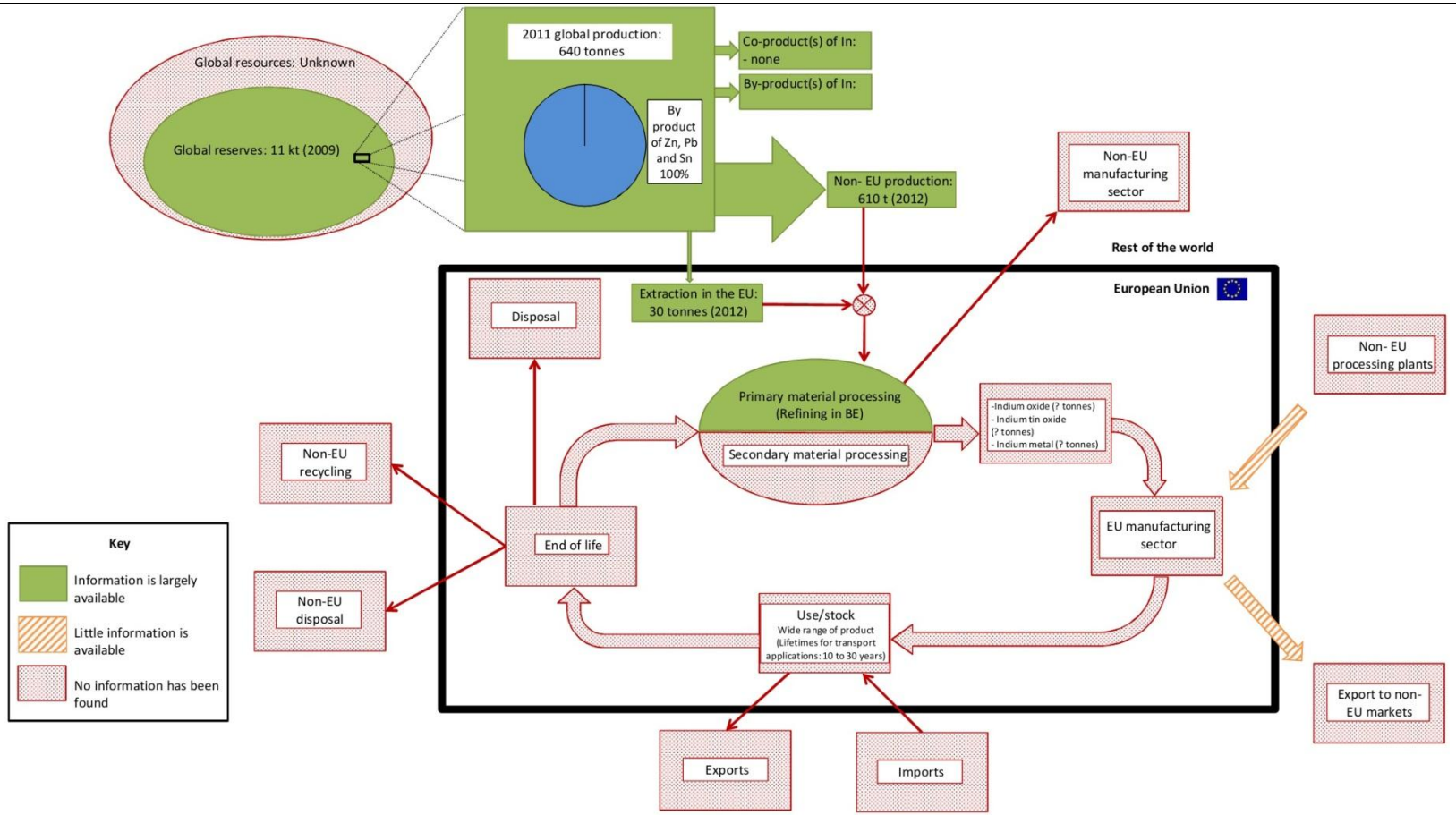
Structure of the relevant sectors		*Future trends*	
Exploration	Insufficient information	**Exploration**	Exploration linked to global germanium prices and zinc market
Extraction	Mainly conducted in China where there are six main companies	**Extraction**	Insufficient information
Refining	Estimated 7 companies in the EU	**Refining**	Insufficient information
Manufacturing	Insufficient information	**Manufacturing**	Increased demand for optical fibres
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Insufficient information	**Recycling**	Insufficient information

Table 4.10: Overview of Graphite Flows in the EU



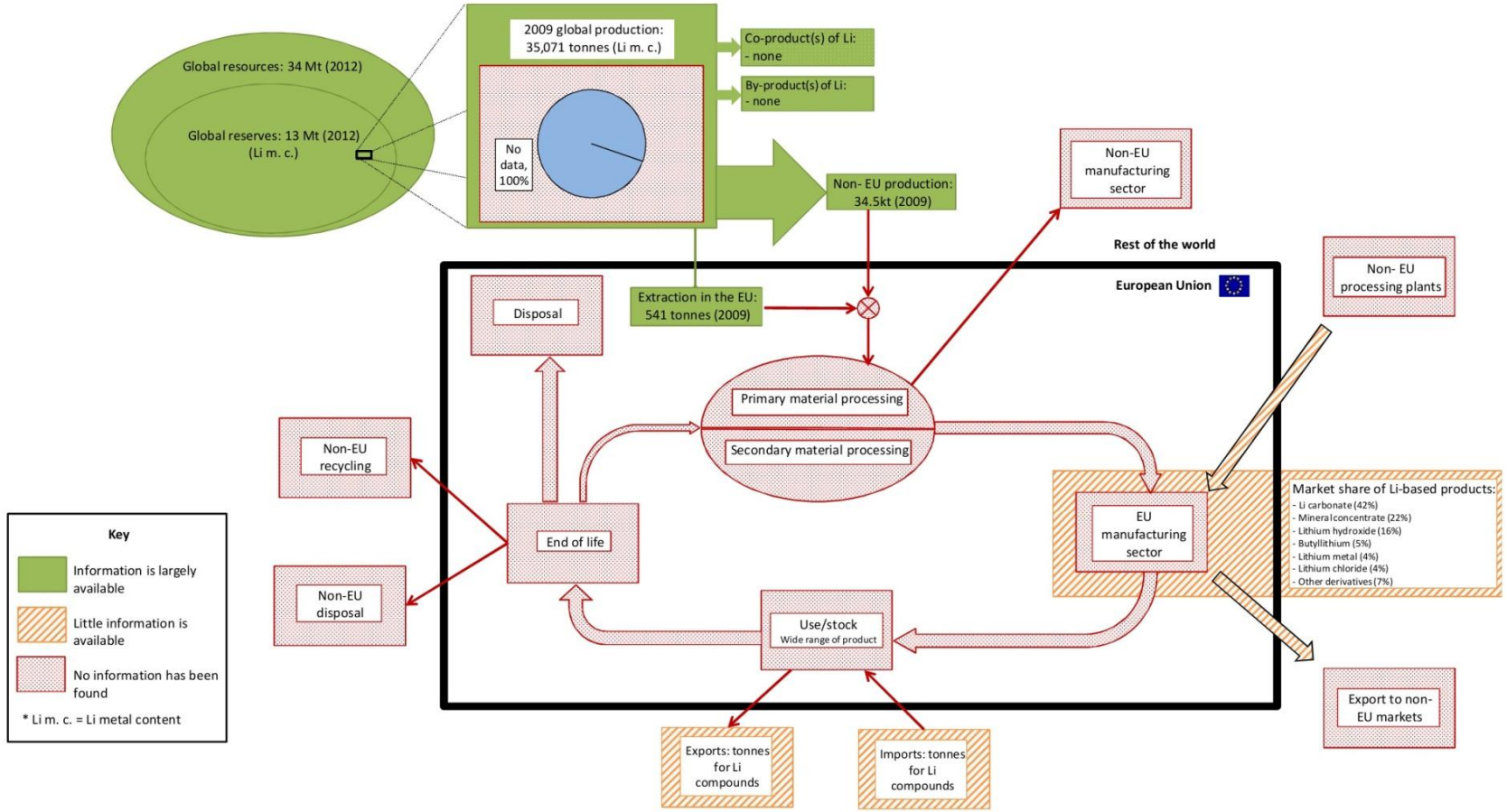
Structure of the relevant sectors		*Future trends*	
Exploration	2 EU firms involved in exploration and extraction (includes producers as by-product)	**Exploration**	Insufficient information
Extraction	Insufficient information	**Extraction**	Insufficient information
Refining	Insufficient information	**Refining**	Insufficient information
Manufacturing	Insufficient information	**Manufacturing**	3% p.a. increase
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Insufficient information	**Recycling**	Recycling will be required in the future

Table 4.11: Overview of Indium Flows in the EU



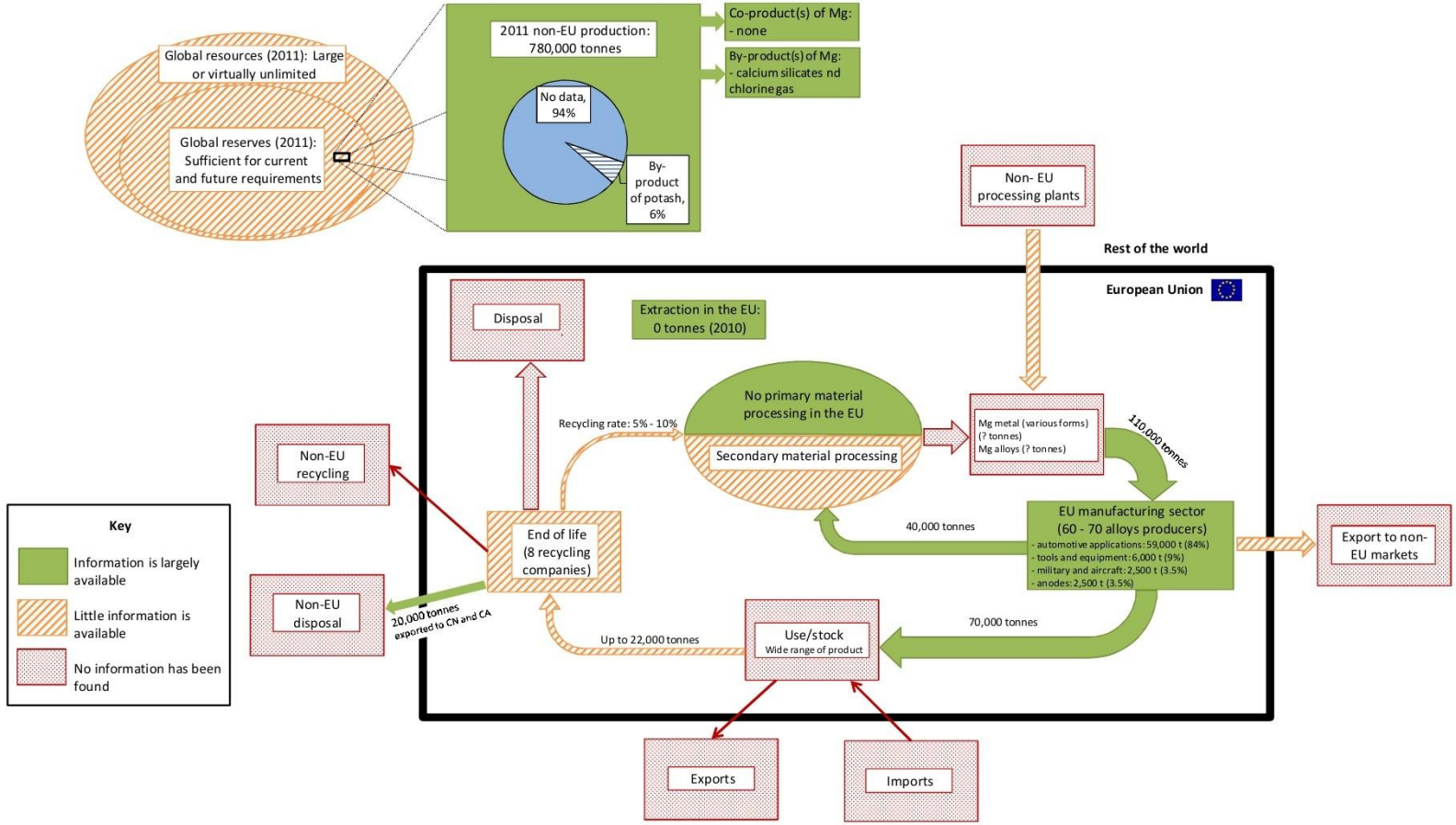
Structure of the relevant sectors		*Future trends*	
Exploration	Limited number	**Exploration**	Limited to Belgium
Extraction	Insufficient information	**Extraction**	Insufficient information
Refining	574 tonnes globally	**Refining**	Insufficient information
Manufacturing	Insufficient information	**Manufacturing**	Insufficient information
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Information for some sub-sectors	**Recycling**	Information for some sub-sectors

