FORAM

TOWARDS A WORLD FORUM ON RAW MATERIALS

MAPPING RAW MATERIALS INITIATIVES

Baseline Report

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Deliverable D.1.3

Baseline Report on Mapping of Initiatives and Data Availability

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Disclaimer

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Executive Summary

This report is the final deliverable of the work package 1 'Inception & Baseline'. The main objective of this work package is a global mapping of existing initiatives along the life cycle of non-energy and abiotic raw materials.

Necessary for the development of this baseline mapping was a common language and understanding of raw materials at the different steps of the value chain within the FORAM WP1-project team; Figure 1 illustrates the approach.

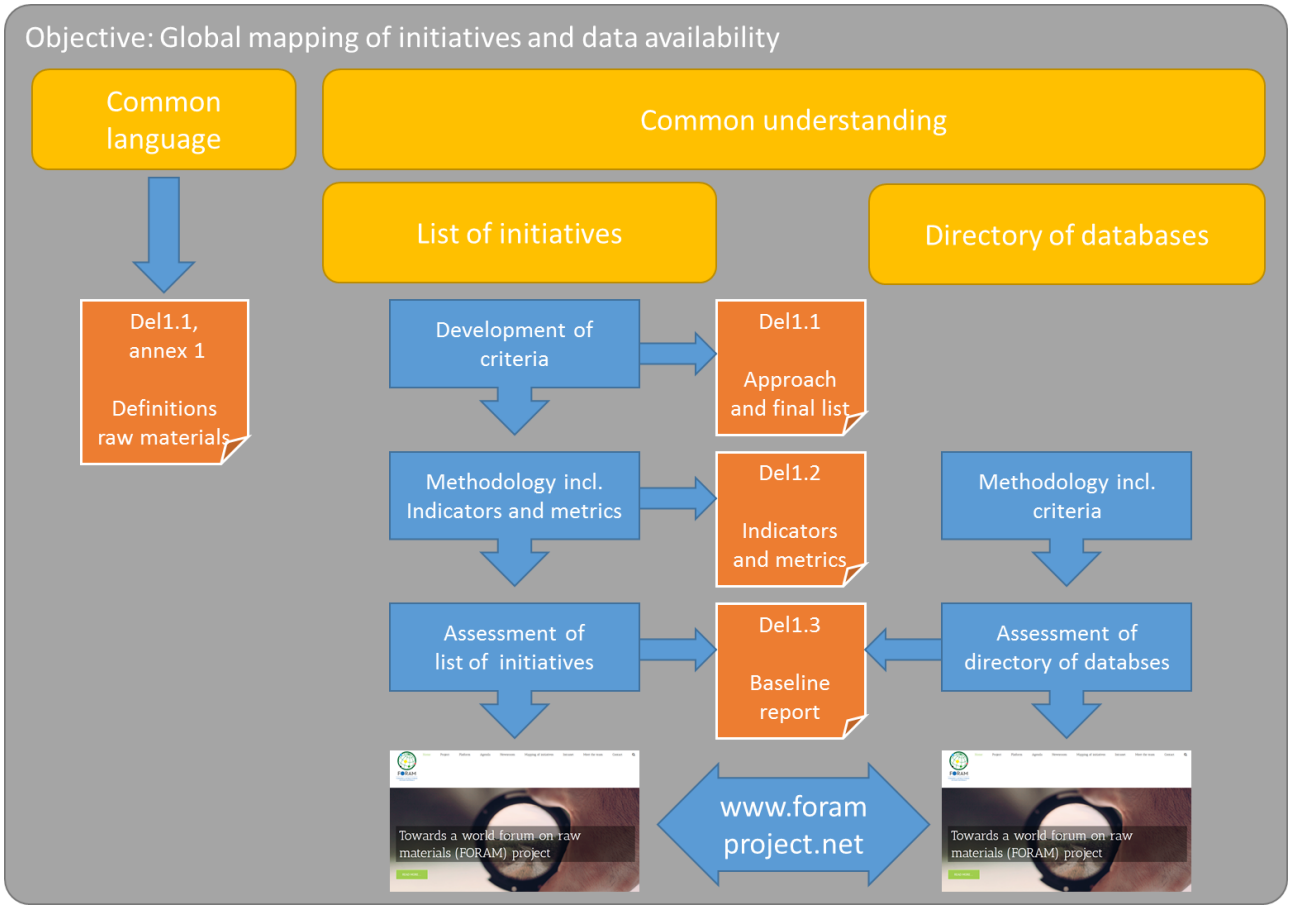

Figure 1: *Approach in work package 'Inception & Baseline'.*

The first task of WP1 was to concentrate on the development of criteria for the mapping of initiatives, data availability and stakeholders linked to raw materials and related topics. The approach to identify suitable criteria, the final list of the criteria and their descriptions, as well as the format for the collection of information is presented in deliverable 1.1 'List of criteria for the mapping'. Having a common template, all partners collected information on initiatives and integrated these into a common 'List of initiatives'. An online form was also prepared to allow a wider collection of information on initiatives through the FORAM website. This approach resulted

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in an unsorted list of initiatives. In order to ensure common understanding of terms among FORAM working team, task 1 also developed a common language of raw materials related terms (see Annex 1 of deliverable 1.1). The objectives of the work package included to provide a baseline for the stakeholder process in Work Package 2. Therefore, it was necessary to prioritize these initiatives, using the most objective approach possible. In task 1.2 a methodology was developed including indicators and metrics for an assessment of the initiatives. A questionnaire shared among FORAM WP1 partners was used to determine the average priority (high, medium or low priority) for each criterion. The same approach was used to prioritize the different categories of the various criteria. The methodology for the establishment of indicators and metrics is described in deliverable 1.2 'Indicators and metrics for the mapping' and is the baseline for the assessment and mapping of initiatives.

The final task of work package 1, is the mapping of initiatives and of available data, which is described in detail in this report. The first part of the report concentrates on the *assessment of the collected initiatives* in work package 1. All criteria and categories collected for each initiative (deliverable 1.1) were analysed using the methodology developed in task 1.2 and described in deliverable 1.2. In total 98 initiatives were recorded by the partners and through the online form. For several criteria (e.g. type of stakeholders, objectives and strategies), more than one category was used to describe an initiative. Thus, the total number in the evaluation of a single criteria could be higher than 98. Some important outcomes of the assessment can be summarized as follows:

- The most represented *type of stakeholders* within the recorded initiatives is 'Company/Industry' followed by 'University/Academia/Research center' and 'Government department/organisation'.
- The *number of stakeholders* differs between 2 and 4,200 with a focus on a range from 7 to 40 stakeholders.
- Most initiatives have multiple *objectives and strategies* including 'Policy and governance contribution' and 'Enhance environmental sustainability and protection'. As the mapping shows only little deviations between the recorded objectives, it is not possible to identify from this analysis the most or least important objectives or strategies.
- Looking at the *activities,* the evaluation indicates that most initiatives are working in the fields of 'Networking and strengthening cooperation' and 'Information exchange'.
- The *target audience* of the initiatives differ slightly from the *type of stakeholders*. Whereas both criteria have a high emphasis on 'Industry' followed by 'Academia/Research center' a further important target audience are 'Policy makers'.
- Almost half of the initiatives are *organized* as 'Associations'. Another well represented organisational structure is 'Projects'. Looking at the methodology, 'Projects' are ranked with a medium priority out of the view of the task partners because of their short and fixed duration and the continuity of project results.
- Regarding the *type of raw material*, the majority of the recorded initiatives are looking at multiple materials/elements including materials/elements of high importance for the EU

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economy. Only a small number of the initiatives are focusing on a single element or material (e.g. copper or nickel).

- Most initiatives are dealing with more than one *step of the value chain*.

This report will be a basis for the next task of the FORAM project, stakeholder consultation that will be happening at WP2 and WP4. During these work packages, a broader group of stakeholders will be approached and consulted and more ideas about the priorities will be collected. According to the new outcomes, there might be a need to adjust the weighing factors used in the metrics or the need to apply filtering looking at specific aspects before assessing the initiatives. Furthermore, the identification of new initiatives is an ongoing process and this will lead to a more accurate assessment process. In addition to initiatives, 452 individual stakeholders were also identified and mapped. These have been divided and categorized based on the *type of stakeholders*, *step in the value chain* and their *locations*.

The second part of the report describes the methodology for gathering databases containing information on raw materials and explains the resulting *directory of databases on primary and secondary raw materials*. The recorded databases in the directory were collected following pre-defined criteria such as 'Raw material', 'Type of data' or 'Geographical focus'. This structured approach led to a directory of databases that could be further developed during the ongoing project duration (e.g. new entries, functional check of links). To spread the information and to ensure a good visibility, the directory will be implemented in the FORAM website. For the evaluation described in this report, the directory was closed on 14th July 2017.

Up to the closing date (14th July 2017), 108 databases were recorded in the FORAM directory. The directory contains mainly information on resources followed by environmental, economic and geopolitical information. Technological and social information are less provided.

As the *use and needs of raw materials in industrial sectors* are less covered in the FORAM directory an exchange of information was initiated with the project MATCH (Material for a Common House). In MATCH more than 1,300 projects were evaluated by material experts on the kinds of materials used, on applications, key enabling technologies in view of the industrial needs. Looking at *information on resources,* the majority of the recorded databases are offering information on primary raw materials. The *geographical distribution* of the mapped databases shows a well-proportioned share between a global, national and European focus. The *data* is, depending on the content, mainly provided as databases, map viewer, directories or a combination of several techniques.

Only few databases in the directory offer information on *technology aspects* in a data processed way and in other databases, the information on technologies is dispersed. Therefore, current information on the status of use, re-use, recycling and substitution taken from the list of initiatives and the directory of databases are summarized for selected raw materials in Annex 5 of this report.

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Introduction

This report describes the methodology and results of task 1.3. The objective of task 1.3 is on the one hand the analysis of the identified initiatives (task 1.1) using the indicators and metrics developed in task 1.2 resulting in a prioritised overview of initiatives. On the other hand, task 1.3 will give an overview of the availability of data on primary and secondary raw materials.

Chapter 1 of this report describes the 'Assessment of initiatives'. Based on the criteria developed and the structural approach for the identification of initiatives in task 1.1 (see deliverable D1.1), the list of initiatives was created nearly throughout the complete duration of work package 1. In parallel to the search of initiatives by the task partners, FORAM also offered the possibility to register an initiative on the FORAM website[1]. In task 1.2 the indicators and metrics for each criterion identified in task 1.1 were developed. The criteria as well as the indicators and metrics are the basis for the following assessment. The chapter concludes with an assessment of the individual stakeholders that were mapped.

Chapter 2 describes the approach to attain an overview of available data on primary and secondary raw materials. This overview was transferred into a directory of databases and evaluated afterwards by pre-defined categories.

The list of initiatives and the directory of databases was closed for the assessment on 14th July 2017. The data and information on the FORAM website will be checked and updated until the end of the project and initiatives will have still the opportunity to register on the website. Therefore, the assessment shows the static situation for a closed list and directory with about 100 entries (representative for assessment), but list and directory on the website are under ongoing improvements.

1. Assessment of initiatives and individual stakeholders

In total 98 initiatives were identified by the partners, of which 25 initiatives through the online form. In this chapter the criteria and metrics, as identified in deliverable 1.1 and 1.2 are compiled and applied to the initiatives. The criteria were developed in deliverable 1.1 and are established based on online searches and literature review. In the assessment, gaps and overlaps between existing initiatives are analysed. Figure 2 is an image of an interactive map created to provide an overview of the initiatives and their characteristics. The map as well as analytical graphs[2] can be accessed on the FORAM website[3].

[1] http://www.foramproject.net/index.php/mapping-of-initiatives/

[2] http://www.foramproject.net/index.php/results/

[3] http://www.foramproject.net/index.php/geo-map-and-results/

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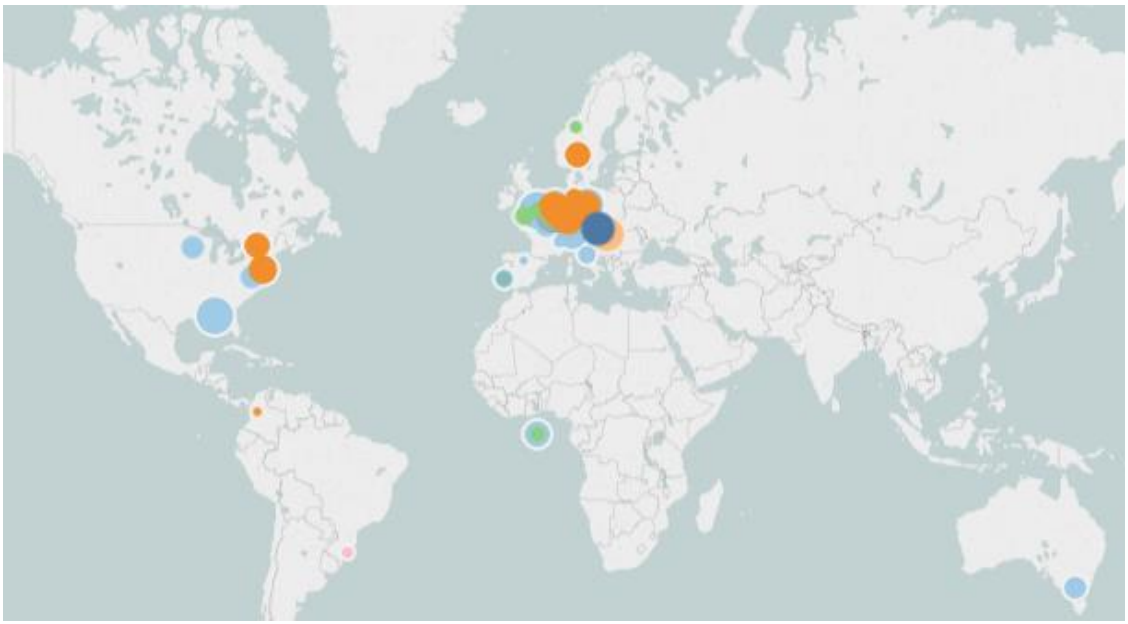

Figure 2: *Geographic map of initiatives available on the FORAM website*

Additionally, 452 individual stakeholders were mapped, of which an overview is provided in sections 1.3. This section describes the type of stakeholders, where they are located and the step in the value chain that they are involved in.

1.1. Assessment of individual criteria

In this section, the individual criteria and categories for the mapping of initiatives linked to raw materials and related topics will be analysed. The criteria and the categories are defined in deliverable 1.2, as well as the priority indicated for each criterion. The priorities are based on the partners perspective on which categories have priority for FORAM (argumentation for these priorities are given in Annex 2 of this report). In this section, it will be assessed which categories of criteria are most and least prevalent in the data gathered on initiatives. In Annex 1 an overview of the criteria with the frequency of each category and their priority can be found.

1.1.1. Type of stakeholders

The criterion 'Type of stakeholders' includes nine different categories and one initiative can include multiple type of stakeholders (see Figure 3). Within the initiatives mapped in this study, the most represented stakeholders are 'Company/Industry' and 'University/Academia/Research center', together they represent 42% of the stakeholders. The third most represented stakeholders are 'Government department/organisation' (14%), followed by 'Association' (9%), 'IGO' (7%), 'NGO' (8%) and 'Civil society/the public' (5%). 'Associations' and 'Initiatives' are multi-stakeholder initiatives within another initiative. Only few 'Initiatives' (4%), were identified as a type of

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stakeholder, so mostly the initiatives are made up of individual stakeholder organisations. The category 'Other' (1%) included 'Financial community' and 'Research funding programme'. 'Association' can refer to both an association of industry as well as an association of individuals. In all initiatives, the 'Type of stakeholder' was identified. Therefore, the category 'Not specified' is not part of this analysis.

Type of Stakeholder	
Association	20
Civil society/the public	12
Company/Industry	71
Government department/organisation	31
Initiatives	9
Intergovernmental Organisation	16
Non-governmental organisation	17
Other	3
University/Academia/Research center	48

Figure 3: *'Type of stakeholders' in identified initiatives*

1.1.2. Objectives and strategies

The categories for the 'Objectives and strategies' are defined based on a discussion between task partners and in accordance with a preliminary analysis of the answers provided already in the mapping file. In total thirteen categories were identified, plus 'Other'. Among the initiatives identified, 10% have as objective 'Policy and governance contribution' and another 10% have as objective 'Enhance environmental sustainability and protection'. This is followed by the objectives to 'Support and raising awareness for the raw materials industry', 'Innovation and promoting of technological development', and to 'Enhance international cooperation' (each 8% or 9% of the initiatives). Between 4% to 7% of the initiatives have 'Supply chain transparency/sustainability', 'Higher resource efficiency', 'Capacity development', 'Social and economic development' (EU and developing countries) and 'Security of supply/material substitution' as objective. Finally, only 3% of the initiatives have indicated 'Improving energy efficiency and climate change policies' as an objective. Figure 4 shows the frequency of 'Objectives and strategies' in the identified initiatives.

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Figure 4: 'Objectives and strategies' in identified initiatives.

1.1.3. Activities

The criterion 'Activities' includes eight different categories and one initiative might include more than one activity. Among the 98 initiatives mapped, two-third are involved in more than one activity. Many initiatives (76%) have as activity 'Networking and strengthening cooperation'. This activity is followed by 'Information exchange' (53%), 'Capacity building' (27%), 'Data collection/ mapping' (23%), 'Research' (24%), 'Development of certification and standards' (19%) and finally 'Development of tools and technologies' (17%). Figure 5 shows the frequency of 'Activities' in the identified initiatives.

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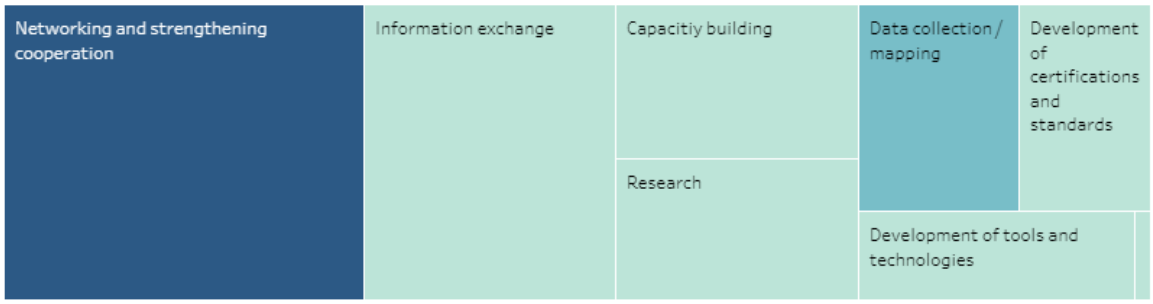

***Figure 5**: 'Activities' in identified initiatives.*

1.1.4. Target audience

For the 'Target audience', seven stakeholder groups (categories) were indicated. The target audience of most initiatives are 'Industry' (32%), followed by 'Policy-makers', 'Academia/Research center' and 'Government' (with 16% each). 'Civil/society/the public' is the target audience of 12% of the initiatives. Finally, only few initiatives with target audience of 'NGO' or 'IGO' have been identified (3% and 4%).

