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Report on methodology and guidance for EU-level data harmonization with UNFC

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Executive Summary

One of the GSEU project objectives is to contribute to implementation of the European Green Deal (2019) that transforms the EU into a modern, resource-efficient and competitive economy that requires a secure supply of critical raw materials (CRM) and innovative solutions to overcome many challenges, including resource management. One of the innovative tools to support sustainable resource management is the United Nations Framework Classification for Resources (UNFC, 2019) which is increasingly being adopted by those responsible for resource management across Europe. The Critical Raw Material Act proposal (CRMA) clearly states how UNFC can meet these objectives.

The goal of the WP 2 T2.4. is to analyse the current status of the UNFC implementation in Europe and, based on analysis of the most up-to-date selected UNFC case studies, to develop an accepted methodology that ensures the CRM data provision to the EC, DG GROW. This will help stakeholders within the raw material community and partners within the GSEU project to prepare for a consistent application of the UNFC in the next phase of the GSEU project, aligning with the requirements of the proposed CRMA and also support the data service to the EuroGeoSurveys (EGS) European Geological Data Infrastructure (EGDI) for CRM data.

Previous national and international projects (e.g.: EU-funded MINVENTORY, ORAMA, MINTELL4EU, MINEA) have provided a strong foundation to continue building a comprehensive knowledge base, to share experience with UNFC. The UNECE UNFC Guidance for Europe (2022) defines how European countries could implement UNFC for minerals and anthropogenic resources, based on general principles and specifications. Based on these we present a baseline assessment for UNFC in Europe in 2023 focusing on the comparison of different available UNFC methodologies in Europe and different national and regional UNFC circumstances. This looks at data for the specific UNFC axes, E, F and G, as well as limiting factors and how they can be overcome.

The baseline assessment shows national and regional resource management systems generally do not pose a barrier for application of the UNFC. However, in some cases, where national raw material classification and reporting systems are prescribed by national legislation, it is necessary to ensure compliance at the operational and professional levels. There is a range of experience with regards UNFC across Europe. There are some countries where the UNFC is integrated into legislation, such as Ukraine, Romania, and Hungary. In some countries, collaboration has recently begun between government agencies and Geological Survey Organization (GSOs), specifically related to the application of the UNFC (i.e. Geological Survey of Finland, the Critical Raw Material Information Centre in the United Kingdom and the Norwegian Government's mineral strategy in 2023).

Guidance-type documents (including case studies and good practice) for the application of UNFC, including decision flows, from nine countries with related expertise (Czech Republic, Hungary, Poland, Slovenia, Finland, Norway, Sweden, and United Kingdom), have been considered alongside other available results of UNFC studies in each European region (e.g., Portugal, France, Austria, Ukraine). This ensures that there is a robust evidence base and expert-led examples for data harmonization on European level. It also needs to be recognised there are many countries and regions where case studies or guidance-type documents are missing. Here, further development is needed (e.g. mapping, bridging, preparation of guidance). One of the next steps within the frame of T2.4 for UNFC is to facilitate the preparation of national guidance documents for most European countries.

This report uses examples from different available national and regional UNFC practices to highlight how data providers and stakeholders can build an evidence base for the three UNFC axes; E, F and G:

UNFC axis	Data source
E axis	Permit applications, economic feasibility studies, environmental impact assessments, information on stakeholder involvement, mining and exploration licenses, status (active/non-active), documents on cancelled and exhausted objects, protected areas for special intervention in the Earth´s crust, exploration reports (indirect evidence on economic importance based on investment to exploration), and land-use planning documents.
F axis	Licensing documentation and officially approved decisions on mining or recycling-related activities (mining and technical operation plans)
G axis	Resource and reserve data from central GSO or authority databases, ad hoc or project databases as well as published company reports. In central databases, resource inventories are based on official decisions on exploration and other mining activities (extraction, suspension, closure) validated by authorized national experts. In feasibility studies and in company reports, resource and reserve data are validated by a company representative and/or Competent/Qualified Person and this data can be integrated into the UNFC database.

The baseline assessment shows how UNFC can be integrated into the reporting systems of European countries. The UNFC can be applied directly (e.g. in Finland, Norway, Sweden, Portugal and Hungary) or indirectly via harmonization between the national database and the UNFC (e.g. in Slovenia) or bridging between national data with, e.g., CRIRSCO-type reporting code and the UNFC (former method in Hungary). Another classification method is the use of decision trees (United Kingdom, by BGS, and France, by BRGM) with specific project-related and objective questions. When national classification systems need to be modified and the consideration of limiting factors, a direct application of the UNFC Guidance for Europe (2022) can be a solution.

The baseline assessment is underpinned by a detailed analysis of barriers and subsequent potential solutions for application of UNFC, based on a survey of GSEU WP2 partners. This survey covered the following topics: policy and legislative framework – institutional background; data and information management – resource classification, reporting; available documents; communication; capacity – expertise. Some selected recommendations based on solutions for barriers by partners include:

- Proper communication channels need to be established between public authorities, organizations and the private sector for raw materials management.
- Capacity building by training, workshops and seminars for national officers, experts in data provider organizations and experts at companies and for decision makers will contribute to the deployment of UNFC in Europe.
- Different levels of knowledge about UNFC and CRMA need to be balanced at relevant data provider organizations and experts across Europe.
- It is necessary to translate UNFC (2019) and UNFC Guidance for Europe (2022) into national languages in Europe. This will significantly contribute to the national-level understanding of the benefit of the UNFC and how to classify raw material projects. In Europe, the UNFC 2019 is currently available in English, French, Spanish, Greek, Portuguese, Hungarian and Russian.

- There is a significant difference between primary and secondary raw materials legislation in different European countries. In the case of primary raw materials, more than two-thirds of the responding countries have legislative documents to maintain data, while in the case of mining wastes (MW) only one third have legislative documents to maintain data.

The CRMA requires reporting of CRM data by EU MS using a standard template. This report outlines the initial development of such a template developed by the UNFC Coordination Team (UNECE, EC DG GROW, GSEU, and FutuRaM project), with significant contributions from the GSEU experts. The UNFC Europe template will be a designated tool for the systematic data collection on European mineral resource projects and defines minimum criteria to be addressed. As well as provision of data to meet the requirements of the CRMA, this also represents a valuable opportunity for serving data of different resource types to the EGDI. This latter aspect is under development in co-operation with GSEU WP7. The initial data collection and UNFC classification, using the template, is proposed to be carried out by EU Members State administrations or mandated agencies to provide CRM data to the EC DG GROW. An equivalent template for secondary RM is currently being developed by the FutuRaM project consortium.

GSEU

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1. Introduction

The GSEU project aims to contribute to the objectives of the European Green Deal, the UN Sustainable Development Goals and the Horizon Europe objectives through the development of a Geological Service for Europe. Task T2.4. in work package 2 ("raw materials") will further develop the United Nations Framework Classification for Resources (UNFC) in Europe for its application in EU-Member States and neighbouring countries. In doing so, country-specific characteristics will be considered.

The EU's mineral potential remains underexplored, despite a few new mining developments (EC 2021 Raw Materials Scoreboard 2021). The UNFC code system is the most promising way to compile unbiased, comparable and standardised resource information at international level. UNFC can be used to identify and to monitor the limiting factors that hinder project development. This understanding is required to aid the transitioning from non-viable to potentially viable projects and from potentially viable projects to viable projects. Furthermore, the understanding is required to monitor the developments of projects in relation to the permitting process. Considering the management of project status from active to non-active ones by the UNFC, or identifying the existence of remaining mineral deposits in mineral inventories (UNFC E3F4G1, 2, 3), the UNFC is a proper tool to handle data that span a wide range of confidence levels, for example clearly defining mineral deposits and occurrences independently from their active or non-active status. Thereby, it supports comprehensive resource management by considering all aspects of resource data.

UNFC is the first widely accepted natural resource management system for classifying multiple types of natural resources globally and in a comparable way. UNFC is also useable for reporting projects by considering economic, social and environmental information (E-axis), technical feasibility (F-axis) and degree of confidence (G-axis).

The application of UNFC contributes to the implementation of the principles of the United Nations Resource Management System (UNRMS). The communication of the accessibility of different types of resources indispensable to society by using UNFC in Europe provides a reliable uniform base for sustainable resource management for European governments, industries and other stakeholders in the raw material community.

To promote the use of UNFC for mineral resources in Europe, T2.4 is focusing on the following actions: 1) Establish a baseline assessment of the most recent results and recommendations on using UNFC for primary and secondary raw materials; 2) Identify good practices and recommendations to properly serve raw materials data in UNFC, especially for CRM at an EU level; 3) Valorise data to highlight the most prospective raw materials areas at regional/province scale, and provide FAIR (Findable, Accessible, Interoperable, Reusable), complete and up to date information on mineral resources and reserves according to UNFC.

This report summarizes available national and regional UNFC methodologies in Europe and the comparison between national UNFC methodologies and opportunities for using UNFC with the UNFC Guidance for Europe (2022) based on baseline assessment and related exercise in the frame of the GSEU project. Previous national and international, mainly EU-funded H2020 projects, results provide a substantial evidence base for comparing different UNFC methodologies in European regions that have specific similarities and differences in 2022/2023.

2. Background

2.1. UNFC as a comprehensive tool for resource management

The United Nations Framework Classification for Resources (UNFC) is a classification and resource management tool for energy resources including oil and gas, renewable energy, nuclear energy, minerals, injection projects for the geological storage of CO_2, groundwater and anthropogenic resources such as secondary resources recycled from residues and wastes.

The United Nations Economic Commission for Europe (UNECE) Working Party on Coal initiated the first version of the United Nations Framework Classification (UNFC) for Solid Fuels and Mineral Commodities in 1992 using the three-dimensional principles developed at the Federal Institute for Geoscience and Resources (BGR), by Dietmar Kelter for reserve and resource estimations (Kelter 1991; Kelter, Wellmer 1994; Müller, Kelter 1997 in Mykhailov 2023). The UNECE Expert Group on Resource Management (EGRM) originally started as a UN Task Force on Coal. It has since then been working to facilitate the application of different versions of the UNFC at global level and providing support for all stakeholders, including early examples of practical application (UNECE 1999). In 2004, the Economic and Social Council of the United Nations (ECOSOC) endorsed for the first time the proposal of the United Nations Framework Classification for Fossil Energy and Mineral Resources (UNFC) submitted by the UNECE. The UNFC is an evolution of the fossil fuel system that has been in place since 1977 and with the latest update in 2019 (UNECE 2019, Figure 1.

UNFC provides countries, companies, financial institutions and other stakeholders an innovative tool for sustainable development of energy and mineral resource endowments. The UNFC, in its core principles, encompasses the holistic management of all socio-economical, technological and uncertainty aspects of energy and mineral projects. The project maturity and resource progression model of UNFC can de-risk projects from costly failures and thus protect the investments. UNFC fully integrates social and environmental considerations and technology readiness required to bring clean and affordable energy and solid mineral resource projects into the market (based on UNECE EGRM 2023).
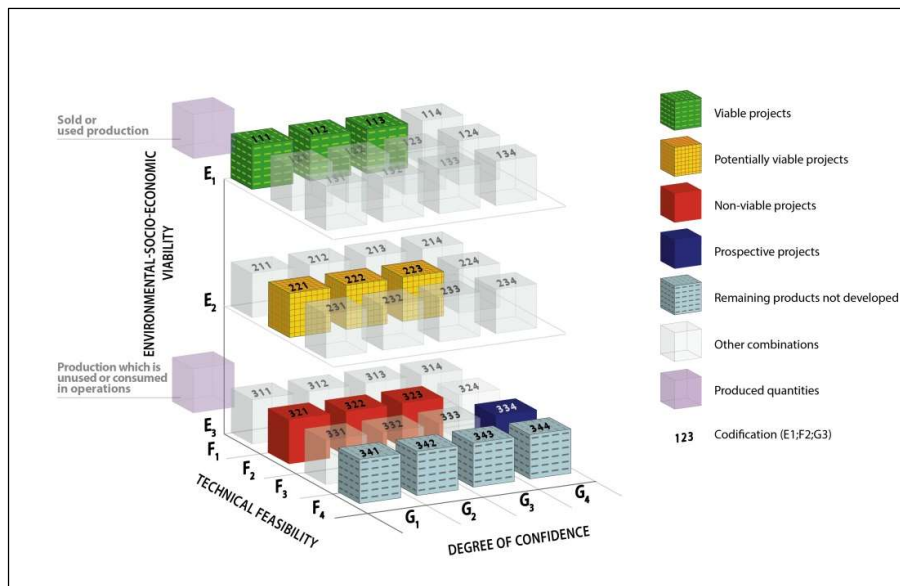
Figure 1. UNFC Categories and Examples of Classes (UNECE 2019)

2.2. Background to the UNFC in Europe

The European Geological Survey Organisations (GSO) have delivered many national and joint international projects, mainly EU-funded, in relation with UNFC, including mapping to national resource classification systems, harmonization-opportunities and developments of regional / EU-level guidance documents, and numerous case studies for all types of resources. Some countries have integrated UNFC in their national mining law. The examples range from early implementations and more recent updates as in the case of Ukraine to concepts of national databases using also UNFC, as in the case of the Nordic countries Finland, Sweden and Norway, as described in Chapter 2.

There are several recent cases of adoption of UNFC at a national level. Ukraine has mandated the use of the UNFC as the foundation of its national resource management based on UNFC-1997 approved by the regulation (Resolution 1997). On 19 September 2018, Ukraine amended its national classification (Resolution 1997) to be aligned with the latest version of UNFC. This amendment makes Ukraine's classification up-to-date with international standards and comparable globally (UNECE 2008). However, the UNFC is not yet applied in full to the materials inventory of the country. In 1998, by the enforcement of Romanian Mining Law and the publication of the technical instructions, a new mineral resource classification system was developed that presents the terms and codifications used in UNFC (www.unece.org). In 2016, Hungarian data harmonization project results were published in the Bulletin of Hungarian Geological Society, including an overview on international reporting codes and UNFC, and a comparison between these tools and national classification system for most types of mineral resources. In Hungary, since 2020, the legislation addresses the internationally recognized reporting standards, the UNFC and the harmonization between the related terms and the national resource classification categories.

Recent studies from different Geological Survey Organizations provided new results on mapping, data harmonization and application of the UNFC in several European countries (Hungary: Horváth et al. 2016; Horváth, Sári 2016; Kovács 2016; Nádor 2016; Czech Republic: Starý et al. 2021; Poland: Malon, Tymiński 2017; Finland, Norway and Sweden: Lax et al. 2017; Finland: Hokka et al. 2020; Portugal: Ponce de Leão 2019; for Spain: Delgado and Bide 2017).

The European Geological Survey Organisations (GSO) have delivered many national and joint international projects, mainly EU-funded, in relation with UNFC, including mapping to national resource classification systems, harmonization-opportunities and developments of regional / EU-level guidance documents, and numerous case studies for all types of resources.

Within the framework of the successful GeoERA program, the MINTELL4EU project has conducted 19 case studies proving the applicability of UNFC for sustainable management of most types of mineral resources. MINTELL4EU has also benefited from the extensive testing undertaken by GeoERA partners. In the MINTELL4EU project, geologist experts from Austria, Belgium, Croatia, Denmark, Finland, Hungary, Norway, Slovenia and Sweden have provided case studies including Au, Cu, Co, Mn, Mo, REE, phosphate, carbonates, graphite, aggregates, natural stones, peat, gypsum and perlite (Aasly et al. 2021). The case studies benefit from the basic principles developed through ORAMA, a previous EU-funded project. Within the ORAMA project, the British Geological Survey (BGS), in cooperation with the project partners, developed an important flowchart for decision making on UNFC E, F and G categories, which was used for a national resource inventory (Bide et al. 2022).

Meanwhile, in many European countries relevant experience with UNFC exists in the academia as well from important data providers in the raw materials industry, responsible geological survey organizations and national government bodies (Aasly et al. 2021; Aggestam et al. 2021; Bide et al. 2022; Eilu et al. 2022; Haschke et al. 2020; Hokka et al. 2020; Horváth et al. 2020; Kelter et al. 1999; Kelter, Wellmer 1994; Nieć et al. 2022; Suppes, Heuss-Aßbichler 2021a, b; Verhulst et al. 2023).

Today, the UNFC is promoted by the European Commission towards Member States. However, UNFC does not replace reserve and resource estimations, as required by the extractive industry to ensure investor confidence, but supports communication on global level. The very recent UNFC Guidance for Europe (UNECE 2022) provides further assistance on how to apply the framework classification. Listed companies are obliged to use internationally recognized codes and standards for reporting on resources and reserves. In contrast, most small and medium-sized enterprises operating in Europe are often not listed on the stock exchange and are not subject to this requirement. Furthermore, different regions with different historical requirements caused fragmentation of how resource data is defined in Europe. As a result, a wide range of resource estimate reporting methods and procedures were developed and are still in use.