Table 4.12: Overview of Lithium Flows in the EU



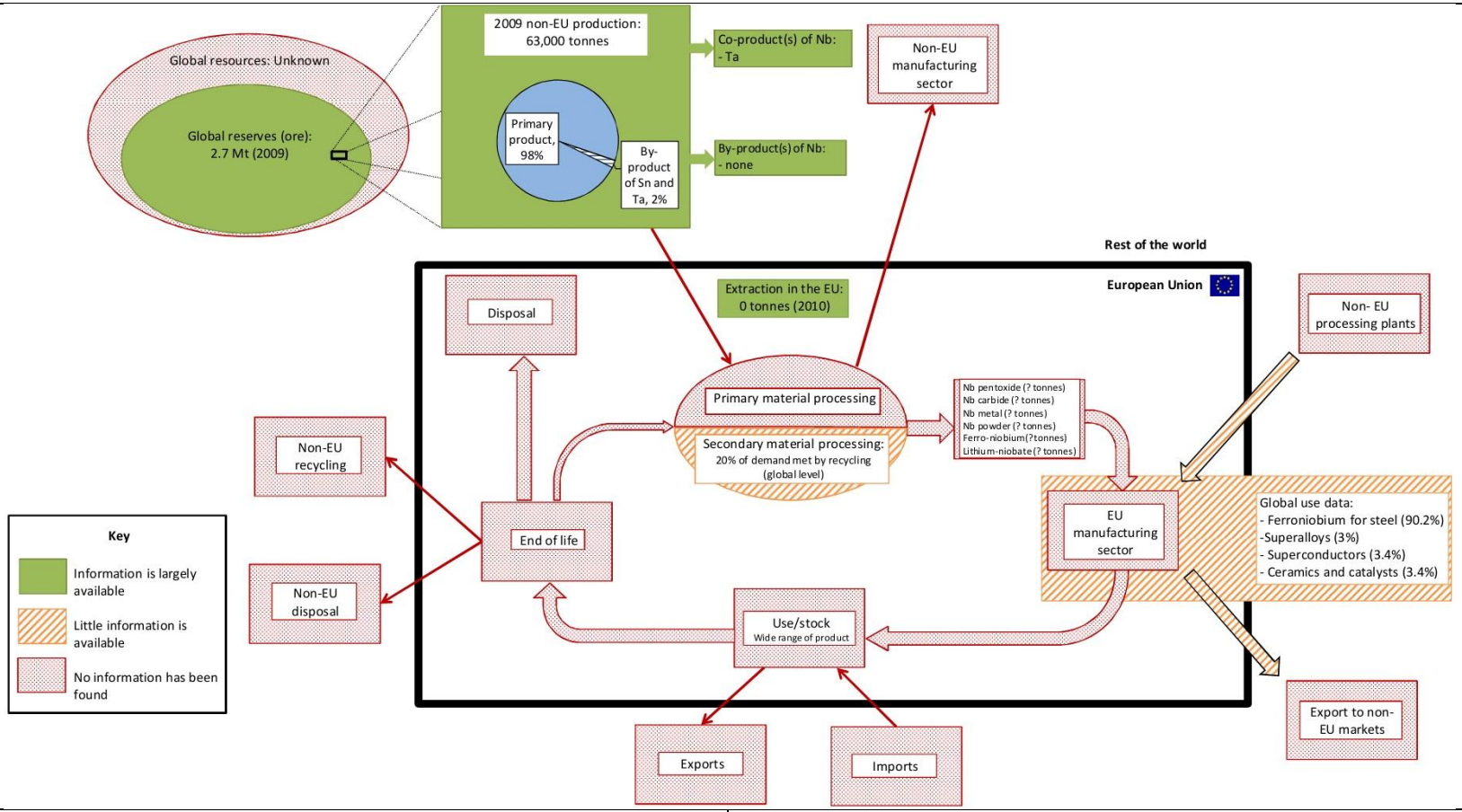
Structure of the relevant sectors		*Future trends*	
Exploration	The 7 main producers make up 78% of the market	**Exploration**	Exploration activities going on globally
Extraction		**Extraction**	Developing new extraction process of lithium from sea water
Refining	No EU data	**Refining**	Increasing capacity in Argentina and Australia
Manufacturing	Insufficient information but potentially very large	**Manufacturing**	Growing market for batteries
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Insufficient information	**Recycling**	New facilities planned

Table 4.13: Overview of Magnesium Flows in the EU



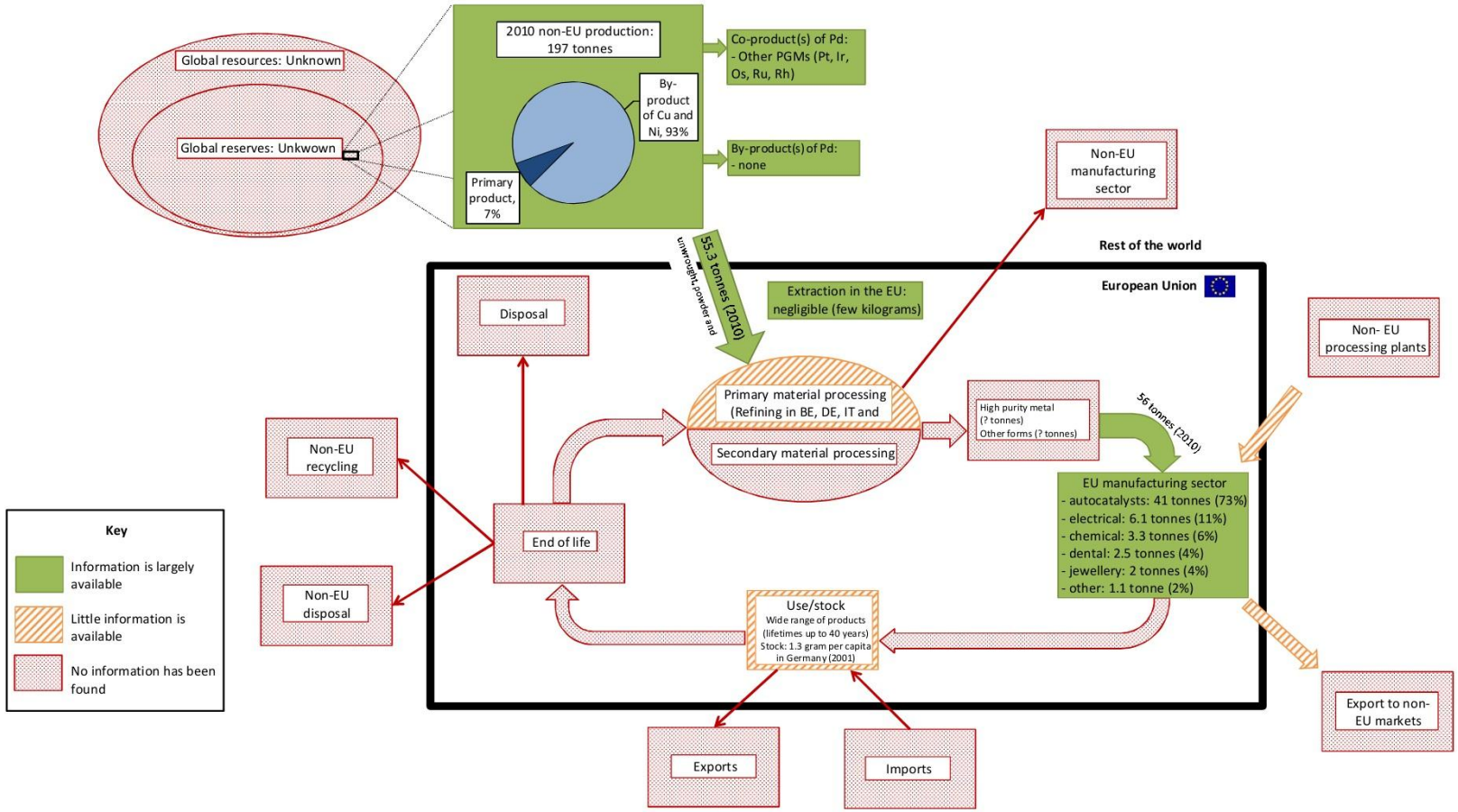
Structure of the relevant sectors		*Future trends*	
Exploration	7 EU companies involved in exploration or extraction	**Exploration**	Insufficient information
Extraction	Around 40 globally, most in CN, unclear whether 0 or several in the EU	**Extraction**	1 new project in the pipeline in the EU
Refining	Insufficient information	**Refining**	Insufficient information
Manufacturing	60-70 Mg alloy producers in the EU	**Manufacturing**	Small growth in Mg demand (large interest but concern over supply)
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	8 recyclers in the EU	**Recycling**	Insufficient information

Table 4.14: Overview of Niobium Flows in the EU



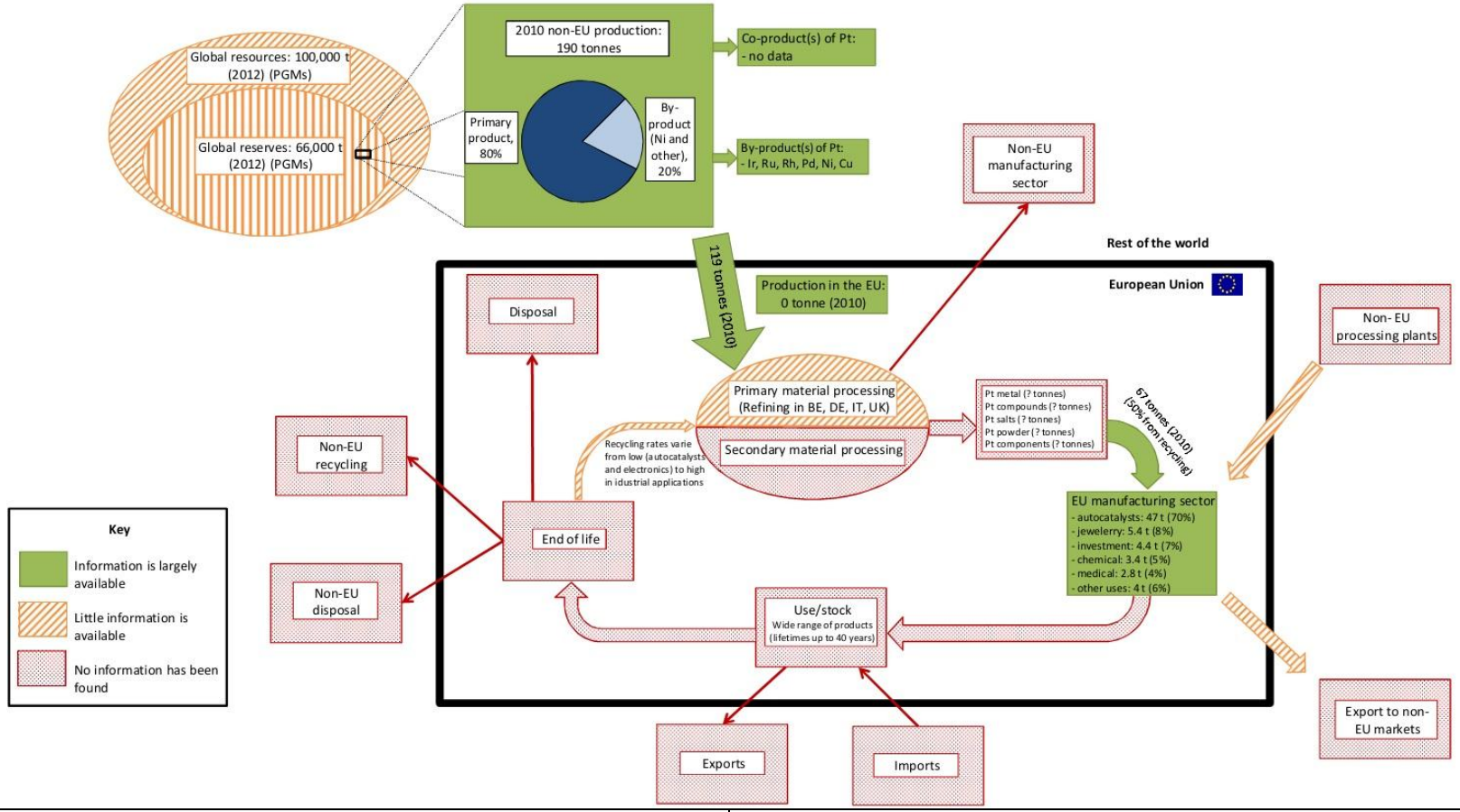
	Structure of the relevant sectors		*Future trends*
Exploration	3 EU firms involved in exploration and extraction	**Exploration**	Insufficient information
Extraction	At least 3 producers globally	**Extraction**	Insufficient information
Refining	Possibly up to 27 refiners in the EU	**Refining**	Insufficient information
Manufacturing	Insufficient information but potentially very large	**Manufacturing**	Moderate increase from micro capacitors and ferroalloys
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Insufficient information	**Recycling**	Insufficient information