1.1.5. Organisational structure

The criterion 'Organisational structure' includes twelve categories. From the 98 initiatives, almost half (41%) are 'Associations'. 'Associations' are followed by 'Projects' (20%, medium priority) and 'Initiatives' (10%, high priority). Though the term 'Initiatives' is used in work package 1 as a collective term for the different organisational structures, some of the initiatives are also named 'Initiatives' and therefore included as a category as well. The least identified organisational structures within the identified initiatives are 'Panels', 'Expert groups', 'Study groups', 'Working groups', 'Communities' and 'Partnerships'. These six organisational structures together only make up 10% of the total initiatives identified. There are also relatively few 'Platforms', 'Fora' and 'Alliances' for raw materials within the mapped data. Figure 6 shows the frequency of 'Organisational structures'.

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Figure 6: *Frequency of Organisational structures and Type of Stakeholders in identified initiatives.*

1.1.6 Type of raw material

More than a half of the 98 initiatives are dealing with 'Materials/elements or material flows containing raw materials of high importance for the EU economy' (57%). As shown in deliverable 1.2 these materials/elements include CRM EC 2014, PGM/PGE, REE and conflict minerals. Another 38% of the initiatives are focused on 'Materials/elements or material flows containing other raw materials'. The least occurring category 'Other' in the data (5%) are either not addressing raw materials questions in a direct way (for example general questions of sustainability) or are dealing with raw materials which are not in the focus of FORAM (e. g. coal). 13% of the initiatives are focused on a single material/element whereas 69% are taking into account multiple materials/elements or material flows. Examples for single elements are copper (3 initiatives), nickel (2 initiatives), gold, aluminium, cadmium, steel, magnesium, cobalt and tungsten (in each case 1 initiative). Multiple materials are covering different kinds of material groups in varying spans such as:

- Raw Materials
- Metals and minerals, metal ores, industrial minerals, mineral resources
- Non-agricultural, non-energy mineral raw materials
- Non-ferrous metals, precious metals
- Critical raw materials, strategic metals
- Minor metals
- Conflict minerals, metals
- Rare earth elements
- PGM/PGE
- Construction materials, natural stone, gravel, sand

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- Nanomaterials

14% of the initiatives are involved in the topics of secondary raw materials. Examples are WEEE (5 initiatives), ferrous and non-ferrous metals (three initiatives), and mineral residues such as C&D waste. Figure 7 shows the frequency of 'Type of Raw Materials' in the identified initiatives.

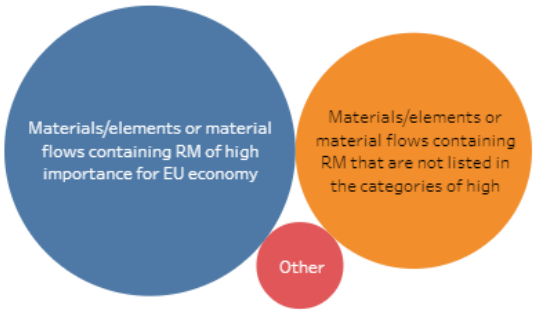

Figure 7: *'Type of Raw Materials' in identified initiatives.*

1.1.7. Number of stakeholders

The criterion 'Number of stakeholders' includes only three different categories. The number of stakeholders in the 98 initiatives mapped range from 2 to 4,200 and can be divided as follows: 8 initiatives have less than 7 stakeholders, 49 initiatives have between 7 and 40 stakeholders, and 39 initiatives have more than 40 stakeholders. From this last group, 4 have more than 500 stakeholders (between 500 and 999) and 5 have more than 1,000 stakeholders, with a maximum reaching 4,200 individual stakeholders. 2 initiatives have an unknown number of stakeholders. Half of the initiatives (50%) have between 7 and 40 stakeholders, while 40% of them have more than 40 stakeholders. Finally, only 8% of the initiatives have less than 7 stakeholders.

1.1.8. Geographical focus

The criterion 'Geographical focus' includes eight categories, of which five were present in the identified Initiatives. Most initiatives have a 'Global' focus (48%), followed by those with a focus on 'Europe' (38%). 12% of the initiatives have a 'National' focus, and 1% has a focus on 'Regional: Africa' or on 'Regional: North America'. During the mapping, no initiatives were identified that solely focus on 'Regional: Asia', 'Regional: South America' or 'Regional: Australia' (Figure 8).

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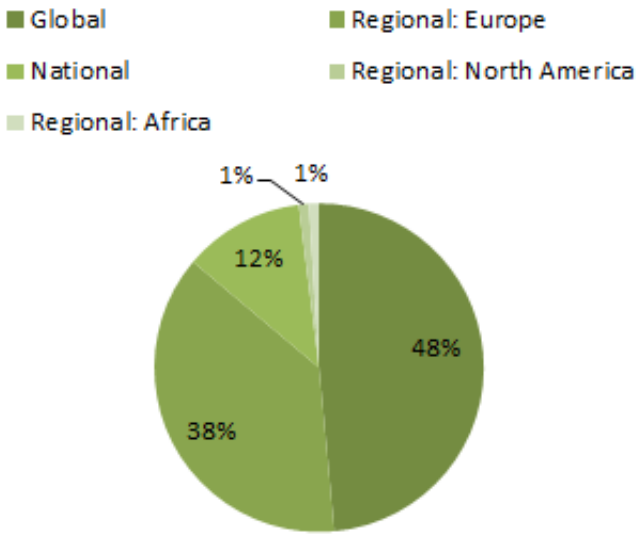

Figure 8: *'Geographical focus' in identified initiatives.*

1.1.9. Step in the value chain

The criterion 'Step in the value chain' includes eight different categories and each initiative might include more than one step in the value chain. The single categories 'Processing' and 'Product development' are not represented by one initiative alone, but these steps are covered by several initiatives, which take multiple steps of the value chain into account. Among the 98 initiatives mapped, 70% are representing more than one-step in the value chain. 13 initiatives are focussing on 'Mining/extraction', one initiative is focussing on 'Manufacturing' and 8 initiatives are focussing on 'Recycling/re-use' as single step in the value chain. Only one identified initiative is focussed on 'Transport and supply chain'. Figure 9 shows the frequency of the 'Step in the Value Chain' in the identified initiatives.

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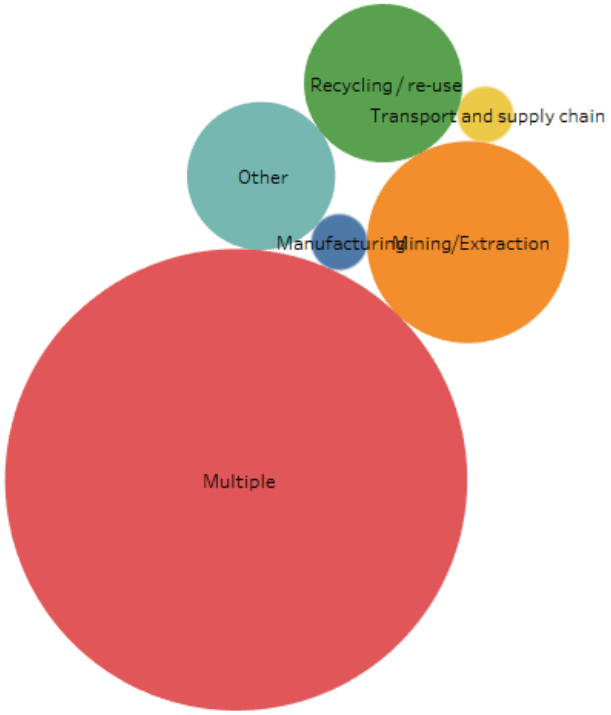

Figure 9: *'Step in the value chain' in identified initiatives.*

Taking a closer look at the 68 initiatives which are dealing with more than one step of the value chain (category 'Multiple'), for 27 initiatives more information about the represented steps are available. Of these, 25 initiatives are involved in 'Mining/extraction', 23 are also involved in 'Processing', 11 in 'Manufacturing', seven in 'Product development', 16 in 'Recycling/ re-use', 11 in 'Transport and supply chain' and 12 in 'Other', which are in 'Disposal' and 'Retail/trade'. In summary in both main groups of initiatives with one step and with multiple steps (without category 'Other'), 'Mining/extraction' is the most represented step in the value chain (in total 39% of the mapped initiatives), followed by 'Recycling/re-use' (in total 24%) and 'Processing' (in total: 23%). 12% of the initiatives are involved in 'Manufacturing' and 'Transport and supply chain'. The least occurring category in the identified initiatives is 'Product development' with 7%.

1.1.10. Description of data

The access to data on raw materials provided by initiatives is often an additional service so that this criterion is not met by all initiatives. The provision of data, their description and the access to the data is of medium priority for FORAM. More detailed information on web-based databases regarding raw materials are described in the chapter 'Availability of information on raw materials'.
More than a half of the 98 initiatives do not have any processed data in the form of databases, map viewer or directories on their websites (53%). The criterion 'Description of data' includes four

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different categories and one initiative might include more than one type of data. Most data are provided on 'primary raw material extraction/benefication' (21% of initiatives), followed by 'Data on secondary raw materials and recycling' (15%) and 'Data on use of materials in production and consumption' (14%). Figure 10 shows the number of initiatives that provide data to the different categories.

Description of Data	
Data on primary raw material extraction/benefication	25
Data on secondary raw materials and recycling	18
Data on the use of materials in production and consumption	16
Not applicable	52
Other	6

Figure 10: *'Description of Data' in identified initiatives.*

1.1.11. Data access

The criterion 'Data access' includes the categories 'Public' and 'Restricted' respectively 'Partly public, partly restricted'. 57% of the initiatives provide no access to databases, map viewers, etc. Four initiatives, in most cases projects, are currently developing databases, so that the access to these databases will be available in the next two years. 28% of the initiatives provide a free and public access to their data. 3% have data that is partly public and partly restricted to the members only. 12% of the initiatives have only a restricted data area. Figure 11 shows the frequency of the 'Data Access' in the identified initiatives.

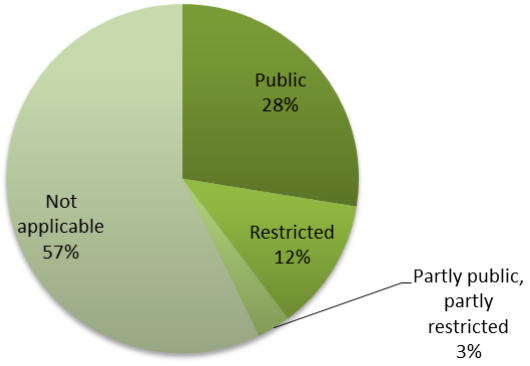

Figure 11: *'Data Access' in identified Initiatives.*

1.1.12. Languages

The criterion 'Languages' includes three different categories. The first is 'English or multiple working languages including English' the second is 'Multiple working languages excluding English' and the third is 'One working languages excluding English'. Out of 98 initiatives, 92 are using English as working language, from these 73 initiatives use only 'English' and 19 initiatives use 'Multiple

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working languages including English'. No initiatives using 'Multiple working languages excluding English' have been identified in this study. Finally, 6 initiatives are using 'One working language other than English' (5 German and 1 Portuguese).

1.1.13. Years of existence

The criterion 'Years of existence' includes three different categories. The first is 'More than 7 years of existence', the second is '2 to 7 years of existence' and the third is 'Less than 2 years of existence'. From the 98 initiatives, more than a half (51 initiatives, 52%) are existing longer than 7 years. 31 initiatives (32%) are existing for 2 to 7 years and 16 initiatives (16%) have less than 2 years of existence. Of these 16 initiatives 10 are projects, mainly funded by the EC and these are often short term.

1.1.14. Source of financial resources

The criterion 'Source of financial resources' includes four different categories: 'Government', 'Industry', 'Intergovernmental organisations' and 'Unknown'. From the 98 initiatives, almost half (49 initiatives) are financed by industry (47%), 27 initiatives by 'Intergovernmental organisations' (26%) and 19 initiatives by 'Governments' (18%). At least five of the initiatives are financed by multiple sources. As many initiatives do not provide public data on this criterion, the source of financial resources could not be identified for 10 initiatives. Figure 12 shows the frequency of the 'Source of financial resources' in the identified initiatives.

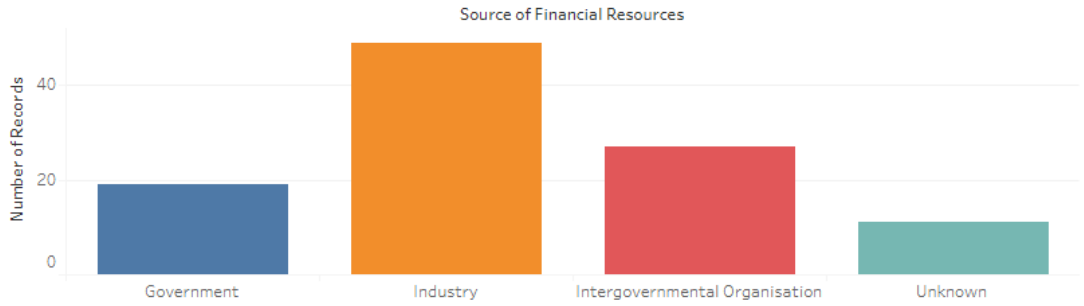

Figure 12: *'Source of financial resources' in identified initiatives.*

1.1.15. Least prevalent categories in the identified initiatives

In the identified initiatives, some categories were not identified or only occurred a limited number of times. These include the categories with the following criteria:

- Organisational structures: 'Partnerships', 'Expert Group', 'Communities'
- Type of stakeholders: 'Civil Society/the public', 'IGO' and 'NGO'
- Initiatives with less than seven stakeholders
- Target audience: 'IGO' and 'NGO'
- Initiatives that exist less than two years
- Initiatives with another working language than English

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- Source of financial resources: 'Government'
- Activities: 'Development of certification and standards', 'Development of tools and technologies'
- Step in the value chain: 'Transport and supply chain' and 'Product development'
- Geographic focus: 'Regional: North America', 'Regional: Africa', 'Regional: Asia', 'Regional: South America', 'Regional: Australia'
- Objectives and strategies: 'Improving energy efficiency and climate change policies', 'Social and Economic Development (EU)' and 'Security of supply/material substitution'

The list provides a first indication of the characteristics of worldwide initiatives. It is to be reminded that not all initiatives could be included in this stage. It is therefore recommended to keep tracking and reaching out to external partners. In particular, it would be interesting to map initiatives within the above-mentioned categories, for instance: initiatives with a geographic focus on North America, Africa, and Asia, initiatives with Objectives and strategies on 'Improving energy efficiency and climate change policies', 'Social and Economic Development (EU)' and 'Security of supply/material substitution' and initiatives with as target audience 'IGO' and 'NGO'.

1.2. Analysis of Metrics

1.2.1. Introduction

In this section, the indicators (high, medium, or low priority) and metrics (numerical value linked to each indicator) attributed to the different criteria and categories that have been developed in task 1.2 (see Table 5 'Overview of Indicators and Metrics' in deliverable 1.2), will be used to have a very first assessment of the mapped initiatives.

The metrics identified in this work package are based on the priorities of the partners in FORAM project. In a questionnaire, all the criteria and categories were listed to which each partner indicated his/her priority, choosing from high, medium, low and no priority. Based on the average of all partners, the metrics were established. The argumentations for the metrics were compiled, a summary of the argumentations for each criterion can be found in Annex 2 and further information about the methodology can be found in deliverable 1.2. These metrics have been tested in this report to make an initial assessment of the identified initiatives. However, in order to be able to more systematically evaluate and rank the initiatives, it is essential to elaborate further on FORAM priorities in the next stage of the project and to identify more available initiatives that might be missing in the current list. These metrics will be used in the next phases of the project (including the stakeholder dialogue in WP 2) to evaluate the initiatives important for FORAM.

1.2.2. Application of indicators and metrics to the criteria

Under each criterion, the number of high, medium and low priority categories have been added (column 'Number') and the corresponding metrics have been applied to give the number of points

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of each category (column 'Points'). Table 1 gives an example, using the criterion 'Organisational structures'.

Priority		Number	Points
Organisational structures	Medium Priority (4)	19 Projects + 6 Platforms + 2 Study Groups + 2 Working Groups + 2 Communities + 2 Partnerships + 1 Expert Group + 1 Panel = **35**	35 x 4 = **140**
	High Priority (6)	40 Associations + 10 Initiatives + 7 Alliances + 6 Forum = **63**	63 x 6 = **378**
	Total	**98**	**518**

Table 1: Indicators and Metrics' total points for the 'Organisational structures' criterion.

The following table gives an overview of the priority and metrics for all criteria.

	Priority	Number	Points
Type of stakeholders (High Priority)	Medium Priority (6)	11	66
	High Priority (9)	87	783
	Total	**98**	**849**
Objectives and strategies (High Priority)	Medium Priority (6)	10	60
	High Priority (9)	88	792
	Total	**98**	**852**
Activities (High Priority)	Medium Priority (6)	18	108
	High Priority (9)	80	720
	Total	**98**	**828**
Target audience (High Priority)	Medium priority (6)	3	18
	High Priority (9)	95	855
	Total	**98**	**873**
Organisational structures (Medium Priority)	Medium Priority (4)	35	140
	High Priority (6)	63	378
	Total	**98**	**518**
Type of Raw Material (Medium Priority)	Low/No Priority (0)	5	0
	Medium Priority (4)	37	148
	High Priority (6)	56	336
	Total	**98**	**484**
Number of Stakeholders (Medium Priority)	Low Priority (2)	10	20
	Medium Priority (4)	49	196
	High Priority (6)	39	234

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	Total	**98**	**450**
Geographical focus (Medium Priority)	Medium Priority (4)	10	40
	High Priority (6)	88	528
	Total	**98**	**568**
Step in the value chain (Medium Priority)	Medium Priority (4)	8	32
	High Priority (6)	90	540
	Total	**98**	**572**
Data description (Medium Priority)	Not applicable	52	0
	Low Priority (2)	6	12
	Medium Priority (4)	15	60
	High Priority (6)	25	150
	Total	**98**	**222**
Data access (Medium Priority)	Not applicable	56	0
	Medium Priority (4)	15	60
	High Priority (6)	27	162
	Total	**98**	**222**
Language (Low Priority)	High Priority (3)	92	276
	Medium Priority (2)	0	0
	Low Priority (1)	6	6
	Total	**98**	**282**
Years of existence (Low Priority)	High Priority (3)	51	153
	Medium Priority (2)	31	62
	Low Priority (1)	16	16
	Total	**98**	**231**
Source of financial resources (Low Priority)	Medium Priority (2)	88	176
	Low Priority (1)	10	10
	Total	**98**	**186**

Table 2: Overview of Indicators and Metrics total points per criterion.

Unsurprisingly, criteria with high priority (and higher points) receive the highest score, with more than 800 points each: Target audience (873), Objectives and strategies (852), Type of stakeholders (849), and Activities (828).