GSEU builds on experiences and competences of those dealing with resource management and the required data. GSEU is aiming to develop the raw material data collection and data management by the application of the UNFC in the EGDI and to the EC DG Grow CRM database.

2.3.   Previous and ongoing UNFC related projects

UNFC has been considered as solution to issues around lack of resource data harmonization and lack of understanding of resources in Europe for some time. The main projects that have worked on this issue and major steps in the timeline for implantation of UNFC in Europe are outlined in Figure 2.
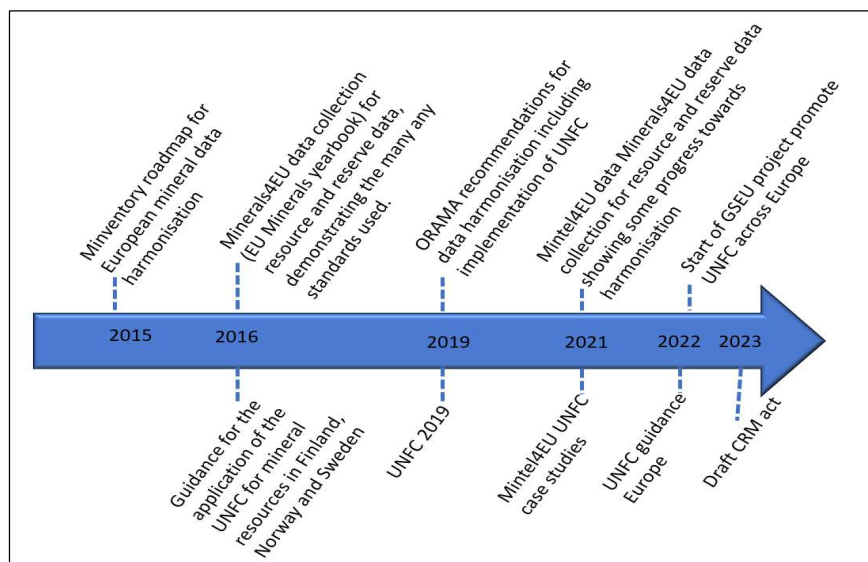
Figure 2. Timeline for selected developments of UNFC for European RM data

2.4. Past UNFC related projects

In this chapter we introduce the most important FP7, Horizon 2020 and other projects that have had significant impact to the development of the UNFC in Europe mainly based on EuroGeoSurveys activities. This chapter is also focusing on most relevant results that are considered in the frame of the GSEU project, more closely in the WP2 T2.4. activities.

2.4.1. Minventory

The aim of the Minventory project was to create a harmonised pan-European metadata inventory on resource and reserve information related to primary and secondary raw materials (including mining wastes, landfill stocks & flows and in-use materials). As part of this resource classification and UNFC were mentioned. At that time there was relatively little experience amongst European geological surveys regarding UNFC, and as such the project outputs reflect this by only giving a brief introduction.

The Minventory project delivered the following:
- A study that documents the prevalence, metadata and standards employed by EU Member States and neighbouring countries of Europe in quantifying resource and reserve information related to primary and secondary raw materials, including an assessment of the level of application of a system of reporting resource and reserve data;
- A roadmap outlining the barriers and possible voluntary actions that might be taken to harmonise and publish the resource and reserve data at an EU level;
- An action plan on harmonisation of resources and reserves statistics and their incorporation in future European Minerals Yearbook (including UNFC implementation);

A key output of the Minventory project was a roadmap for European data harmonisation (Figure 3).

Minventory concluded that a reporting standard or code aligned to the CRIRSCO-template (www.crirsco.com/template/) or the UNFC system could be adopted for reporting resources and reserves at the European level. The Final Report presents advantages and disadvantages of each. The report states such a system should be used for transmission of information to the EU level and by the EU in its subsequent publication or communication of statistical data related to resources and reserves. In any case, any CRIRSCO-based reporting system can be mapped to UNFC by prevailing bridging documents.

Relevant to UNFC implementation within Europe was the results of a review of systems of reporting of data on mineral resources and reserves. This, although now dated, shows the background level of data harmonisation, and how far it has moved on. The review showed data is far more structured for countries in Eastern Europe (seven of these are aligned or in the process of aligning to a widely accepted code or standard). Here, requirements to provide data to the relevant authority commonly form part of the legislation on mining. Likewise, it is also a requirement to provide data in a format that complies with a national Reporting Code. National Reporting Codes often align to the international CRIRSCO template. Whilst only the UK does not have a national mining policy for resource data, all other States have such a law or policy, and two thirds of these mandate data disclosure.
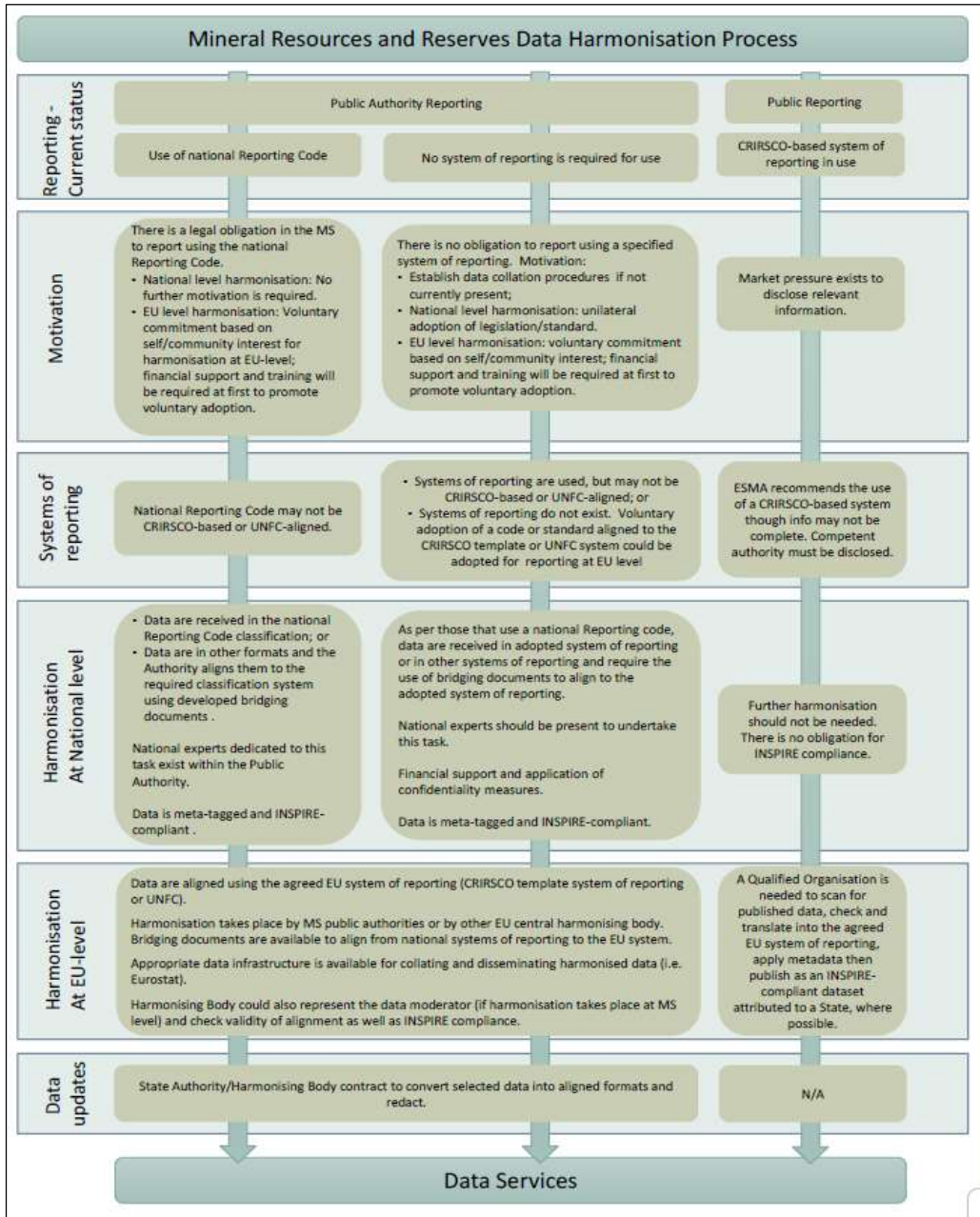
Figure 3. A potential road map outlined by the Minventory project for data harmonisation (Parker et al. 2015)

2.4.2. ORAMA

The aim of the ORAMA project was to improve the provision of raw materials information across Europe, for all data types, for both primary and secondary raw materials to ensure policymakers had access to data critical for informing long term planning for industrial strategy and raw materials supply. A significant part of this was addressing a specific requested from The European Commission for pan-European resource and reserve statistics. The ORAMA project, building on work laid out by the

Minventory project, viewed the suitability of globally recognised mineral resource reporting standards, frameworks and classification and recommended that the United Nations Framework Classification (UNFC) was the most suitable tool to produce harmonised figures and should be adopted for pan-European reporting. Whilst the ORAMA project did not collect new data it aimed to facilitate the use of the UNFC by European data providers by:

- Producing a detailed report outlining the issues around statistical minerals data collection, exploring the issues around different standards of reporting mineral resource information and highlighting good practices;
- Producing a simplified guide on use of the UNFC;
- Producing training materials for use of the UNFC;
- Producing a range of case studies for how UNFC had been used by various European countries.

These documents formed the basis of a webinar designed to facilitate the use of the UNFC, and is available as a recording here: https://orama-h2020.eu/

It should be noted that the discussion around data harmonisation and use of UNFC has significantly progressed since the inception of the ORAMA project. Since the completion of this project UNFC has become widely accepted within Europe and numerous detailed documents regarding its use have been published, such as the 2019 UNFC update and the UNFC Guidance for Europe. These documents supersede much of the introduction to UNFC that the ORAMA project focused on.

2.4.3. PROSUM

The ProSUM project (https://www.prosumproject.eu/documents), funded by the European Union and the Swiss Government has delivered the First Urban Mine Knowledge Data Platform, a centralised database of all available data and information on arisings, stocks, flows and treatment of waste electrical and electronic equipment (WEEE), end-of-life vehicles (ELVs), batteries and mining wastes. The availability of primary and secondary raw materials data, easily accessible in one platform, and provides the foundation for improving Europe's position on raw material supply, with the ability to accommodate more wastes and resources in future. ProSUM provided data for improving the management of these wastes and enhancing the resource efficiency of collection, treatment and recycling. Regarding Mining Wastes and Minerals4EU database during the project:

- Data on amount and composition of stocks of mining waste was collected with the purpose to create a dataset from which deposits with high levels of CRM could be identified and explored for.
- These data, which also contain other information about the mining waste such as location, type of waste and origin, was stored in an extension of the database for primary raw materials, the Minerals4EU database.
- This database was an important part of the European Minerals Knowledge Data Platform (MKDP).
- The Minerals4EU extension for mining waste made it possible to store information about generated waste rocks from mines, generated tailings from mineral processing plants but also data on waste from metal producing plants, i.e. smelters and blast furnaces.

2.4.4. GEOERA/MINTELL4EU

As a part of the GeoERA programme the MINTELL4EU (Mineral Intelligence for Europe, https://geoera.eu/projects/) aimed at supporting responsible domestic sourcing in Europe by making RM data available in a harmonised and INSPIRE-compliant way for policy making, for subsurface planning and management, for investments as well as for the general public (Wittenberg et al. 2022). When

comparing data across borders, harmonised data as well as a uniform classification system is required. Thus a need for harmonized support tools for sustainable resource management in Europe was identified.

During the MINTELL4EU project the MIN4EU database was established as part of EGDI including the results form Minerals4EU and some of the other GeoERA projects. This is now the central database for EGS for mineral occurrences, for mines and for the Minerals Yearbook.

It was also clear that geological surveys needed a tool that can be used to manage a country's resources and potential resources, and that the society (at national and European level) needed a tool for resource awareness, foresight and policy formulation, safeguarding and management.

19 case studies from nine different countries were carried out to test and assess if the UNFC could be used to harmonize and aggregate resource data. The case studies are described in Simoni et al (2021) and can be found on EGDI as a separate map layer. A report on harmonization issues and data gaps (Hokka et al. 2021) was published as a deliverable of the project.

MINTELL4EU confirmed that UNFC can be used as an international standard for resource classification.

However, MINTELL4EU also identified some challenges that needs to be addressed further in GSEU to compile mineral resource data according to the UNFC:

1) Policy frameworks, both nationally and internationally, are needed to overcome poor data availability and accessibility.
2) There is a need to develop UNFC reporting templates for data compilation and classification.
3) There must be a common, harmonized understanding on how to apply the UNFC. Extensive training is required to assist in providing more transparent, comparable, and reliable results.
4) National mineral resource accounting practices needs to be uniform across countries to assist in attaining aggregated data which are realistic and complete on a pan-European scale.
5) It is necessary to create a permanent pan-European instrument for training in standardized mapping of national raw material resources and related data according to the UNFC system.

2.4.5. MINLAND

Mineral resources in sustainable land-use planning, the MINLAND project (https://www.minland.eu/project/), has been designed to meet challenges concerning competing land-use planning related to different land-use interests. In the Deliverable 2.3 on Safeguarding mineral resources in Europe, regarding existing practice and possibilities, a comprehensive concept was described with reference on UNFC and its benefit in the land-use planning (Carvalho et al. 2019). It was stated that UNFC can help in land-use planning concepts. The long-term (sustainable) supply depends on the undiscovered or poorly defined resources (e.g., Briskey et al. 2000) which will only be mineable if the areas containing them are also protected from unnecessary sterilisation.

2.4.6. MINATURA

One of the important conclusions of the MINATURA2020 project regarding UNFC and mineral deposits of public importance (MDOPI) as building blocks of a coordinated European MDOPI strategy was in 2018:

Mineral resource inventories: Mineral management requires well developed, regularly updated, modern and standardised data-sets on minerals. A comprehensive inventory supports the MDoPI definition, helping decision makers with the evaluation of quantity and quality of minerals on a specific territory. A mineral resource inventory ideally follows international reporting standards, such as UNFC-2009 or the

CRIRSCO family. Mineral potential assessment: Not only well-known (indicated and measured resources as well as mineral reserves) but also little-known (inferred resources) deposits can be safeguarded for future use. Therefore, appropriate data of the mineral potential is important to take into consideration in land-use planning. The assessment of mineral potential is needed for long term mineral planning so it is a matter of national interest (Horváth et al. 2018).

2.4.7. COST-MINEA

"Mining the European Anthroposphere" (COST-MINEA) project between 2016-2020 identified enablers of and barriers to resource availability and developed a comprehensive knowledge base. It addressed methods for waste characterization, recovery technologies, economic settings, and environmental impacts as well as case studies that illustrate the use of the knowledge base to assess resource availability. This knowledge base is publicly available and helps experts to develop their own case studies (http://dx.doi.org/10.5281/zenodo.3739164). Complementary reports on recovery technologies are available as well as articles, proceedings and presentations on various aspects of material recovery from anthropogenic resources (https://doi.org/10.5281/zenodo.3767910). Experts recognized the complexity of the assessments and the challenges in achieving comparable results and communicating these to recovery project developers in industry and raw material policy makers. To meet this challenge, the experts made use of the UNFC. The results of the project can be found on the project website: http://www.minea-network.eu/.

The project has developed a common understanding and definitions regarding material resources/reserves in all types of landfills (e.g. municipal solid waste landfills, industrial waste landfills) and mining residues (mine waste rock, tailings and metallurgical deposits), both closed and in operation. In co-operation with 26 countries many UNFC classification related information and data were assessed including inventories and surveys using new technologies, to assess how to excavate, separate and upcycle waste from landfills/mining residues into products from a technical, environmental and economic viewpoint.

Considering the gaps in knowledge on residues from the extractive industry (i.e. reporting on non-sales production and non-technical and external factors; lack of information on resource characterization and evaluation) and the objective of available inventories of closed mine waste facilities (implementation of the Directive 2006/21/EC) representing mainly environmental considerations some selected recommendations on classification and data management were: the need for reliable mineral inventories to underpin mineral policies and incorporation of data from governments, NGOs as well as industry.

Regarding different resource classifications and the UNFC a Resource Classification Framework to secondary materials was developed that contributed to the preparation and publication of the Specifications for the application of the United Nations Framework Classification for Resources to Anthropogenic Resources (UNECE 2018).

2.4.8. FutuRaM

The FutuRaM project has been developing since 2022 the Secondary Raw Materials knowledge base on the availability and recoverability of secondary RMs within the European Union (EU), with a special focus on critical raw materials (CRMs). The project research will enable fact-based decision making for the recovery and use of secondary RMs within and outside the EU, and disseminate the data generated via an accessible knowledge base developed in the project (https://futuram.eu/). FutuRaM will establish a methodology, reporting structure, and guidance to improve the raw materials knowledge base up to 2050. It will integrate secondary RM and CRM data to model their current stocks and flows, and consider economic, technological, geopolitical, regulatory, social and environmental factors to further develop,

demonstrate and align secondary RM recovery projects with the UNFC. The handling of data of the FuTuRaM project will be coordinated with the MIN4EU database and organisation. This will enable the commercial exploitation of secondary RMs and CRMs by manufacturers, recyclers, and investors, and the knowledge base developed in the project will support policy makers and governmental authorities.