Table 4.15: Overview of Palladium Flows in the EU



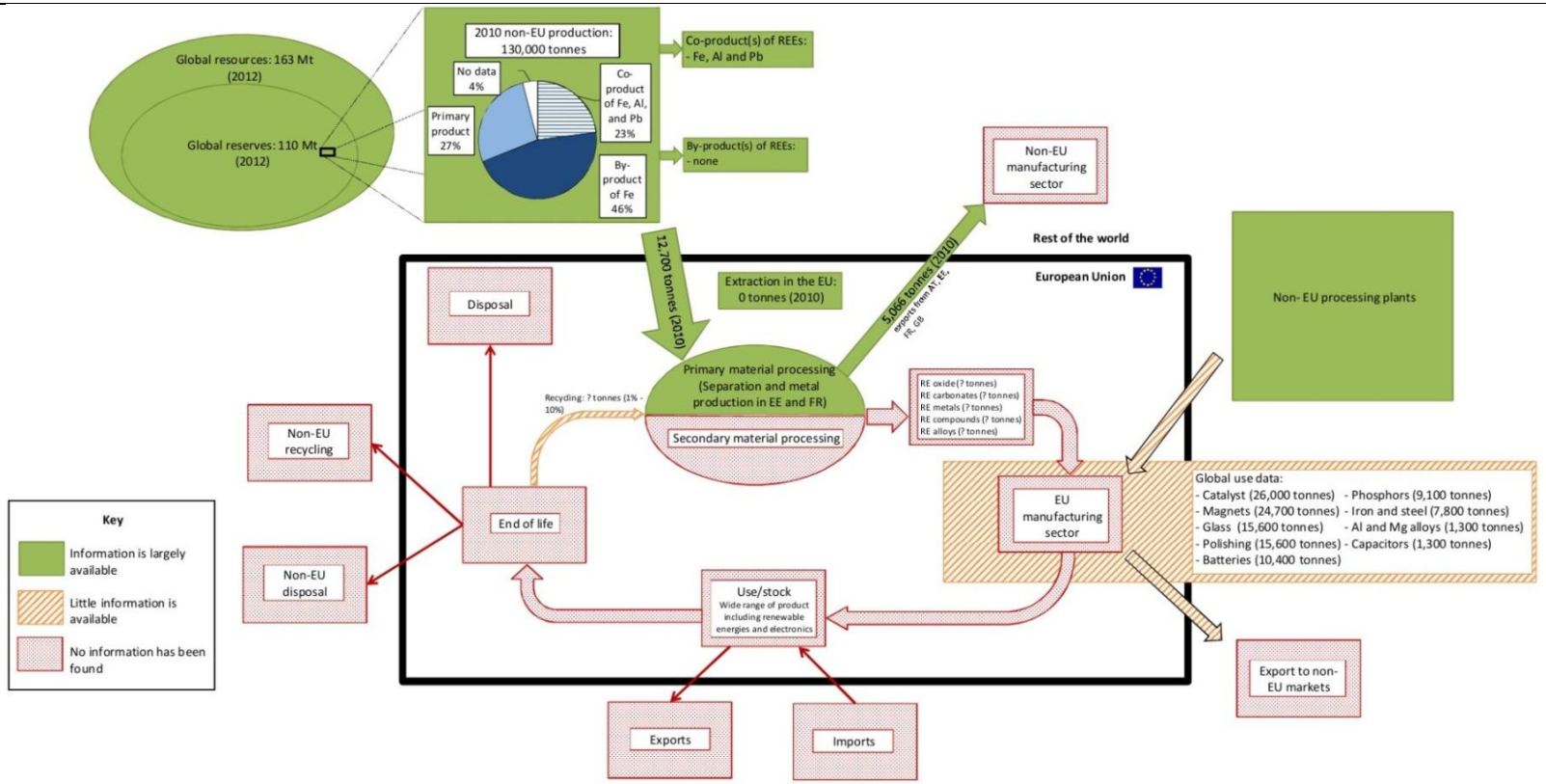
Structure of the relevant sectors		*Future trends*	
Exploration	10 EU headquartered firms exploring and extracting PGMs	**Exploration**	Insufficient information
Extraction	0 in the EU, at least 15 globally	**Extraction**	Dependent on many factors but new projects in preparation
Refining	More than 5 in the EU	**Refining**	Insufficient information
Manufacturing	Very large number	**Manufacturing**	Differs by use sector, see Annex
Collection	Insufficient information (potentially large in ELV collection)	**Collection**	Insufficient information
Recycling	For Germany, in Annex	**Recycling**	Only known for specific sub-sectors

Table 4.16: Overview of Platinum Flows in the EU



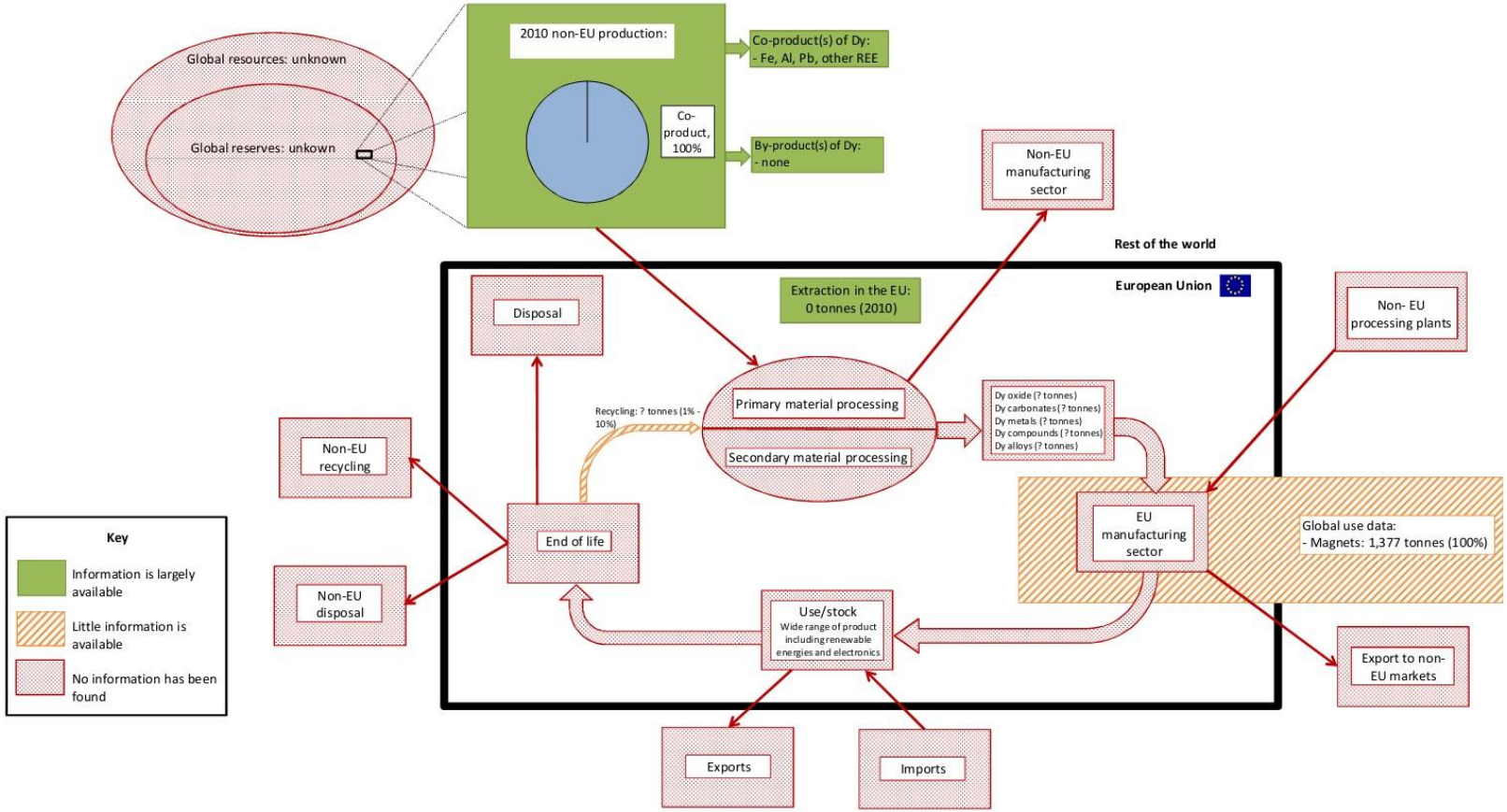
Structure of the relevant sectors		*Future trends*	
Exploration	10 EU headquartered firms exploring and extracting PGMs	**Exploration**	Insufficient information
Extraction	At least 20 globally	**Extraction**	Dependent on many factors but new projects in preparation
Refining	More than 5 in the EU	**Refining**	Insufficient information
Manufacturing	Very large number	**Manufacturing**	Insufficient information (potentially large in ELV collection)
Collection	Insufficient information (potentially large in ELV collection)	**Collection**	Insufficient information
Recycling	For Germany, in Annex	**Recycling**	Only known for some sub-sectors