There are more discrepancies among the medium priority criteria, receiving between 220 and 582 points: Geographical focus (582), Step in the value chain (572), Organisational structures (518), Type of raw material (484), Number of stakeholders (450). While being medium priority criteria, Data description and Data access receive both a relatively low scoring (220 points), closer to the

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score of low priority criterion. This could be explained by the fact that only a part of the initiative mapped have data on primary and secondary raw material that are publicly accessible. A detailed analysis of the available databases related to raw material is developed in chapter 'Availability of information on raw materials'.

Finally, criteria with low priority receive around 200 points: Language (282), Year of Existence (231), and Source of financial resources (186).

1.2.3. Application of indicators and metrics to the initiatives

Besides this global analysis, indicators and metrics have also been applied and summed for each initiative, in order to get a first quantitative ranking among initiatives mapped. It is to be noted that this method has been developed to perform only a first review of the mapped initiatives, based on established characteristics (criteria and metrics) and reflecting only the priorities as expressed by the current FORAM partners. It is recommended to conduct a sensitivity analysis with this list depending on the specific topics of a stakeholder dialogue. This is possible by adjusting the weighing factors in the metrics or by filtering the list looking at specific aspects (regional focus instead of global, primary or/and secondary raw materials and so on). This review will be updated based on further development of FORAM's priorities, collection of additional data and mapping of new initiatives.

The maximum number of points an initiative can get is 86 (9 points for the 4 high priority criteria, 6 points for the 7 medium priority criteria and 3 points for the low priority criteria, considering that 'Source of financial resources' have only medium priority as a maximum). Almost all initiatives mapped at this stage, have received high to medium ranking and none of them can be rated as low priority for the objective of the FORAM project. As mentioned before, after the process of stakeholder consultation, we will be able to conduct a more systematic evaluation and benchmarking of the initiatives.

The following table (Table 3) shows how the metrics apply to the various criteria and categories, using as example a fictive initiative 'A'. This fictive initiative comes out of the metrics calculations with the highest priority as it receives the highest number of points for each criterion. For further information, please refer to the summary of argumentation (Annex 2) and deliverable 1.2 'Indicators and metrics for the mapping'.

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Acronym	Language	Organisa-tional structure	Objectives and strategies	Year of establish ment	Type of Raw Material	Type of Stakeholder s	Number of Stakehol ders	Step in the value chain	Activities	Descripti on of data	Data access	Geograp hical focus	Target audienc e	Source of financial resourc es
A	English	Forum	Capacity development, Enhance environmental sustainability and protection, Social and economic development, Policy and governance contribution, Other	2002	Multiple	IGO, Government	55	Mining/ Extractio n	Networking and strengthening cooperation, Capacity building, Research	Data on primary raw material extractio n/ beneficat ion	Public	Global	Govern ments Industr y	Govern ment Industry
	3	6	9	3	6	9	6	6	9	6	6	6	9	2

Table 3: Example of ranking applying the metrics to the criteria and categories of an initiative

1.3. Mapping of Individual stakeholders

In addition to the initiatives, the FORAM project mapped 452 individual stakeholders based on information collected through the FORAM partners' networks. Most of these individual stakeholders are companies (57%), followed by governmental organisations or institutions (23%) and universities and research centres (19%). The remaining stakeholders (1%) are non-governmental organisations.

Of the individual stakeholders identified more than half are involved in mining/extraction (56%). A quarter of the stakeholders (25%) are involved in multiple steps of the value chain. This is followed by stakeholders involved in processing (11%), manufacturing (4%) and recycling/re-use (4%).

More than half of the identified stakeholders are located in Europe (59%). Around 10% of the stakeholders are in Africa (11%), Asia (9%), South America (8%) and North America (8%). Finally, there are some stakeholders identified in Australia and Oceania (3%) and Central America (2%). The FORAM mapping of- and engaging with individual stakeholders will be an ongoing activity.

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2. Availability of information on raw materials

2.1. Methodology for collecting databases with information on raw materials

The other goal of task 1.3, besides the mapping and assessment of initiatives, is the creation of an overview of available data on primary and secondary raw materials. This overview focuses on different categories connected to available information on primary and secondary raw materials. These categories cover:

- the use and needs of raw materials in industrial sectors important for EU economy and society;
- overall resources, geological distribution, general availability and accessibility;
- geopolitical, economic and financial information;
- current status of use, re-use, recycling, substitution of raw materials; and
- ecological and social impact.

The objective of this sub-task was not to create or collect new data on these categories, but to compile already existing web-based databases in one clearly arranged directory. The information of this compilation is shown as a table in Annex 4 and provided via the FORAM website.

Databases containing information on the above mentioned categories were gathered by all task partners in one table. After the evaluation of a first overview of databases, the criteria for the final collection were defined as shown in Table 4.

The description for the criteria 'Type of data' should consider the possibility to merge or integrate data. Map viewers can often be integrated in the viewers of other providers for example as web map service (WMS). One very good example is the map service of BRGM, which has integrated the results of the projects ProSum, ProMine, EURARE and Minerals4EU (as example http://minerals4eu.brgm-rec.fr/minerals4EU/). Databases could offer the possibility to download the content of single datasets for example as Excel-file (for example EUROSTAT, resource trade).

The focus of the collected directory is on public available data. Nevertheless, it is possible that some restricted databases or public databases using an obligatory registration are integrated in the directory.

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Criteria	Description of criteria	Criteria	Description of criteria
Name	Free text: Name/short name of database	**Description**	Free text: Short description
Provider	Free text: Provider of the database or host of the website	**Information on**	Selection field: Resources Geopolitics, Politics Economics Technology Environment Social Combination of the criteria
Raw Material	Selection field: Primary raw materials Secondary raw materials Primary and secondary raw materials Products Primary raw materials, Products Secondary raw materials, Products all Not applicable	**Type of raw material**	Free text: If more information is available
Geographical focus	Selection field (same as in list of initiatives): Local National Regional: Europe Regional: South America Regional: North America Regional: Asia Regional: Africa Regional: Australia Global Not applicable	**Type of data**	Selection field: database statistical database map viewer map viewer, database directory database, reports reports software no data provided at the moment
Geographical coverage	Free text: If more information is available	**Data content**	Free text: Description of the content of the provided data
Homepage	Free text: Link to the main homepage	**Database URL**	Free text: Direct link to database

Table 4: Description of criteria

Information on the up-to-dateness and hence for the resilience of the data could not be integrated in the overview as the provider of the databases in most cases do not offer any information on the

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last updates, update frequency of information or on the methodology of how a good quality of the data is ensured. To ensure at the best extent possible the quality of the data in the overview, only databases of reliable sources (geological survey, on-going projects, associations…) were included. The links to the single databases were double-checked. If the link to a database was not valid or the provided data was outdated and the homepage no longer operated, the database was removed from the overview.

2.2. Directory of databases on primary and secondary raw materials

The directory of databases is shown as table in Annex 4 of this report. To ensure a good readability the table is shorten to the columns 'Name', 'Description', 'Raw material', 'Type of data' and 'Database URL'. To spread the information in the community and to ensure a good visibility, this directory of databases is also implemented in the FORAM website. On the website presentation, all collected information will be displayed.

The collection of databases for the following assessment was closed at 14th July 2017. The following sub-chapters describe the availability of information regarding raw materials to the different sub-topics as static picture to this state of knowledge. The web-based directory will be checked (functioning of links, provided content) and continuously up-dated until the end of the project.

The FORAM directory, which is a meta-database of databases, has collected information on 108 databases until the closing date (14th July 2017). Information are mainly provided to resources (55 databases), followed by environmental (33 databases), economic (31 databases) and geopolitical (20 databases) information. Technological and social information are less provided in the FORAM directory of databases. In the category 'Information on' and for the categories 'Raw material' and 'Type of data', the choice of multiple selections was possible. Primary raw materials are well represented in the FORAM directory. 88 databases (more than 80%) contain data on primary raw materials, followed by data on secondary raw materials (56 databases, 51%). Data and information are primarily provided as databases (50%), map viewer or reports (each 26%). The following charts in Figure 13 show the distribution among the different criteria of the FORAM directory of databases.

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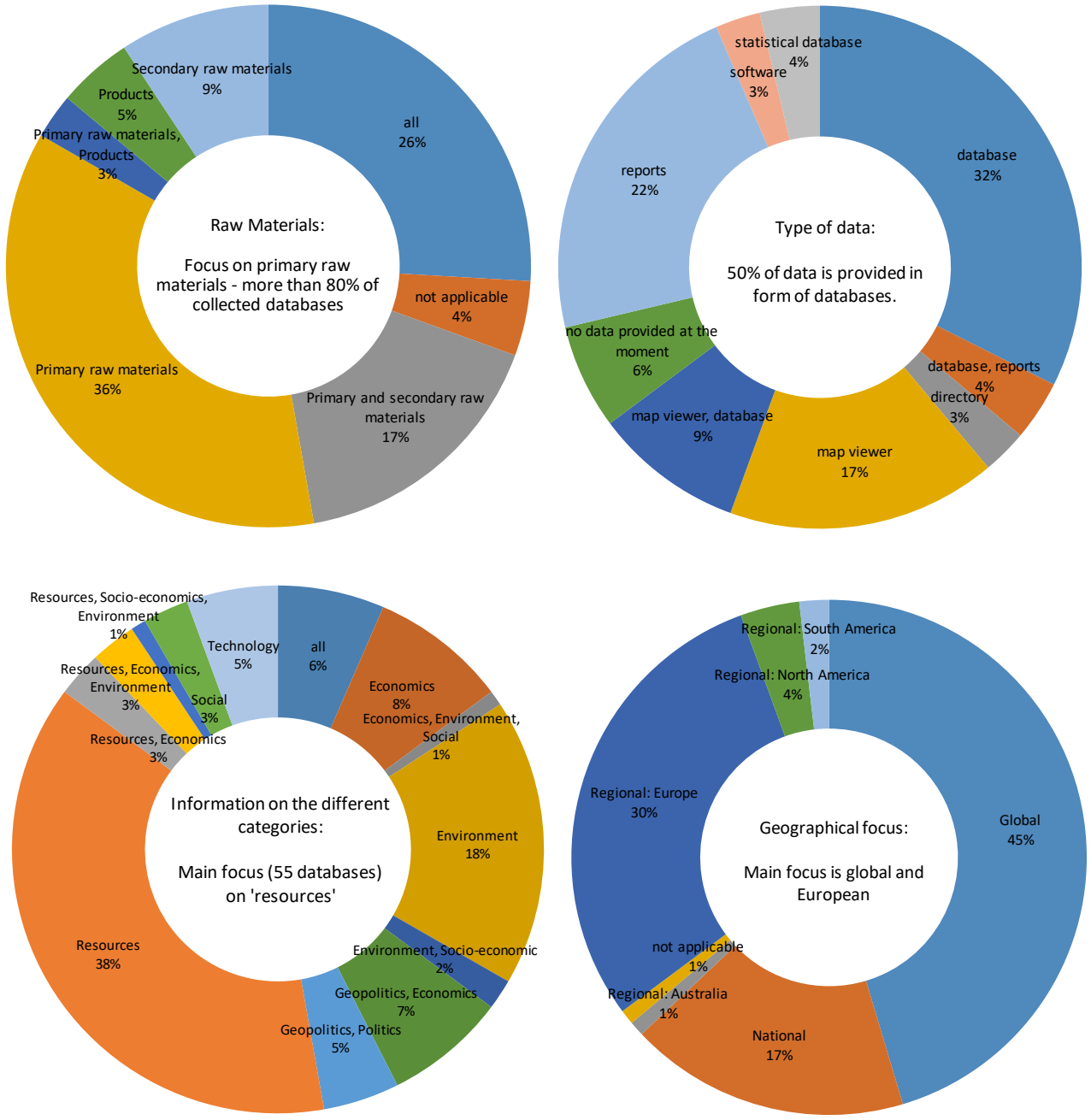

Figure 13: *Distribution among criteria of FORAM directory*

2.2.1. Use and needs of raw materials in industrial sectors

The collected databases in the FORAM directory are difficult to evaluate regarding the use and needs in industrials sectors. Therefore, an exchange of information was initiated with the project

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MATCH. The European Horizon 2020 project MATCH (Materials for a Common House, January 2015 – June 2017) has undertaken an evaluation of research and development in all kinds of materials on regional, national and European level[4]. In total, more than 1,300 projects were evaluated by materials experts on the kinds of materials used, on applications, key enabling technology sectors (KETS) and their project scope in view of the industrial needs. Most of the evaluation criteria were additionally divided in sub-criteria to get more detailed information. All information is collected in the MATCH database (MATCH WEB DB) which can be accessed by the MATCH webpage (www.match-a4m.eu). In addition to this information, various stakeholder workshops with experts from industry, research and technology organisations were carried out by the MATCH project to make correlations between the materials research and the application side.

The evaluation of the data will lead to a materials roadmap, which is still confidential as long as the MATCH project is not fully evaluated. However, some information can already be given:

There are various former and current roadmaps developed in the last years by different organisations which are helpful to relate materials and their functions (innovation push) with industrial needs for the next technology or product innovation (innovation pull). MATCH partners have already evaluated some of the roadmaps; MatSearch (partner of project FORAM) has newly evaluated others. The list has been prepared to relate materials to their applications/industrial sectors. The following roadmaps were evaluated: SETIS EC roadmap (2011)[5], SETIS EC roadmap (2014)[6] Strategic Energy Technology, Strategic Research Agenda of EuMaT Technology Platform on Advanced Engineering Materials and Technologies (2016), NANOFuture (2015)[7], 4M2020 (2016), ESTEP Strategic Research Agenda (2013)[8], SusChem Strategic Innovation and Research Agenda (2017)[9].

The outcome of the research on the roadmaps of the various European Technology Platforms shows materials interest under the different objectives of the organisations involved. The evaluation highlights also problems in the assignment of materials to applications. It is not possible to define the need in research and development of certain materials as they are not classified in the same way as materials engineers and scientists are using the terms. Instead of classification, the authors of roadmaps often use the expressions like 'advanced materials', 'functional materials' and 'smart materials', which are difficult to assign to materials classes. Therefore, the evaluation of materials related roadmaps becomes very difficult especially if the use of and the demand for critical raw materials should be investigated. Taking the information from the various roadmaps and from the MATCH database, a certain ranking of application and materials groups can be presented (Figures 14 and 15).

[4] http://www.match-a4m.eu/
[5] https://setis.ec.europa.eu/about-setis/technology-map/2011_Technology_Map1.pdf/view
[6] https://setis.ec.europa.eu/system/files/Towards%20an%20Integrated%20Roadmap_0.pdf
[7] http://nanofutures.eu/sites/default/files/VALUE4NANO%20Implementation%20roadmap.pdf
[8] https://www.estep.eu/ftp.cordis.europa.eu/pub/estep/docs/sra-052013-en.pdf
[9] www.suschem.org/files/library/.../SIRA_Brochure_Web.pdf

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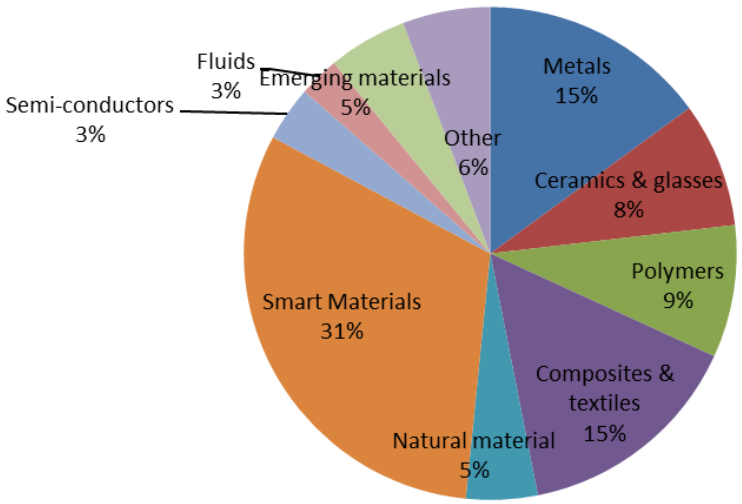

***Figure 14**: Materials investigated in European Programmes under FP7 and Horizon 2020 (evaluated by the MATCH DB of more than 1300 R&D projects. Source MATCH Project, CEA Liten)*

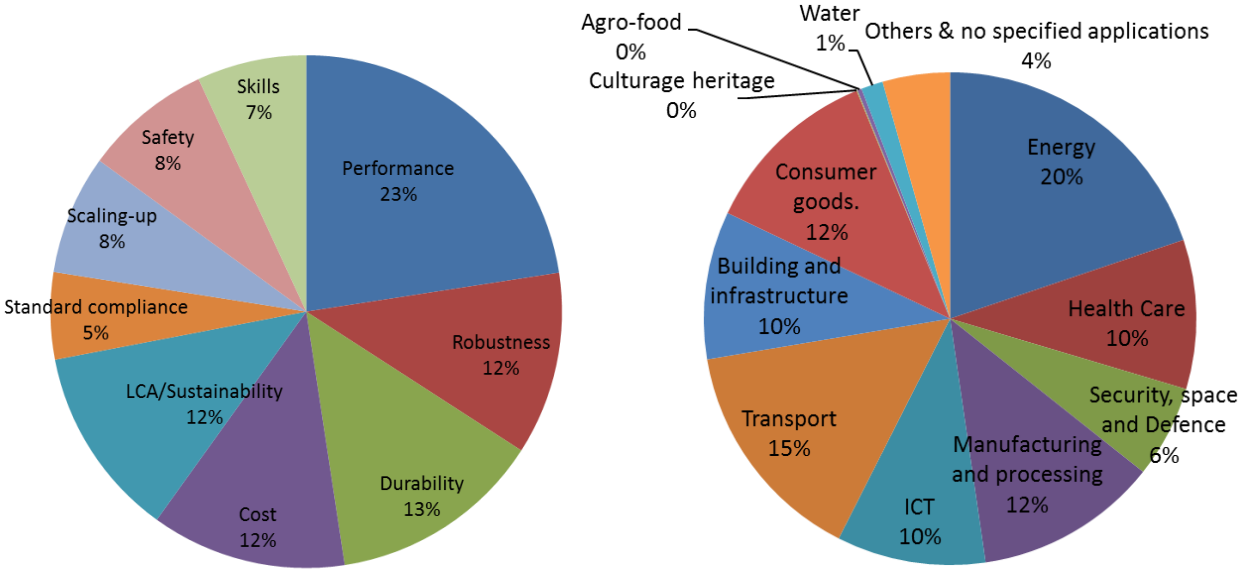

***Figure 15:** left - Application requests related to materials research and development, right - Application fields related to materials research and development both performed in European Programmes under FP7 and Horizon 2020 (evaluated by the MATCH DB of more than 1300 R&D projects. Source MATCH Project, CEA Liten)*

The roadmaps are presented by organisations which are related to the chemical industry (SusChem), new energy politics (SETIS), materials R&D as such (EuMat), steel and construction (ESTEP), nanomaterials and nanotechnology (NanoFuture) and projects like 4M2020, a FP7 project that will 'facilitate cross fertilisation of product centred advanced manufacturing platforms along the five R&D+I streams'.