2.5. Critical Raw Materials Act and UNFC

According to the state of the CRMS to 31 of August 2023, the UNFC is mentioned four times in the CRMA proposal (CRMA 2023) at following topics:

1. Strategic projects
2. Exploration
3. Monitoring
4. Extractive waste

For **strategic projects** Chapter 3 on strengthening the Union raw materials value chain in Section 1 Article 6 deals with "Application and Recognition" as follows: "Applications for recognition of a raw material project as a Strategic Project shall be submitted by the project promoter to the Commission. The application shall include: a classification of the project according to the United Nations Framework Classification for Resources, supported by appropriate evidence."

In addition the CMRA also states: "Any promoter of strategic raw materials project should apply for the recognition of their project as a Strategic Project. To better assess the social, environmental, and economic viability, the feasibility of the project as well as the level of confidence in the estimates, the project promoter should also provide a classification of the project according to the United Nations Framework Classification for Resources, and to allow for objective validation, they should support this classification with relevant evidence."

For **exploration projects** Chapter 3 on strengthening the Union raw materials value chain Section 4 Article 18 deals with "National exploration programmes" as follows: "Member States shall make the information on their mineral occurrences containing critical raw materials gathered through the measures set out in the national programmes referred to in paragraph 1 publicly available on a free access website. This information shall, where applicable, include the classification of the identified occurrences using the United Nations Framework Classification for Resources."

For **monitoring projects** Chapter 4 on risk monitoring and mitigation Article 20 deals with "Information obligations for monitoring" as follows: "Member States shall, as part of the report referred to in Article 43 (*Reporting of Member States*), provide information to the Commission on any new or existing raw material project on their territory that is relevant regarding to Article 19 (Monitoring and stress testing) (1), point (d *on Union and global production and production capacities at different stages of the value chain*), including a classification of new projects according to the United Nations Framework Classification of Resources."

For **extractive waste** Chapter 5 on sustainability, Section 1 on circularity, Article 26 deals with "Recovery of critical raw materials from extractive waste" as follows: "The activities described in paragraph 64 (*reference on principle of subsidiarity as set out in Article 5 of the Treaty on European Union*) shall be carried out within the limits of national legal systems pertaining to property rights, ownership of land, mineral resources and waste, and any other relevant provisions. Where such factors

inhibit the activities, the Member State authorities shall seek the cooperation of the operator or owner of the waste facility. The results of the activities described under paragraph 6 shall be made accessible as part of the database. Where possible, the Member States shall include in the database a classification of the closed extractive waste facilities according to the United Nations Framework Classification for Resources."

National GSOs are specifically referenced in the CRMA, which equates to a legal recognition of the key role that they play in implementation of the Act, including by delivering data compliant with UNFC (in relation to the national programs and recovery of CRMs from extractive waste). Thereby the work currently being done in GSEU WP2, T2.4. is centrally in line with the policy direction.

3. Methodology

This task is focused on the preparation of a baseline assessment for the 2022/2023 period on selected topics that have importance to the joint European level UNFC application of the UNFC with involvement of Geological Survey Organizations.

The first element of the methodology is that we provided a questionnaire survey with other WP2 Tasks on resource management. Based on answers from most European countries a wide range of information is made available for a baseline assessment providing an evidence base for further steps during the GSEU project lifetime. Some selected UNFC related topics are resource management with legislation, data collection for UNFC E, F and G categories, activities of Geological Surveys Organizations with UNFC and the related experience and some additional topics that might have relevance to use UNFC comprehensively.

The second element is the analysis of recently available UNFC methodologies and comparison between the UNFC for Europe (2022) and UNFC data sources in different European regions. The aim is to facilitate the joint European UNFC application using he most up to date knowledge on recent UNFC methodologies.

The third element of the methodology is co-operative with the UNECE, the EC DG Grow and FutuRaM with the development an UNFC template for raw materials data collection. It is based partially on the CRM data base structure of the EC Grow but consists of other national and regional considerations that were suggested by GSEU experts. This UNFC template is the core document of UNFC guidance documents on national levels that will be developed in the next period of the GSEU projects in synergy with related trainings (on going establishment of the EU ICE-SRM by WP2 T2.3.). The UNFC template should also be in harmony with the EGDI data provision in order to avoid parallel assessments and using the recently available raw materials information in the EGDI (co-operation with WP7).

The results of these activities will contribute to the UNFC data valorisation in the third period of the GSEU project with proper data service to the EGDI and improved data provision to the EC DG Grow by Member States who will be more familiar with the UNFC, due to the requirements of the CRMA, led by initiatives of EC DG Grow and capacity building within the GSEU project. International Centres of Excellence on Sustainable Resource Management in Europe (EU ICE-SRM; WP2 T.2.3.) together with UNFC experts at least from the WP2 T2.4. will provide events (consultation and training) for stakeholders to deepen UNFC knowledge and apply the classification as accurately as possible. Participating countries are on Figure 4.
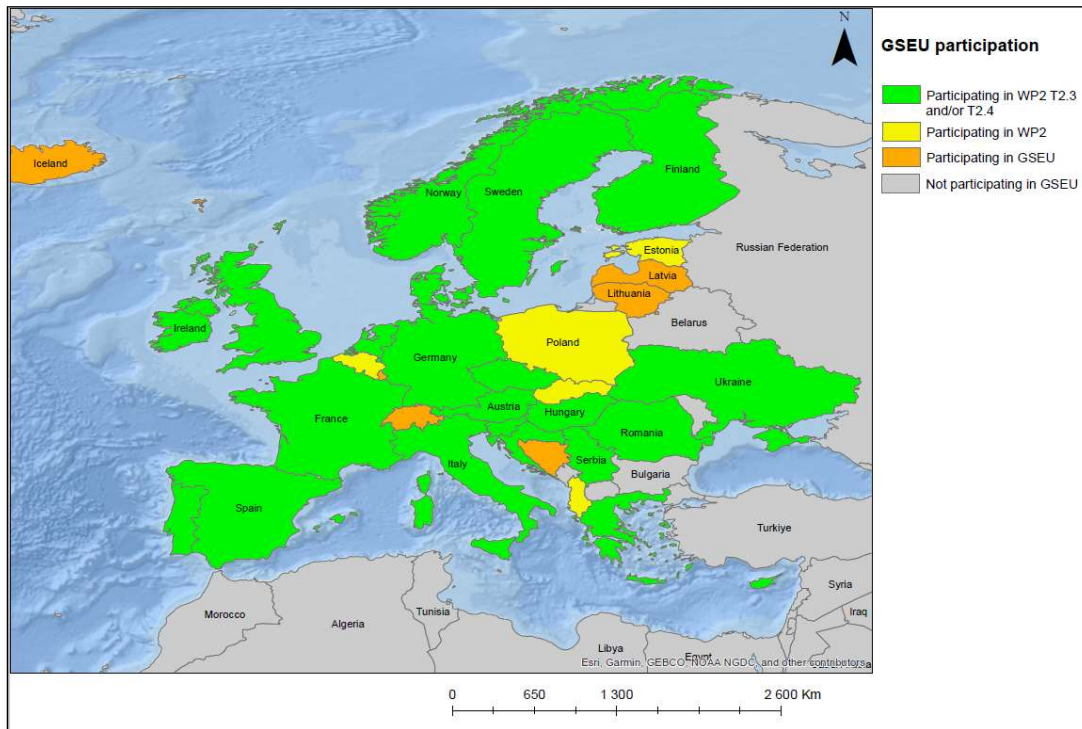
Figure 4. GSEU partners who have contributed to the UNFC questionnaire survey

4. Baseline assessment

This chapter summarizes the results of the questionnaire, sent to GSEU WP2 project partners and focuses on the answers on UNFC related topics in GSEU partner countries that are relevant for the planning of the activities in the lifetime of the GSEU project. The answers of project partners were discussed with them and, when necessary, completed with additional data sources in some cases for a more accurate overview on national and regional UNFC related topics.

The aim of the baseline assessment, based on the survey and other sources of information, is to explore the most recent situation regarding UNFC and what factors are most important to apply to enable the use of UNFC on a coherent and comprehensive way by each of the GSEU partners, and later on by other stakeholders in Europe.

Some selected UNFC related topics are legislation related to resource management, data collection for UNFC E, F and G categories, activities of Geological Surveys Organizations with UNFC and the related experience and some additional topics that might have relevance to develop and use UNFC comprehensively. Answers and conclusions contribute:

- to identify regional/national circumstances or considerations to properly use the recently available UNFC Guidance Europe and EC DG Grow UNFC instructions (RMSG members and partners within the GSEU WP2 T2.4.)
- to identify gaps on proper data and information management that may influence the UNFC application and UNFC data management later
- to find solutions to barriers for the use of UNFC.

4.1. Sustainable resource management

A question on resource management addressed strategies and relevant sustainable resource policies, and updates on UNFC related considerations. It is important to be aware about the legislative framework by involved partners and on project level as well in order to characterize the framework in which the appropriate UNFC application will have to be embedded. Answers are completed with MINLEX study results regarding the number of acts and laws relevant for NEEI (Non-Energy Extractive industry) permitting and some selected updates relevant to developing or published strategies. Answers on the question about sustainable resource management including UNFC with some additional references are in the Annex 1.

A summary of the statements given in the survey are:
- Raw materials have a strategic importance in almost all European countries considering the number of relevant legislations that relate to resource management, and existence of published resource or mining related strategies, or other supporting strategies that address minerals, raw materials, critical raw materials or mining or wastes.
- Published resource, or mineral, or raw material strategies, and strategic action plans are available in Austria, in Belgium, Finland, in France, in Germany, in Hungary, in Norway, in Poland, in Portugal and in Sweden, and in the United Kingdom.
- Policy documents addressing raw materials or mining are available in the Central Denmark Region (Sustainability Strategy 2030 in 2021), in Cyprus (Study for the Strategy for Sustainable Quarrying and Mining development of Cyprus 2001- 2025 and 2025-2050), in in Estonia (General principles of Earth's crust policy until 2050), in Ireland (Policy Statement on Mineral Exploration and Mining - Critical Raw Materials for the Circular Economy Transition (2022)).
- The Law of Ukraine on the approval of the State-wide program for the development of the mineral and raw material base of Ukraine for the period until 2030.

UNFC is integrated into the legislation or addressed within resource management documents:
- Ukraine has mandated the use of the UNFC as the foundation of its national resource management based on UNFC-1997 approved by the regulation (Resolution 1997).
- Since 1998, the UNFC classification system has been used in Romania. The Mining Law and the Norms for applying to resources/reserves evaluation.
- In Hungary UNFC has been addressed in the legislation since 2021 and UNFC is partially integrated into the non-metallic resource reporting form.
- In Norway the Mineral Strategy necessitates the Geological Survey of Norway to produce an inventory aligned with the United Nations Framework Classification for Resources (UNFC).
- UNFC has been addressed with results on mapping between national systems and UNFC for several years in official annual mineral yearbooks by Geological Survey Organizations in the Czech Republic, in Poland and in Slovenia.
- UNRMS is addressed in the UK in a report provided to UK Government on UNFC and UNRMS as part of the CMIC program.

Committees/commissions vs. authorities/offices in the resource management
The role of different authorities (mining, environmental, land use planning, etc. on local, regional, and national levels) is important when companies provide and submit exploration reports or mining related permissions. In many cases this is with the involvement of Geological Survey Organizations (the majority

of GSEU partners). This way required information on resources can be made available for stakeholder organizations that deal and will be dealing with UNFC.

Based on questions on responsible organizations (authority, agency, geological survey) and /or on responsible resource committees or commissions that decides on resource related data directly from exploration reports or indirectly embedded in other official decisions (e.g. Technical Operation Plan, establishment of mine plot) the statement is the following:

In most European countries there are responsible government bodies, organizations, ministries, authorities, agencies or specific commissions or committees that deal with permitting, decide on exploration reports or mining related activities. This can include the post closure phase of a mining site and the restoration of mining sites. These bodies may collect data and information on raw materials in co-operation with or independently from Geological Survey Organizations.

In Central and Eastern Europe there are specific committees / commission for classification of mineral resources and reserves with decisions on acceptance or rejection of exploration reports and other plans related to mining activities (e.g. establishment of mine plot, maintenance of changes). This is mainly for projects that have regional or national level importance. These commissions are operating in Croatia the Czech Republic, in Slovakia, in Serbia and in Ukraine. In addition, the operation of these commissions was also indicated from Poland, from Romania and from Slovenia.

There are some other specific commissions next to the inspectorates and mineral resource committees that are inter-ministerial, and their goal is decision-making or the ministerial preparation of certain raw materials subject to a concession or strategically important project (e.g. in Croatia and in Hungary).

Regionality appears in the operation of the authorities, but this also becomes important in relation to the subsequent comprehensive application of the UNFC, when mineral resource management is carried out on the basis of different regulations and practices in different regions (e.g. Germany, Italy, Switzerland). In the United Kingdom, mineral planning is mainly implemented through regional planning authorities. BGS has an important role to hold data on resources and reserves on ad hoc basis. Mineral planning authorities may also collect data on minerals if they are particularly important in selected areas.

4.2. National and regional UNFC activities

This chapter briefly presents the past, recent and in some cases the planned activities of GSOs and possibly other organization responsible for raw materials data with UNFC considering national projects and the related data harmonization (mapping, bridging, guidance preparation) and involvement of other UNFC related activities (e.g. NoPE) especially regarding CRMs.

Annex 2 provides a summary on national and regional UNFC activities mainly by Geological Survey Organizations with reference to other stakeholders based on answers by partners and considerations of other information (e.g. UNECE EGRM activity).
More intensive UNFC activities mainly by GSEU partners in years are seen on the Figure 5.
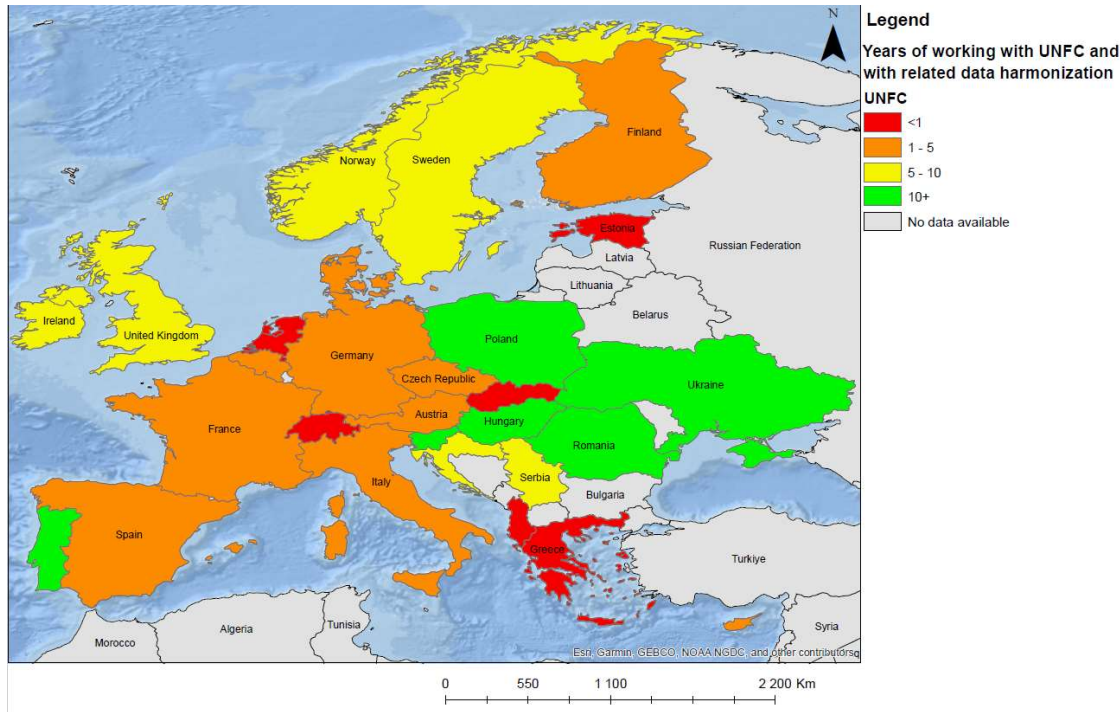
Figure 5. Map showing the years of practice with UNFC based on answers by project partners

Most of the Central and Eastern European GSOs have longer experience with UNFC, especially in relation to solid mineral raw materials. This may be related to the fact that one of the pillars of mineral resource management in this region for decades has been the regular collection of data on changes in mineral resources based on legally binding provision by companies which is essential for determining the UNFC category G.