Table 4.17: Overview of REE Flows in the EU



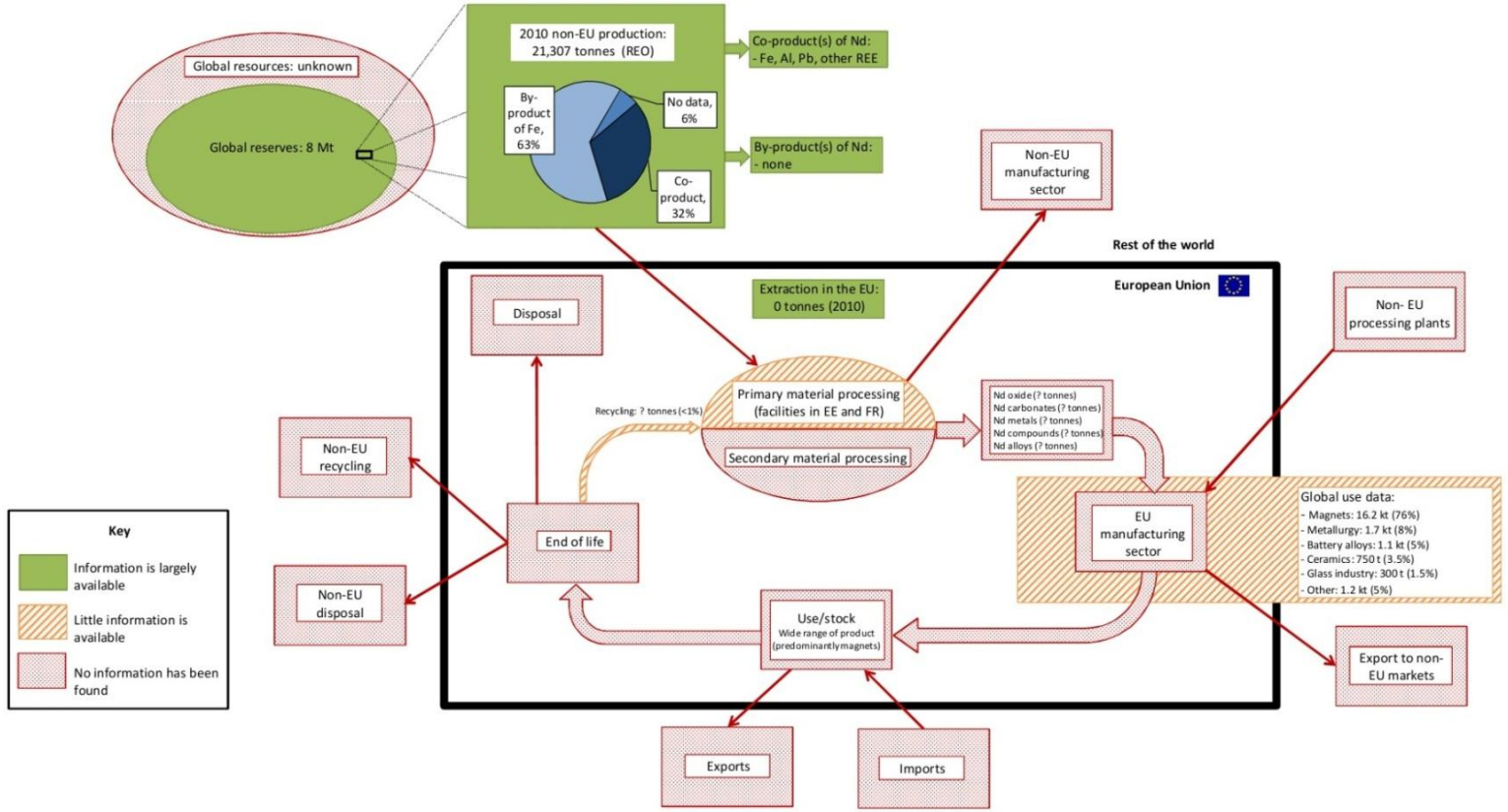
Structure of the relevant sectors		*Future trends*	
Exploration	Estimated 300 globally, 4 headquartered in the EU	**Exploration**	Continued intense activity
Extraction	4 headquartered in the EU, unknown globally	**Extraction**	Increased demand, supply from new reserves
Refining	Possibly 2 in the EU; 100 in China separating, smelting and refining, unknown globally	**Refining**	Insufficient information
Manufacturing	Insufficient information; few companies in EU	**Manufacturing**	Increased demand for all applications
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Insufficient information	**Recycling**	Increased emphasis on development of recycling programmes and recycling research

Table 4.18: Overview of Dysprosium Flows in the EU



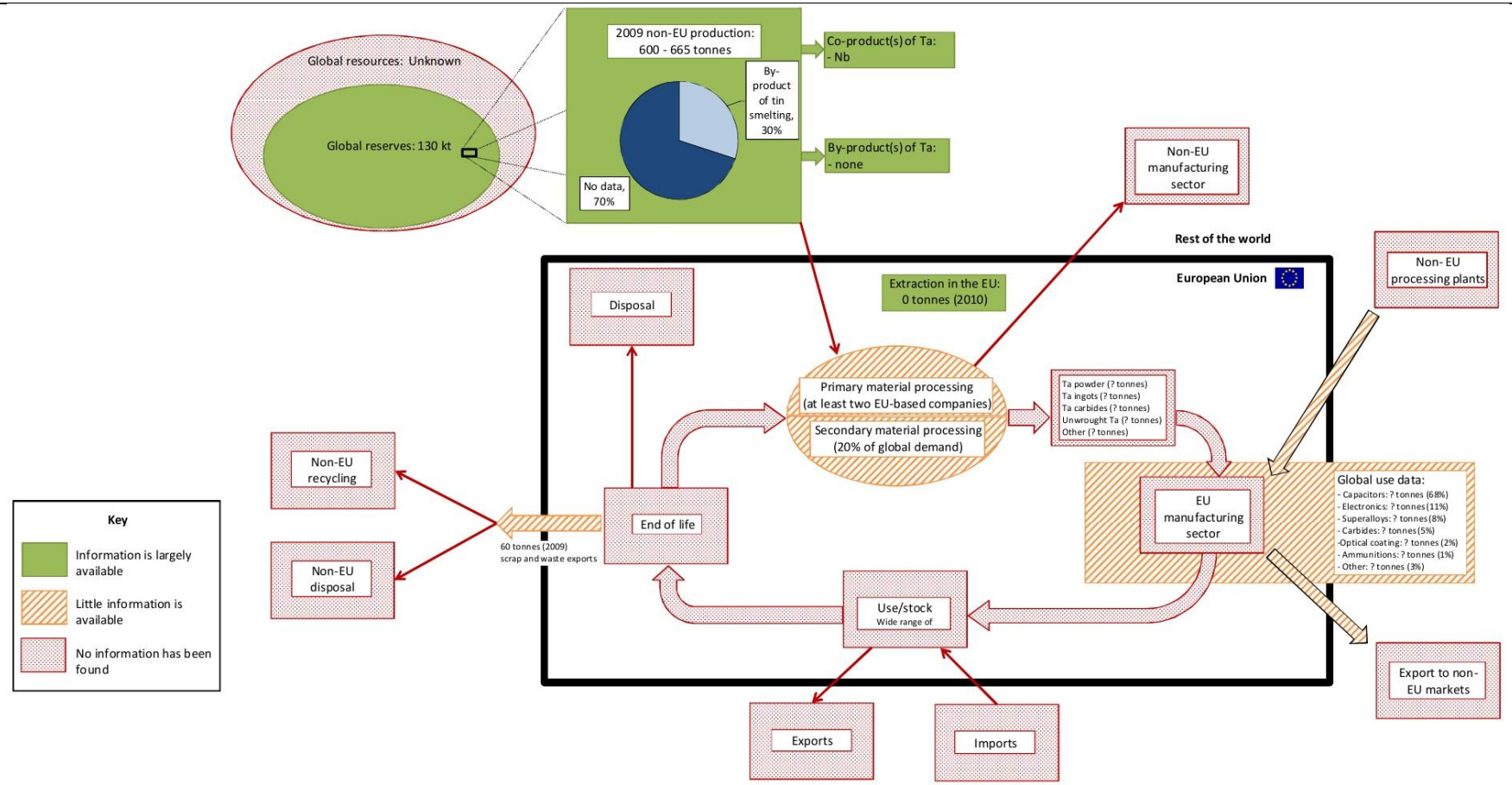
Structure of the relevant sectors		*Future trends*	
Exploration	Insufficient information for Dy; estimated 300 globally for REEs collectively, 4 headquartered in EU	**Exploration**	Insufficient information
Extraction	Insufficient information for Dy; large number for REEs collectively, 4 headquartered in EU	**Extraction**	Increased demand, supply from new reserves
Refining	Insufficient information for Dy; REEs collectively: possibly 2 in EU; 100 in China	**Refining**	Insufficient information
Manufacturing	Insufficient information for Dy, few companies in EU for REEs collectively	**Manufacturing**	Increased demand of Dy
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Insufficient information	**Recycling**	Increased emphasis on development of recycling programmes and recycling research

Table 4.19: Overview of Neodymium Flows in the EU



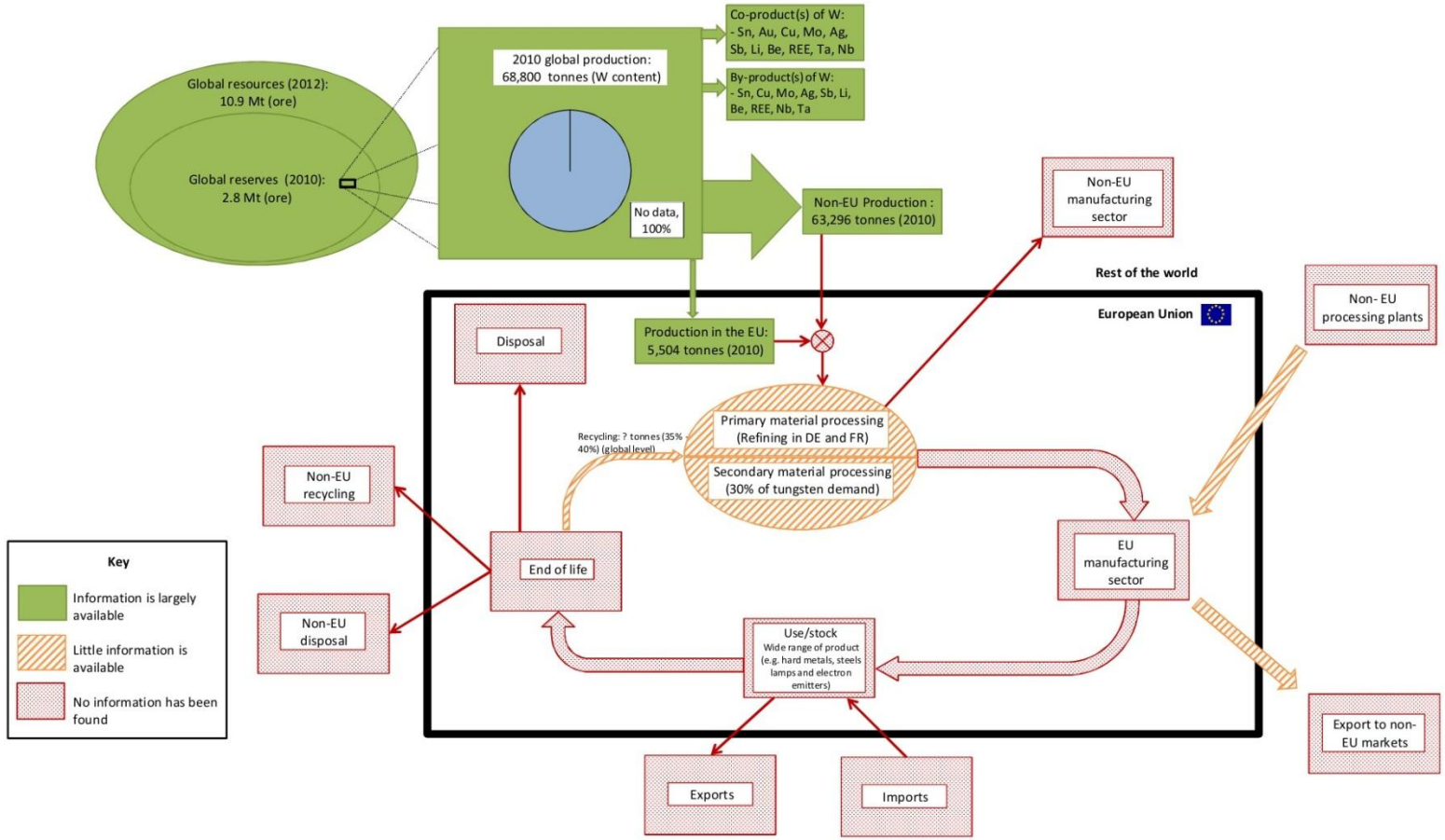
Structure of the relevant sectors		*Future trends*	
Exploration	Insufficient information for Nd; estimated 300 globally for REEs collectively, 4 headquartered in EU	**Exploration**	Insufficient information
Extraction	Insufficient information for Nd; large number for REEs collectively, 4 headquartered in EU	**Extraction**	Increased demand, supply from new reserves
Refining	Insufficient information for Nd; REEs: possibly 2 in EU; 100 in China separating, smelting and refining	**Refining**	Insufficient information
Manufacturing	Insufficient information for Nd, few companies in EU for REEs collectively	**Manufacturing**	Increased demand of Nd
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Insufficient information	**Recycling**	Increased emphasis on development of recycling programmes and further research