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Although the energy sector is the most important one if looking into the roadmaps, also other industrial sectors are important in view of the materials used and needed. Three main industrial sectors can be shown as drivers for materials R&D:

1. Energy Sector and Transportation: Energy production, energy transmission, energy storage (especially also transportation)
2. Construction Sector: Steel for construction important also for the energy sector, steel for transportation – especially the automotive sector
3. Chemical Engineering and Manufacturing Industry: important for all kinds of final products and end-users of energy, transportation, consumer goods

All these sectors demand for advanced materials and smart materials, which is reflected also by the information of the MATCH database.

As a conclusion of the evaluation of different roadmaps (only the most important materials related roadmaps in Europe were evaluated for this report) and the evaluation of materials related R&D projects shows a clear demand for advanced, smart and functional materials being semiconducting materials, advanced steels, advanced light materials, coatings, polymers, especially bio-based materials and all kinds of composites.

2.2.2. Overall resources, geological distribution, general availability and accessibility

Among the databases mapped by FORAM, one half of all (51%) are providing information on resources. As shown in Figure 16, 41 databases (75% of resource databases) are offering information about resources, 5% are containing additional data on economics or economics and environment and 2% also on socio-economic and environmental aspects. 13% of these databases combine information on all categories.

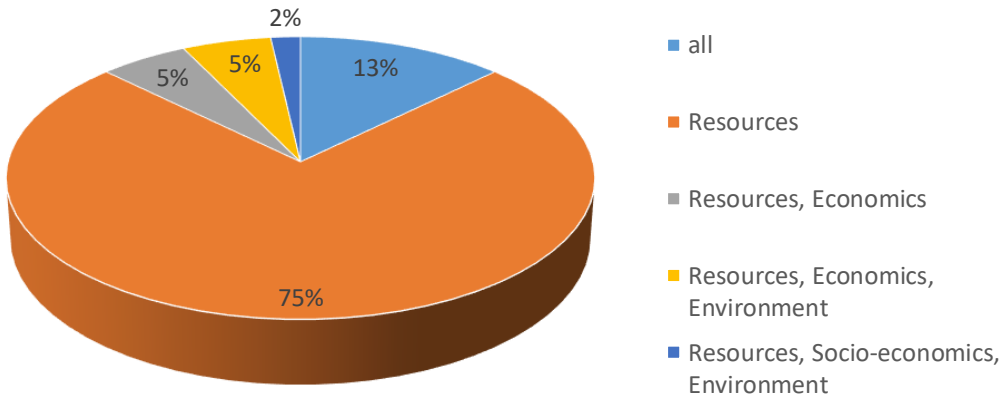

Figure 16: *Distribution of kind of information in databases.*

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87% of the databases are offering information on primary raw materials (26 databases only on primary raw materials, 11 on primary and secondary raw materials, 2 on primary raw materials and products and 9 to all types of raw materials). 47% of the resource-connected entries are providing data on secondary raw materials. Only 6 databases out of this are focussing only on secondary raw materials. Figure 17 shows the number of databases focussing on the different types of raw materials. The database that has no applicable assignment to one of the categories contains data on the earth's surface.

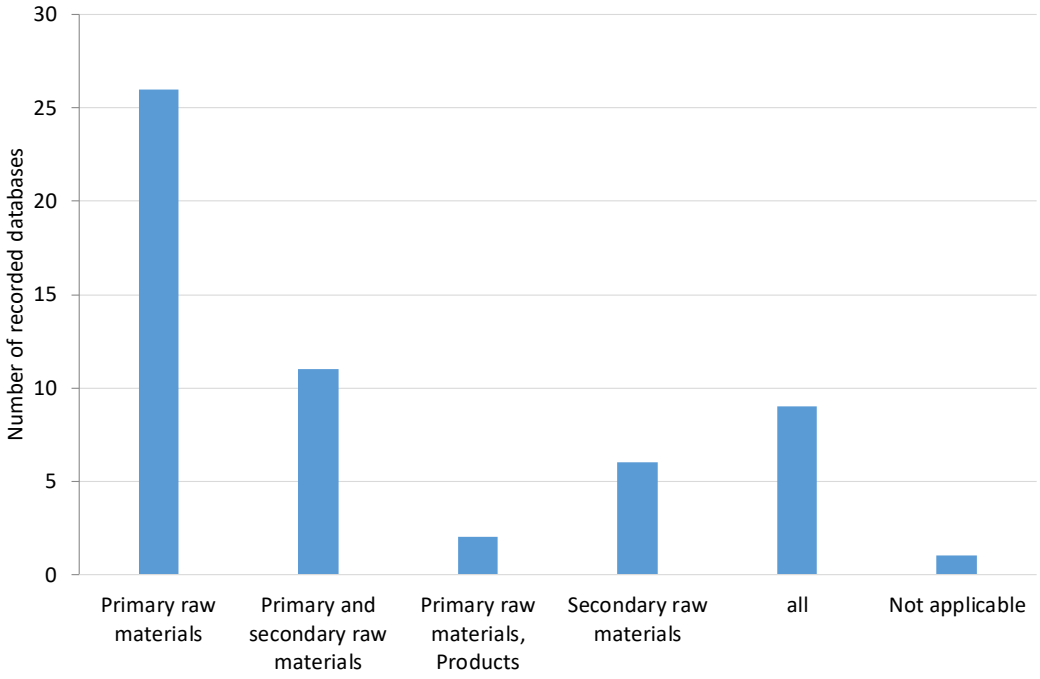

Figure 17: Number of resource databases focusing on different material groups.

Databases concentrating on primary resources are providing mainly information on natural mineral resources (occurrences of metal ores and industrial minerals). Some of these provide also information on mining operations (e.g. BGR) or on specific materials such as critical raw materials, precious metals, base metals or energy metals (EGDI). Broadening the focus additional to secondary raw materials information on mining wastes or landfill stocks (anthropogenic deposits) are contained in the databases. Additional to natural mineral sources and metals, aggregates come into focus. Looking at the criteria 'Products', chemicals are the most mentioned specific raw materials. In the case of secondary raw materials WEEE, mining and landfill waste, metallurgical and incineration residues, as well as C&D waste are in the focus.

As illustrated in Figure 18, a closer view on the geographical focus of the resource databases shows a well-proportioned share between a global (31%), national (22%) and European (40%) focus. Databases with a regional focus on Australia, North and South America are less represented (2-3%). Databases with national focus are concentrating mainly on primary raw materials, one database

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has additional information on secondary raw materials (Czech Geological Survey) and one is only looking at secondary raw material (mining waste, metallurgical residues). All of the primary raw materials databases with national focus are operated by the respective geological survey. The databases with a regional focus on Europe are often provided by European projects (H2020: ProSum, CloseWEEE, Minventory, MICA, …) or European agencies (EUROSTAT, EuroGeoSource, RMIS by JRC…). Looking at databases of European projects, often data of the participating countries are provided.

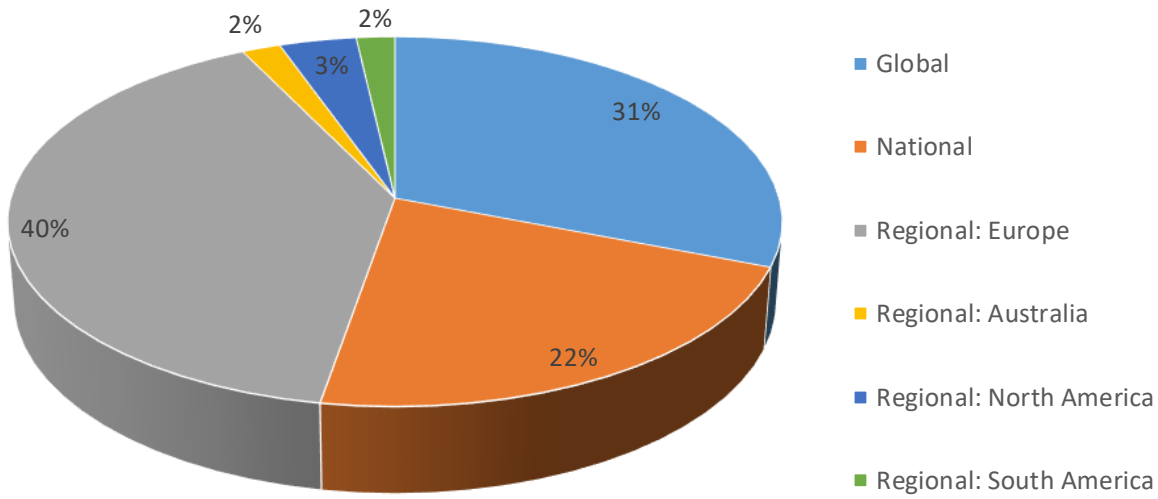

Figure 18: *Geographical focus of resource databases.*

As shown in Figure 19, the majority of databases provide the data in form of map viewers (27%) followed by databases (25%, thereof 7% statistical databases) or a combination of both (13%). Additional 4% combine database and reports in their data portfolio. 18% of the databases contain reports (e.g. fact sheets, country or material profiles, publications). Less represented (4%) are directories containing links to information or datasets. 9% of the databases do not provide data at this moment. These are mainly recently launched H2020-projects, which describe in their objectives the development of knowledge platforms, databases or map viewers.

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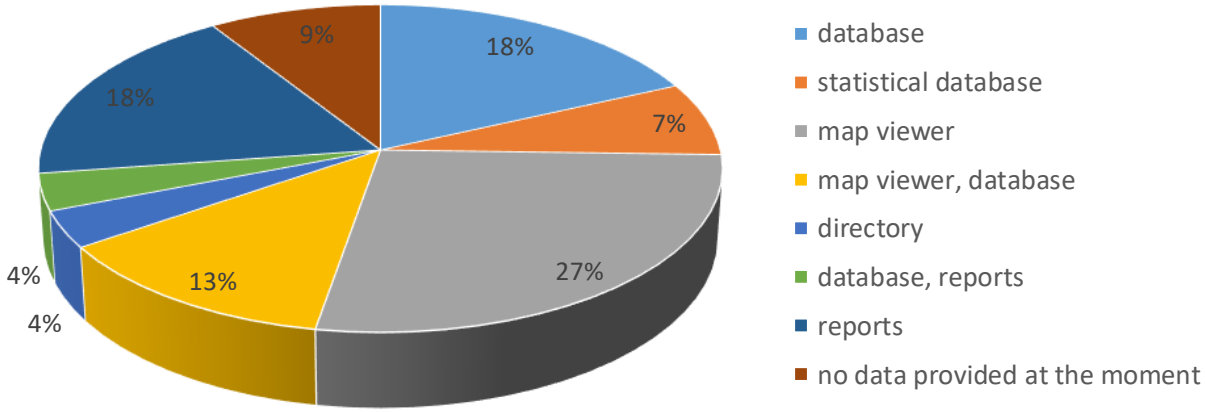

Figure 19: *Type of data.*

2.2.3. Geopolitical, economic and financial information

Excluding the databases that contain all criteria, the FORAM directory indicate further information under the subject geopolitics (13 databases) as illustrated in the following diagrams (Figures 20-23). This information facilitates the search in the FORAM database. As shown in Figure 20, more information about primary raw materials (38%) are given than about secondary raw materials (15%) and that part of the databases contain both information (31%).

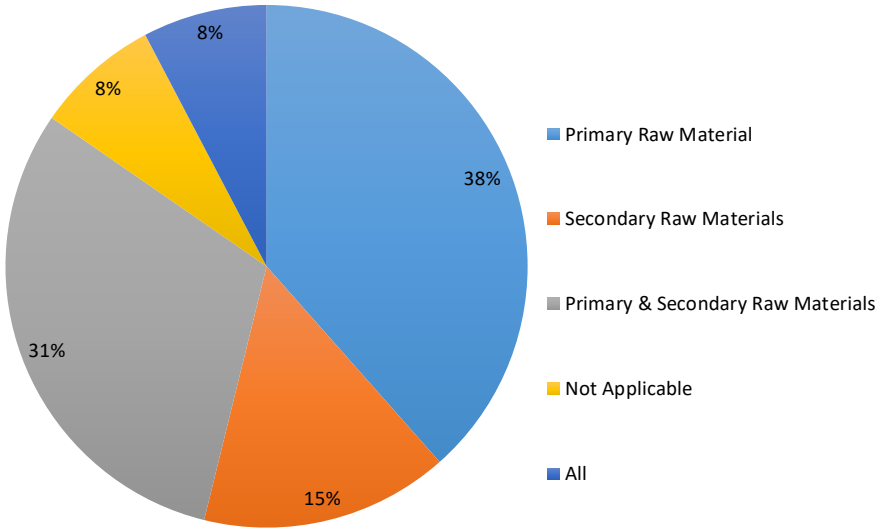

Figure 20: *Information about the kind of raw materials described in the information system.*

Most of the information systems (Figure 21) allow to search globally (46%) followed by regional information in Europe (38%). Databases with a national focus or with a regional focus of South

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America are less represented (one database each). The information systems provided via websites are mainly databases and reports (both 38%).

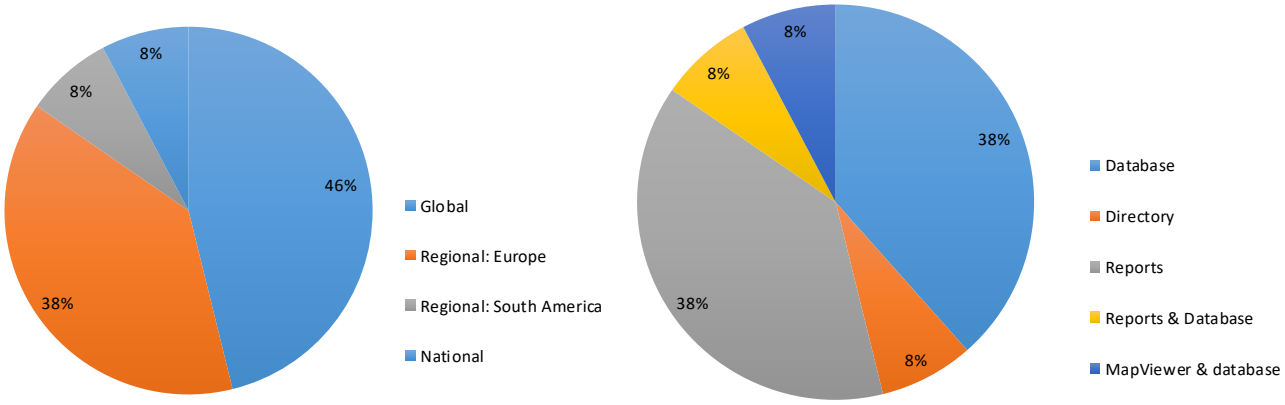

Figure 21: *left - Information about the areas which are covered by the information system; right – Type of data which can be found by the FORAM directory*

Regarding databases with an economic focus, 27 databases could be found in the FORAM directory (excluding databases containing all criteria). As shown in Figure 22, 33% of these databases dealing mainly with economic issues like commodity prices or trade flows. In combination with geopolitical information, 30% of the databases are in the FORAM directory, followed by a combination with resources and environment (15%). Similar to the geopolitical databases the focus of the economic databases is also on primary raw materials (48%) or on all types of materials (30%). There is no economical database looking only at secondary raw materials.

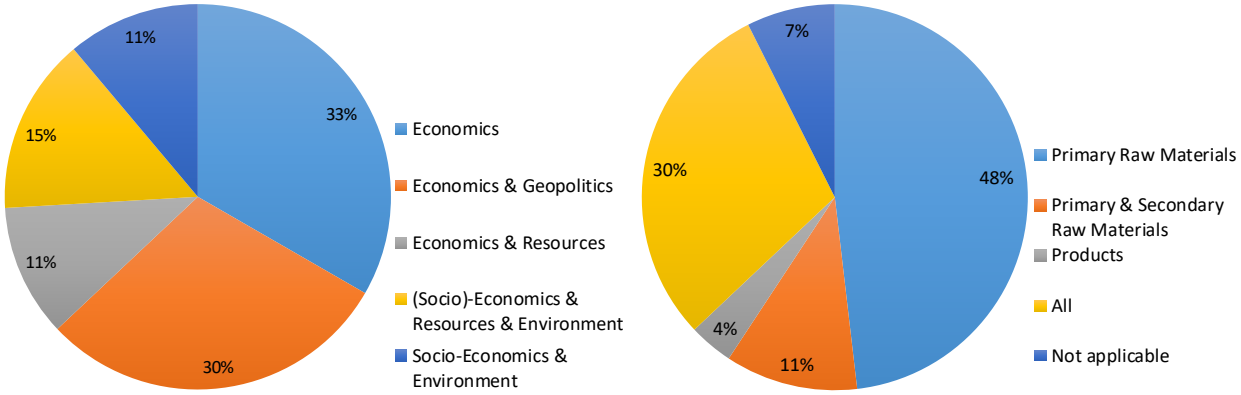

Figure 22: *left - Information about areas; right – Type of raw material*

A majority of databases is focusing on global data (22 databases) and only 11% (3 databases) are concentrating on Europe. Most of the information are provided via databases (15 entries) or reports (7 entries). Two databases are working with map viewers to illustrate commodity flows (Figure 23).

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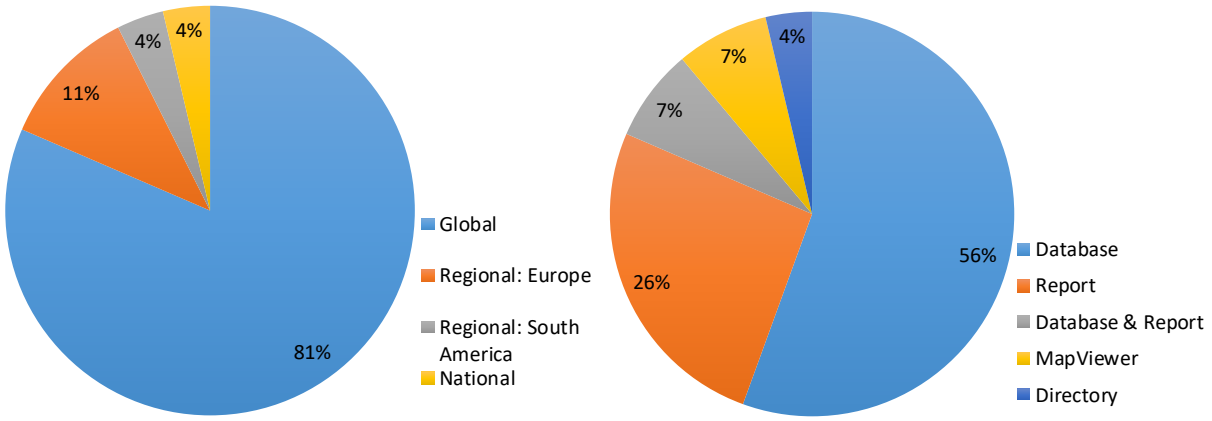

Figure 23: *left – geographical focus; right – Type of data provided by economic databases*

2.2.4. Current status of use, re-use, recycling, substitution of raw materials

Six databases out of 108 provide information on technologies. One database will in future summarize technological information on primary raw materials and is hence not in the focus of the discussed topic. Two databases are providing reports on secondary raw materials, one of them with a specific focus on rare earth elements. In the other databases information on primary and secondary raw materials are compiled. This shows that regarding technical issues the origin of material is not in the first sight essential, but the composition of the material and the content of valuable raw materials. The latter datasets provide information on critical raw materials, refractory metals as well as metals and minerals in general.