Norway, Sweden, and the United Kingdom belong to the group where the responding experts reported 5-10 years of UNFC experience with solid raw materials, which may also be related to the fact that mineral raw materials began to become increasingly strategic in this region around this time.

The positive aspect of the increasing UNFC activities in Europe with the wider consideration sustainability is that UNFC has been significantly gaining ground in Europe during the past years.

Switzerland has a specific position because Geneva is the heart of global UNFC activity since the beginning of 1990's. Due to previous and recent project activities, the Swiss GSO has also started to deal with UNFC.

Summary:

Based on answers to questions and considering other observations (involvement of the UNECE EGRM activity of European countries) it can be stated that:

- Most European Partners of the GSEU project have at least preliminary experience but many of them developed from their own regional activity the application of the UNFC either for raw materials or for other resources.

- In the last 8 years the community of mineral resource experts within the EuroGeoSurveys (EGS MREG) paid special attention to the UNFC, with the formation of a specific UNFC subgroup and joint efforts within EU-funded and national projects. This has included disseminating information on UNFC, sharing of news and results to the members, sharing of experience on mapping

between different methodologies, development of case studies in a wider range within the GEOERA program (MINTELL4EU) and, in some cases, bridging and guidance documents were also developed. Significant milestones are guidance document in both national and English languages.

- Central European countries mapped their national resource classification system with the relevant UNFC (2009) and UNFC (2019) documents.
- Geological Survey of Finland (GTK), Norway (NGU) and Sweden (SGU) experts have published the Guidance for the application of the UNFC-2009 for mineral resources in Finland, Norway, and Sweden (Lax et al. 2017). GTK experts were involved in the preparation of the UNFC Guidance for Europe (2022).
- Within the ORAMA project, the British Geological Survey (BGS), in cooperation with the project partners, developed an important flowchart for decision making on UNFC E, F and G categories, with many different examples (Bide et al., 2022).
- Ukraine has implemented UNFC in its national classification of mineral reserves and resources since 1997.
- Other countries and mainly Geological Survey Organizations (Portugal, Romania, Slovenia) that have more than 25 years intermittent or continuous activity with UNFC can also share their experience with GSEU partners. BGR from Germany identified the accelerated UNFC activity in the last 5 years but the experts of the BGR were involved in the UNECE EGRM from the very beginning (Mid 1990's).
- Based on many national and regional level alongside more detailed site level UNFC case studies, including the results of the GEOERA Program, the joint knowledge base is sufficient for further developments to apply UNFC on European level.

4.3. The involvement of national geological survey organizations in the CRM data provision to the EC DG Grow RMSG

This topic is important for several reasons. In accordance with the draft Critical Raw Materials Act published on March 16, 2023, the GSEU project supports the preparation of project partners in connection with data provision of CRM projects according to the UNFC at the national and regional level. In addition, it helps to identify the responsible national ministries and authorities with which the GSEU partners need to jointly develop and strengthen the CRM data service. This will promote the most comprehensive European-level CRM data collection and data management by the Directorate General for Internal Market, Industry, Entrepreneurship and SMEs (EC DG Grow).

Direct and indirect involvement of GSOs in the CRM data provision to the EC DG Grow is described by answers of partners in the Annex 3. Based on answers from GSEU partners regarding the CRM data provision and the role of the GSOs conclusions are the following:

- There are countries where GSOs directly or indirectly, via the responsible Ministry, are involved in the CRM data provision to the EC DG Grow within the activity of the RMSG. Geological Survey Organizations from Finland, France, Germany (considering regional differences), Hungary, Ireland, Italy, Norway, Slovenia, Spain and Sweden directly provide data to the RMSG.
- In some countries responsible Ministries have the exclusive right to report CRM data to the EC DG Grow. These countries are Austria, Belgium, Croatia, Czech Republic, Estonia, Greece, Portugal, and Slovakia.

- Some GSOs are not involved in the CRM data provision to the EC DG Grow. These countries are Netherlands and Romania.
- Of course, considering the EU territory the CRM data provision to the EC DG Grow is not applicable or relevant to countries such as Albania, Serbia, Switzerland, Ukraine, and the United Kingdom but responsible Ministries and/or GSOs in most of these countries actively contribute to the development of the UNFC application and CRM data collection even when it is appropriate to European data platforms (and does to EGDI).
- Many partners indicated that independently from their role in the CRM data provision to the RMSG they serve CRM data to the EGDI. Partners from Austria, Belgium, Romania, and Norway have referred on their EGDI data provision activity and most GSOs serve CRM data to the EGDI with a developing joint vision that EGDI needs to be prepared for CRM UNFC data provision.

Expertise in the context of UNFC application

This topic is important in order to identify available expert base for further developments in the common application of the UNFC for at least CRMs in both EuroGeoSurveys and national to regional levels. The Guidance Note on Competency Requirements for the Estimation, Classification and Management of Resources (2022), published by UNECE, needs also to be taken into consideration in order to develop the expertise of staffs in GSOs and other relevant stakeholders.

A question was focusing on experts capability for reading public reports, preparing a resource estimation and/or reporting it in accordance with CRIRSCO International Reporting Template. Another question asked if the organization has internationally recognized Competent/Qualified Persons, certified national experts and how many of these.

In total,16 GSOs have experts with proper experience for reading public reports, preparing a resource estimation and/or report it in accordance with CRIRSCO International Reporting Template (Croatia, Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Norway, Poland, Portugal, Romania, Sweden, Switzerland, Ukraine) (Figure 6. , left).

Twelve GSOs have internationally recognized Competent/Qualified Person or certified national expert (Croatia, Finland, Germany, Hungary, Ireland, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden, Switzerland) (Figure 6. , right).

In Croatia, Finland, Germany and Slovakia have each more than 5 such highly qualified experts.
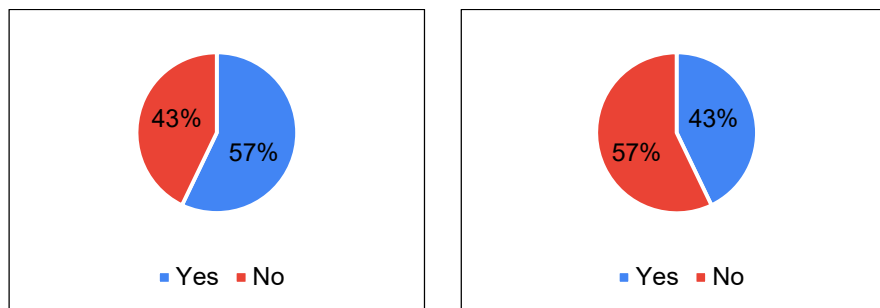
Figure 6. Experience with CRIRSCO reporting (left) and employment of experts certified on national or international level (right) in GSOs in Europe

Summary: The result is that approximately half of the GSOs have qualified experts with practical application of international mineral resource reporting standards, and/or also employ national or international experts. However, this does certainly mean that other GSO geoscience specialists cannot properly contribute to the UNFC classification.

The message of this result is that EGS has a strong base (40-50 highly qualified experts) who can effectively contribute to the strengthening and long-term operation of the CRM data service at the European level, but additional trainings are needed to ensure consistent expertise. This will be organized by the EU ICE-SRM together with UNFC experts.

4.4. Experience in resource policy, management, and planning

The essence of this question was to get information about the role of the GSOs in national mineral resource management and planning, including the consideration of sustainable development goals (which relates to the UNRMS), which can facilitate the wider application of the UNFC within the country. Respondents were asked to rate their experience from 1 to 5. Nine countries responded they are well experienced and belong to level 4 and 5. Approximately 60% of countries are in level 2 or 3. The following countries responded in level 5 (high experience): Croatia, Hungary, Poland and Slovenia (Figure 7). This could mean that most GSOs have an important role in contributing to the national and regional resource management. The consideration of SDGs and the principles the United Nation Resource Management System (UNRMS), and the better integration of the UNFC into resource management practices, will increase the sustainability.
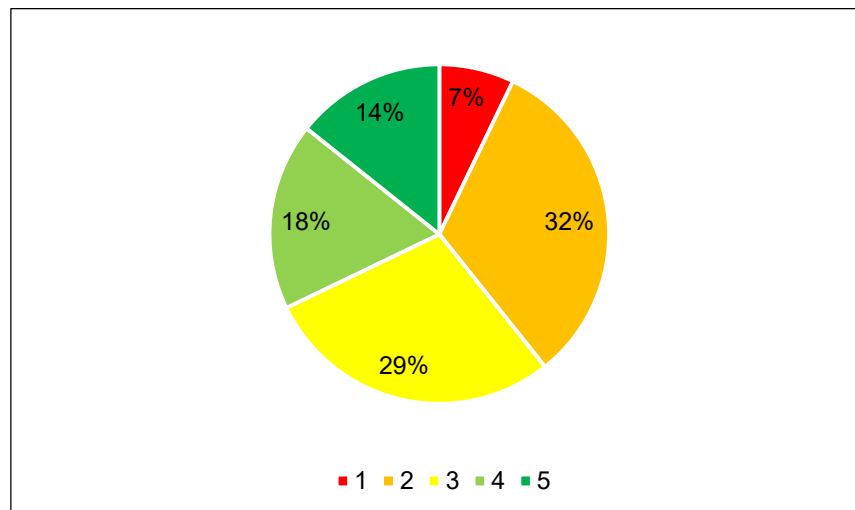
Figure 7. Level of experience of GSEU partners in resource policy, planning and management (including UNRMS) [n=28] 1 = low, 5 = high experience

4.5. Types and volume of information to be provided to the EGDI

GSEU partners were asked to provide the types of information from GSO/authority that will be served on UNFC categorization. Another question was about the estimation of the number of CRM-related projects (including strategic metals) for primary RM and mining waste (MW). Such projects might be planned for data provision to the EGDI in the later phase, depending on the availability of related UNFC documentation (use of guideline, trainings, etc.).

Results show that, according to the recent state of data collection for raw materials, only about a quarter of the GSOs will be able to serve comprehensive datasets using the UNFC classification. But together with other GSOs that have partial data for UNFC classification, the readiness for UNFC data provision – with some improvements on data collection – may exceed more than 50% of the GSOs. On the other hand, about one third of GSOs indicated that there was no information available for UNFC classification (Figure 8.).
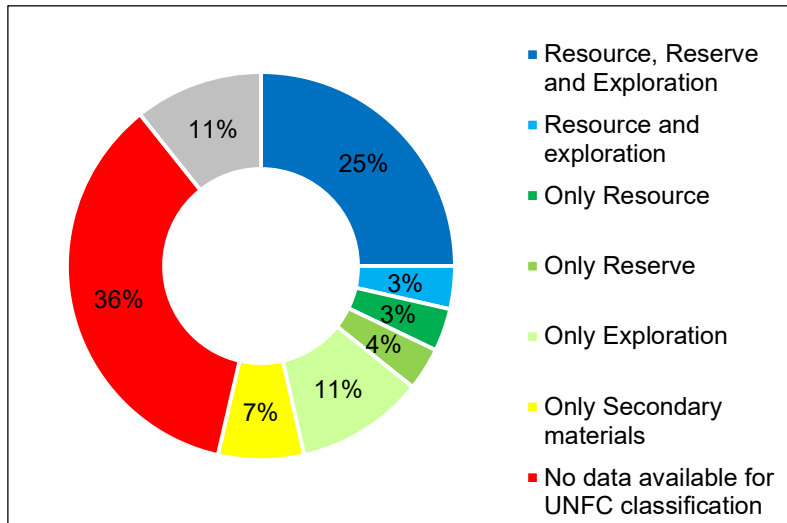
Figure 8. Types of information related to UNFC categorization that GSO/authority may be able to serve. [n=28]. Dk/Nr = no response

Based on the answers, there are around 1,900 active projects for which GSEU partners can provide UNFC data to EGDI, considering exploration and mining (Figure 9.). The scope of the previously estimated UNFC data primarily covers CRMs (as currently identified by EC DG GROW), but also includes other strategically important RMs (e.g. polymetallic ores).

Based on the answers, there are also around 1,900 non-active projects for which GSEU partners can provide UNFC data to EGDI (Figure 10.). There are four countries with more than 20 non-active projects: Cyprus, Finland, France, and Hungary. SGU (Sweden) has indicated about 20 projects that are considered non-active, but may potentially be relevant for EGDI in the frame of GSEU. There are six countries with more than 20 active projects. These are Cyprus, Finland, Norway, Slovenia, Sweden, and Ukraine. Seven countries have no active projects.
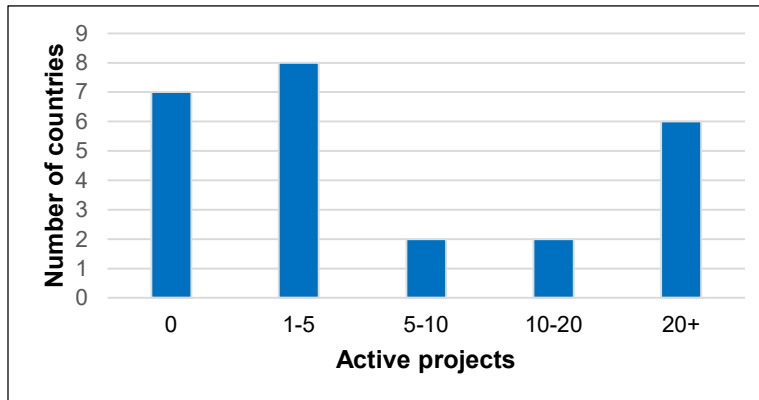
Figure 9. Estimated number of active project (n=25) (dk/nr=no response: 3)
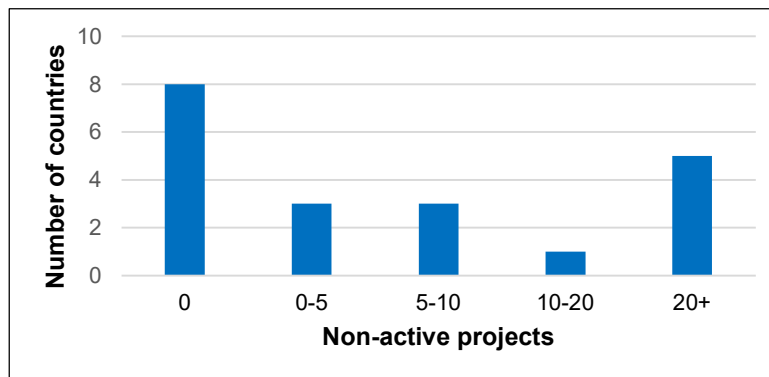
Figure 10. Estimated number of non-active projects (n=22, dk/nr no response: 6)

4.6. UNFC E, F and G categories managed by GSEU Partners

It is important to know the status of UNFC E, F and G categories in each country, represented by GSEU partners, in order to assess the consistent application of UNFC in Europe. Policies, legislation and responsibilities for factors relating to the UNFC categories will differ across national boundaries.
Based on answers the following can be concluded:

- Category G is managed by all countries;
- Category G and E is managed in half of the countries;
- Category G, E and F is managed by only 7: Austria, Czech Republic, Finland, France, Hungary, Norway, and Sweden;
- The most common handling is E and G categories, which is conducted in 14 countries (Figure 11. , Figure 12.).