Table 4.20: Overview of Tantalum Flows in the EU



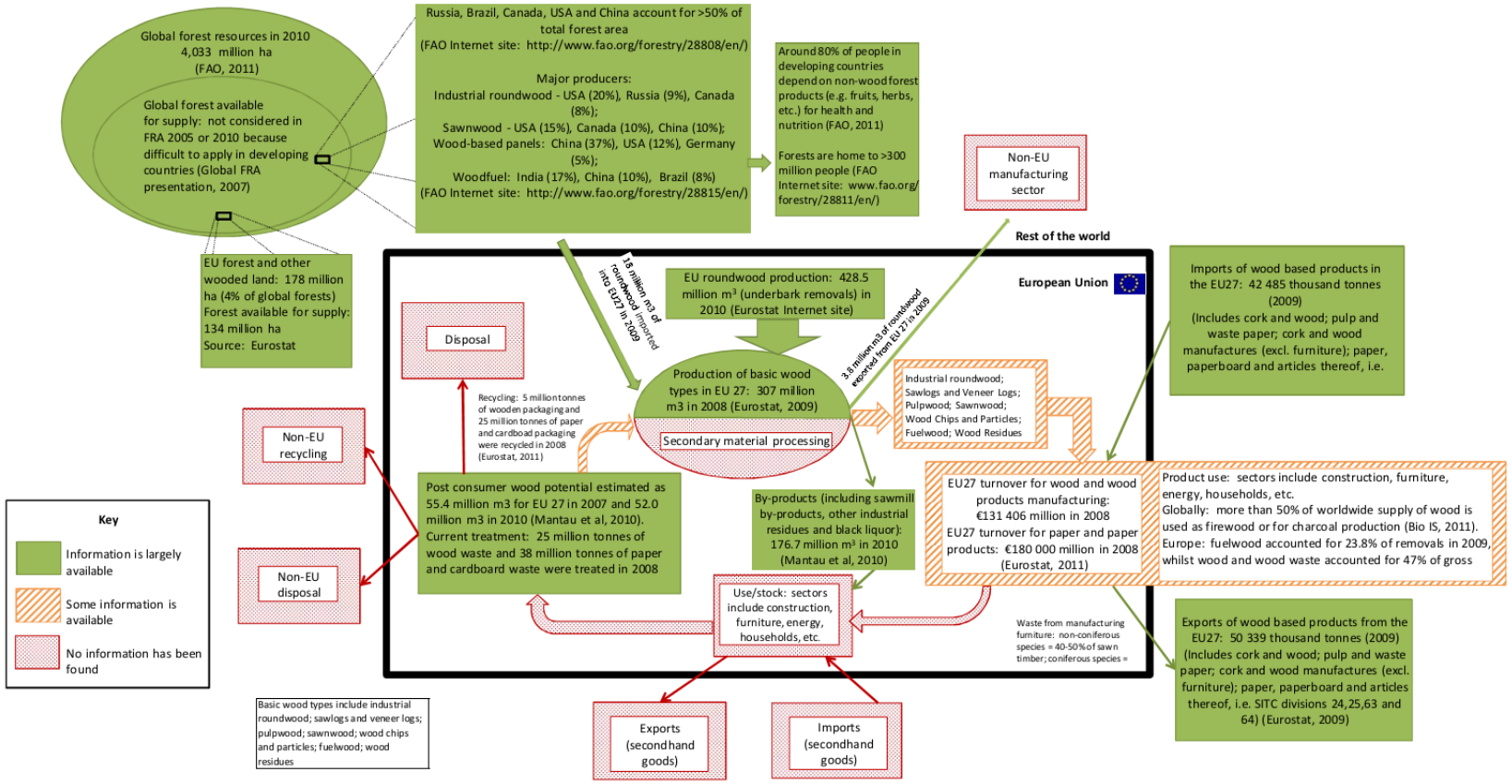
Structure of the relevant sectors		*Future trends*	
Exploration	4 EU firms involved in exploration and extraction	**Exploration**	Insufficient information
Extraction	At least 8 producers globally	**Extraction**	Possibility of new mines coming on stream between 2011 and 2013
Refining	Min. 9 globally & 2 in the EU, potentially around 30 in the EU	**Refining**	Insufficient information
Manufacturing	Insufficient information but potentially very large	**Manufacturing**	Increase from micro capacitors and medical technology expected
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Insufficient information	**Recycling**	Insufficient information

Table 4.21: Overview of Tungsten Flows in the EU



Structure of the relevant sectors		*Future trends*	
Exploration	Limited number	**Exploration**	New mines opening in Spain and the UK
Extraction	8% in the EU, China: 85%	**Extraction**	Underground, max 2.000 ores per day
Refining	FR, DE, China and the USA	**Refining**	Increase in processing outside the EU
Manufacturing	Insufficient information	**Manufacturing**	Insufficient information
Collection	Insufficient information	**Collection**	Insufficient information
Recycling	Only known for specific sub-sectors	**Recycling**	Only known for specific sub-sectors

Table 4.22: Overview of Wood Flows in the EU



Structure of the relevant sectors		*Future trends*	
Supply	Forests available for supply range from small private to large state owned plantations	**Supply**	If recent trends continue, forest area available may increase
Harvesting	Total annual working units: 204 125 in 2009	**Harvesting**	Decrease in wood removals and hence employment expected
Processing	350 000 forest based enterprises in EU in 2005	**Processing**	Increased competition likely due to renewable energy sector
Manufacturing	3 928 thousand employed in 2008	**Manufacturing**	Unsure – much variation between products
Collection	No specific information identified	**Collection**	None identified
Recycling	Number of specialist firms may be increasing	**Recycling**	May increase

5. RECOMMENDATIONS FOR A FUTURE DATA ACQUISITION STRATEGY

5.1 Overview

This study aimed to collect information on all lifecycle stages (potentially covering over 60 different aspects) for 21 materials. It then looked in more detail at data availability and quality for the ten materials presented; the outcome of this exercise is presented in Annex A. Recommendations for a future data acquisition strategy, presented in this Chapter, have been based on the analysis in Annex A and in some instances have also drawn on the information collected for other materials and presented in Annex D.

Information presented in this report and in its annexes was collected from a wide range of sources including publicly accessible databases and reports as well as information requests submitted to Eurostat, a wide range of public authorities in each EU Member State, industry associations and companies. In addition, a review of commercially available market reports was conducted to identify the types of information potentially available from these sources. The approach to data collection was therefore broad and resource intensive.

Although this report presents the data and information collected, given the time and budgetary constraints associated with the study, the information presented here is not exhaustive. It is therefore highly likely that more information could be identified with additional research effort[10]. By way of example, this study provides an overview of by-products and co-products of the 21 materials. However, by-products and co-products may differ from mine to mine and published sources summarising this information have not been identified. As a consequence, it is likely that the overview of by-products given in this report is not all-encompassing and further research effort could identify additional by-products.

For this reason, the assessment of data availability and quality in Annex A focuses on those issues that have been judged as particularly significant by the core study team and/or highlighted by the three experts that assisted the core study team. Consequently, the purpose of our recommendations cannot be to comprehensively address all identified data gaps for the 60 or so different aspects across the eight lifecycle stages; rather it has focussed on the best ways to address a selection of fundamental and often cross-cutting issues.

Recommendations on cross-cutting issues relating to all/several lifecycle stages are presented first, followed by recommendations on issues relating to specific lifecycle stages.

[10] Time and budget constraints meant that it was only possible to allocate a few days of desk research per material which limits the robustness of the analysis.

Several options for a data acquisition strategy are presented below for a number of the main data gaps. We then suggest one of these based on the study team's assessment of the feasibility of their implementation.

5.2 Recommendations relating to Several Lifecycle Stages

5.2.1 Reliance on One-off and/or Non-EU Sources

Problem Definition

Much of the available information on the 21 materials can be found in one-off sources (i.e. studies that are not regularly updated) and in sources which have not been published in the EU and/or which do not provide data at the level of the EU27. This includes, for example, reports published by industry associations and international organisations (e.g. the United Nations Economic Programme, hereinafter referred to by the acronym UNEP) or by geological surveys in non-EU countries (e.g. the Unites States Geological Survey, hereinafter USGS).

Reliance on one-off and/or non-EU/non-EU-level sources is a general characteristic of the identified data for almost all materials and lifecycle stages. However, not all materials and lifecycle stages are affected to the same degree, with for example lifecycle stages other than extraction having less geographically suitable and regularly updated information. In addition, a comparatively larger amount of periodically updated data at the European level appears to be available for wood and construction aggregates than for many of the metals.

More specific examples of this issue include:

- as regards the extraction stage, the most comprehensive 'one-stop' source of data on reserves and resources is the USGS, with no corresponding European source providing a similar service;
- as regards the processing stage, data on processing output (which are generally very sparse) tend not to be regularly updated and EU-specific;
- as regards the end-product manufacturing stage, much of data on applications in which these materials are used are only available from one-off reports, which often have a global perspective, rather than dealing with the EU specifically. In addition, data on substitutes are often available from non-EU sources such as the USGS;
- as regards the product use stage, data on stocks of raw materials in society are often only available for non-EU countries and one specific year; and
- as regards the recycling stage, data on the various recycling metrics are often available as global or developed country estimates and are not EU-specific. In addition, these data tend to be available for specific reference years only.

The implications of the above-described problem include:

- reliance on one-off sources (which often focus on specific narrow issues) means that there are large disparities in information availability between materials and lifecycle stages;

- reliance on one-off sources means that temporal comparisons and identification of trends is often not possible and as such it is often not possible to carry out a material flow analysis for the same reference year;

- reliance on one-off sources means that future updates of available data are uncertain;

- reliance on non-EU sources means that data are often not available for the EU27 specifically and extrapolation from MS-level data or adaptation of data for countries outside the EU is often not possible on the basis of readily available information (in particular considering that differences in regulatory and economic environments between countries may mean that some of the information given at the global level or at the level of non-EU countries may not be applicable to the EU); and

- reliance on non-EU sources means that where data are collected by foreign agencies, such as non-EU geological surveys, it is outside the EU's control whether such data will continue to be collected in the future.

Possible Solutions to Address this Problem

Generally, the following strategies might theoretically be considered with regard to addressing this problem (their relevance is further described below):

- purchasing data from proprietary sources to address specific data gaps and utilising in-house resources at the European Commission to collate these data; or

- mandating Member States to report a wide range of specified indicators to the European Commission or other appropriate EU body; or

- setting up structures to carry out or fund EU-specific research in a systematic manner.

These theoretical data acquisition strategies are considered further below.

While some EU tailored information could probably be provided by commercially available reports, as many claim that their analyses use data specific to single countries, it cannot be determined with any degree of certainty which data are actually provided in these reports using only the advertising materials published by these companies (such as Tables of Contents or Lists of Tables and Figures for each report). Each provider would therefore have to be approached with a detailed query as to

which specific data they could provide prior to purchasing any reports. Only at that point would it be possible to determine how cost-effective this option would be. Data from individual reports would have to be collated by the European Commission. In addition, while some of these reports are periodically updated, there is no guarantee that further editions will be published in the future. In conclusion, while using commercial data sources might be effective in terms of addressing specific narrow data gaps, it is not seen as an effective tool for addressing cross-cutting issues, such as the one in hand. Furthermore, publishers may restrict how the information contained in these reports can be used, e.g. internal use within the Commission services only.