Additional four databases provide different information to all categories and have technological data as one aspect.

The information on the status of use, re-use or recycling can usually be found in reports, for example as factsheets on metals or mineral profiles. The geographical focus of the databases is on Europe (3 databases), national or global (in each case 1 database). In future, the landscape of available data will be probably improve as there are several ongoing projects with the objective to provide raw material specific databases (for example: SCRREEN – EU CRM Knowledge base, SMART GROUND - Data and information on secondary raw materials, STRADE – Raw materials profiles).

As the number of databases in the field of the status of use, re-use, recycling and substitution is quite low and respectively the information is dispersed throughout the databases, current information is summarized for selected raw materials in the information sheets given in this report (Annex 5). These sheets contain information about the industrial use, re-use, recycling and substitution of specific raw materials/group of raw materials taken from the directory of databases and the list of initiatives. They are not showing the current state-of-the-art or best practices for the

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single materials, but they give an overview on the information that can be found in the FORAM list of initiatives and directory of databases. The sources of information and, if possible, the last updates are indicated in the tables. Potential primary references for the information are documented in the given sources. Further information (e.g. deposits, markets, specifications) can be found under the quoted links.

A missing entry in the information sheets does not automatically mean that there is no re-use or no recycling. Missing entries only shows that during the short evaluation of the FORAM directory, information to those entries could not be found.

Comparing the materials in Annex 5 with the high priority 'Types of Raw Materials'-indicator from the metrics (deliverable 1.2) some gaps in the information to raw materials are revealed. For example, information on antimony, chromium, cobalt, magnesium, niobium, platinum group metals, rare earth elements (without differentiation in light and heavy REE), tantalum and tungsten can be found in different depths in more than one source. Whereas less information is provided to gallium, indium, germanium and beryllium, which are also on the list of critical raw materials.

A closer look at the sub-criteria of this topic shows that the re-use of materials either does not happen or is not reported in the online-presentations of initiatives and databases. Only few information could be found about the re-use of raw materials.

2.2.5. Ecological and social impact

Out of 108 databases, one-third (36 databases) are providing data on ecological and/or social impacts of raw and secondary materials.

Out of these 36 databases, 33 databases (92%) are containing environmental information and 11 databases (31%) social information. As shown in Figure 24, 19 databases (53%) are providing solely information on ecological impacts and 3 databases (8%) solely on social impacts. 15 databases (39%) are containing a mix of environmental, economic, socio-economic, social and resource-oriented information. The databases cover a wide range of ecological and social aspects regarding extraction of primary raw materials and production of raw materials. They are containing information on material use, consumption of energy and waste generation.

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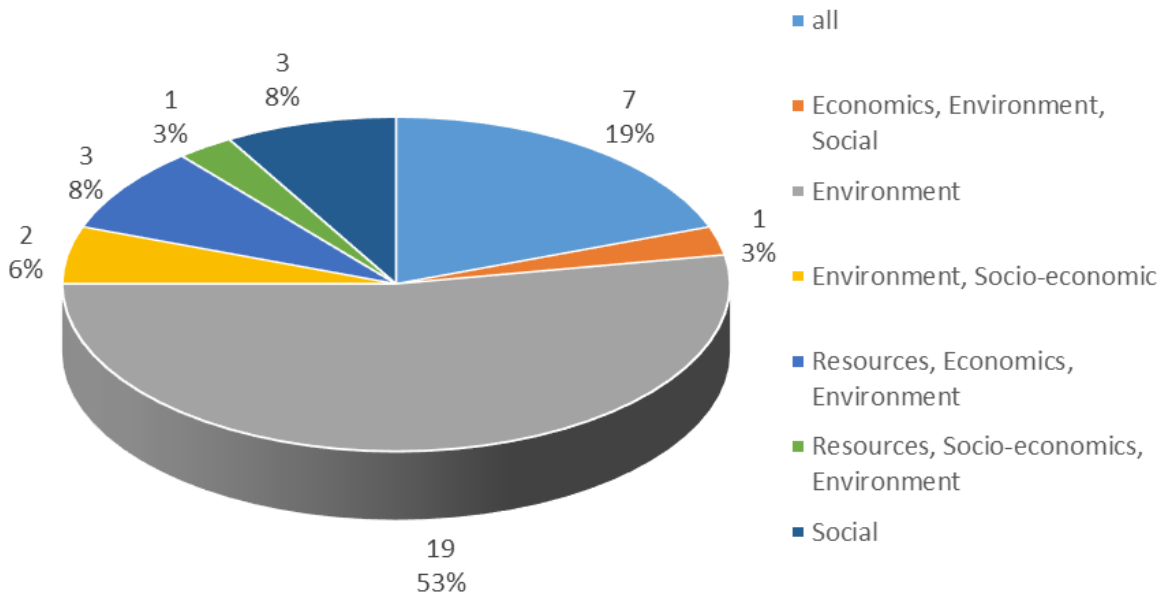

Figure 24: Databases providing information on ecological and/or social impacts

Nearly half of the databases are providing data that are used for life cycle assessment (LCA) to determine environmental impacts, e.g. global warming, stratospheric ozone depletion, photochemical oxidant formation, acidification, nutrient enrichment or human toxicity. There are databases covering all industrial sectors and processes worldwide and sector, product or country specific databases, e.g. BioEnergieDat for the German bioenergy sector (www.bioenergiedat.de) or Ökobautdat for construction materials (www.oekobaudat.de).

Some LCA databases are publicly accessible, e.g. the European Life Cycle Database or the Life Cycle Data Network (eplca.jrc.ec.europa.eu), the U.S. Life Cycle Inventory Database (uslci.lcacommons.gov) or ProBas (www.probas.umweltbundesamt.de). Other LCA databases are commercial software solutions, e.g. ecoinvent (www.ecoinvent.org) or GaBi (www.gabi-software.com).

Social and socio-economic LCA databases complementing environmental LCA databases and contributing to the full assessment of goods and services, e.g. the disturbance of local communities through raw material extraction. They provide access to social risk and opportunity information and methods to summarize this information into a social footprint.

Most databases are providing raw or aggregated data for further calculation of results. Four databases are using maps to provide information on environmental and social impacts. Materialflows.Net is visualising global material flows on national level and the related material footprint (www.materialflows.net), the PanGeo initiative shows the geological conditions capable of causing damage or loss of property and life for many of the largest cities in Europe (www.pangeoproject.eu) and the Environmental Justice Atlas (EJA) documents social conflict

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around environmental issues around the world (ejatlas.org). The National Pollutant Inventory of the Australian Government is providing data and maps about emissions and transfers from industrial sectors, e.g. mining sector (www.npi.gov.au).

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Conclusion

The *assessment of the mapped initiatives* reveals a significant interest of industry in the field of raw materials. 'Company/Industry' are on the one hand the most represented type of stakeholder; on the other hand, a majority of initiatives refer to this stakeholder group as main target audience. Besides the industrial sector, the academic sector is also well represented regarding the 'type of stakeholders' as well as the 'Target audience'. A further important target audience are 'Policy makers'. The 'Number of stakeholders' shows a wide variety between 2 and 4,200. With a majority of initiatives having between 7 and 40 stakeholders.

Most initiatives define multiple 'Objectives and strategies' and follow several 'Activities'. Whereas the assessment shows only little deviations between the recorded objectives (most mentioned topic with each 10% 'Policy and governance contribution' and 'Enhance environmental sustainability and protection'), a majority of initiatives identified 'Networking and strengthening cooperation' as important activity followed by 'Information exchange'. The 'Development of certification and standards' as well as 'tools and technologies' are less mentioned activities of the mapped initiatives.

As 'Organisational structure' almost half of the initiatives have the form of an 'Association'. Besides 'Associations', 'Projects' are also a wide represented organisational structure. A main difference between both structures is the pre-defined duration: 'Associations' are normally open-ended, 'Projects' have a pre-defined ending.

Regarding 'Type of raw material' and 'Step in the value chain' most of the mapped initiatives are not focussed on a single material or a single process step, but they are dealing with more than one step of the value chain for multiple materials. Less presented by the recorded initiatives are the 'Transport and supply chain' and the 'Product development'.

This report is the basis for the next phase of the FORAM project, Stakeholder Consultation (WP2 and WP4). During these work packages, a broader group of stakeholders will be approached and consulted and more ideas about the priorities will be collected. Furthermore, it is clear that not all initiatives could be included in this stage and identification of new initiatives will be continued in the course of the FORAM project. According to the new outcomes, there might be a need to adjust the weighing factors used in the metrics or the need to apply filtering looking at specific aspects before assessing the initiatives. With applying the adjusted metrics and indicators, we will be able to evaluate the initiatives and benchmark the best practices in future.

The *assessment of the recorded databases* shows a distinct focus on primary raw materials. Against this, information on secondary raw materials are less provided. One explanation could be that the reporting on primary raw materials has a long history. For example, to inform all kinds of stakeholders with public accessible data, is an established praxis of the national geological surveys. Examples of these databases are also implemented in the FORAM directory. Secondary raw materials are very heterogeneous in their content and in their origin. There is no common praxis on

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how to report on them, except the information given by Eurostat and the national statistic agencies. However, this information does not allow a direct estimation if there are specific raw materials in a waste flow and where these waste flows occur. Common standards on data reporting regarding urban stocks (landfills, mining/metallurgical heaps, cities, urban mining) or secondary raw materials (specifications, origin) are not widespread.

A closer look at the use and end-of-life phase of raw materials shows that for a majority of materials from the list of critical raw materials and conflict minerals (high priority for FORAM) information is provided by the initiatives and databases listed by FORAM. Less information is provided to gallium, indium, germanium and beryllium, which are also on the list of critical raw materials. Identifying this gap one further approach of FORAM could be to search for databases covering information on these materials and integrate them in the web-based FORAM directory.

Regarding the value chain, the topic re-use is under-represented in the FORAM directory. Based on this assessment it is not possible to state that re-use does not happen or that activities on re-use are not reported.

The analysis of the LCA databases shows that the life-cycle-wide use of primary raw material and the related environmental and social impacts are almost disregarded. It seems therefore worthwhile to add material input indicators like Raw Material Input (RMI) and Total Material Requirement (TMR) to address explicitly material resource use in the LCA framework to determine the environmental impacts by the resources taken from nature including unused extraction.

The assessment of the databases and the list of initiatives shows differences between the single records listed in the FORAM directory. On the one hand, databases can consist of a kind of ‘raw data’, for which expert knowledge is required in order to obtain required information. Other databases provide reports based on various datasets. This kind of data source is not a ‘database’ per se, but an assessment of data by experts and their individual assessments.

Further differences among the evaluated databases occur in the current state of the data. On the one hand, some databases list irregular data up to certain point in time, other databases deliver information (e.g. reports) for a certain period (often project duration). On the other hand, some databases (e.g. geological surveys) update frequently the webpage with new reports and information on various topics. How up-to-date a website is, is also relating to the organization that operates the website. Some websites are related to projects with a defined project duration. After the project ended, no further data or reports are available although the site is still active.

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FORAM

ANNEXES

ANNEX 1: Overview of criteria with frequency of categories and priority

Criteria	Categories	Number of Initiatives	Priority
Organisational structure (Medium priority)	Association	40	High
	Project	19	Medium
	Initiative	10	High
	Alliance	7	High
	Platform	6	Medium
	Forum	6	High
	Study Group	2	Medium
	Working Group	2	Medium
	Community	2	Medium
	Partnership	2	Medium
	Expert Group	1	Medium
	Panel	1	Medium
Type of stakeholders (High Priority)	Company/Industry	71	High
	University/Academia/Research center	48	Medium
	Government department/organisation	31	High
	Association	20	Medium
	IO	16	Medium
	NGO	17	Medium
	Civil society/the public	12	Medium
	Initiatives	9	High
	Other	3	Low
Number of stakeholders (Medium Priority)	More than 40	39	High
	7 to 40	49	Medium
	Less than 7	8	Low
	Unknown	2	Low
	Total	99	Low
Target audience (High Priority)	Industry	86	High
	Policy makers	48	High
	Academia/Research center	41	High
	Government	39	High
	Civil society/the Public	32	Medium
	NGO	11	Medium

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Criteria	Categories	Number of Initiatives	Priority
	IGO	9	High
Years of existence (Low Priority)	More than 7	51	High
	2 to 7	31	Medium
	Less than 2	16	Low
Languages (Low Priority)	English or multiple working languages incl. English	92	High
	Multiple working languages excl. English	0	Medium
	One working languages excl. English	6	Low
Source of financial resources (Low Priority)	Industry	49	Medium
	Intergovernmental Organisation	27	Medium
	Government	19	Medium
	Unknown	10	Low
Activities (High Priority)	Networking and strengthening cooperation	74	High
	Information exchange	52	Medium
	Capacitiy building	26	Medium
	Research	24	Medium
	Data collection / mapping	23	High
	Development of certifications and standards	19	Medium
	Development of tools and technologies	17	Medium
	Other	1	Medium
Type of Raw Material (Medium Priority)	Materials/elements or material flows containing RM of high importance for EU economy	56	High
	Materials/elements or material flows containing RM that are not listed in the categories of high priority	37	Medium
	Other	5	Low/No
Step in the value chain (Medium Priority)	Multiple / all	68	High
	Mining/Extraction	38	High
	Recycling / re-use	24	High
	Processing	23	High
	Manufacturing	12	High
	Transport and supply chain	12	Medium
	Product development (Design and substitution)	7	Medium
	Other	7	Medium
Description of data (Medium Priority)	Data on primary raw material extraction/benefication	25	High
	Data on secondary raw materials and recycling	18	Medium
	Data on the use of materials in production and consumption	16	Medium

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Criteria	Categories	Number of Initiatives	Priority
	Other	6	Low
	Not applicable	52	
Data access (Medium Priority)	Public	27	High
	Restricted	12	Medium
	Partly public, partly restricted	3	Medium
	Not applicable	56	
Geographical focus (Medium Priority)	Global	49	High
	Regional: Europe	38	High
	National	12	Medium
	Regional: North America	1	High
	Regional: Africa	1	High
Objectives and strategies (High Priority)	Other	49	Medium
	Policy and governance contribution	41	High
	Enhance environmental sustainability and protection	39	High
	Support and raising awareness for raw materials industry	35	Medium
	Innovation/ promoting technological development	34	High
	Enhance International Cooperation	33	High
	Supply chain transparency/sustainability	26	High
	Higher resources efficiency	25	High
	Advance recycling and waste management	22	Medium
	Capacity development	20	Medium
	Social and economic development (developing countries)	19	Medium
	Security of supply/material substitution	18	High
	Social and economic development (EU)	17	Medium
	Improving energy efficiency and climate change policies	10	High

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ANNEX 2: Summary of argumentations for the metrics

- Type of stakeholders: The type of stakeholders within the initiative influence the nature and scope of the organisation and whether it is relevant to FORAM project. Governmental departments/organizations are identified as high priority in the analysis, as they have a strong impact in defining proper policies towards sustainable management and investment on raw materials. Subsequently, Companies/Industry will be the first sectors to apply and implement these policies. Cooperation between these two types of stakeholders to know about the challenges, gaps and opportunities is essential. These have therefore high priority in the current weighing of categories. Nevertheless, the Research and Academia could increase the benefit by bringing the innovations and scientific knowledge needed by industry/policy makers. Communication between all the types of stakeholders would have the strongest impact on the raw materials sector development. By providing scientific data and innovative ideas to the policy-makers as well as to the companies and industries they play an important role in the value chain of the raw materials. As mentioned in the FORAM vision document, advancing the idea of a World Forum on Raw Materials requires a participative and structured discussion involving different stakeholders.
- Objectives and strategies: The vision of the FORAM project is to support cooperative actions to safeguard a sustainable use as well as a fair and reliable global supply of raw materials. This vision can be realized when stakeholders with all identified strategies and objectives initiate a dialogue, exchange about their needs and challenge and collaborate. A selection of high and medium priority objectives and strategies is made, based on links with the FORAM partners objectives and strategies. However, the weighing of these objectives and strategies is negotiable in the stakeholder dialogue. It is key that additional information, related to focus and impact, are assessed individually.
- Activities: One of the main goals of the FORAM project is to identify, cluster and involve different stakeholders into a participative and structured discussion. Cooperation and synergy between different initiatives active in data collection and mapping will help to harmonize the current scattered activities and improve the identification of the potential initiatives that can work together. 'Data collection and mapping' serves as a basis for any assessment and analysis of challenges and exchange of information. This activity is therefore identified as high priority. However, this should be noted that the goal of FORAM is not to make a database of all available technical data, but only the initiatives that are available and active. 'Networking and Strengthening of cooperation' also has high priority, as initiatives with this activity are needed to strengthen synergies and communication. All activities are of importance and different weighing can be given to the categories. In the current analysis all other activities are ranked as medium priority. For example, 'Research' as previously mentioned is bringing new ideas and innovativeness that is crucial from a long-term perspective as any progress is based on that. Continuous research effort is needed in the field of exploration and mining technologies, raw materials properties,

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substitutes, recycling and others. The 'Development of certification or standards' is a longer process and FORAM may have "only" a consultation position as this is the work of governments and industry. And the 'Development of tools and technologies' can be considered mainly the work of industry in collaboration with the FORAM project.

- Target audience: FORAM's goal is to create a multi-stakeholder platform where experts from the entire value chain of the raw materials will be invited to work together. As discussed in the section on stakeholders, initiatives with as target audience of 'Policy-makers', 'Industry', 'Government' and 'Academia/Research center' all have high priority.
- Organisational Structure: The priority for 'Organisational structures' is based, amongst others, on the perceived stability, duration (sustainability) and activeness of the organisational structure. The stability is determined by the strength of the legal relationship – more specifically determined requirements, roles, tasks and milestones allow more stable initiative and better effect. If the organisational structure is based only on simple membership or common topics/interest, the activity and stability are lower. For example, 'Associations' are identified as high priority in this analysis, as they exist long term and Projects exist a short term and therefore have medium priority.
- Type of Raw Material: Following the methodology/results of deliverable 1.2, the raw materials that are of high importance for the EU economy have also a high priority for FORAM. This criterion does not only include the list of critical raw materials defined by the EU (CRM EC 2014) but also group of elements as platinum group metals or rare earth elements which are economical important in other regions of the world. Another group of minerals resulting in a high priority by task 1.2 are conflict minerals (Dodd-Frank Act, Section 1502 and European legislation). Other unspecified metals, ores and minerals result in a medium priority. The "type of raw materials" which are important or critical may change in the next years, depending on our technologies and depending on the wealth and health of the world's society. Therefore, the weighing of these categories in the method can be changed based on the conditions and priority (economic importance, environmental impact, criticality etc.)
- Number of Stakeholders: Initiatives that have more stakeholders are indicated as higher priority for FORAM, because these initiatives have more possibilities for higher outreach, participation and dissemination. However, it should be noted that small initiatives can also have a high importance for FORAM.
- Geographical focus: Regarding the 'Geographical focus', initiatives with wide outreach have high priority, and national/local initiative have medium priority for FORAM. The goal of FORAM is to involve international stakeholders and experts into the dialogue.
- Step in the value chain: All core steps of the raw material value chain and the stakeholders involved in these processes (production, processing, manufacturing and recycling) are equally important and have high priority. As often product design and substitution is dealt inside of manufacturing industry, as a sub-category they have medium priority, as well as 'transport and supply chain' and 'other'.