In most cases the UNFC category estimates also include the management of mining waste related data that is suitable for preliminary identification of UNFC G category.
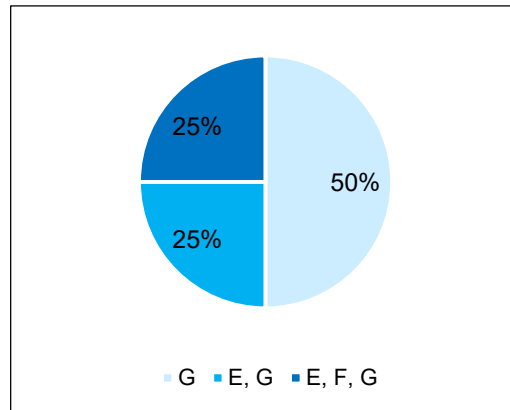
Figure 11. UNFC categories related data handled by GSEU partners (n=28)
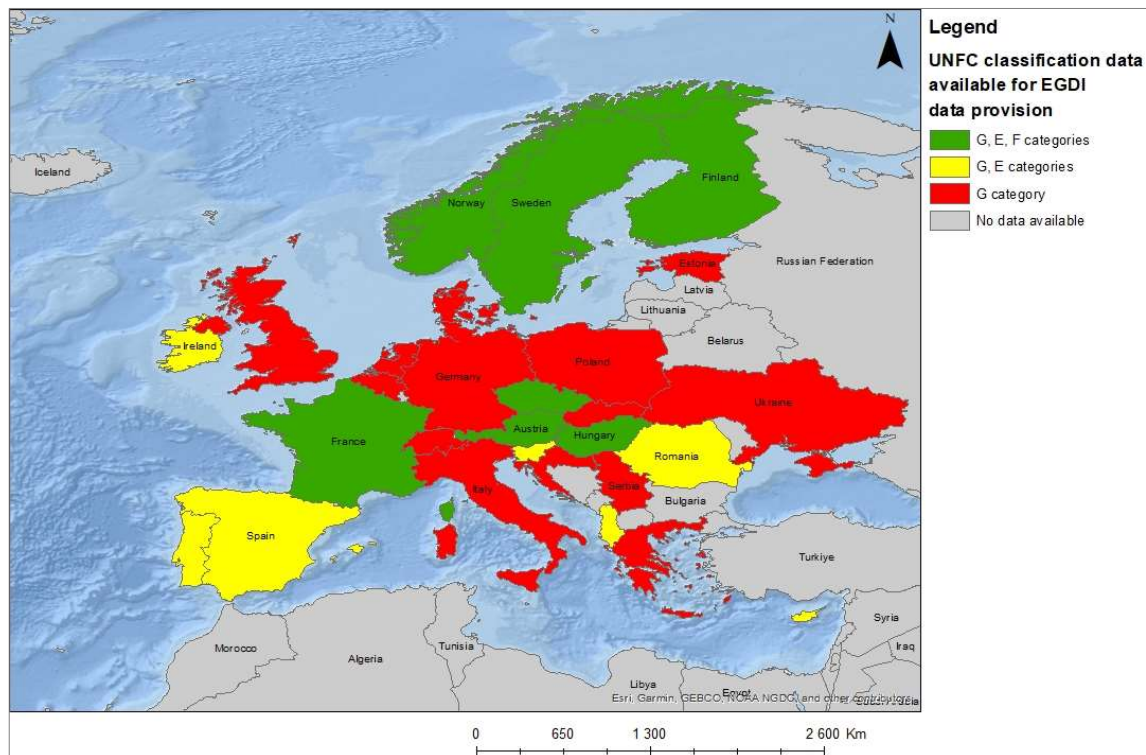
Figure 12. Available data by country, related to UNFC categories and managed by GSOs (n=28)

4.7. National or regional legislative background or guidance to maintain data for mineral resources

National and regional legislative background (presidential instructions, act/law, government decree, etc.) or guidance at an internal survey/authority level to maintain data for primary RM and MW as well as instructions for raw materials classification (resources and reserves) are crucial for UNFC classification and UNFC data management on national and regional level.

Based on answers by GSEU partners for this topic the following can be concluded:

Most of the responding countries, 71% (20 countries: Albania, Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Norway, Poland, Serbia, Slovakia, Slovenia, Sweden, Switzerland, Ukraine and United Kingdom) have national/regional legislative background or guidance on internal survey/authority level to maintain data (Figure 13.).

In terms of classification, reporting, use of international reporting standards and UNFC related data, about 1/3 of countries collect data (10 countries: Cyprus, Czech Republic, Greece, Hungary, Norway, Poland, Serbia, Sweden, Ukraine, United Kingdom) 1 country (Switzerland) partially collects data, but 16 countries responded they do not currently collect UNFC related data (One answer is lacking).
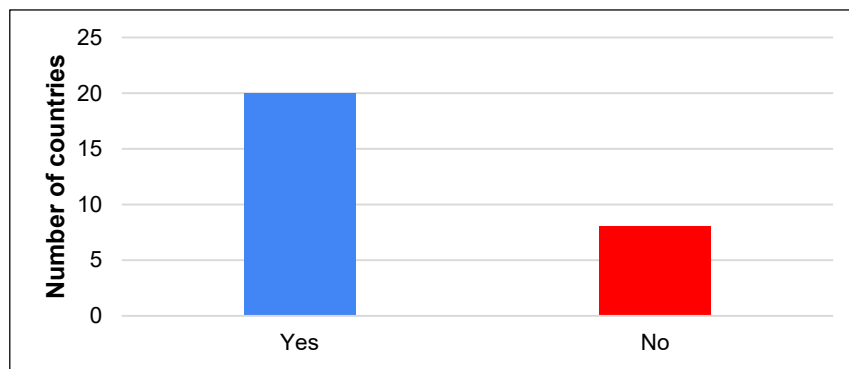
Figure 13. National or regional legislative background or guidance on internal survey or authority level to maintain data for primary RM resources or reserves, or classification of raw materials in 2022 by countries (n=28)

There is a significant difference between primary and secondary RMs in terms of data maintenance. In the case of primary RM, more than two-thirds of the responding countries are collecting data. In the case of MW, this ratio is 31% (8 countries: Albania, Czech Republic, Estonia, Finland, France, Hungary, Poland, Ukraine) (Figure 14.).
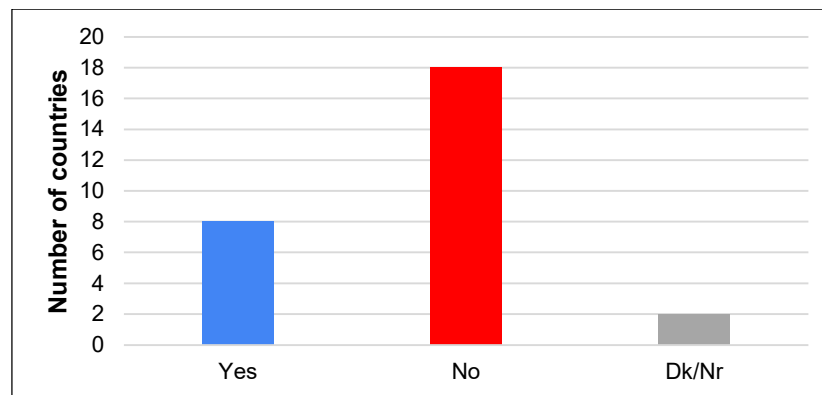
Figure 14. National or regional legislative background or guidance on internal survey or authority level to maintain data for MW resources or reserves (secondary RM), or classification of raw materials in 2022 by countries (n=28), Dk/Nr: no response

4.8.   Data Access

Access to raw materials data (primary and secondary RM) is essential, not only for UNFC classification on national to regional level by GSOs and other responsible authorities, but also important for consideration of investments in exploration and exploitation projects of CRMs, and for recycling projects. Better access to raw materials data can also contribute to the effectiveness of resource management.

Regarding the availability of the data, in 12 of the 22 responding countries (54%) data is made available through the competent mining authority, in 4 countries (Germany, Slovakia, Sweden, Switzerland) the data is available online, in 6 countries data is not available or unknown (Figure 15.).
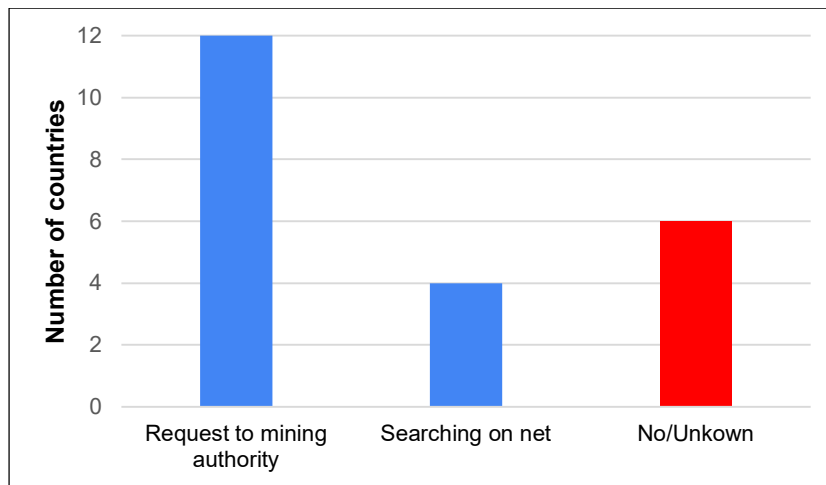
Figure 15. UNFC related data access opportunities in case of missing data [n=22]

4.9.   Reporting codes and resource classification

In 2023 the heterogeneity of reporting codes and resource classification systems that are often required by national legislation is still an important factor. The code or classification used will define how resources are managed on a national level within the related legislative or traditional background. One of the main objectives of the GSEU project is to prepare GSEU partners for data management in UNFC, especially for CRMs but also for other resources to enable data harmonization.
Although the UNFC Guidance for Europe, which is the most important document to promote harmonization (UNECE 2022), has been available since 2022, it is important to ensure that countries are sufficiently equipped for the expected classification and reporting systems in UNFC, through training and capacity building provided by the GSEU project.

UNFC, as a classification tool, exists at least in two countries (Romania, Ukraine) but Hungary also partly belongs here based on prescription and application. CRIRSCO-type reporting code is applied in Portugal. Specifically PERC is indicated for reporting in three countries: Ireland, Sweden, Switzerland. National classification for raw materials is reported in 11 countries: Albania, Austria, Czech Republic, Estonia, Greece, Italy, Norway, Poland, Serbia, Slovakia, and Slovenia. It is important to note that most of the Central and Eastern European national classification systems have a root in Russian-type classification (with A, B, C1, C2 and D categories). Some countries use several of the previously mentioned, or other classification systems (Denmark, Finland, Germany and Hungary). In Finland, there

is no national resource reporting standard. All resource and reserve reporting is filed into the national deposit database including information on which reporting standard the company has used. The database also includes algorithms which bridge the data into UNFC categories, following the official bridging guidelines (between UNFC and the CRIRSCO template). In Hungary, the basic classification system is the national one, but UNFC and international reporting codes are also referred to in the legislation and applied in official decisions. There is no specific classification in six countries (Belgium, Cyprus, France, Netherlands, Spain, and United Kingdom; Figure 16.).
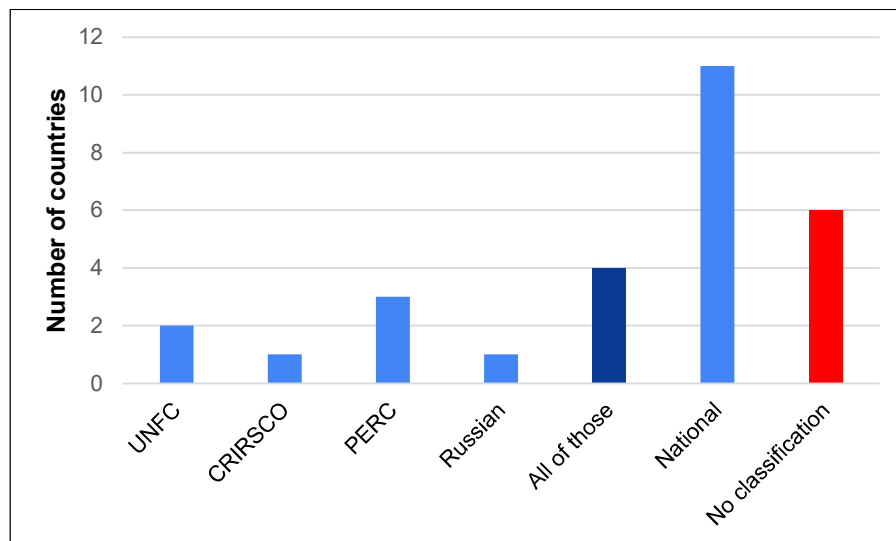
Figure 16. Applied reporting standards and different classification systems among project partners representing European countries [n=28]

4.10. Mapping, bridging and preparation of guidance

This topic needs to be handled separately from other topics describing UNFC activities and dealing with raw materials classification or reporting systems. Mapping and bridging between national and international systems (including UNFC) and the preparation of guidance or guidelines are an important milestone to the transformation of national raw materials datasets into the UNFC.

Based on answers by GSEU partners it can be concluded that, in 2023, there are 4 countries (Czech Republic, Hungary, Poland, Slovenia) where the GSO/authorities have created mapping documents and bridge resource data, national raw materials datasets (PRM and MW) and international reporting code terms to UNFC codes (Figure 17. , left).
Considering that many other GSOs have published documents on bridging opportunities between national raw materials datasets and UNFC (BGS on United Kingdom, NGU on Norway, GTK on Finland, and SGU on Sweden), the picture of available guidance documents is more complicated (Figure 17. , right). NGU, GTK, SGU and SveMin Have published a Guidance for the Application of the UNFC for Mineral Resources in Finland, Norway, and Sweden (Lax et al, 2017).

The Geological Survey of Finland has published guidance on mapping of current and historical mineral inventories into UNFC in Finland (Hokka et al, 2020). The report provides the criteria of classification for various commodities through a variety of case-examples from active and non-active projects. Thus, it

provides guidance to the Geological Survey of Finland (GTK) personnel, and other stakeholders, to help in mapping public mineral resource and reserve data, as well as for classifying non-compliant and historical estimates into the UNFC code [(https://www.gtk.fi/en/current/practical-guidelines-for-application-of-the-unfc-resource-code/)](https://www.gtk.fi/en/current/practical-guidelines-for-application-of-the-unfc-resource-code).
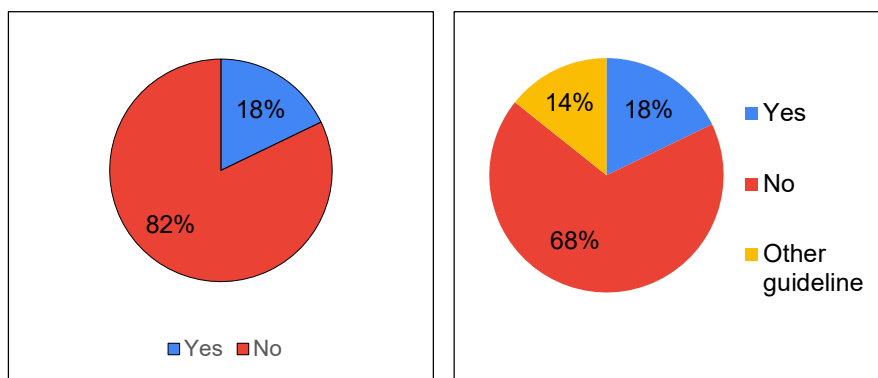
Figure 17. GSO/authority results on mapping documents and mapping resource data, bridging between national raw materials datasets (primary RM and MW) and international reporting code terms (left) and/or UNFC codes, and development of UNFC guidance in 2022 (right) [n=28]

4.11. Frequency of data collection, types and availability of data

The frequency of data collection for raw materials that is related to UNFC categories influences the periodic update of collected datasets that are essential to UNFC classification.

Based on the answers, all responding countries collect current data related to raw material management in some form, and more than two-thirds also collect and keep records of archive data. Most of the respondents store the incoming data in a central database, but only one third of the member countries have available online data collection system (Figure 20). In total, 79 % of the countries participating in the project collect data on an annual basis (Albania, Austria, Belgium, Cyprus, Czech Republic, Finland, France, Greece, Italy, Netherlands, Norway, Poland, Portugal, Serbia, Slovakia, Slovenia, Sweden, Switzerland, Ukraine, United Kingdom), while in some member countries data is provided quarterly (Hungary, Romania). 10% of the countries collect data continuously (Croatia, Ireland, Spain). Results are shown on Figure 18.

Regarding the types of data collected, the following groups were identified (Figure 19.):

- Resources and reserves, exploration results, possible targets and mined ore and waste: Croatia, Cyprus, Czech Republic, Finland, Greece, Hungary, Ireland, Norway, Poland, Romania, Slovakia, Slovenia, Spain, Sweden (52 %)
- Resources and reserves, exploration results and possible targets: Albania, Denmark, France, Switzerland, Ukraine (18.5 %)
- Production: Austria, Belgium, Germany, Italy, United Kingdom (18.5 %)
- Other: Netherlands, Portugal, Serbia (11 %)

About a fifth of the respondents collect data only related to production. A similar proportion also collect data related to raw material resources, as well as data related to exploration results and possible targets. Half of the member countries are also responsible for the registration of mining waste.