Mandating Member States to collect additional information would require comparatively more significant resources than purchasing data from commercial sources and would require legislative changes as well as the involvement of Eurostat to collate the data provided. This option is therefore not seen as feasible.

The option of setting up structures to carry out or fund EU-specific research in a systematic manner is seen as the most feasible one. In this respect, it is of interest that the EU appears to have a large pool of expertise on raw materials within existing public institutions as well as industry associations that, if co-ordinated, may potentially address some of the data gaps and provide a regular and systematic analysis of raw material flows. This may be achieved either by means of regular funding provided to one or several existing institutions to co-ordinate such efforts, or through the establishment of a dedicated legal entity which would perform these functions on a regular basis.

In this respect, it is of interest that the Seventh Framework Programme (FP7) 2013 Work Programme Cooperation (Theme 4)[11] indicates that funding may become available for coordinating a collaborative EU network to improve the availability of data on raw materials. The objective of the European Intelligence Network on the Supply of Raw Materials would be to create a network to facilitate access for the EU to the raw materials information sources and to promote collaboration among experts. More specifically, this action would aim to:

- *"create a sustainable network gathering a critical mass of institutions with the relevant authority and competencies at world, EU and national levels, resulting in the creation of a permanent body before the end of the project;*

- *create a harmonised and standardised EU knowledge base interoperable with national databases including information on primary and secondary resour ces on land and in marine environment down to 4 km depth, and estimations of the resource availability including urban mines (landfills and mining waste), and*

[11] Theme 4 under the Cooperation Work Programme deals with 'Nanosciences, Nanotechnologies, Materials and New Production Technologies (NMP)' and is available here: http://ec.europa.eu/research/participants/portal/ShowDoc/Extensions+Repository/General+Documentation/All+work+programmes/2013/Cooperation/d-wp-201301_en.pdf

contribute to the establishment of the 'European Raw Materi als Yearbook' in close coordination with Eurostat;

- *produce a foresight study on raw materials supply and demand in the EU, together with competent financial institutions, with special attention given to critical minerals. A strategy for annual updates of this foresight study on raw materials should be included as well; and*

- *develop a multi-stakeholders' Internet portal providing information on the raw materials resources and deposits within European Union."*

The relevant call was published in July 2012.[12]

As a context to this recommendation, and by way of comparison to analogous information collection activities undertaken outside the EU, Box 5.1 provides an overview of the activities of USGS.

Box 5.1: Overview of USGS Activities

USGS collects data from a wide variety of sources, both domestically in the United States as well as internationally. To this end, a large number of information requests are sent out each year. In order to cover the entire mineral economic cycle in the United States from exploration to recycling, approximately 150 monthly, quarterly, semi-annual, and annual surveys are sent out domestically (including some to Canada) to companies, mines, plants, and other operations. Where no response is obtained, estimation techniques are used to account for missing data; these may be based on knowledge of prior establishment reporting or may rely on external information to estimate the missing data (USGS, 2012b).

International data are collected and gathered from a wide range of sources including published reports of foreign agencies and international organisations. Each year, questionnaires enquiring about minerals production are sent to foreign organisations (USGS, 2012b). Questionnaires to foreign respondents are sent in a variety of languages (English, French, Spanish, Arabic) and these are sent to geological surveys and statistical offices as well as to other organisations such as ministries and central banks. Response rate is 30-50% which is lower than for domestic data collection and responses require adjustments to make the reported data across all countries. The reliability of data (domestic and international) is reflected in the significant figures use in the presentation of the results (USGS, 2012a). Where no data are received, estimates are made by USGS specialists on the basis of historical trends and other information (USGS, 2012b). Other sources include site visits to mining operations and counterpart agencies as well as cooperation with the US Department of State. For China, all figures are estimates from publications and attendance at conferences (USGS, 2012a).

While the USGS (2012a) indicated that it is unlikely that data collected by them would cease to be released into the public domain (as the USGS is financed from public funds, it is required to provide the information that it collects to the public), it was noted that future collection of data may also depend on political and budgetary decisions that are outside of USGS control. In this respect, it was pointed out that government agencies are not necessarily permanent institutions; for example, the US Bureau of Mines was a great source of information worldwide but it was suddenly closed down in 1995-1996. Its "Minerals Yearbook" functions were transferred to the USGS. The Bureau had been

[12] See http://ec.europa.eu/research/participants/portal/page/cooperation?callIdentifier=FP7-NMP-2013-CSA-7

Box 5.1: Overview of USGS Activities

established in 1910 and was responsible for Federal minerals information from 1925 through 1995.

Overall, it was noted that on average one full time equivalent employee is responsible for about 3 mineral commodities, with the ratio of commodities monitored per expert having increased over the last 17 years. There are presently 30 mineral commodity specialists monitoring 80-90 mineral commodities. In addition, there are 15 country specialists with a wide range of language capabilities monitoring 180 countries (USGS, 2012a).

USGS obtains information from Eurostat, the UK (BGS), and many other individual Member States. USGS also exchanges data through their participation in the International Consultative Group on Non-Ferrous Metals Statistics, alongside geological surveys in the France, Germany, Poland, and the UK (USGS, 2012a).

As can be seen from Box 5.1, in the United States, this function is carried out by the USGS. It is of interest that a body for co-ordination between European geological surveys already exists (EuroGeoSurveys) but this does not currently fulfil this function. However, it is important to note that this function may also be performed by another organisation and that it might be advantageous to set up a structure that involves a variety of stakeholders including representatives of industry organisations, national statistical agencies, intergovernmental organisations and major companies, thus resembling the membership of the International Consultative Group on Non-Ferrous Metals Statistics.

It is also recommended that any action undertaken as a result of this recommendation is coordinated with existing initiatives and stakeholders involved in relevant research. By means of example, the Joint Research Centre (JRC) is currently involved in research on raw materials used in strategic energy technologies, including research on supply and demand.[13] Any action undertaken as a result of this recommendation should be coordinated with these efforts.

Summary and Recommended Data Collection Strategy

- **Problem:** There is a lack of periodically updated data that are published by EU sources and that are specific to the EU.

- **Recommendation:** Further explore the feasibility of establishing structures to carry out or fund EU-specific data collation in a systematic manner. This may possibly involve funding the coordination of existing institutions. This would chiefly require the involvement of the European Commission in setting up a new body or mandating/funding an existing institution to carry out this task. This body or institution would then be required to undertake this work.

- **Objective:** Make use of available but uncoordinated and dissipated expertise within Europe leading to a situation where a European source publishes periodically updated EU-level data.

[13] See http://setis.ec.europa.eu

5.2.2 Lack of Standardised Data

Problem Definition

As noted in the annexes to this report, the use of the relevant terms as well as the methods of data collection vary across countries and institutions, which presents a significant challenge for research that aims to compile MFA-related information from multiple sources. This appears to be a cross-cutting issue affecting a number of indicators across multiple lifecycle stages.

Specific examples of this problem include:

- as regards the exploration stage, different countries and companies report reserves to different standards, while others misuse the term 'reserve' for promotional reasons;

- as regards the extraction stage, the methods of collection of data on aggregates production vary between EU Member States and consequently the accuracy of a single EU production figure based on summing the country totals is questionable. Furthermore, there is also variation between countries in the terminology used in the collection of production data, potentially meaning that different sources treat the term 'aggregates' differently. Similarly, data on platinum production may refer to the amount of material produced or shipped; and

- as regards the processing stage, it might benefit future data collection efforts if there were a single point of reference to guide the understanding of the term 'processing'. The relevant supply chains can be highly complex and differ significantly between materials. It might therefore be beneficial to define, for example, which activities carried out at or near the mine should be included.

It can be concluded that there is therefore a need for standardised use of terms more generally to guide collection of data using standardised methods and indicators; this would facilitate data aggregation at the EU level.

It is expected that the availability of data collection standards would encourage future research to produce results which are in accordance with these standards. Indeed, the use of these standards could be a precondition to providing EU funding for materials-related research.

This would also help with problems posed by the grouping of the relevant materials and their reporting within aggregated categories. However, it is acknowledged that grouping of materials for statistical reporting may be a long-held industry practice and changes to past approaches may be slow.

Possible Solutions to Address this Problem

It is expected that guidance on the use of standardised terms and approaches could be developed either by:

- using in-house capabilities at the European Commission. This would likely require undertaking the following actions:
    - organising a workshop to be attended by interested stakeholders in order to develop proposals. These stakeholders should include the main organisations involved in publishing data, such as Member State agencies, including national geological surveys, research institutes, relevant national ministries and statistical offices and industry associations;
    - if required, carrying out a stakeholder survey to elicit opinions on proposals from a broad range of interested parties; and
    - publishing written advice or guidance on the terminology to be used for the reporting of relevant information; or

- if the recommendation outlined above in Section 5.1.1 were to be implemented, it is proposed that this body produces written guidance. This would likely facilitate this organisation's future data collection/collation efforts; synergies with the previous recommendation suggest that this would be the preferable option.

Summary and Recommended Data Collection Strategy

- **Problem:** The use of the relevant terms as well as the methods of data collection vary across countries and institutions which makes aggregation of data from different sources difficult.

- **Recommendation:** Draw up standards for the use of the main terms as well as data categories and methods for data collection, preferably by means of commissioning the body proposed under Section 5.1.1 to undertake this work, or should this not be possible, by means of in-house work at the European Commission.

- **Objective:** Encourage production and reporting of data based on common standards.

5.2.3 Streamlining Currently Collected Trade Statistics

Problem Definition

Although the Eurostat ComExt database provides large amounts of data on international trade with many forms of the materials in question, it has not been possible for the study team to use these data to construct a comprehensive and reliable overview of the flows of the relevant materials into and out of the EU. This is partly because the product categories for which Eurostat collects data are not detailed enough (in many cases they include several materials) but also because for some

product categories, it is not clear what the precise content of the material in the compounds may be (in particular where the product category refers to all grades of concentrates or all types of waste/scrap). In addition, it is often difficult to determine whether some product categories are raw, intermediate or final products (e.g. ores and concentrates are grouped together). Such limitations would need to be addressed.

On the example of cobalt, it can be shown that it is not possible to readily determine cobalt content of statistical categories:

- cobalt ores and concentrates;
- sulphates of cobalt and of titanium;
- cobalt mattes and other intermediate products of cobalt metallurgy, unwrought cobalt, cobalt powders;
- cobalt waste and scrap (excl. ash and residues containing cobalt); and
- nitrates of barium, of beryllium, of cadmium, of cobalt, of nickel and of lead.

In addition, as noted in the annexes to this report, it is not clear whether cobalt powders are a processed or an unprocessed product.

Other examples include insufficient data on individual Rare Earth Elements.

Possible Solutions to Address this Problem

The following solutions could theoretically be adopted to address this problem:

- undertaking a detailed study of the Eurostat data to determine which data categories are relevant to each lifecycle stage and to disaggregate data categories that are not sufficiently detailed. This could be carried out in-house by the Commission staff in collaboration with experts on each material. Please note that this would not be merely a statistical exercise but would require significant expertise on each of the materials in order to provide assumptions/estimates for disaggregating many categories. As a result, the possibility to call on experts that are highly knowledgeable about each material would be key to the success of this exercise. For this purpose it might be useful to organise a series of expert workshops which would attempt to link existing data with particular stages in the lifecycle and to provide assumptions required for the disaggregation. These workshops would need to be attended by experts from public authorities (e.g. national geological surveys) as well as by experts from industry associations; and

- tailoring data categories reported by EU Member States to Eurostat to the needs of material flow analysis (i.e. for example, establishing data categories specific to individual materials and specific lifecycle stages).

It is proposed that initially the European Commission pursues the first strategy but should this not prove to lead to the desired result, the latter strategy is initiated. The proposed sequence of events also has the advantage that the extent of changes required to be implemented within reporting to Eurostat would be minimised. It would also be prudent to ensure that the overall number of data categories reported by

EU Member States does not increase significantly, even though this may be the case where categories currently recording several materials together are broken into several categories so that each material is reported separately.