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- Description of data: Data along the complete value chain are important. For the extractive sector, developments and thus data for production and consumption are very relevant. The extraction determines activities and economic and environmental impacts, and relevant data is therefore of high priority. However, for the knowledge of the criticality of raw materials it is also necessary to have a dataset on the value chain and to know, if, when and in what quantities primary raw materials are used or materials can be recycled to get secondary raw materials
- Data access: Public data can be accessed by a wider audience and therefore has high priority, while restricted data has medium priority. Though it should be noted, the weighing of these categories are dependent on the type of data required and the user community.
- Languages: English and multiple working languages including English have priority, as this is the main working language of FORAM and the internationally used language. English would facilitate the communication, though it should be noted initiatives excluding English can be involved in FORAM as well.
- Years of existence: The duration of an initiative can indicate its sustainability and therefore longer existing initiatives have higher priority for FORAM. This is also an indicator to which exceptions should be considered.
- Source of financial resources: Government, industry and intergovernmental organisations are equally important high priority financial resources for FORAM. The transparency of the financing can also weigh in the metrics.

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ANNEX 3: List of initiatives

Initiatives mapped in the FORAM project			
Name	**Acronym**	**Website**	**Organisational structure**
Alliance for Responsible Mining	ARM	www.responsiblemines.org	Alliance
Aluminium Stewardship Initiative	ASI	https://aluminium-stewardship.org	Initiative
Better Sourcing Program	BSP	www.bsp-assurance.com	Initiative
Bettercoal		https://bettercoal.org/	Initiative
Federal association of the German waste-, water-, and raw materials industry	BDE	https://bde.de/	Association
German Federal Association of Mineral Raw Materials	MIRO	http://www.bv-miro.org/	Association
Federal association of steel recycling companies	BDSV	www.bdsv.org	Association
Bureau of International Recycling	BIR	www.bir.org	Association
bvse-Bundesverband Sekundärrohstoffe und Entsorgung e.V.	bvse	http://www.bvse.de/	Association
Circularise		www.circularise.com	Project
Cobalt Development Institute	DCDI	http://www.thecdi.com/index.php	Association
Combined Heat, Power and Metal extraction from ultra- deep ore bodies	CHPM2030	http://www.chpm2030.eu/	Project
Critical Raw Materials Alliance	CRM Alliance	http://criticalrawmaterials.org/	Alliance
Deep Sea Mining Alliance	DSMA	http://www.deepsea-mining-alliance.com/index.php	Alliance
EMIRI - The Energy Materials Industrial Research Initiative	EMIRI	http://emiri.eu	Initiative
EREAN: FP7 Marie-Curie Initial Training Network Project	EREAN	http://erean.eu	Project
EU-Canada Investment Facility		http://www.ey.com/Publication/vwLUAssets/ey-eu-mif-study-2017/$FILE/ey-eu-mif-study-2017.pdf	Project
EU-LA Platform on raw materials		www.mdnp.org; www.mets.org	Project

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Eurometaux	Eurometaux	https://eurometaux.eu	Association
European Association of Mining Industries, Metal Ores & Industrial Minerals	Euromines	http://www.euromines.org	Association
European Copper Institute	ECI	http://copperalliance.eu/	Association
European Federation of Geologists- PE Minerals	EFG	http://eurogeologists.eu/	Association
European Federation of Waste Management and Environmental Services	FEAD	http://www.fead.be/	Association
European Ferrous Recovery and Recycling Federation	EFR	http://ec.europa.eu/environment/archives/waste/pdf_comments/efr.pdf	Association
European Precious Metals Federation	EPMF	http://www.epmf.be/index.php/contact	Association
European Quality Association for Recycling e.V.	EQAR	http://www.eqar.info/en/home.html	Association
European Technology Platform for Advanced Engineering Materials and Technologies	EuMat	http://www.eumat.eu	Platform
European Technology Platform Manufuture	ManuFuture	http://www.manufuture.org	Platform
European Technology Platform on Sustainable Mineral Resource	ETP SMR	http://www.etpsmr.org/	Platform
Extractive Industries Transparency Initiative	EITI	eiti.org	Initiative
Federation of Austrian Industries		www.iv-net.at	Association
Federation of European Materials Societies	FEMS	www.fems.org	Association
G7-Alliance on Resource Efficiency	G7	http://www.iges.or.jp/files/research/scp/PDF/20160222/session4_6_Stanislaus.pdf	Forum
Geological Society of Hungary	MFT	http://foldtan.hu/	Association
German Federation of International Mining and Mineral Resources	FAB	http://www.consulting-fab.de/index.php?article_id=1&clang=1	Association
GERRI - German Resource Research Institute	GERRI	www.gerri-germany.org	Alliance
Global e-Sustainability Initiative's	GeSI	gesi.org	Initiative
Global Material Flows and Demand-supply Forecasting for Mineral	MinFuture	http://cordis.europa.eu/project/rcn/206335_en.html	Project

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Strategies			
Global Reporting Initiative	GRI	www.globalreporting.org	Initiative
HiTech AlkCarb project	CSM	https://emps.exeter.ac.uk/csm/staff/dem211	Study Group
Industry Minerals Association	IMA	http://www.ima-europe.eu/	Association
Intergovernmental Forum on Mining Minerals, metals and sustainable development	IGF	http://igfmining.org/	Forum
International Cadmium Association	ICdA	http://www.cadmium.org	Association
International Copper Association, Ltd.	ICA	http://copperalliance.org/about-us/	Alliance
International Copper Study Group	ICSG	www.icsg.org/	Study Group
International Council on Mining and Metals	ICMM	www.icmm.com	Association
International Magnesium Association	IMA	http://www.intlmag.org/page/about_ima	Association
International Nickel Study Group	INSG	http://www.insg.org/index.aspx	Association
International Precious Metals Institute	IPMI	http://www.ipmi.org/?page=About	Association
International Raw Materials Observatory	INTRAW	www.intraw.eu	Project
International Research center in Critical Raw Materials for Advanced Industrial Technologies	ICCRAM	http://www.ubu.es/iccram/about-iccram	Partnership
International Solid Waste Association	ISWA	http://www.iswa.org/	Association
International Tungsten Industry Association	ITIA	www.itia.info	Association
Knowledge Innovation Community (KIC) on Raw Materials (EIT RM)	KIC EIT RM	https://eit.europa.eu/eit-community/eit-raw-materials	Community
MineralsPolicy Guidancefo r Europe	MIN-GUIDE	http://www.min-guide.eu/	Project
Mechanical Engineering Industry Association - sector mining	VDMA	http://mining.vdma.org/	Association
Metallurgy Europe	Metallurgy Europe	http://metallurgy-europe.eu	Initiative
Mineral deposits of public importance	Minatura	http://minatura2020.eu/	Project

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Mineral Intelligence Capacity Analysis	MICA	mica-project.eu	Project
Minerals4EU Project	Minerals4 EU	http://www.minerals4eu.eu/	Project
Mining the European Anthroposphere	MINEA	http://www.minea-network.eu/	Alliance
Minor Metals Trade Association	MMTA	https://mmta.co.uk/	Association
Multi-Stakeholder Platform for a Secure Supply of Refractory Metals	MSP REFRAM	http://prometia.eu/msp-reframe/	Project
Nanotechnology Industry Association, Sector Recycling and Waste	NIA	http://www.nanotechia.org/sectors/recycling-waste	Association
Nickel Institute	NI	www.nickelinstitute.org	Association
OECD Policy Dialogue on Natural Resource-based Development	PD-NR	http://www.oecd.org/dev/natural-resources.htm	Platform
PROMETIA AISBL	PROMETI A	www.prometia.eu	Association
Prospecting Secondary raw materials in the Urban mine and Mining wastes	ProSUM	http://prosumproject.eu/	Project
Public-Private Alliance for Responsible Minerals Trade	PPA	http://www.resolv.org/site-ppa/	Alliance
Raw Materials Supply Group	RMSG	http://tinyurl.com/RawMatrlSplyGrp	Expert Group
Research &Innovation Programme on raw materials to foster circular economy	ERA-MIN 2	www.era-min.eu	Project
Research Network Sustainability in Mining	RPSM/RI MP	www.ufrgs.br/ilea	Project
Responsible Raw Materials Initiative (under Electronic Industry Citizenship Coalition)	RRMI (part of EICC)	www.eiccoalition.org/initiatives/rrmi	Working Group
Society of Mining Professors	SOMP	http://www.miningprofs.org/	Community
Solutions for CRitical Raw materials - a European Expert Network	SCRREEN	http://scrreen.eu/	Project
Solutions for Critical Raw Materials Under Extreme Conditions	CRM-EXTREME	https://www.crm-extreme.eu	Association
Solving the e-waste problem Initiative	Step Initiative	www.step-initiative.org	Initiative
Strategic Dialogue on Sustainable Raw Materials for Europe	STRADE	stradeproject.eu	Project

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Strategic, Sustainable R&I Cooperation with Latin America (Climate Action, Resource Efficiency and Raw Materials)	ENSOCIO-LA	http://www.ensocio-la.eu	Platform
Sustainable Process Industry through Resource and Energy Efficiency	SPIRE	https://www.spire2030.eu/contact-aspire	Association
Sustainable Recycling Industries	SRI	https://sustainable-recycling.org/recycling-initiatives	Association
Swiss Better Gold Association	SBGA	www.swissbettergold.ch	Association
Swiss Recycling	Swiss Recycling	http://www.swissrecycling.ch	Partnership
Tantalum-Niobium International Study Center	T.I.C.	www.tanb.org	Association
The European Innovation Partnership on Raw Materials	EIP	https://ec.europa.eu/growth/tools-databases/eip-raw-materials/en/content/european-innovation-partnership-eip-raw-materials	Platform
The Group of 77 (G-77)	G-77	http://www.g77.org/doc/contact.html	Working Group
The International Platinum Group Metals Association	IPA	http://ipa-news.com/index/about-us/	Association
The World Steel Association	worldsteel	https://www.worldsteel.org	Association
UNEP International Resource Panel	IRP	http://www.unep.org/resourcepanel/	Panel
VDI Zentrum Ressourceneffizienz GmbH / VDI Centre for Resource Efficiency	VDI ZRE	http://www.ressource-deutschland.de	Initiative
VERAM		www.veram.eu	Project
Vereinigung Rohstoffe und Bergbau e.V. / Association of Raw Materials and Mining e.V.	VRB	http://v-r-b.de	Association
Viable Alternative Mine Operating System	¡VAMOS!	www.vamos-project.eu	Project
WEEE Forum a.i.s.b.l	WEEE	http://www.weee-forum.org	Association
World Forum of Universities of Resources on Sustainability	WFURS	http://www.worldforum-sustainability.org/	Forum
World Materials Forum		www.worldmaterialsforum.com	Forum
World Materials Research Institute Forum	WRMRIF	www.wmrif.org	Forum
World Resources Forum	WRF	www.wrforum.org	Forum

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ANNEX 4: Directory of databases

Name	Description	Raw material	Type of data	Database URL
Agribalyse	AGRIBALYSE v1.3 is a French agricultural database for background LCIs, food LCA and benchmarking in the food sector. It comprises the most common French agricultural products and a few imported ones, with production data from 2005 to 2009.	Products	database	http://www.ademe.fr/en/expertise/alternative-approaches-to-production/agribalyse-program
AGS	Albanian Geological Survey is a government organization, which perform its activity in field of geosciences, according to law 111/2015, that define the role of AGS, as scientific and technical adviser of Albanian government in this field of expertise.	Primary raw materials	directory	http://www.gsa.gov.al/en/home/Maps.html
ARM	Alliance for Responsible Mining	Primary raw materials	reports	http://www.responsiblemines.org/en/publications-and-booklets/#
Auscope	The national provider of integrated research infrastructure to realise the collective potential of Australian Earth and Geospatial Science researchers.	Primary raw materials	map viewer	http://portal.auscope.org/portal/gmap.html
BGR - Monitor	The Federal Institute for Geosciences and Natural Resources is the central geoscientific authority providing advice to the German Federal Government in all geo-relevant questions.	Primary raw materials	directory	https://www.bgr.bund.de/DE/Themen/Min_rohstoffe/min_rohstoffe_node.html
BGR - Viewer	The Federal Institute for Geosciences and Natural Resources is the central geoscientific authority providing advice to the German Federal Government in all geo-relevant questions.	Primary raw materials	map viewer	https://geoviewer.bgr.de/mapapps/resources/apps/geoviewer/index.html?lang=de
BGS - Data	The British Geological Survey (BGS) and its predecessor organisations have compiled production and trade statistics on a wide range of mineral commodities since 1913. As part of our ongoing work to make these data more accessible we have created an online tool which allows users to extract the data in Microsoft Excel format.	Primary raw materials	database	http://www.bgs.ac.uk/mineralsuk/statistics/wms.cfc?method=searchWMS
BGS - Profiles	The mineral profile series presents essential background information on individual mineral commodities for the non-specialist user. They are not intended to be highly technical but contain sufficient detail to enable the reader to gain a broad understanding of the particular mineral described.	Primary and secondary raw materials	reports	http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html

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Name	Description	Raw material	Type of data	Database URL
bioenergie dat	supply chains for bioenergy options, with a specific German background. Altogether about 180 data sets have been created, for provision and conversion of the following bioenergy fuels: wood and wastewood, wheat, biowaste	all	database	http://www.bioenergiedat.de/daten.html
Blue Nodules	Blue Nodules is a research and innovation project to develop New highly-automated and technologically sustainable deep sea mining system for the harvesting of polymetallic nodules from the sea floor with minimum environmental impact.	Primary raw materials	reports	http://www.blue-nodules.eu/downloads/
CGS	The task of the Czech Geological Survey, established in 1919, is to provide the state geological service for the Czech Republic. It has the statutory responsibility to gather, store and interpret geological information so that the state administration can take appropriate decisions about national economic and environmental issues. It provides the results of systematic regional geological mapping and investigation to all interested persons.	Primary and secondary raw materials	map viewer	http://www.geology.cz/extranet-eng/maps/online/wms
CHPM2030	Combined Heat, Power and Metal extraction from ultradeep ore bodies: Mineral extraction from the geothermal fluid will decrease the import dependency of Europe and justify the economics of deep geothermal or EGS systems.	Primary raw materials	reports	http://www.chpm2030.eu/outreach/
CloseWEEE	The main goal of CloseWEEE is to increase the range and yields of recovered materials from waste electrical and electronic equipment streams through various research activities.	Secondary raw materials	no data provided at the moment	http://closeweee.eu/project-documents/
CPRM	Database through map viewers for outcrops, geochemistry, petrography, mineral resources etc.	Primary raw materials	map viewer	http://geosgb.cprm.gov.br/
CRM Innonet	Critical Raw Materials Innovation Network: FP7 project on substitution of critical raw materials ended June 2015	Primary and secondary raw materials	reports	http://www.criticalrawmaterials.eu/documents/
CWIT/LibraWEEE	Countering WEEE Illegal Trade	Secondary raw materials	database	http://www.cwitproject.eu/reports-downloads/database-ewaste-stakeholders/
Data Tools, Apps, and Maps	Information and databases on various resources and infrastructure	all	map viewer, database	https://www.eia.gov/tools/

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Name	Description	Raw material	Type of data	Database URL
DataBank	DataBank is an analysis and visualisation tool that contains collections of time series data on a variety of topics. You can create your own queries; generate tables, charts, and maps; and easily save, embed, and share them.	all	database	http://databank.worldbank.org/data/home.aspx
ECHA	The European Chemicals Agency (ECHA) is the driving force among regulatory authorities in implementing the EU's groundbreaking chemicals legislation for the benefit of human health and the environment as well as for innovation and competitiveness.	Primary raw materials, Products	reports	https://echa.europa.eu/information-on-chemicals
ecoinvent	ecoinvent is one of the world leading life cycle inventory database	all	database	http://www.ecoinvent.org
Ecolex	ECOLEX is an information service on environmental law. Its purpose is to build capacity worldwide by providing the most comprehensive possible global source of information on environmental law.	Primary and secondary raw materials	database	https://www.ecolex.org/result/?q=&type=legislation&xsubjects=Mineral+resources&xdate_min=&xdate_max=&leg_type_of_document=Legislation&leg_type_of_document=Regulation
EGDI	EGDI is EuroGeoSurveys' European Geological Data Infrastructure. It provides access to Pan-European and national geological datasets and services from the Geological Survey Organizations of Europe.	Primary raw materials	map viewer, database	http://www.europe-geology.eu/map-viewer/
EITI	The Extractive Industries Transparency Initative is the global standard for the good governance of oil, gas and mineral resources.	all	database, reports	https://eiti.org/data
ELCD	European Life Cycle Database comprises Life Cycle Inventory (LCI) data from front-running EU-level business associations and other sources for key materials, energy carriers, transport, and waste management.	all	database	http://eplca.jrc.ec.europa.eu/ELCD3/
EMODnet	The European Marine Observation and Data Network (EMODnet) consists of more than 160 organisations assembling marine data, products and metadata to make these fragmented resources more available to public and private users relying on quality-assured, standardised and harmonised marine data which are interoperable and free of restrictions on use. EMODnet is currently in its second development phase with the target to be fully deployed by 2020.	Primary raw materials	map viewer	http://www.emodnet-geology.eu/map-viewer/
Enviree	Environmentally friendly and efficient methods for extraction of rare earth elements (REE) from secondary sources	Secondary raw materials	reports	http://www.enviree.eu/publications/