Regarding the on-line availability of raw materials data, one third of the respondents already have an available online data collection system. However, some participating countries that currently do not collect data by means of an online system are working on the development of such a database (Figure 20.). On-line data collection system for raw materials is available in the following countries: Czech Republic, France, Greece (from 2024 on), Netherlands, Norway, Poland, Slovakia, Spain, Sweden.
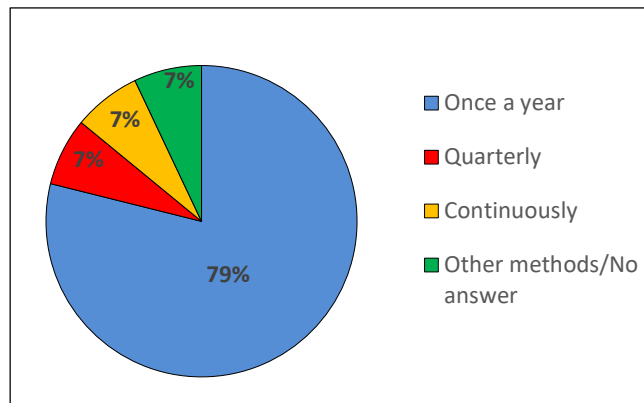
Figure 18. Frequency of data collection [n=28]
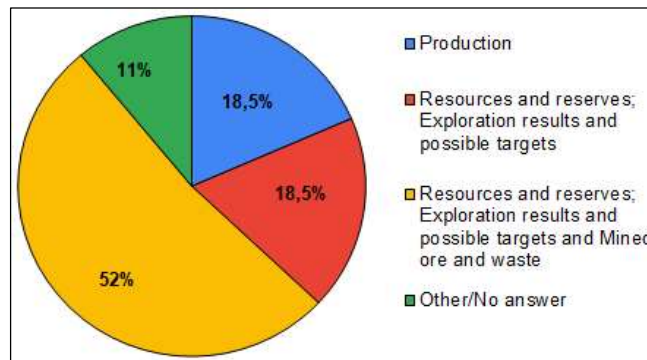
Figure 19. Types of data collected [n=28]
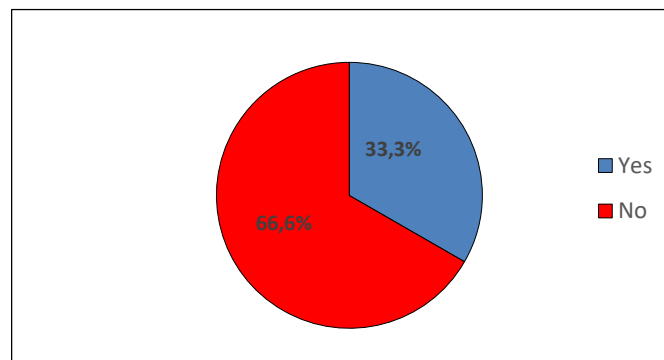
Figure 20. Available online data collection system [n=28]

4.12. Summary on UNFC baseline assessment

In order to summarize some important relevant facts and messages related to implantation of the UNFC within Europe, a preliminary SWOT analysis is provided below. Results and conclusions contribute to further specifications of next steps, in the frame of the GSEU project, mainly focusing on creation of a CRM data service in UNFC to the EC DG GROW according to the CRMA.

The following topics were selected that also relate to other UNFC subtopics (e.g. E, F, and G categories) and are detailed in Table 1: sustainable resource management, authorities and committees, raw materials and UNFC related legislation, data management I.-II., data management II., and UNFC activities and expertise.

These topics need to be considered for application of UNFC on national, regional and European levels by responsible organizations (in most cases GSOs and authorities). They also cover some practical details that are necessary to consider in the preparation of a template for data provision at European level (and the related supporting documents, e.g. national guidance documents) as well as trainings that will be organized by the European Union International Centre of Excellence on Sustainable Resource Management (EU ICE-SRM-SRM).

The goal is the correct and consistent use of the UNFC update 2019 (UNECE, 2019) and the UNFC Guidance for Europe (UNECE 2022a) by GSEU partners based on recently available national and regional experiences, methodologies, and guidance documents. A European-wide methodology for application of UNFC needs to take into consideration national and regional circumstances. The methodology should also cover national and regional specifications that are consistent with UNFC 2019 and be in line with the CRMA (EC, 2023). Results of the survey that fed the SWOT analysis are detailed in Table 1.

Table 1. Preliminary SWOT analysis on some UNFC related topics

	Strengths	Weaknesses	Opportunities	Threats
Sustainable resource management	Strategic importance of RM can be detected almost in all European countries and principles of sustainability has also high importance in most countries.	Not all countries have published strategies for raw materials and integrated consideration of primary and secondary RM. Consideration of sustainability in resource management is limited.	Increasing and integrating the principles of sustainability into resource management with wider use of UNFC and UNRMS contributes to sustainable resource management including CRMs.	Without the integration of UNRMS and UNFC into resource management considering both primary and secondary RM, common application of the UNFC may take more time.
Authorities and committees	Most European countries have government organizations and authorities and/or committees that deal with raw materials.	Duties and responsibilities are separated for primary and secondary RM in many authorities and the application of UNFC in European authorities is not common. UNFC related data are also separately available in different authorities and GSOs.	The improvement of communication between authorities responsible for raw materials from different point of view helps the UNFC classification and data service. The improvement of primary and secondary RM data collection in GSOs and in authorities as well as the implementation of a central database may improve the UNFC application.	Limited or difficult communication between authorities and GSOs does not promote the easy and proper application of UNFC.
Raw materials and UNFC related legislation	More than two thirds of countries have regional and/or national background legislation or guidance on an internal NGSO/authority level to maintain, and issue data for primary RM.	More than two thirds of the countries have no legislation for secondary RM data collection. UNFC is integrated into the legislation only in 3 countries.	Establishment of legally binding data collection for primary and secondary RM, where it is missing or is limited, regarding data types needed for UNFC E, F and G categories.	In cases of a lack of mandatory data provision from companies for primary and secondary RM, the voluntary or project-based data collection by authorities and GSOs may limit the proper UNFC data provision.
Data management I.	Most GSEU partners collect data for raw materials at least once a year. Some respondents collect data more frequently.	The data collection for primary and secondary RM is not uniform and there are some different methods.	The improvement of data collection for primary and secondary RM and sharing experience with harmonizing UNFC methodologies based on UNFC Guidance for Europe will improve the UNFC data management.	Insufficient data collection for primary and secondary RM may cause difficulties in the proper and consistent EU-level UNFC data management.
Data management II.	All countries have data for the UNFC G category. At GSOs, 50% of respondents have data for G and E categories and 25% have data for G, E and F categories. 25% of the GSOs/authorities collect comprehensive datasets compliant with UNFC.	Around 40% of GSOs/authorities do not collect comprehensive data compliant with UNFC. Data for E and F categories are in some cases collected by different organisations from those responsible for collection of reserve data (G) and application of UNFC.	Collection of data and information for UNFC E, F and G categories in a centralized database and/or by a designated authority or GSOs would facilitate the UNFC data management.	If the data collection for RMs is not complete, then the necessary CRM data provision according to UNFC may prove more difficult or not be properly executed.
UNFC activities and expertise	Since 2013, the UNFC activity in most EGS member organisations has increased. Based on many national and international activities, mapping and harmonization of national datasets with UNFC including many guidelines there has been a significant contribution to the UNFC deployment in Europe.	Even if there are many national and regional UNFC methodologies, there are still many countries where GSOs or authorities have no proper UNFC experience. This may hinder the proper EU-level CRM data collection and the long-term maintenance of UNFC data management.	The GSEU project, EGS and MREG activities on UNFC in synergy with the EU ICE-SRM serves as a unique opportunity to increase and balance expertise within UNFC. The co-operation within the UNFC Coordination Team will facilitate the proper EU-level use of UNFC. Products: UNFC template for RM, National guidance documents.	Without improvement of expertise with UNFC, the UNFC data management for CRMs and for other resources may not be developed. Achievement of SDGs might be limited.

4.13. Conclusions

- **Raw materials have a strategic importance almost in all European countries** considering the number of relevant legislations that are the tool of resource management, the existence of published resource or mining related strategies, or other supporting strategies that address minerals, raw materials, critical raw materials, mining or wastes. UNFC will effectively contribute to sustainable resource management.

- Based on past and developing experience with UNFC before and in the GSEU project, **most GSOs have an important role to play in contributing to national and regional resource management with consideration of SDGs and by fostering better integration of the UNFC into resource management.**

- **In most European countries there are responsible government bodies, organizations,** (ministries, authorities, agencies, specific commissions or committees) that deal with permitting, decide on exploration reports or mining related activities. **All of these organizations that collect and manage data and information for raw materials related to UNFC E, F and G categories need to be aware and familiar with UNFC. The communication between these organizations needs to be developed in order to fulfil CRMA requirements.**

- **UNFC data provision for raw materials to the EC DG GROW needs to be harmonized with UNFC data services for other types of resources (e.g. geoenergy and groundwater) in the EGDI.**

- **EGS has a strong expert base that can effectively contribute to the strengthening and long-term operation of the CRM data service at the European level**, but additional trainings are needed to ensure consistent expertise. This will be organized by the GSEU Task 2.3 (in charge of establishing the EU ICE-SRM), together with UNFC experts.

- **Category G is managed by all countries in GSOs. Categories G and E are handled in half of the GSOs, while categories G, E and F are managed by only 7 GSOs (25%).** The most common handling is the E and G categories, which is carried out in 14 countries by GSOs (50%). In most cases it also means that management of mining waste-related data that is suitable for preliminary identification of UNFC G category for mining wastes, if relevant data is available (area, height, concentration estimate on secondary RM CRMs). In the case of a lack of data for E and F categories at GSOs, a data request is needed from the relevant national competent authorities (mining and environmental). In many cases, searching for published information on the internet can also be a solution. In 6 countries (36), data is not available at GSOs or the potential source of information is unknown.

- **Regarding the legislation, there is a significant difference between primary and secondary mineral raw materials in terms of issuing.** In the case of primary RMs, 71% of the countries issue data, while in the case of mining waste, this ratio is 35%.

- **Used and/or mandatory national mineral resource classification systems and national and international reporting codes in many cases remain heterogeneous.** In order to provide consistent UNFC data to the EGDI and to the EC DG GROW (mainly for CRMs), the best way to develop **a joint UNFC methodology within the EGS with GSEU partners would be in co-operation with other competent authorities. The UNFC Guidance for Europe (UNECE, 2022) is a starting point from which GSEU partners need to develop national and regional guidance documents** that integrate both the UNECE statements and instructions for the use of UNFC in Europe as well as country and/or regional level UNFC circumstances (e.g., available data types, specifications on legal or traditional methodologies, data management for E, F and G categories). This will contribute to the proper implementation of the CRMA.

- **Guidance-type documents, including decision flows** of nine countries (Czech Republic, Hungary, Poland, Slovenia, Finland, Norway, Sweden, and United Kingdom) ensure that next to other available results with UNFC in each European region (e.g. Portugal, France, Austria, Ukraine) **there is a proper core of information and expertise for data harmonization on European level.** However, in **countries and regions where a guidance-type documents are missing further developments need to be done** (e.g., mapping, bridging, preparation of guidance). National guidance documents should be prepared in all European countries.

5. Preliminary comparison between GSEU results and UNFC Guidance for Europe

The second element of the analysis to facilitate the joint European UNFC application using experience gained from recent UNFC methodologies is a comparison between the UNFC Guidance for Europe (UNECE, 2022a) and recently applied UNFC methodologies in different European regions.

From the beginning of the GSEU project, based on discussions with partners of the WP2 T2.4, it was confirmed that the UNFC Guidance for Europe (UNECE, 2022a) was the most appropriate document that needs to be taken into consideration in order to develop a joint methodology for the application of the UNFC. This document provides guidance on the use of the United Nations Framework Classification for Resources (UNFC) Update 2019 (UNECE, 2019) and the Supplementary Specifications for the Application of the United Nations Framework Classification for Resources to Minerals (UNECE, 2021) and Specifications for the Application of the United Nations Framework Classification for Resources to Anthropogenic Resources (UNECE, 2018). In case of a conflict between the documents and this guidance, the texts in UNFC 2019 (UNECE, 2019) and its Specifications shall prevail.

Based on heterogeneous resource classification and reporting systems in Europe and national and regional specifications on the legislative and data management background, the aim of Task 2.4 was to approach gradually the national and regional UNFC-related circumstances compared to the recently available UNFC Guidance for Europe (UNECE, 2022a). In the first step, different regional GSO experts who have preliminary or advanced experience with UNFC mapping, bridging and preparation of guidance have shared their results on a physical GSEU WP2 meeting in Ljubljana in March of 2023 (see chapter 6.). Applied data for UNFC E, F and G categories, details of UNFC methodologies and some case studies were presented and discussed.

In the next step all partners were asked to compare their national and regional UNFC-related datasets and information with the UNFC Guidance for Europe instructions, in order to facilitate the third exercise and task, the preparation of national guidance documents in the GSEU project, with assistance of the UNFC Coordination Team (UNECE, EC DG GROW, GSEU and FutuRaM representatives and experts). The goal of this exercise was for the partners to be able to identify the most important data sources and where they are available for defining the UNFC E, F and G categories by getting to know the details of the guidance. In addition, those partners who are in the initial phase of using UNFC can get ideas and support for the simpler and more accurate fulfilment of UNFC data provision in accordance with CRMA. Stakeholders who might play an important role in UNFC data provision can also be defined.

This chapter summarizes the data and information types that can be used on national and regional level to identify UNFC E, F and G categories.

An example for the preliminary comparison between national UNFC circumstances and the UNECE UNFC Guidance for Europe (2022a) classes, subclasses and categories is on Figure 21.

UNFC Classes Defined by Categories and Sub-categories						INSPIRE Code List	National/regional data sources and used databases for E,F,G categories by raw material data provider organizations (mainly GSOs or other Authorities) *here: Hungarian answers briefly*
Produced	Sold or used production						
	Production which is unused or consumed in operations *Future production that is either unused or consumed in the Project operations is categorized as E3.1. These can exist for all Classes of recoverable quantities* [c]						
	Class	Sub-class	E	F	G[a]		
Viable Projects *Estimates associated with Viable Projects are defined in many classification systems as Reserves, but there are some material differences between the specific definitions that are applied within different industries and hence the term is not used here.* [c]	On Production	1	1.1	1, 2, (3)	operating continuously operating intermittently	**E:** Inventory of mining areas where data can be found for exploration areas and mines with permissions (Technical Operational Plans: TOP) and mine plots and on other mining activities (extraction, suspension, closure). With more details: The State Geological, Geophysical and Mining Data Store (e.g. original exploration reports).
	Approved for Development	1	1.2	1, 2, 3	under development	
	Justified for Development	1	1.3	1, 2, 3	pending approval	
Potentially Viable Projects *Not all Potentially Viable Projects will be developed*	DevelopmentPending	2[b]	2.1	1, 2, 3	feasibility evaluation of the ore deposit	**F:** Inventory of mining areas (see E category especially regarding TOPs). The State Geological, Geophysical and Mining Data Store (incl. exploration reports and other documents of geoscientific survey).
	Development OnHold	2	2.2	1, 2, 3	care and maintenance retention	
Non-Viable Projects *Non-Viable Projects include those that are at an early stage of evaluation in addition to those that are considered unlikely to become Viable developments within the Foreseeable Future.* [c]	DevelopmentUnclarified	3.2	2.2	1, 2, 3	resource assessment (geological interpretation, approximate calculation of the resource)	**Regarding E and F categories:** Basically there are no missing data types at SARA. At most contact is necessary to Environmental Authorities or to Municipalities in some specific cases (complex cases, results of public hearing/SLO) or internet search are solutions (e.g. for feasibility studies).
	DevelopmentNot Viable	3.3	2.3	1, 2, 3	closed abandoned/ historic	
Remaining Products not developed from identified Projects *Remaining Products not developed from identified Projects or Prospective Projects may become developable in the future as technological or environmental-socio-economic conditions change. Some or all these estimates may never be developed due to physical and/or environmental-socio-economic constraints.* [c]		3.3	4	1, 2, 3		**G:** Mineral resource inventory.
Prospective Projects		3.2	3.1	4	subsurface exploration	**E,F:** There is insufficient basis for concluding on reasonable prospects from environmental, social and economic point of views.
		3.2	3.2	4	detailed surface exploration	
		3.2	3.3	4	regional reconnaissance	**G:** Mineral resource inventory and project results on potential assessments (predictive mapping). Geological and geophysical and other earth scientific survey project results.
Remaining Products not developed from Prospective Projects		3.3	4.1	4		
		3.3	4.2	4		
		3.3	4.3	4		

Figure 21. An example for the preliminary comparison between national UNFC circumstances and the UNFC Guidance for Europe (2022) classes, subclasses and categories

5.1. Results

More detailed results are in the Annex 4.

Environmental-socio-economic viability (E category) can be identified based on available licenses for the exploration, mining and recycling activities and by using different types of available feasibility studies that contain information on environmental, social and economic considerations.

Based on answers from responding partners, information for E category can be found through different organizations. The role of ministries is significant in data management for E category (Austria, Croatia, Greece, Italy, Spain). Another way is to obtain data more directly from mining authorities, mainly in co-operation with geological surveys (Austria, Hungary, Sweden and Ukraine) but in some cases the geological survey organizations can also directly provide information to identify the correct E category (Czech Republic, Cyprus, Slovakia). In some countries, agencies collect data that can be used to identify the E category (Finland, Romania). Important information to category E is handled at land-use planning authorities (among others in Belgium - Flanders - and in the United Kingom). Directorates and municipalities also have important roles in handling documents relevant to E category next to various governmental institutions (Norway). All this does not mean, however, that only these data provider organizations have been managing relevant data for category E. Depending on the structure and jurisdiction of the public administration, several types of ministries, authorities, agencies, land-use planning authorities in co-operation with, or without, geological survey organizations can manage information relevant to E category. Databases are under continuous development, and in most cases the information for the UNFC categories needs to be obtained not only from one organization, especially in the case of category E, but from other publicly available data sources (feasibility studies, company reports). It is obvious that official decisions would be the best source of relevant information, but some partners have also indicated the use of the internet for searching publicly available information for E category.