Summary and Recommended Data Collection Strategy

- **Problem:** There is insufficient data on the flows of materials to and from EU countries. At the same time, there is a large pool of trade data available from Eurostat.

- **Recommendation:** Explore the potential for determining which data categories are relevant to each lifecycle stage and disaggregating data categories that are not sufficiently detailed. Should this not prove successful, it is recommended to explore the feasibility of organisations such as Eurostat working on adjusting their product category codes so that the particular forms of a raw material are adequately, transparently and unambiguously covered. This would likely require the involvement of different Commission services and amendment of current legislation (which, however, appears to be periodically amended for other reasons).

- **Objective:** Make use of data that are currently reported to be able to reliably assess the flows of various material forms into and out of the EU (or even within the EU).

5.3 Recommendations relating to Each Lifecycle Stage

5.3.1 Recommendations relating to Exploration

Problem Definition

It is clear that there is a lack of consistent and comprehensive information on companies involved in exploration activities and of the investment channelled into this activity. While this is partly due to the constantly changing nature of the exploration industry, there are sources reporting information on specific undertakings.

Possible Solutions to Address this Problem

While these often entail an element of speculation, common sources of up-to-date information are public announcements and statements made by capital market funds or companies involved in associated activities. Whilst these sources can provide an up-to-date view into current developments, their quality could be influenced by hype and speculation and by the companies' wish to attract attention and investment. It is clear that when the extraction of a raw material becomes more attractive (e.g. because its market price has increased), several companies may enter the market with the intention of being involved in exploration and extraction; however, only a small percentage of such attempts will be fruitful. In addition, other important information might be confidential.

Even so, it is recommended that further examination is given to whether such information could be collated on a systematic and regular basis. This may be best considered either by means of commissioning a dedicated study or organising a workshop on this issue (such a workshop may include experts from geological surveys, research institutes, commercial data providers and major investment providers).

No alternative strategies have been identified.

Summary and Recommended Data Collection Strategy

- **Problem:** There is a lack of systematic and comprehensive research into data on exploration undertakings and investment.
- **Recommendation:** Commission a dedicated study or organise a workshop to assess the possibility to systematically collect data on exploration.
- **Objective:** Improve available knowledge base on exploration.

5.3.2 Recommendations relating to Extraction

Problem Definition

Overall, comparatively more information on extraction has been identified than for some of the other lifecycle stages (e.g. quantities mined), although significant data gaps remain, including for example data on mining waste, by-products/co-products, extractive methods, information on risks & hurdles to future development, etc.

Possible Solutions to Address this Problem

In the short period available for the preparation of this report, we have been able to create a list of information sources that are only available for a fee or are available to subscribers only and which may provide additional information on extractive activities. It is not possible to immediately assess the usefulness of each source. However, it is possible that some of these reports are compiled by researchers or organisations with good contacts in the relevant industry sectors and potentially a very good understanding of the flows of the materials. This knowledge should ideally be tapped into and used alongside publicly available information, where possible. Nevertheless, it should also be noted that there may be restrictions on how data sourced from commercial providers could be used e.g. it would have to be clarified with each provider whether the Commission would be able to quote such information in their policy documents.

It is recommended that the possibility of gaining access to paid-for data sources is investigated (in addition to those that the Commission already has access to). The authors of relevant reports could be approached with a request for a more detailed

explanation of the contents and scope of each of these reports, before a decision is made to acquire them.

An alternative strategy would be to commission research or organise a series of workshops to address data gaps identified by this report. However, it is recognised that it may be easier to use an existing paid-for source of information, should this source be able to provide the required data (including production as by-products of other materials).

Summary and Recommended Data Collection Strategy

- **Problem:** Some information relating to extraction has been identified (e.g. quantities mined) but other information may be lacking (for example data on mining waste, by-products/co-products, extractive methods, etc.).

- **Recommendation:** It is recommended that the possibility of gaining access to paid-for data sources (additional to those for which the European Commission already holds subscriptions) is investigated. This would require the involvement of the European Commission and commercial data providers.

- **Objective:** Improve available knowledge base on extraction.

5.3.3 Recommendations relating to Processing

Problem Definition

Although some information on the main types of semi-processed and processed material forms that are produced and traded has been identified, this by no means amounts to a consistent, standardised overview across all ten selected materials on the output of the EU processing industries. This is, however, essential for an MFA and it is possible that a general overview of material forms available globally may differ from the material forms processed in the EU; there is therefore a need to collect such information. This is further complicated by the fact that the flows of these materials can be highly complex with EU headquartered companies processing at EU and/or non-EU locations, and different steps in the refining process may be carried out at different EU and non-EU locations.

Possible Solutions to Address this Problem

Information on processed forms and on the associated quantities is crucial to an MFA and it is essential in order to explain some of the material flows recorded by Eurostat's ComExt. It is therefore proposed to organise a workshop attended by experts from industry associations and public institutions to elaborate on this issue. Due to the complexity of the relevant supply chains, it is proposed to organise a workshop (or commission a study involving a survey of the relevant companies) dedicated specifically to this issue.

An alternative solution would be to purchase commercially available market reports (some of which appear to have information on processing) but this would require a prior confirmation from their providers that the desired data are available and can be used by the Commission for various purposes (including citation in official documents where this may be desirable).

Summary and Recommended Data Collection Strategy

- **Problem:** The quantity and nature of materials produced by EU processing facilities are generally not known (although some limited information is available). This includes a lack of knowledge on which material forms are only semi-processed and which are ready to be used by the manufacturing sector, which is relevant to making sense of some of the data reported by Eurostat's ComExt.

- **Recommendation:** Organise a workshop attended by experts from industry associations and public institutions to elaborate on this issue. Due to the complexity of the relevant supply chains, it is proposed to organise a workshop (or commission a study) dedicated specifically to this issue.

- **Objective:** To obtain improved understanding of material processing within the EU and of its outputs (intermediate and final products).

5.3.4 Recommendations relating to End-product Manufacturing

Problem Definition

The assessments carried out demonstrate that for nearly all the raw materials analysed in more detail there are severe data gaps regarding:

- the amounts used for the production of different final products;

- the amounts imported/exported as part of complex articles into/from the EU;

- the precise functionalities of these materials in the different products and consequently the options for their substitution; and

- at what point in time and in what concentrations it can be expected that these materials will be found in different end-of-life products/waste streams.

There is therefore a need for more information both on the amounts of materials contained in the different products as well as on their precise functionalities.

Possible Solutions to Address this Problem

The following solutions could theoretically be adopted to address this problem (please note that the objectives of all the options listed below are the same, i.e. to address the above described lack of data):

- Option A: voluntary action taken by the market actors e.g. including materials information in voluntary self-declaration schemes; or
- Option B: mandatory requirements regarding labelling and/or notification of the raw material content, possibly including the tagging of material content; or
- Option C: a series of workshops bringing together industry experts to attempt to estimate the relevant information for broader product groups; and/or
- Option D: use of information that may become available on these materials within REACH[14] registration and/or authorisation/restriction procedures, reporting under Article 15 of the WEEE[15] Directive, or any other legislation.

Two theoretical possibilities for implementing Option B are analysed in more detail in Box 5.2. Similar possibilities would theoretically also be available under Option A but would likely not be effective due to limited participation by companies.

Box 5.2: Theoretical Possibilities for Improving Data Availability under Option B

Example B1: Tracing Total Material Flows

The necessary mandatory routines to report on the absolute amounts may be implemented as part of a raw material notification scheme. Such notification scheme may oblige any market actor to notify the total amounts of the respective raw materials in all products and pre-products bought and in all products placed on the market, differentiated along some wider product-groups/types. Presently, there is no existing legal basis for such a raw material notification scheme at the EU level. But the currently implemented French Nanomaterial Regulation may be used as an example for a regulation supporting the tracing of materials, even if the nanomaterial debate is triggered more by risk aspects than by the question of supply risks. Under this regulation the following information will have to be reported:

- identity of nanomaterials;
- uses of the nanomaterials;
- quantities that are produced, imported or distributed; and
- identity of downstream users.

This information is to be provided in aggregate form once a year. The information on identity and uses of nanomaterials will be made available to the general public. The following clarifications are given:

- the reporting requirement will apply to manufacturers, importers into France and distributors;
- the threshold for reporting is set at 100 grams;
- some exemptions and adaptations are specific to research and development; and
- the decree allows the reporters to require the confidentiality of their data.

[14] REACH stands for Registration, Evaluation, Authorisation and Restriction of Chemicals.

[15] WEEE stands for Waste Electrical and Electronic Equipment.

Box 5.2: Theoretical Possibilities for Improving Data Availability under Option B

The reporting scheme will start in 2013 and will relate to nanomaterials that were produced, imported to France or distributed in 2012.

Example B2: Tracing Quantities and Functions of Materials in Individual Products

Mandatory reporting by companies for selected product groups with a (possible) relevant content of the raw material(s) under discussion mandatory declaration requirements may be implemented. Following these requirements any actor placing products (out of these product groups) on the market, needs to declare:

- the total amount of the raw material in the respective product;
- the components/parts of the complex product containing the respective raw material; and
- the technical function the raw material provides in the components.

Declaring this information directly on/with the product may lead to problems with market competition and confidential business information issues as well as increased administrative burden. An option to avoid this but to still provide market actors, scientific institutions and authorities with the necessary information is to store the respective information in a centralised database while the company/product specific information are separated from information linked to a meaning full structure of products and functional devices/functions. In addition, the single products may be accompanied with a code or registration number directly on the product or in the technical descriptions that allows access to the database to gain helpful information (e.g. for targeted recycling activities).

The legal basis for such mandatory (raw)-material declaration requirement is offered by the EU Ecodesign Directive (2009/125/EC). Article 15 and Annex I and II of the Directive offer the possibility that such information requirements may be part of an implementing measure for a specific product group. Up to now, no examples of such information requirements exist from the Implementation Regulations brought into force under the 2009/125/EC. One of the reasons is that any official prioritisation of different raw materials is missing at the EU level (although for the purposes of this study, such a list is provided by the list of the 14 critical raw materials). On the other hand Directive 2009/125/EC offers a structured procedure including all relevant technical information ensuring that only targeted measures relevant for the specific product group are proposed.

A less costly (in particular for the industry) and more efficient means of achieving these objectives than Options A and B would be Options C and D, which also have the added advantage that they could complement each other. Despite the possibility that Options C and D may deliver less comprehensive and less reliable information than Option B, these are preferred by this study and recommended to the European Commission as the most feasible way forward. Furthermore, it is recommended that Options C and D are pursued simultaneously. In addition, estimations of the average material content in main product groups may allow the Commission to use existing Eurostat data on trade in manufactured goods to estimate international flows of the relevant materials within manufactured products, and would contribute to estimating potential future waste arisings.

With regard to Option D, REACH will be generating information on some metals and metal compounds and their use in different types of goods as a result of authorisation and restrictions. This could help identify possible target product groups for more detailed review. For example, cobalt salts may fall under REACH authorisation

(though this is not yet determined) so their uses in consumer products may have to be notified to ECHA (the European Chemicals Agency). This in turn provides a starting point for collecting better data on product categories and eventually on quantities authorised for continued use under REACH. REACH may also provide some insight into the quantities of chemicals imported into the EU. In addition, Article 15 of the WEEE Directive (Directive 2012/19/EU) is relevant to the determination of the material content of electrical and electronic products, although this may currently relate to dangerous substances only.

Summary and Recommended Data Collection Strategy (Option C)

- **Problem:** There is a lack of data on the content of these materials in end products.
- **Recommendation:** Undertake a series of expert workshops to estimate average material content in main product groups. This will likely require a series of expert workshops. This would require the involvement of the European Commission as well as of a large number of stakeholders, including research institutes and industry representatives. These workshops could also be organised by the body proposed in Section 5.1.1.
- **Objective:** Deal with the significant data gaps that have been identified by this study in relation to this lifecycle stage.

Prior to implementing this recommendation, the Commission is urged to explore what data may become available from reporting under REACH and the WEEE Directive.