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Name	Description	Raw material	Type of data	Database URL
Environmental Data Centre on Waste	Statistical data on Waste (and recycling)	Secondary raw materials	statistical database	http://ec.europa.eu/eurostat/web/waste/overview
environmental justice atlas	documents and catalogues on social conflict around environmental issues	Primary raw materials	map viewer	https://ejatlas.org/
EORA	The Eora multi-region IO database provides a time series of high resolution IO tables with matching environmental and social satellite accounts for 187 countries. Full list, high-resolution heterogeneous classification, or 25-sector harmonized classification, raw data drawn from the UN's System of National Accounts and COMTRADE databases, Eurostat, IDE/JETRO, and numerous national agencies, distinction between basic prices and purchasers' prices through 5 mark-ups, and reliability statistics (estimates of standard deviation) for all results.	all	database	http://worldmrio.com/
ESMA	The European Securities and Markets Authority (ESMA) provides market size calculations for MiFID II ancillary test	not applicable	database, reports	https://www.esma.europa.eu/databases-library/esma-library
EU-OSHA	EU-OSHA is the European Union information agency for occupational safety and health.	not applicable	reports	https://osha.europa.eu/en/surveys-and-statistics-osh/european-opinion-polls-safety-and-health-work
EURARE	The main goal of the EURARE project is to set the basis for the development of a European Rare Earth Element (REE) industry. It will safeguard the uninterrupted supply of REE raw materials and products crucial for sectors of the EU economy (including automotive, electronics, machinery and chemicals) in a sustainable, economically viable and environmentally friendly way.	Primary raw materials	map viewer, database	http://eurare.brgm-rec.fr/
EURMKB	The European Raw Materials Knowledge Base - Knowledge Base Architecture: A one-stop-shop for all information on raw materials in the EU	Primary and secondary raw materials	no data provided at the moment	https://ec.europa.eu/growth/sectors/raw-materials/specific-interest/knowledge-base_en
EuroGeoSource	EuroGeoSource is a data portal, which allows access by Internet to the aggregated geographical information on geo-energy (oil, gas, coal etc.) and mineral resources (metallic and non-metallic minerals, industrial minerals and construction materials: gravel, sand, ornamental stone etc.), coming from a wide range of sources in a significant coverage area of Europe (ten countries).	Primary raw materials	map viewer	http://maps.eurogeosource.eu/

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Name	Description	Raw material	Type of data	Database URL
Euromines	European Association of Mining Industries, Metal Ores & Industrial Minerals	Primary raw materials	database, reports	http://www.euromines.org/mining-europe
EUROSTAT	Eurostat is the statistical office of the European Union situated in Luxembourg. Its mission is to provide high quality statistics for Europe.	all	statistical database	http://ec.europa.eu/eurostat/data/database
Eurostat Manufactured goods	Contains Prodcom statistics on production of manufactured goods together with related external trade data. Production statistics on Mining of metal ores, Other mining and quarrying, Mining support service activities, Manufacture of basic metals, Manufacture of other non-metallic mineral products	Primary raw materials, Products	statistical database	http://ec.europa.eu/eurostat/web/prodcom/data/database
Exiobase	Exiobase is a global, detailed Multi-regional Environmentally Extended Supply and Use / Input Output (MR EE SUT/IOT) database. The international input-output table that can be used for the analysis of the environmental impacts associated with the final consumption of product groups.	all	database	http://www.exiobase.eu/index.php/about-exiobase
GaBi	This software is the next generation product sustainability solution with a powerful Life Cycle Assessment engine	all	software	http://www.gabi-software.com/international/overview/what-is-gabi-software/
GBA	The Geological Survey of Austria collects and interprets geoscientific information in Austria, lays the foundation for the sustainable use of the geogenic potential and provides them to the public in a systematic manner.	Primary raw materials	map viewer	http://gisgba.geologie.ac.at/gbaviewer/?url=https://gis.geologie.ac.at/geoserver/mr_lagerst/wms?
GEMIS	The Global Emissions Model for integrated Systems (GEMIS) is a public domain for life-cycle and material flow analysis model and database	all	software	http://iinas.org/gemis.html
GSI	The GEOLOGICAL SURVEY OF IRELAND (GSI), founded in 1845, is the National Earth Science Agency. It is responsible for providing geological advice and information, and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geology.	Primary raw materials	map viewer, database	http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228
GTAP	Global Trade Analysis Project	all	database	https://www.gtap.agecon.purdue.edu/databases/default.asp
GTK	GTK's business based operations focus on expert services related to exploration of natural resources, land use and environmental sectors and laboratory and support functions. Our services support the competitiveness of business, provide public administration with background information and supplement the service range in the sector.	Primary raw materials	map viewer	http://gtkdata.gtk.fi/mdae/index.html

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Name	Description	Raw material	Type of data	Database URL
ICSG	International Copper Study Group	Primary raw materials	database	http://www.icsg.org/index.php/external-database
IFC	International Finance Corporation	all	reports	www.ifc.org/ehsguidelines
IGF	Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development	Primary raw materials	reports	http://igfmining.org/resources/
IISD	International Institute for Sustainable Development	Primary raw materials	reports	http://www.iisd.org/topic/mining
INTMET	Integrated innovative metallurgical system to benefit efficiently polymetallic, complex and low grade ores and concentrates	Primary raw materials	no data provided at the moment	http://www.intmet.eu/downloads/
INTRAW	H2020 project to foster international cooperation on raw materials. INTRAW has been set up to map and develop new cooperation opportunities related to raw materials between the EU and other technologically advanced countries, such as Australia, Canada, Japan, South Africa and the United States.	Primary and secondary raw materials	reports	http://intraw.eu/publications/
InvestmentMine	InfoMine provides focused, in-depth information and functionality encompassing most aspects of mining and mineral exploration activities worldwide.	Primary raw materials	database	http://www.infomine.com/investment/metal-prices/
IRP	UNEP International Resource Panel	all	reports	http://www.resourcepanel.org/reports
ISWA	International Solid Waste Association	Secondary raw materials	reports	http://www.iswa.org/media/publications/knowledge-base/
LC Inventories	The direct environmental impacts (emissions and ressource uses), the amount of semi-finished products, auxiliary materials and energy of the processes involved in the life cycle are determined and inventoried in the Inventory Analysis. The Inventory Analysis provides the basis for the Impact Assessment . Applying current valuation methods, e.g. eco-indicator, ecological scarcity or CML, to the inventory results in indicator values that are used and referred to in the interpretation	all	database	http://esu-services.ch/data/public-lci-reports/
LCDN	Worldwide dataset from different providers on resource consumption and emissions for product supply chains, their use, and end-of-life waste management options. (includes developer tools)	all	database	http://eplca.jrc.ec.europa.eu/LCDN/

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Name	Description	Raw material	Type of data	Database URL
LGT	The Lithuanian Geological Survey was founded on October 16. 1940, though the necessity and preconditions for establishing a service of geological investigations had been formed earlier.	Primary raw materials	map viewer	https://www.lgt.lt/zemelap/main.php?sesName=lgt1489708730&back=
MATCH Database	National and European Projects dealing with materials	all	database	http://www.match-a4m.eu/index.php/match-web-db
Material Flows Net	This is an online portal for material flow data, providing access to data on the national level. The website is based on the worldwide unique comprehensive database on global resource extraction - WU Global Material Flows Database	Primary raw materials	map viewer, database	http://www.materialflows.net
MatWeb	Property database of 115,000 metals, plastics, ceramics, and composites.	all	database	http://www.matweb.com/search/CompositionSearch.aspx
MICA	The MICA project contributes to on-going efforts towards the establishment of a stakeholder tailored product, namely the "European Union Raw Materials Intelligence Capacity Platform" (EU-RMICP).	Primary and secondary raw materials	database	http://metadata.bgs.ac.uk/mica/srv/ger/catalog.search#/home
MINATURA2020	The overall objective of MINATURA2020 is to develop a concept and methodology for the definition and subsequent protection of "mineral deposits of public importance" in order to ensure their "best use" in the future in order to be included in a harmonised European regulatory/guidance/policy framework.	Primary raw materials	no data provided at the moment	http://minatura2020.eu/project-publications/
MINEA	Networking project COST action: MINEA – Mining the European Anthroposphere	Secondary raw materials	no data provided at the moment	http://www.minea-network.eu/
Minerals4EU	The Minerals4EU project is designed to meet the recommendations of the Raw Materials Initiative and will develop an EU Mineral intelligence network structure delivering a web portal, a European Minerals Yearbook and foresight studies. The network will provide data, information and knowledge on mineral resources around Europe, based on an accepted business model, making a fundamental contribution to the European Innovation Partnership on Raw Materials (EIP RM), seen by the Competitiveness Council as key for the successful implementation of the major EU2020 policies.	Primary and secondary raw materials	map viewer	http://minerals4eu.brgm-rec.fr/
MIN-GUIDE	The MIN-GUIDE project addresses the need for a secure and sustainable supply of minerals in the European Union by developing a Minerals Policy Guide for the EU.	Primary and secondary raw	reports	http://min-guide.eu/project-results

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Name	Description	Raw material	Type of data	Database URL
		materials		
MINLEX	Study- Legal framework for mineral extraction and permitting procedures for exploration and exploitation in the EU	Primary raw materials	database	http://minlex.minpol.com/
Minventory	The Minventory metadata portal is a directory of statistical data holders, the characteristics of the data they hold and – where possible – links to where the data may more easily be located. It covers the EU28 and a number of neighbouring countries. Material stocks are analysed and described not only by statistics. The portal provides links to other related initiatives and portals which cover these complementary aspects.	Primary and secondary raw materials	directory	https://ec.europa.eu/jrc/en/scientific-tool/minventory
MIT-Factors	is database on the material intensity (MIT) of different materials listed according to abiotic and biotic materials, water, air and earth movement	Primary raw materials, Products	reports	https://wupperinst.org/uploads/tx_wupperinst/MIT_2014.pdf
MSP REFRAM	Multi-Stakeholder Platform for a Secure Supply of Refractory Metals	Primary and secondary raw materials	reports	http://prometia.eu/deliverables/
Multi-regional input-output (MRIO) data	An open access forum to multi-regional input-output (MRIO) data, focussing on environmental footprints. The environmental footprints explorer is primarily based on output from 5 multi-regional input-output models: EXIOBASE, WIOD, EORA, OECD, GTAP	Products	database	http://www.environmentalfootprints.org/mriohome
Nanotechnology Databases from Nanowerk	Nanomaterial Database with thousands of nanoparticles (elements like critical ones), Nano Company & Labs directory with thousands of links to labs, associations, networks and companies.	all	database	http://www.nanowerk.com/nanotechnology_databases.php
National Pollutant Inventory	provides the community, industry and government with free information about substance emissions in Australia	all	map viewer, database	http://www.npi.gov.au/
NEEDS	Life cycle inventories of future electricity supply in Europe. It contains industrial LCI data on future transport services, electricity and material supply.	all	reports	http://www.needs-project.org/
NGU	NGU is the national institution for the study of bedrock, mineral resources, surficial deposits and groundwater. NGU actively contributes to the goal of using geological knowledge towards achieving an efficient and sustainable management of Norway's natural resources	Primary raw materials	map viewer, database	http://www.ngu.no/en/topic/maps-and-data

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Name	Description	Raw material	Type of data	Database URL
	and its environment.			
OECD - ICIO	The OECD inter-country input-output (ICIO) table incudes Trade in Value Added (TiVA) indicators, extensions of the ICIO regarding CO2 emissions from fuel combustion (based on IEA CO2 data), energy used for electricity production (based on IEA energy balances) and trade in employment are available.	not applicable	database	http://www.oecd.org/sti/ind/input-outputtablesedition2015accesstodata.htm
OECD export restrictions	This Inventory contains information on export regulations in the raw materials sector, namely minerals, metals and wood. It records measures known to restrain export activity from 2009-2014 at the 6-digit level of HS2007 classification.	Primary and secondary raw materials	database	http://qdd.oecd.org/subject.aspx?Subject=ExportRestrictions_IndustrialRawMaterials
Ökobaudat	Construction materials database, provided by the German Federal Ministry of Transport, Building and Urban Development.	all	database	http://www.oekobaudat.de/home.html
OneGeology	OneGeology's aim is to create dynamic digital geological map data for the world and to provide service to other types of geoscience data.	not applicable	map viewer	http://portal.onegeology.org/OneGeologyGlobal/
OneMine	OneMine is a collaborative effort among multiple societies to place the world's most comprehensive collection of mining and minerals based research in one place. The goal of OneMine is to collect the most relevant and reliable aggregation of technical papers associated with mining and minerals in one, easy to navigate location.	Primary raw materials	reports	www.onemine.org
PanGeo	PanGeo provides free access to geohazard information for many of the largest cities in Europe (information about the stability of the ground).	not applicable	map viewer	http://www.pangeoproject.eu/eng/coverage_map
Polish Geological Institute – National Research Institute	The Polish Geological Institute (PGI) was founded on the 7th of May 1919 on the strength of the Resolution of the Parliament of the Republic of Poland. It is the oldest Polish nation-wide scientific institution. It is involved in comprehensive studies of geological structure of the country for practical use in national economy and environmental protection.	Primary raw materials	map viewer, database	http://www.pgi.gov.pl/en/data-bases.html
ProBas	ProBas is a German dataset library originally provided by the German Federal Environment Agency (Umweltbundesamt). It includes unit as well as aggregated processes, for the following topics: Energy, Materials & Products, Transportation services and Waste	Products	database	http://www.probas.umweltbundesamt.de/php/index.php

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Name	Description	Raw material	Type of data	Database URL
ProSum	Prospecting Secondary raw materials in the Urban mine and Mining wastes	Secondary raw materials	database	http://prosum.brgm-rec.fr/mapviewer/
PSILCA	PSILCA is a totally new database for social LCA developed by GreenDelta. It contains comprehensive generic inventory information for almost 15,000 industry sectors and commodities, for calculating and assessing social impacts of products along their life cycles, and for detecting social hotspots.	Products	database	http://www.psilca.net/
Raw Material System Analysis (MSA)	Study on Data Inventory for a Raw Material System Analysis	Primary and secondary raw materials	reports	https://ec.europa.eu/jrc/en/scientific-tool/msa
Raw materials score board	The EU Raw Materials Scoreboard is an integral part of the Raw Materials Information System (RMIS), a cornerstone of the EU's knowledge base on raw materials.	Primary and secondary raw materials	database	http://rmis.jrc.ec.europa.eu/Scoreboard/
resourcetrade	resourcetrade.earth has been developed by Chatham House to enable users to explore the fast-evolving dynamics of international trade in natural resources, the sustainability implications of such trade, and the related interdependencies that emerge between importing and exporting countries and regions.	Primary raw materials	map viewer	https://resourcetrade.earth/data
Ressourcenkataster	Dumps of mining and metallurigcal industry in Germany	Secondary raw materials	map viewer	https://webgis.ressourcenkataster.de/client/baseclient2/index-dev.html
RMIS	The JRC Raw Materials Information System (RMIS) provides a structured repository of knowledge on non-energy, non-agricultural raw materials from primary and secondary sources	Primary and secondary raw materials	map viewer, database	http://rmis.jrc.ec.europa.eu/
RSC-MI	Resource Reporting Intelligence (RSC-MI) is an online interactive map and database repository that displays and stores public reports for mineral exploration and mining projects globally.	Primary raw materials	map viewer	http://intel.rscmme.com/
SARMa	The two main objectives are: to develop a common approach to SARM across SEE, and ensure a SSM in SEE based on fair distribution of costs and benefits of aggregate production, use, waste disposal and recycling, so as to enhance resource and energy efficiency and quality of life. project ended	Primary and secondary raw materials	reports	http://www.sarmaproject.eu/index.php?id=1557

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Name	Description	Raw material	Type of data	Database URL
SCRREEN	Solution for Critical Raw Materials – a European Expert Network: SCRREEN will establish an EU Expert Network that covers the whole value chain for present and future critical raw materials.	Primary and secondary raw materials	no data provided at the moment	http://scrreen.eu/eu-crm-knowledge-base/
SGU	The Geological Survey of Sweden, SGU, is the expert agency for issues relating to bedrock, soil and groundwater in Sweden.	Primary raw materials	map viewer	https://apps.sgu.se/kartvisare/index.html
SMART GROUND	SMART GROUND aims at improving the availability and accessibility of data and information on SRM (Secondary Raw Materials) in the EU territory, while creating collaborations and synergies among the different stakeholders involved in the SRM value chain.	Secondary raw materials	no data provided at the moment	http://www.smart-ground.eu/downloads.php?cat=2#
SNL	The Metals and Mining database gives mining information and analysis	Primary raw materials	Reports and map viewer	http://marketintelligence.spglobal.com/client-solutions/users/metals-mining-companies
Social Hotspots Database	The aim of this database is to provide access to best available social risk and opportunity information to provide methods and tools to calculate and summarize this information into a social footprint	all	database	https://socialhotspot.org/
Step Initiative	Solving the e-waste problem Initiative	Secondary raw materials	map viewer, database	http://www.step-initiative.org/step-e-waste-world-map.html
STRADE	The "Strategic Dialogue on Sustainable Raw Materials for Europe" (STRADE) addresses the long-term security and sustainability of the European raw-material supply from European and non-European countries.	Primary and secondary raw materials	reports	http://stradeproject.eu/index.php?id=7
SWISSTOPO	swisstopo offers its products in both analogue and digital form. Analogue products include paper maps, e.g. the sets of national maps, and various thematic maps (hiking, geology, history, aviation). Digital products include maps, aerial images, orthophotos, landscape and height models, as well as software. swisstopo also produces numerous specialised publications.	Primary raw materials	map viewer	https://map.geo.admin.ch/?topic=geol&lang=en&bgLayer=ch.swisstopo.pixelkarte-grau&layers=ch.swisstopo.geologie-geocover&layers_opacity=0.75&catalogNodes=1828
TGI4	The Targeted Geoscience Initiative (TGI) is a collaborative federal geoscience program that provides industry with the next generation of geoscience knowledge and innovative techniques, which will result in more effective targeting of buried mineral deposits.	Primary raw materials	database, reports	http://www.nrcan.gc.ca/earth-sciences/resources/federal-programs/targeted-geoscience-initiative/10907

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Name	Description	Raw material	Type of data	Database URL
U.S. Life Cycle Inventory Database	This database provides individual gate-to-gate, cradle-to-gate and cradle-to-grave accounting of the energy and material flows into and out of the environment that are associated with producing a material, component, or assembly in the U.S	all	database	https://uslci.lcacommons.gov/uslci/search
umberto	Umberto is a German life cycle inventory database	all	software	https://www.ifu.com/en/umberto
UN Comtrade Database	Detailed global trade data on raw materials	Primary raw materials	statistical database	https://comtrade.un.org/data
USDA	The Life Cycle Assessment Commons (LCA Commons) is a data repository hosted by the United States Department of Agriculture (USDA) National Agricultural Library (NAL). It is a repository dedicated to access and long-term preservation of life cycle assessment (LCA) data, tools, and resources.	Products	database	https://www.lcacommons.gov/
WEO	The World Economic Outlook contains selected macroeconomic data series from the statistical appendix of the World Economic Outlook report, including data on national accounts, inflation, unemployment rates, balance of payments, fiscal indicators, trade for countries and country groups (aggregates), and commodity prices whose data are reported by the IMF.	Primary raw materials	database	http://www.imf.org/external/np/res/commod/index.aspx
WIOD	World Input-Output Database is the first public database that contains new information on trends and provides the opportunity to analyse the consequences of fragmentation, for example for shifting patterns in demand for skills in labour markets, or for local emissions of air pollutants. In addition, the WIOD provides data on labour and capital inputs and pollution indicators at the industry level that can be used in conjunction enlarging the scope of possible applications.	all	database	http://www.wiod.org/database/wiots16
World mining data	Information on mineral production, market concentrations and the resulting trends.	Primary raw materials	reports	http://www.wmc.org.pl/?q=node/49
WTO - Country Profiles	The World Trade Organization (WTO) deals with the global rules of trade between nations. Its main function is to ensure that trade flows as smoothly, predictably and freely as possible.	all	database	https://www.wto.org/english/res_e/statis_e/miwi_e/countryprofiles_e.htm
WTO - Time series	time series on import and export; scope: only exchange under Regional integration agreements (EFTA, NAFTA, EU28, CACM, 2 and selected products according to Standard International Trade Classification (SITC) details WTO Statistical data sets	all	database	http://stat.wto.org/StatisticalProgram/WSDBStatProgramSeries.aspx?Language=E

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ANNEX 5: Information sheets for specific raw materials

The following tables contain information on the industrial use, re-use, recycling and substitution of specific raw materials/group of raw materials taken from the directory of databases and the list of initiatives. The sources of information and, if possible, the last update are indicated in the tables. Potential primary references for the information are documented in the given sources. Further information (e.g. deposits, markets, specifications) can be found under the quoted links.