In the GSEU project lifetime, further assessment will be necessary to identify proper sources of relevant information and proper communication channels to develop the UNFC data service on national and regional level in the mirror of the CRMA.

Typical documents for category E were identified by responding partners as follows:

Permit applications, economic feasibility studies, environmental impact assessments, information on stakeholder involvement, mining and exploration licenses, rights holder, status (active/non-active), documents on cancelled and exhausted objects, on protected areas for special intervention in the Earth´s crust, protected mineral deposits areas, mining areas (mining lease), active mining areas, non-active mining areas, cancelled mining areas, report and confirmation of reserves, conceptual mining projects, study on Natura 2000 areas, spatial plans harmonization study, parts of different types of feasibility studies, mines and prospecting permits, exploration reports and records for mining areas, reports on abandoned mines and mines waste, Technical Operational Plans (TOP), Environmental Operation Plan (EOP), general land use plans, data and information on nature protection, water protection, protected cultural heritage, demography, etc.

Technical feasibility (F category) can be identified from similar licensing documentation and officially approved decisions on mining or recycling-related activities or based on different types of available studies that contain information on technical feasibility.

Based on answers from responding partners, the source of information for F category is similar to category E because similar ministries, authorities, agencies and geological survey organizations and

other responsible data provider organizations have data, based on data collection or co-operation between different authorities, depending on jurisdiction. In most cases, official decisions address or integrate technical and environmental considerations (e.g. a Technical Operation Plan that can be issued by the mining inspectorate as an authority, e.g. in Hungary) when the environmental authority contributes to the mining activity with environmental permission. Different types of feasibility studies generally cover technical aspects, and many databases operated by responsible organizations contain information on the status of the project. Geological survey organizations have also an important role here if they have been managing technical data (Greece, Hungary, Slovakia, Italy, Ukraine). Considering the Italian mineral data fragmentation, the Geological Survey of Italy (ISPRA) is building a Geological, Mining, Museum and Environmental Database (DB GeMMA, prototype) to collect all relevant information from national and regional/provincial public and private sources that would also be used to identify category F. Companies have important roles as data providers on major finds in exploration, CRIRSCO compliant data and feasibility studies (Norway and in general in Europe).

Some partners also highlighted the importance of the EGDI that is a proper database for managing different UNFC related (E, F, G) datatypes.

Typical documents for category F were identified by responding partners as follows:
Technical Operational Plans (TOP), permit applications, feasibility studies, mining and exploration licenses, documents on status (active/non-active), documents on mining areas (mining lease), active mining areas.

Level of confidence (G category) can be identified predominantly based on datasets and inventories by GSEU partners that are mainly geological survey organizations but in many cases the co-operation (data access) or the integrated operation of the geological survey organization and mining inspectorate within a supervisory authority (Hungary) is important. In Austria, the Mining Authority (Ministry of Finances) holds all necessary information for the derivation of the G category of primary mineral resources. Grades, tonnages or volumes of resources as well as the certainty associated with these numbers, rest with the mining authority and are not shared. In Romania, the mineral resource inventory with resource and reserve data, and project results on potential assessments (predictive mapping with prognostic resources) are partially managed by the Geological Institute of Romania but the inventory of mining areas at the National Agency for Mineral Resources also contains resource and reserve data. In some countries, there is no requirement in the legislation for systematic data collection on resources and reserves, so the mineral resource inventory is updated on an ad-hoc basis. In Finland, most mining and exploration companies use CRIRSCO-compliant reporting, allowing easy bridging into UNFC in most cases.

Typical documents for category G were identified by responding partners as follows:
Geological research and exploration reports, company reports, local, regional, country level surveys and results of predictive mapping with resource estimation (systematically or occasionally), related maps and databases.

Some additional comments to the comparative analyses:

Missing data: Many GSEU partners (9 from 16 responding) indicated that even if they have data for G category and may be aware of data needs and availability of information for E and F categories in specific cases, there is an insufficient basis for concluding on reasonable prospects from environmental, social and economic points of view (potential resources / recently non-viable projects). In case a

company does not prepare a feasibility study, the identification of E and F categories is limited. In this case, the official decision on technical documents (e.g. Technical Operation Plan) can be a guiding tool. It is very common that different government and non-government organizations host national datasets on various subjects like nature protection, water protection, and cultural heritage, which are available and can be used. Not all the relevant datasets are equally easy to obtain and use in GIS analyses, to conclude on UNFC classification. Further details are in the Annex 1.

Confidentiality is a major issue among others in Austria, Czech Republic, Hungary, Norway and in Spain.

Regarding the surveys where the existence of a national level data base for primary or secondary raw materials was addressed (24 countries have a database for primary RM and 17 countries for secondary RM) it can be stated that the mining waste databases and inventories in European countries can be used partially to classify heaps and tailings in UNFC. However, the consideration of available quality data in these databases is important. E.g., in Hungary the Inventory for Closed Mine Waste Facilities basically contains data for heaps and tailings from an environmental consideration. Due to further development of this database with collection of information for raw materials in heaps and tailings, and additional geochemical data, this improved database is suitable for preliminary estimation of potential assessment of secondary RM. The Registry of Mineral Resources also contains data for the volume of available resources in heaps and tailings. However, regarding the G category, not all heaps and tailings have sufficient quality data, which limits resource estimation. Regarding the E and F categories, the number of published feasibility studies is negligible, and environmental permits are handled by environmental authorities.

Application of the Austrian national mineral resource classification system (G 1050) to metal and industrial mineral resources is currently mandatory for any mining company which operates in Austria. However, the classification results cannot be bridged to UNFC since G 1050 does not separate environmental, social, economic, technical and legal aspects sufficiently. The Mining Authority does not have the mandate to classify resources according to UNFC and the required expertise and necessary resources may not exist in this institution.

The Czech Classification System is not compatible with any internationally recognized system (e.g. JORC, PERC etc.) and is not even compatible with the former Soviet-based classification system. Implementation of UNFC would need a high commitment from the Ministry of Environment, with high financial cost and staff capacity to implement the UNFC into the incompatible Czech classification system.

5.2. Barriers to using UNFC and solutions for these

In the frame of comparison of national and regional UNFC situations with the UNFC Guidance for Europe (2022), this chapter summarizes the observations of GSEU partners who have answered for the barriers and solutions to apply UNFC, considering requirements for UNFC classification in the long term. The summaries are based on collection and categorization of answers from the questionnaire (see Annex 5.). In many cases, observations can be considered as general ones based also on answers for the questionnaire in the frame of baseline assessment (see Chapter 4.).

Barriers:

Policy - legislative framework – institutional background

- In many cases there is a recent lack of national mandate or framework to classify resources according to UNFC (Austria, Cyprus, Greece, Italy, UK) or for systematic UNFC data collection and integration (general).
- In a few cases there is no formal scheme for licensing mineral exploration, collecting data on minerals projects or collecting royalties (with some specific exceptions) (e.g. in the UK).
- National law prescribes the form and details of reporting (Slovakia), and different classification methods are traditionally used which also originate from an old legislation of industrial and mining activities (e.g in Italy).
- In some countries, the division of jurisdiction over mineral resources is considered to be the biggest barrier in the implementation of the UNFC (e.g. in Croatia).
- The management of secondary mineral raw materials (resources) is difficult if different laws deal with secondary raw materials (here: mining waste) under supervision of different ministries and authorities that are separately responsible for mining and environmental related affairs (e.g. in Croatia and in Hungary).

Data and information management – resource classification, reporting

- In most countries UNFC classification has not been systematically applied neither officially nor in private or public projects. Currently, the application of UNFC codes is in an early stage, with limitations. Results are mainly available in national and international projects.
- In many cases, data about reserves and resources belong to private mining companies that only share production data with the mining authorities (mainly in W-, N- and S-European countries).
- It is difficult to implement UNFC in any formal way as there are no formal official databases/structures (general). The development of UNFC CRM database is in progress in the EGDI in the frame of EU-funded projects (e.g. GSEU and FutuRaM).
- Statistical data obtained from (often confidential) industry reporting of mine production is not integrated with data on in-ground mineral resources.
- Mining enterprises who possess mining concessions are not obligated to report their resource assessments to NGOs. The absence of reporting impedes the monitoring of sustainability of resource exploitation (e.g. in Norway and in Finland).
- Some national classification systems are not compatible with any internationally recognized systems (like JORC, PERC etc.) and not even compatible with former Soviet-based classification systems (e.g. in the Czech Republic).
- Lack or limited sharing of information between geological survey organizations and mining authorities or other responsible organizations.
- Even if data on mineral raw materials and resources (primary and secondary) exist, they may not be harmonized into a single database.
- There are no established workflows for systematic integration of public industry disclosure with national mineral inventories.

Availability of documents

- Lack of translated UNFC (2019) and UNFC Guidance for Europe (2022) into national languages in Europe / official EU languages (general, UNFC 2019 is available in English, French, Spanish,

Greek, Portuguese, Hungarian and Russian in Europe). This hinders the acceleration of application of the UNFC on European level.

- The absence of national "bridging documents" that is based on UNFC Guidance for Europe (2022) is a general limiting factor, or the translation of the UNFC Guidance for Europe (2022) has not been completed in most countries.

Communication

- There are gaps in the communication between the various organizations/companies/public authorities that discourage the implementation and proper use of UNFC.
- There are no established workflows for systematic integration of public industry disclosure with national mineral inventories.

Capacity - expertise

- Questionable expertise for applying UNFC in data provider organizations (including authorities and ministries) that are responsible for necessary data and information.
- Isolated and rare trainings
- Even if there were many regional stakeholder consultations in the last years in all European regions on national and regional levels, there is still limited knowledge on UNFC and on CRMA at relevant stakeholder organizations.

Solutions:

Policy - legislative framework – institutional background

- In many cases, mandatory use of the UNFC on national level with the development of legislative framework can facilitate the proper CRM data provision to the EC DG GROW. Regarding the UNFC data service to the EGDI and resources other than CRM (e.g. other ores, industrial and construction materials, geoenergy, groundwater) relevant WPs will develop the concept and the IT background (see Chapter 9).
- The reporting obligation of mineral-producing enterprises who possess mining concessions can support the monitoring of the sustainability of resource exploitation.
- When reserves and resources data belong to private mining companies and they share only production data with the mining authorities, mandatory resource data collection by authorities would support the streamlined implementation of the CRMA.
- In a few cases, a formal scheme for licensing mineral exploration, collecting data on minerals projects or collecting royalties (with some specific exceptions) is necessary.
- A clear legal/regulatory framework with common (EU level) reporting forms are necessary. Development of an integrated national database with systematic update is a part of the progress. It is necessary to increase resources (e.g., personnel). In case the reporting is involved in the legislation even referring on UNFC, according to the CRMA further amendments may be needed (e.g. modified reporting form). In case the legislation does not prescribe systematic data collection for raw materials, improvement of the data collection at least for CRMs with the designation of the responsible organization would allow proper UNFC data management and more accurate bridging of commodities into UNFC.
- An integrated resource management system would support the application of UNFC and the development of sustainable resource management. The integration of UNRMS principles into national and regional resource management can contribute to achieve SDGs.

- In order to streamline the development of sustainable resource management, the UNFC classification for all mineral raw materials and resources (primary and secondary) should be implemented by one administrative body designated by the Government, which would create and maintain an unique knowledge or data base of mineral raw materials and resources.
- Additional funding for resources to allow continued work with UNFC needs to be taken into consideration.

Data and information management – resource classification, reporting
- Development of classification of mineral resources with systematic UNFC data collection and integration into a database on a national and regional level contributes to the implementation of the CRMA. Frequent update of existing databases is necessary.
- If any UNFC classification is to be performed outside mining or other responsible authorities, data sharing and protection agreements are necessary between GSOs and other responsible authorities that may be tackled and the framework set up by the ICE-SRM.
- For the F category, the implementation of financial standards / financial reporting in the mining industry would be necessary (as exists for example on the Toronto Stock Exchange or Australian Securities Exchange).
- Formal databases (mainly for CRMs) for raw materials need to be developed on national and regional levels that are compatible with the EC DG GROW CRM database. The EGDI is prepared for integrating UNFC data and further specifications are in progress based on co-operation between WP2-WP3 and other relevant WPs.
- Confidential data in an integrated raw material database needs to be handled separately when serving data to the EGDI (FAIR data preparation is in progress within GSEU) and the annual CRM data provision to the EC DG GROW according to the CRMA might be implemented based on the consideration of the potential difference between FAIR data for raw materials and the required data by the CRMA.
- In case of lack of systematic data collection and data processing for raw materials for UNFC classification and CRM data provision corresponding to the CRMA, the establishment of proper workflows for systematic integration of public industry disclosure with national mineral inventories is necessary at national and regional levels.

Availability of documents
- More case studies are suggested and content-appropriate documents that would clearly document the usefulness of the UNFC as the pan-European system for reporting.
- After creating a unique database of primary and secondary mineral raw materials and resources, it is necessary to create bridging documents on national and regional levels.
- The compatibility of some national classification systems that are not compatible either with the former Soviet-based classification system or with any internationally recognized system (e.g. JORC, PERC etc.) and UNFC can be harmonized on national level within the framework of the preparation of national guidance documents in accordance with the UNFC Guidance for Europe (2022).
- It is necessary to translate UNFC (2019) and UNFC Guidance for Europe (2022) into national European languages. That would significantly contribute to the national level understanding of the benefit of the UNFC and the methodology of how to classify raw material projects. UNFC 2019 is available in English, French, Spanish, Greek, Portuguese, Hungarian and Russian (for the European continent).

Communication

- Geological survey organizations, authorities, ministries that are responsible for primary and secondary raw materials need to be aware of the benefits of the application of UNFC and the need for proper implementation of the CRMA. It can be done via proper communication and dissemination activities on national, regional and EU-level. The CRMA, since March of 2023 and the amended CRMA since September of 2023, and the consultation between Member States and EC DG GROW are proper authorizations and serve as proper forums to support the implementation of the UNFC.
- Proper communication channels need to be developed between public authorities, organizations, and the private sector to improve information sharing for raw materials related data (e.g. documents for resources, environmental and technical permissions, and SLO) including with integrated databases for official decision making. Workflow for systematic integration of public industry disclosure with national mineral inventories needs also to be established.

Capacity – expertise

- Capacity building with trainings for UNFC practitioners and for national officers, experts in data provider organizations, experts and decision makers will support the common use and deployment of UNFC.
- The organization of workshops and seminars, also interacting with the regional/local authorities, could favour the application of the UNFC classification (also at the level of existing databases). This should lead to a lively and constructive comparison with stakeholders, professionals and competent bodies that can help the application of the same UNFC, possibly starting from other classifications (general, Austria, Hungary, Italy, Norway, Sweden).
- Networking of experts from different professional and administrative bodies dealing with issuing mining related permits and deciding on exploration reports into one "professional group" on national level would support the proper use of the UNFC. On European level EGS Expert Groups and ICE-SRM can facilitate the capacity for UNFC application having mandates for this activity.
- There is a need for sufficient number of experts and to create positions for resource management in both GSOs and in responsible authorities on national levels. For UNFC data management the EGDI operated by EGS is a proper database.
- Former regional stakeholder consultations for UNFC need to be updated and to continue in order to refresh knowledge on UNFC and requirements in the context of the CRMA.

Despite the fact that many barriers were observed from different European regions (W, N, E, S and C) many benefits were also identified:

- UNFC can be applied to primary mineral resources in most countries on the basis of existing data for active projects, projects under evaluation or development, and for former projects as well.
- UNFC 2019 is available in English, French, Spanish, Greek, Portuguese, Hungarian and Russian (in Europe; www. unece.org). This can be a good base for further European regional UNFC activities and development of the implementation of the UNFC.
- For the application of UNFC for secondary RM, there are many case studies from different regions of Europe taking into account mining waste bearing objects (MINEA and FutuRaM

project results: https://www.minea-network.eu/; https://futuram.eu/ , UNECE EGRM activity: https://unece.org/anthropogenic-resources-working-group).

- Most geological survey organizations, authorities and ministries responsible for raw materials have the required expertise to perform UNFC resource classification for at least some commodities. An agreement with a mining authority to share the necessary data would have to be put in place beforehand and personal / financial resources made available to implement UNFC, and it should be established through the ICE-SRM.
- UNFC has already been applied fully or partially to national mineral inventories in many European regions, according to countries that provided UNFC methodology (see Chapter 6.) and this expertise will be important for further developments of capacities (e.g. trainings).