Summary and Recommended Data Collection Strategy (Option D)

- **Problem:** There is a lack of data on the content of these materials in end products.
- **Recommendation:** Monitor REACH and WEEE developments and make use of information on the materials of interest could be sourced from ECHA (i.e. from registration and/or authorisation/restriction procedures under REACH) and from reporting under Article 15 of the WEEE Directive.
- **Objective:** Make use of data that may become available under existing legislation to address some of the main data gaps identified by this study.

5.3.5 Recommendations relating to Product Use

Problem Definition

For the product use phase, the key problem identified by this study is that information and data relating to product use are sparse. More specifically, there are significant data gaps with regards the following indicators:

- average product lifetime; and
- re-use potential.

Even where data are available, it cannot be claimed that these are always complete, consistent and up to date. It is important that the knowledge base on these aspects expands.

Data regarding the average product lifetime of products containing raw materials is available for six of the 21 materials considered by this study, including two of the ten materials analysed in detail in Annex A, with most of this information[16] coming from the UNEP (2010) report 'Metal Stocks in Society' which is essentially a literature review of existing studies from various countries; the report does not include primary data. As a result, the data provided by the study is not always consistent (i.e. it is not from the same country, does not cover the same time period or sample size etc.). Furthermore, the data provided by UNEP (2010) does not always cover the average product lifetime for all product uses for each raw material. For example, for antimony, data is available only for the transportation field of application and not for other, more common, applications such as flame retardants. In addition, the report also further emphasises the lack of data for this stage in the material flow analysis for the vast majority of metals.

Data regarding the re-use potential of the raw materials studied are also sparse. Qualitative information is available for indium with some information available on the existence of a second-hand market for palladium and platinum.

Possible Solutions to Address this Problem

It is proposed that a series of expert workshops is organised to estimate average product lifetimes and elaborate on re-use potential of key products. These workshops would require participation of experts from the industry and academia. Alternative strategies would be similar to the ones considered above for the product manufacturing lifecycle stage but expert workshops are considered the most preferable option.

Summary and Recommended Data Collection Strategy

- **Problem:** There is a lack of data on average product lifetimes and re-use potential, which hinders a temporal analysis of these materials' lifecycles as well as projections of waste arisings; it is therefore difficult to understand the potential of urban mines.

- **Recommendation:** Undertake a series of expert workshops to provide estimates of average product lifetimes. These could be combined with those used to estimate average material content in main product categories. This would require the involvement of the European Commission as well as the specialists that would be consulted for average material content in products (see recommendations

[16] Data concerning the average product lifetime for Beryllium comes from a USGS publication titled 'Beryllium Recycling in the United States in 2000'. As a result, the data apply only to US material flows and is already dated; which raises questions as to its applicability and relevance to the EU flows of beryllium.

above) and could be carried out in conjunction with workshops on average product content. These workshops could also be organised by the body proposed in Section 5.1.1.

- **Objective:** Estimate the time that the relevant materials spend dormant in products and thus contribute to estimating potential future waste arisings.

5.3.6 Recommendations relating to Collection, Sorting and Recycling

Problem Definition

Generally, insufficient data are available for most indicators and materials (please note that wood is dealt with separately at the end of this section). Examples of data gaps include:

- in the collection and recycling stage:
  - as regards post-consumer waste arisings, quantities of waste collected, old scrap recycling rate and industry structure, data are only available for a few materials (less than four of the 21 considered by this study and usually only one of the ten materials for which data quality and availability has been analysed in detail in Annex A);
  - as regards waste exports and imports data are available for a few more materials (three of the ten analysed in Annex A and six or seven of the 21 considered in this study);
- in the recycling stage, data are generally available for the end-of-life recycling rate (with the exception of two materials); data gaps include:
  - data on the recycling process efficiency rate are available for none of the ten materials analysed in detail and only three materials in total; and
  - data on international trade with wastes containing these materials and on the structure of the recycling sector are generally not available, with very few exceptions, and neither is information on landfill mining, although this could be because such mining of these materials may not yet be taking place on a significant scale.

From the above, it is evident that, for the majority of indicators, few materials have any data available. Importantly, however, data are widely available for the end-of-life recycling rate. Data are available for all materials studied with the exception of tungsten and graphite and some uncertainty surrounds the data available for beryllium, fluorspar and lithium.

While extensive data on overall levels of waste generation, collection, recycling, exports and imports in the EU have been identified (often available from Eurostat's Environmental Data Centre on Waste), these are usually highly aggregated and not material specific. As such, these data do not allow full MFAs to be drawn up for the vast majority of the specific materials under consideration and it has not been possible

for the study team to use these data to construct a comprehensive and reliable overview of the flows of specific materials.

Possible Solutions to Address this Problem

The following solutions could theoretically be adopted to address this problem:

- integrating the need to collect additional data on the flows of critical raw materials into current and future policy making at the EU level as well as monitoring data generated by existing legislation in the future;

- tailoring data categories reported by EU Member States to Eurostat to the needs of critical materials flow analysis (i.e. for example, establishing data categories specific to individual materials) and undertaking a study or organising a workshop to explore whether it might be possible to provide estimates/assumptions that would allow disaggregation of any of the data categories reported by Eurostat.

It is recommended that both strategies mentioned above are pursued simultaneously.

Firstly, it is proposed that MFA needs should be taken into account when current EU legislation is revised or when new legislation is introduced and that there is monitoring of which data are being generated by existing legislation and structures.

Potential opportunities include:

- The new WEEE Directive 2012/19/EU was been published on 24 July 2012. From 2019, the Commission proposes to set mandatory collection targets equal to 65% of the average weight of electrical and electronic equipment placed on the market over the three previous years in each Member State. Article 16 of the new Directive requires Member States to draw up a register of producers, including producers supplying EEE. Member States shall collect information, including substantiated estimates, on an annual basis, on the quantities and categories of EEE placed on their markets, collected through all routes, prepared for re-use, recycled and recovered within the Member State, and on separately collected WEEE exported, by weight. These data collection exercises will be of help in drawing material flows in the future.

- The Waste Shipment Regulation (Regulation (EC) No 1013/2006), sets out a system by which certain types of waste are subject to a notification procedure prior to export (Annex III) and notification and consent (Annex IV). The notification procedure could be used as a tool to gather further data on specific substances but this will only be related to waste shipments.

- The Batteries Directive (2006/66/EC) introduces measures to prohibit the marketing of some batteries containing hazardous substances. It contains measures for establishing schemes aiming at a high level of collection and recycling of batteries with quantified collection and recycling targets. As for the WEEE Directive, Member States shall monitor collection rates on a yearly basis

and shall transmit reports to the Commission within six months of the end of the calendar year concerned.

- The Waste Framework Directive (Directive 2008/98/EC) provides for a general framework of waste management requirements and sets the basic waste management definitions for the EU. Every three years, Member States shall inform the Commission of the implementation of this Directive by submitting a sectoral report in an electronic form. This report shall also contain information on the management of waste oil and on the progress achieved in implementation of the waste prevention programmes. The report shall be drawn up on the basis of a questionnaire or outline established by the Commission.

- The End-of-Life Vehicles Directive (Directive 2000/53/EC) requires Member States to report to the European Commission every three years on issues such as possible changes in the structure of motor vehicles dealing and of the collection, dismantling, shredding, recovery and recycling industries, leading to any distortion of competition between or within Member States. Reporting is carried out based on a questionnaire from the European Commission. In addition, economic operators are required to publish information on the design of vehicles and their components with a view to their recoverability and recyclability.

- It is recommended that the Commission monitors the outcome of the e-AIMS project[17] (due to be completed in late 2013) which is undertaking an investigation of the technical and economic feasibility of automated sorting and management methods based on Radio Frequency Identification (RFID). This appears to involve the embedding of information on the producer, presence of hazardous substances and component materials within an appliance.

- It is recommended to periodically check what data have become available in the course of reporting under the Basel Convention (presently Basel Convention questionnaires to national authorities request information on the generation of antimony, beryllium and copper waste arisings). Any queries could be addressed to Eurostat which appears to be aggregating data reported by individual Member States.

- It is recommended to integrate the needs of material flow analysis into policy considerations on certification of waste exports to third countries. Any possible action should take into account the need to collect data from waste traders on exports of critical raw materials contained in waste.

However, it should be noted that generating material-specific data for an MFA is not the primary purpose of existing EU legislation on waste and as such the amounts and data currently generated for individual materials may be relatively limited. Presently collected data might thus only provide insights into relatively narrow issues. In addition, it can be expected that there may be some stakeholder resistance to any

[17] See http://www.eaims-project.com

proposals that would significantly increase the reporting burden on EU Member States. This option is therefore more suitable for collecting additional information on a limited number of specific issues that are of high significance from the policy making perspective and may require some time before additional data are generated.

Secondly, it is recommended that the European Commission further explores the feasibility of adjusting product category codes used by Eurostat to provide waste and recycling data for individual materials. This would likely require changing existing legislation, including amending the EU Waste Statistics Regulation (Regulation (EC) No 2150/2002) which lists data categories for which statistics are compiled by EU Member States and by the European Commission. However, this approach is only likely to generate additional data to the extent that these do not significantly increase the reporting burden on EU Member States. In addition, it is recommended that the Commission assesses the feasibility of establishing assumptions or developing models that would allow disaggregation of any of the data categories reported by Eurostat (such as estimating the average content of each of the materials in selected waste streams). However, it should be recognised that due to the highly aggregated nature of the data categories reported by Eurostat and due to the complexity of the products present in the relevant waste streams, it might be very difficult to develop such assumptions and that this would likely require significant technical expertise; as a result, it is unlikely that this could be carried out by the Commission without the support of external expertise.

Summary and Recommended Data Collection Strategy

- **Problem:** There is a lack of data at the level of individual materials as regards their collection and recycling. This includes material-specific data on waste generation, collection, recycling, exports and imports.

- **Recommendations:** It is proposed that MFA needs should be taken into account when current EU legislation is revised or when new legislation is introduced and that there is monitoring of which data are being generated by existing legislation and structures. This would chiefly require the involvement of the relevant Directorates-General (DG Enterprise & Industry, DG Environment) and of Eurostat's Environmental Data Centre on Waste. However, as noted above, this strategy is unlikely to result in generating comprehensive data for all missing data categories. In addition, it is proposed that the Commission explores the feasibility of Eurostat adjusting their product category codes to provide waste and recycling data for individual materials. This would likely require the involvement of different Commission services and a change of legislation. It is also recommended that the Commission assesses the feasibility of establishing assumptions or developing models that would allow disaggregation of any of the data categories reported by Eurostat.

- **Objective:** Provide reliable and comprehensive data on waste generation, collection and sorting for the specific materials in the EU.

Specific Considerations Relating to Collection, Sorting and Recycling of Wood

Data are available for early stages in the wood cycle (i.e. supply availability, harvesting and removals, and processing). One of the main sources is the Joint Forest Sector Questionnaire (JFSQ), which is carried out by Eurostat, the UNECE and the ITTO. Any changes to this would require a rolling work programme, with actions taking 2-3 years to be set up and piloted prior to deciding whether they should be retained. However, further on in the wood cycle, there is less information. Since there are so many different uses for wood, keeping track of all the products containing the material is an extensive and time consuming task. At the end of each product's life, there is then the problem of where the wood goes next. Considerable data is available for recycling of wooden packaging and also of paper. There are also statistics for the overall quantities of wood waste treated in each Member State. However, there is no information on the breakdown of these quantities by treatment type. Furthermore, it is unclear how much wood waste is generated in total, and thus what the potential amount available for collection and recycling is.

- **Problem**: there is limited information on the quantity of wood waste which is generated each year. It is also not clear how much of this is actually recycled or reused, since statistics on treatment include incineration (without energy generation) as a treatment option.

- **Recommendation**: a detailed analysis of all available data on wood waste generation and treatment should be undertaken in conjunction with data providers (including Member States and Eurostat) and industry federations to determine data availability and quality, and to investigate how the gaps can be filled.

- **Objective**: improved estimates of amount of wood waste generated and recycled within the EU.