The tables are not showing the current state-of-the-art or best practices to the single materials, but they give an overview on the information that can be found in the FORAM list of initiatives and directory of databases.

Raw material	*Aluminium*
Sources	https://eurometaux.eu/about-our-industry/introducing-metals/ http://www.resourcepanel.org/reports/recycling-rates-metals (2011) http://www.bir.org/industry/non-ferrous-metals/
Industrial use	▪ Vehicle light weighting ▪ Beverage cans & other packaging ▪ Buildings and construction ▪ Transportation ▪ Electricity ▪ Cooking and tableware
Re-use	
Recycling Production residues	
Recycling End-of-life	▪ EOL-recycling rate: > 50% ▪ Over 90% of aluminium is recovered from buildings and transport ▪ 60% is recovered from packaging
Substitution	

Table 5: Information sheet 'Aluminium'

Raw material	*Antimony*
Sources	https://www.deutsche-rohstoffagentur.de/DERA/DE/Rohstoffinformationen/Rohstoffe/rohstoffe_node.html (German Language, 2013) http://www.resourcepanel.org/reports/recycling-rates-metals (2011) http://closeweee.eu/recovery-of-pcabs-from-weee-plastic-shred-by-the-creasolv-process/ (2017)
Industrial use	▪ Flame retardants ▪ Catalysts

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	▪ Glass ▪ Pigments ▪ Lead-antimony alloys ▪ Alloying elements
Re-use	
Recycling Production residues	
Recycling End-of-life	▪ Recycling rate less than 5% (DERA, 2013) ▪ EOL-recycling rate: 1-10% (UNEP IRP, 2011) ▪ Lead-antimony alloys of lead-acid batteries ▪ Lead-antimony alloys of other sources (sheet metals, tubes, cable insulation) ▪ No recycling of antimony from plastic products (dissipative use) in large scale ▪ Research approach in CloseWEEE-H2020 project
Substitution	▪ Flame retardants: aluminium hydroxide, magnesium hydroxide ▪ Batteries: Calcium, Copper ▪ Hardening lead: Tin

Table 6: Information sheet 'Antimony'

Raw material	*Bismuth*
Sources	https://www.deutsche-rohstoffagentur.de/DERA/DE/Aktuelles/rohstoff_bismut.html?nn=5091226 (German language, 2015)
Industrial use	▪ Pigments ▪ Low-melting alloys ▪ Industrial catalysts ▪ Metallurgical additives ▪ Pharmaceuticals ▪ Other
Re-use	
Recycling Production residues	▪ New scrap
Recycling End-of-life	▪ EOL-recycling rate: ▪ Old scrap of low-melting alloys or solders
Substitution	▪ Pigments: titanium (TiO_2)-coated mica, lead carbonate ▪ Low-melting alloys: Indium ▪ Steel, aluminium alloys: Lead, selenium, tellurium ▪ Catalysts: tin

Table 7: Information sheet 'Bismuth'

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Raw material	*Cadmium*
Sources	http://www.cadmium.org/cadmium-applications (2003) http://www.resourcepanel.org/reports/recycling-rates-metals (2011)
Industrial use	▪ Batteries ▪ Pigments ▪ Stabilisers ▪ Coatings ▪ Alloys ▪ Other
Re-use	
Recycling Production residues	
Recycling End-of-life	▪ EOL-recycling rate: >10-25% ▪ Nickel-cadmium batteries
Substitution	

Table 8: Information sheet 'Cadmium'

Raw material	*Chromium*
Sources	https://www.deutsche-rohstoffagentur.de/DERA/DE/Downloads/steckbrief_chrom.pdf?__blob=publicationFile&v=8 (German Language, 2013) http://www.resourcepanel.org/reports/recycling-rates-metals (2011) http://criticalrawmaterials.org/chromium/ (mainly use, May 2016)
Industrial use	▪ Stainless steels ▪ Refractory industry ▪ Chemicals ▪ Pigments ▪ Solar industry ▪ Leather tanning
Re-use	
Recycling Production residues	
Recycling End-of-life	▪ EOL-recycling rate: > 50%
Substitution	

Table 9: Information sheet 'Chromium'

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Raw material	*Cobalt*
Sources	http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (August 2009) http://www.resourcepanel.org/reports/recycling-rates-metals (2011) http://www.thecdi.com/cobaltfacts.php (2006)
Industrial use	▪ Metallurgical, e.g. super-alloys, wear resistant coatings… ▪ Magnetic alloys ▪ Batteries and electronics ▪ Chemicals ▪ Pigments ▪ Ceramics & Enamels ▪ Others
Re-use	▪
Recycling Production residues	▪ New scrap from processing and manufacturing as hard scrap (solid pieces, cemented carbide parts) or soft scrap (grinding sludge, dust, powders)
Recycling End-of-life	▪ EOL-recycling rate: > 50% ▪ Old scrap as alloys re-melted and used again in the form of original alloy ▪ Rechargeable batteries ▪
Substitution	▪ Almost all substitutes result in reduced product performance; Opportunities: ▪ High-hardness alloys: barium and strontium ▪ High performance magnetic alloys: nickel-iron alloys ▪ Cutting and wear-resistant materials, jet engine manufacture, petroleum catalysts, batteries: Nickel (limited extend) ▪ Batteries (reduction): Cobalt-manganese-nickel compound ▪ High temperature-resistant, high-hardness materials: High performance ceramics ▪ Pigments (to some degree): cerium, iron, lead, manganese, vanadium

Table 10: Information sheet 'Cobalt'

Raw material	*Copper*
Sources	http://www.resourcepanel.org/reports/recycling-rates-metals (2011) http://copperalliance.org/benefits-of-copper/recycling-circular-economy/ (2014) http://copperalliance.eu/about-copper/recycling https://www.deutsche-rohstoffagentur.de/DERA/DE/Aktuelles/rohstoff_kupfer.html?nn=5091226 (German language, 2012/2013) http://www.bir.org/industry/non-ferrous-metals/
Industrial use	▪ Copper alloy ▪ Electrical applications ▪ Automotive

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	▪ Consumer electronics ▪ Electricity ▪ Coinage ▪ Pipes ▪ Nutrients ▪ Roofing and insulation ▪ Household items
Re-use	
Recycling	▪ Recycling without any quality loss
Production residues	▪ New scrap from production and downstream manufacturing processes used as directly melted high grade copper scrap
Recycling End-of-life	▪ EOL-recycling rate: >50% ▪ Old scrap, end-of-life products used as low grade copper scrap for smelting and refining
Substitution	Depended on the application, possible substitutes could be ▪ Aluminium ▪ Titanium ▪ Steel ▪ Glass fibre ▪ Plastics

Table 11: Information sheet 'Copper'

Raw material	*Fluorspar*
Sources	http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (February 2011)
Industrial use	▪ Hydrofluoric acid ▪ Fluorocarbon chemicals ▪ Metallurgical use ▪ Other
Re-use	
Recycling	▪ Recycling of the mineral is not possible
Production residues	
Recycling End-of-life	
Substitution	▪ Fluorosilicic acid ▪ Sodium Fluorosilicate ▪ Sodium Fluoride ▪ Calcium fluoride ▪ Depleted uranium hexafluoride

Table 12: Information sheet 'Fluorspar'

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Raw material	*Lithium*
Sources	http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (July 2016) http://www.resourcepanel.org/reports/recycling-rates-metals (2011) https://mmta.co.uk/metals/Li/
Industrial use	▪ Ceramics and glass ▪ Batteries ▪ Lubricating greases ▪ Air treatment, air-conditioning ▪ Metallurgical use ▪ Polymers ▪ Pharmaceuticals ▪ Primary aluminium production ▪ Other
Re-use	▪ Catalysts
Recycling	
Production residues	
Recycling End-of-life	▪ EOL-recycling rate: < 1% ▪ End-uses often dissipative ▪ Recycling from lithium-ion batteries
Substitution	▪ Little incentive to use substitutes; Opportunities: ▪ Non-lithium fluxes as sodium or potassium compounds in glass ceramics instead of lithium carbonate ▪ Calcium and aluminium soaps instead of lithium stearates in greases ▪ Boron, glass or polymer fibre composites instead of aluminium-lithium alloys in structural materials ▪ Other battery types instead of lithium-ion batteries

Table 13: Information sheet 'Lithium'

Raw material	*Magnesium*
Sources	www.intlmag.org/page/mg_applications_ima; http://intlmag.site-ym.com/page/mg_sustain_ima http://www.resourcepanel.org/reports/recycling-rates-metals (2011) http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (March 2004)
Industrial use	▪ Automotive ▪ Aerospace ▪ Medical ▪ Electronic

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	▪ Non-structural ▪ Sports ▪ Aluminium alloys ▪ Die casting ▪ Steel desulphurisation ▪ Other
Re-use	
Recycling Production residues	▪ Scrap of die casting to be o sold on open markets (downgraded in desulphurization of steel or other markets), o recycling internally o recycling externally
Recycling End-of-life	▪ EOL-recycling rate: >25-50% ▪ Process and ELV scrap, for example ▪ Re-melting of magnesium chips ▪ Hot extrusion ▪ Shredding
Substitution	

Table 14: Information sheet 'Magnesium'

Raw material	*Molybdenum*
Sources	http://prometia.eu/deliverables/ (D5.1, 2016) http://www.resourcepanel.org/reports/recycling-rates-metals (2011)
Industrial use	▪ Engineering steels ▪ Stainless steels ▪ Chemicals ▪ Foundries ▪ Tool Steels ▪ Mo-Metals ▪ Nickel alloys
Re-use	
Recycling Production residues	
Recycling End-of-life	▪ EOL-recycling rate: >25-50%
Substitution	▪ Stainless steel: Other grade with higher chromium content ▪ Alloy steels: Boron, chromium, niobium, vanadium ▪ Tool steels: Tungsten ▪ High-temperature electric furnaces: Graphite, tantalum, tungsten

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	▪ Refractory properties, material strengthening: niobium ▪ Super-alloys: Tungsten alloyed, Nickel-and Cobalt-based super-alloys ▪ Catalysts in hydrodesulfurization (Depending on application for HDS): ruthenium, nickel, cobalt, tungsten / NEBULA (Ni-Mo-W- based trimetallic catalyst) ▪ Pigments: Cadmium (red), chromium (orange) organic pigments

Table 15: Information sheet 'Molybdenum'

Raw material	*Nickel*
Sources	http://www.insg.org/whatnickel.aspx http://www.resourcepanel.org/reports/recycling-rates-metals (2011) http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (September 2008)
Industrial use	▪ Stainless Steel ▪ Alloys; Other steel alloys and non-ferrous alloys ▪ Plating ▪ Casting ▪ Batteries ▪ Other
Re-use	
Recycling Production residues	▪ The refining processes used in producing steel may include: o Waste from primary nickel producers
Recycling End-of-life	▪ EOL-recycling rate: >50% ▪ Nickel bearing srcap recycled for stainless steel industry ▪ Special alloys as single fraction: recycling as same alloy ▪ The refining processes used in producing steel may include: o Mixed turnings o Nickel containing slags o Dusts o batteries
Substitution	▪ Very limited options for substitution, especially in alloying ▪ Substitution results in a reduction of performance o Stainless steel, other nickel-containing alloys: Plastics o Reduction of nickel content by nickel-coated steel o Low-nickel alternatives in steel: higher chromium and manganese content

Table 16: Information sheet 'Nickel'

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Raw material	*Niobium*
Sources	http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (April 2011) https://www.tanb.org/about-tantalum http://www.resourcepanel.org/reports/recycling-rates-metals (2011)
Industrial use	▪ Steel and other alloys ▪ Carbides ▪ Powders ▪ Chemicals ▪ Cutting tools ▪ Others
Re-use	
Recycling	▪ Recycling of scrap
Production residues	▪ Niobium: Niobium-steels and supperalloys
Recycling End-of-life	▪ EOL-recycling rate: Niobium > 50% ▪ Recycling of metal waste ▪ Niobium: Niobium-steels and supperalloys
Substitution	▪ The physical and chemical similarities of niobium and tantalum allows a substitution for each other in different application. Further examples are ▪ HSLA steels: Molybdenum, titanium and vanadium ▪ Stainless and high-strength steels: Tantalum, titanium, high nitrogen steels ▪ High-temperature applications: Ceramics, molybdenum, tantalum and tungsten ▪ super-alloys: ceramic matrix composites ▪ superconductors: vanadium-gallium alloys

Table 17: Information sheet 'Niobium'

Raw material	*Platinum Group Metals*
Sources	http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (September 2009) https://www.deutsche-rohstoffagentur.de/DERA/DE/Downloads/studie_Platin_2015.pdf?__blob=publicationFile&v=2 (German language, 2015) http://www.resourcepanel.org/reports/recycling-rates-metals (2011) http://ipa-news.com/index/platinum-group-metals/pgm-fact-sheets.html
Industrial use	▪ Autocatalysts, catalysts ▪ Jewellery ▪ Chemicals ▪ Electrical and electronics ▪ Glass ▪ Petroleum refining

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	▪ Investment ▪ Dentistry ▪ Others
Re-use	
Recycling Production residues	▪ By-products and residues of PGM downstream industries o Glass industry o Petroleum refining o Chemical industry o catalysts
Recycling End-of-life	▪ Recycling rate 50-60% (Rhodium), 60-70% (Platinum, Palladium) (DERA, 2015) ▪ EOL-recycling rate: > 50% (UNEP,2011) ▪ Autocatalysts recycling ▪ Industrial catalysts ▪ Electrical, electronic equipment
Substitution	▪ Ceramic condensators (Palladium): Nickel and silver ▪ Platinum groups elements by other platinum group elements

Table 18: Information sheet 'Platinum group metals'

Raw material	*Rare earth elements*
Sources	http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (November 2011) http://www.resourcepanel.org/reports/recycling-rates-metals (2011) https://www.deutsche-rohstoffagentur.de/DE/Themen/Min_rohstoffe/Downloads/rohstoffsteckbrief_se.pdf?__blob=publicationFile&v=6 (German Language, 2013)
Industrial use	▪ Catalysts ▪ Magnets ▪ Metallurgical alloys ▪ Phosphors ▪ Glass and polishing ▪ Ceramics ▪ Others
Re-use	
Recycling Production residues	
Recycling End-of-life	▪ EOL-recycling rate: < 1% ▪ Most REE recycling technologies are in the research stage
Substitution	▪ Substitutes have in most cases worse properties ▪ Rare earth elements by other rare earth elements ▪ Petroleum cracking: Platinum group metals

Table 19: Information sheet 'Rare earth elements'

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Raw material	*Rhenium*
Sources	http://prometia.eu/deliverables/ (D5.1, 2016) http://www.resourcepanel.org/reports/recycling-rates-metals (2011)
Industrial use	▪ Super-alloys ▪ Catalysts ▪ Others
Re-use	
Recycling Production residues	
Recycling End-of-life	▪ EOL-recycling rate: > 50%
Substitution	▪ Super-alloys: Reduction of rhenium by use of ceramic matrix composites

Table 20: Information sheet 'Rhenium'

Raw material	*Tantalum*
Sources	http://prometia.eu/deliverables/ (D5.1, 2016) http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (April 2011) https://www.tanb.org/about-tantalum http://www.resourcepanel.org/reports/recycling-rates-metals (2011)
Industrial use	▪ Steel and other alloys ▪ Cutting tools ▪ Capacitors ▪ Super-alloys ▪ Sputtering targets ▪ Mill products ▪ Carbides ▪ Chemicals
Re-use	
Recycling Production residues	▪ Tin slag from tin smelting ▪ Cemented carbides and alloys
Recycling End-of-life	▪ EOL-recycling rate: < 1% ▪ Scrap recycling ▪ Tantalum: cemented carbides and alloys ▪ Tantalum: recycling from capacitors
Substitution	▪ The physical and chemical similarities of niobium and tantalum allows a substitution for each other in different application. Further examples are:

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	▪ Capacitors: Niobium-oxide, aluminium, ceramic ▪ Cemented carbides: niobium, tungsten, titanium carbides and titanium nitride ▪ Steel super-alloy (strength at high temperatures): vanadium, molybdenum ▪ Super-alloys for high-temperature applications: hafnium, iridium, molybdenum, niobium, rhenium, tungsten ▪ Corrosion-resistant equipment: Glass, niobium, platinum, titanium and zirconium ▪ Process equipment: Niobium, glass, platinum, titanium, zirconium

Table 21: Information sheet 'Tantalum'

Raw material	*Tungsten*
Sources	http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html (January 2011) http://www.resourcepanel.org/reports/recycling-rates-metals (2011) http://www.itia.info/applications.html (2011) http://prometia.eu/deliverables/ (D5.1, 2016) https://www.deutsche-rohstoffagentur.de/DERA/DE/Rohstoffinformationen/Rohstoffe/rohstoffe_node.html (2014)
Industrial use	▪ Hard metals ▪ Steel and other alloys ▪ Mill products ▪ Chemicals ▪ Cemented carbides ▪ Lamp Industry ▪ Electronic & Electrical ▪ Other specialist applications
Re-use	
Recycling	▪ High recovery rates by internal recycling
Production residues	▪ Production residues from casting is recycled in-house or sold to recyclers ▪ Direct scrap
Recycling End-of-life	▪ EOL-recycling rate: >10-25% ▪ Cemented carbide parts ▪ Tungsten metal and tungsten metal alloys ▪ Old super-alloy scrap ▪ Tungsten-bearing catalysts ▪ No recycling of dissipative application like chemical applications
Substitution	▪ Only limited options for substitution, because of unique combination of tungsten properties ▪ Cemented tungsten carbide: molybdenum carbide and titanium carbide, ceramics, ceramic-metallice composites, diamond tools, and tool steels ▪ Certain mill products: Molybdenum, Carbon nanotube filaments

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	▪ Tungsten steel (some applications): molybdenum steel ▪ Lightning equipment: carbon nanotube filaments, light –emitting diodes, other light sources ▪ Super alloys: molybedenum, ceramic matrix composites, tantalum fiber

Table 22: Information sheet 'Tungsten'

Raw material	*Stainless Steel*
Sources	http://www.bir.org/industry/stainless-steel/?locale=en_US
Industrial use	▪ Construction ▪ Food storage and production ▪ Transport ▪ Healthcare ▪ Household
Re-use	
Recycling	
Production residues	
Recycling	▪ EOL-recycling rate: ~ 90%
End-of-life	
Substitution	

Table 23: Information sheet 'Stainless steel'

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