6. **UNFC methodologies**

This chapter introduces different national and regional UNFC methodologies in 2023 that contributes to establish a solid base of comparison between different methods developed in the last ten years or were refined during or after the GEOERA program. The source of information presented below is based on 10 UNFC case studies that were presented on the first physical GSEU meeting in Slovenia (Figure 22). Partners presented their mapping and bridging activities between national classification, reporting and UNFC and/or the intermediate bridging between national and international reporting codes, if any. Current Practice and case studies were discussed for Austria, Czech Republic, Finland, France, Hungary, Norway, Portugal, Slovenia, Sweden and from the United Kingdom. UNFC practice was also considered for Ukraine where Ukrainian partners provided relevant information (and a presentation on UNFC in Ukraine: Sergii, 2023).
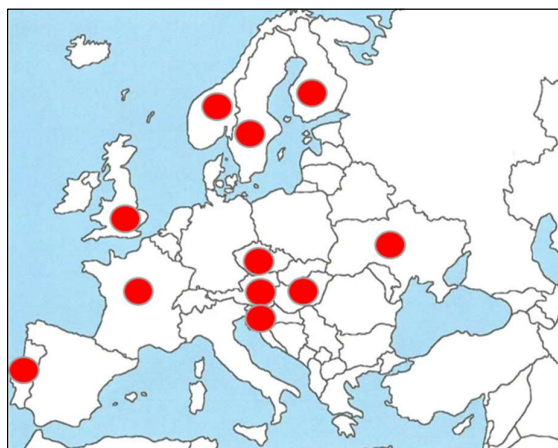
Figure 22. Most recent UNFC methodologies were collected from each European region

Results are seen in the Table 2. and some descriptions of most recent UNFC methodologies are enclosed in Annex 6. Results are summarized as follows:

- **In all European regions there are existing UNFC methodologies** that are based on previous or the most recent UNFC and UNECE documents. Despite this regional coverage, in some cases, traditional application or project-based use of the UNFC, different approaches need to be harmonized. Considering next statements, trainings will facilitate the achievement of the project goals and the improved CRM data provision.

- **In most cases GSOs collect or can collect data for UNFC E, F and G categories** even if data request is necessary mainly for E and F categories from other authorities, or publicly available information is gathered from world wide web, or from companies.

- **When a GSO has a centralized database for resources and/or reserves and for mining areas based on legally binding data provision by companies, the UNFC classification is easier** mainly for G category, but E and F category information can also be integrated into a unique database. Centralized database mainly for the most important CRM (both primary and secondary) can also be developed on project base (UK, Norway, Sweden, and Finland). CRIRSCO-compliant resource and reserve data are in many cases easier to use directly to bridge to the UNFC classification. Bridging with national classification or reporting systems may cause errors and may be time consuming.

- **INSPIRE compliant databases are obvious in many countries** (e.g., Finland, Slovenia). In most countries, where data service exists for primary RM occurrences and potential secondary RM sites (e.g., heaps and tailings), databases are fully or partially compliant with INSPIRE. However, in order to increase the INSPIRE compliant UNFC data service to both EGDI and EC DG Grow CRM databases, a template for CRM data provision needs to contain information on INSPIRE-related terms (e.g., MineralOccurrence/name, miningActivityType, mineStatus) in accordance with the UNFC Guidance for Europe (2022).

- **In some cases, the core database of secondary RM (mainly mining waste) that can be used for UNFC classification is derived from the implementation of the Directive 2006/21/EC** and this database needs to be developed in order to provide proper UNFC data at least for the most important CRM potential occurrences (e.g., Hungary and Slovenia). Because mining waste inventories were developed mainly for closed facilities, data for CRM resources and reserves is rare. Preliminary estimations may be provided based on recent data (volume, limited geochemical data). This is also related to the rarity of MW recovery projects.

- **Regarding datatypes in inventories, or databases that have been developed for UNFC,** in Central and Eastern European countries **officially approved resource and reserve data** facilitate the UNFC application. In some other countries, like Scandinavian countries and in the United Kingdom **UNFC project-based data are direct information for Active and Non-Active Projects** (Viable, Potentially Viable or Non-Viable) based on status, ownership, exploration history, geology, resource and reserves production, and classification. are in use. Environment codes and metals (mining codes) are in the database in France that means the French database includes environmental and commodity-based considerations. Scientific publications with a proper reference are also used in the UNFC (e.g., Portugal and Sweden). Next to primarily official decisions for E and F categories (mining, technical and environmental permissions and for social acceptance) the consideration of limiting factors to access mineral deposits and land-use planning issues are important, with GIS-based support (e.g., Austria, Finland, Hungary, Norway, Sweden, and Slovenia).

- **For UNFC E category, in most cases GSEU partners use information** on permit applications, economic feasibility studies, environmental impact assessments, stakeholder involvement, mining and exploration licenses, status (active/non-active), documents on cancelled and exhausted objects, protected areas for special intervention in the Earth´s crust, exploration reports (indirect evidence on economic importance based on investment to exploration) and land use planning documents.

- **Regarding F category, information** can be collected from licensing documentations and officially approved decisions on mining or recycling-related activities (technical plans).

- **Regarding datatypes for UNFC G category** resource and reserve data from central databases are dominant but these data can be derived from ad hoc or project databases. In central GSOs or in mining authorities, resource inventories are based on official decisions on exploration and other mining activities (extraction, suspension, closure) validated by authorized expert. In feasibility studies and in company reports resource and reserve data are validated by company representative and/or Competent/Qualified Person and this data can be integrated into the UNFC database.

- **UNFC methodologies can be a direct application of the UNFC** (e.g. Finland, Norway, Sweden, Portugal and Hungary) **or indirect via harmonization between the national database and UNFC** (e.g., in Slovenia) **or bridging between national data with, e.g., CRIRSCO-type reporting code and UNFC** (Hungary former method).

- **Decision tree** (United Kingdom -by BGS or modified versions based on this for national cases: France) is useable by using specific project related and objective questions supports to avoid subjective decisions.

- **In case of modification of the former national classification system** (A, B, C1, C2 to "explored reserves", "prospected reserve") and the appearance of limiting factors to apply UNFC, a direct application of the UNFC Guidance for Europe (2022) can be a solution.

- **Comments to UNFC methodologies**: Countries that provided UNFC methodology dominantly use UNFC on project level or in house purposes. Most GSOs that have proper experience with UNFC and have provided an overview on UNFC methods are committed to develop their national inventory with UNFC or relevant databases for UNFC data provision. Next to primary and secondary RM (mainly MW) recently available or planned MW inventories are a good base to develop a UNFC database for mining waste. However, in such cases further information is needed from other authorities. Limited number of MW recovery projects influences the development of the related database. The lack of legally supported data collection for primary and secondary RM with an access to information on E and F category hinders the official UNFC classification, but the need for systematic data collection for at least CRM projects in the context of the CRMA facilitates further inventory developments.

- **A large number of UNFC case studies range** from CRM deposits to construction and industrial minerals addressing only deposits or historical data via exploration to mining projects (see the Table 2). This is a foundation for next steps in the development of a common template for data provision and to develop national guidance documents.

- **Considering many similarities of methodological aspects and some differences (including datatypes and information, databases, case studies that are used regionally in Europe) it can be concluded that based on these results the identification of national and regional information to UNFC E, F and G categories in all European countries facilitate the joint application of UNFC Guidance for Europe (2022).**

- **This way a coherent, comprehensive European level database for CRM projects can be developed, ensuring the proper expertise for UNFC classification.**

Table 2. Brief summaries of different regional UNFC methodologies in Europe and some relevant and discussed case studies

	Data and information type	Database	Methodology	Comment	Case studies
Austria (GeoSphere)	Geological and exploration and mining data, permit applications and accompanying documents such as economic feasibility studies, technical feasibility plan and studies, environmental impact assessments and information on stakeholder involvement; inventory of mining waste	Areas with existing mining licences (BerGIS), mineral deposits and occurrences (IRIS), mining sites database mining sites, GIS database	UNFC methodology was developed by GeoSphere, and it is based on distinguishing between permitted areas, safeguarded areas, potential conflict areas and legally prohibited areas in GIS; the Austrian Standard G 1050 was published in 1989 and is similar to early versions of UNFC;	Data are not shared, Mining Authority holds necessary data for UNFC; no information exists to derive the E and F categories at Geosphere and Mining Authority; mining companies use PERC; there are also gaps for primary and secondary RM data (not consistent, regionally)	Mainly for aggregates, high-grade quartz, graphite
Czech Republic (CGS)	Data (reserves/resources) of deposits explored/exploited by commercial organizations in the inventory of the CGS;	Centralized, on-line data raw materials collection system, GIS based related data,	Based on previously used USSR system (A,B,C1, C2) that is modified after 1991 ("explored reserves", "prospected reserve"); comparison of national resource classification with CRIRSCO compatible system	UNFC classification is not used officially, occasional activities on methodology and comparison of national resource classification with CRIRSCO compatible system	No case study, general introduction on hypothetical UNFC categorization
Finland (GTK)	Databases contain both Active and Non-Active Projects which can be either Viable, Potentially Viable or Non-Viable (status, ownership, exploration history, geology, resource and reserves production, and classification)	Relational Oracle database, INSPIRE-compliant, and includes references to the source information;	Direct application of UNFC with attributes for E category (1. Value at source, 2. Access to resources, 3. Competition for land use; a. Environmental contingencies, b. Landowner interests, c. Local authority interests) and with a supporting	GTK uses UNFC for in-house reporting of mineral potential projects. The results are published in internal technical reports and in the national mineral deposit database	All deposits checked on their UNFC categories. Prospective, Potential Viable and Viable cobalt, nickel, lithium, and vanadium regarding resources on national level.

	Data and information type	Database	Methodology	Comment	Case studies
			valuation (Net Present Value) using continuous variables based on Nordic Guidance.		
France (BRGM)	Industrial minerals (environment code) and metals (mining code), "measured" and "estimated" resources, historical data	Mineral resource national database for primary and mining wastes (BRGM); Mineral cadastre (Environment Ministry)	Using decision trees (BGS and GTK); Adapted to consider the French legislative framework to obtain the authorizations and permits for exploration and exploitation; It facilitates objectivity and replicability of the evaluations and improves empirically the methodology by iteration as projects are classified.	It is not mandatory to use resource classification using reporting systems, very few data with resources estimated in CRIRSCO-PERC-JORC, no standardised data for resources classification; Easy for ongoing projects (recyclers) but difficult to assess G axis; for mining wastes: integrate data from environmental monitor (FutuRaM)	44 projects or deposits have been classified in France with UNFC, for primary (Sb, bauxite, fluorite, Ge, Li, Mg, Mo, Ta, W) and secondary resources (Co, Ni, Li, In, Hf, PGMs); projects range from "nonviable" to "producing".
Hungary (SARA)	Exploration areas, mining areas, production, reserves and resources (G category based on A,B, C1 and C2 classes; Mineral Resource Inventory, MRI) and prognostic, D classes (project results) historical data, licences in the Inventory of Mining Areas (BATER) (Technical Operation Plan), inventory of mining waste (related to Directive 2006/21/EC)	Central database, on-line data collection system is in progress, UNFC data are separated on project level (not in the official database)	Two ways: using of triple harmonization between national classification - GKZ-CRIRSCO – CRIRSCO - UNFC Bridging (former); Direct use UNFC based on data in mineral resource and mining area inventories (new)	Annual reporting of changes in resource volume by companies is obligatory, UNFC and CRIRSCO is referred in the legislation next to national resource classification classes, official use of UNFC and CRIRSCO type reporting is rare. National bridging is published (former); gaps for primary and secondary RM data	For all types of commodities UNFC was tested (non-metallic, ores, coal, hydrocarbons, geothermal energy, mining wastes; for aggregates a regional, for barite a site level case study was presented.
Norway (NGU)	National databases on resources and other geological data, exploration reports, publications,	National and publicly available databases on on-line data raw materials collection	Application of Nordic Guidance (see GTK and SGU); different types of UNFC methods have been	Data availability determines the best suited approach, such as bridging where CRIRSCO compliant data exist or where	National: graphite and phosphate.

	Data and information type	Database	Methodology	Comment	Case studies
	exploration and mining licences and information on concessions (Directorate of Mining) that are requested from other authorities; ArcGIS and land use planning data are used (raster terrain model).	system; databases on resources and other geological geoscientific data (continuously updated). The database is currently under further development, UNFC will be implemented.	used: GIS Spatial analysis, CRIRSCO bridging, both probabilistic and deterministic methods.	previous resource estimates are available, or other methods where these numbers are not available. Analysis of land use conflict.	Regional: dimension stone, aggregates. Local: gravel, titanium-phosphate-vanadium deposit.
Portugal (LNEG)	Geoscientific, technical and economic information related to occurrences, resources and mineral reserves and areas with mining potential.	SIORMINP is a nationwide information system that contains data in a systematic and synthetic way.	Direct application of UNFC (1997)	2,292 mineral occurrences including resources and reserves are classified in UNFC according to the UNFC-1997	In general: U, Au, Ag (Sb), Sn, W (Ta, Nb, Ti), Quartz, Feldspar, Fe, Mn, Cu, Pb, Zn, Pyrite, Kaolin, Talk, Diatomite, Li, Evaporite, Ba, Be, Cr, REE
Slovenia (GEOZS)	Exploration areas, mining areas, production, reserves and resources, limiting factors to access of mineral occurrences (e.g. Natura2000), licences	National centralized database; reserves data comply with a standard national code system (derived from the "Russian classification").	Reserves data are transformed (using bridging documents to UNFC codes) and harvested into the pan-European mineral intelligence system. Data reported to EGDI is INSPIRE compliant and spatially referenced. Based on Russian classification: A, B, C1 (so called "reserves") and C2 (so called "resources")	Data are collected for PRIMARY RM by the GEOZS; data provision by companies is obligatory, Data are held/owned by the relevant Ministry. Data according to UNFC-2009 are incorporated in EU Mineral Yearbook; For mining wastes there is a comprehensive dataset as part of the implementation of Directive 2006/21/EC	clay (brick and ball clay), dimension and ornamental stone, quartz, sand, clay, chalk, clay, calcite, bentonite, puzzolan tuff, limestone,
Sweden (SGU)	Exploration data, geoscientific data form SGU and scientific papers, public company reports, (feasibility studies, resource, reserve reports), permissions (exploration permits, mining licenses,	On-line data raw materials collection system; database; it is designed for further development, by adding multilingual user interface, incorporating	Application of NORDIC Guidance (see GTK and NGU); direct application of UNFC and also using information of CRIRSCO family reports.	There is no national coordinated mineral resources classification. Companies report minerals reserves using classifications of the CRIRSCO family (e.g. PERC, JORC, NI 43-141). Accessible	Several REE projects Presented: Norra Kärr (HREE project, low in U and Th)

	Data and information type	Database	Methodology	Comment	Case studies
	exploitation concessions, environmental permits), ownership	other UNFC resource categories, adding enhanced project (map) search etc.		mining tailings are also in the focus.	
United Kingdom (BGS)	Data supplied and/or published by the extractives industry; historical data held in research reports and academic studies; data created using geospatial analysis State of the exploration and mining project, published information in accordance with international standards (feasibility studies), permissions including social acceptance; resource and reserves.	BGS compile database on an ad hoc basis.	Decision flow by BGS: objective decision-based process for E, F and G categories; decision tools specific project related objective questions can help to avoid subjective decisions;	No system for collecting mineral resource data and no specific standards or definitions are present in national legislation.	Presented: VMS for Cu, Zn and Au (Gairloch, Scotland); other: ball clay, barytes, brick clay, celesite, copper, crushed rock aggregates, fluorspar, fullers earth, gold, gypsum, kaoline, lead, lithium, mica, nickel, offshore sand and gravel, phosphate rocks, polyhalite, potash, salt, silica sand, silver, talk, tin, tungsten, zinc.
Ukraine*	Cadastre of mineral resources and mining areas; exploration data, resources, reserves, consideration of social, environmental and technical feasibility and determination of the level of confidence	Central database that was inherited from the former period of classification between 1960-1981	Classification of Mineral Reserves and Resources was developed following the UN ECOSOC decision No. 227/1997. E category is based on presence of "balance reserves" and "off-balance reserves"; F category is based on preparation phase of project (commercial, prospective, exploration, mining) or obstacles of extraction) presence in the Balance or in the Cadastre, G is based on A, B, C1, C2.	Bridging reserves and resources of deposits accounted by the State Inventory of mineral resources, which are not under development into National classification based on UNFC has just finished by Geoinform.	3,971 deposits are classified in UNFC (natural gas, oil, metallic ore, water, coal, peat, non-metallic, precious or collectible stones)

*based on contribution from Ukrainian project partners and publicly available documents (Sergii P., 2023).

7. UNFC template for primary raw materials

7.1. Introduction

The UNFC Europe template for primary RM was developed as a concerted effort by the UNFC Coordination Team (UNECE, EC DG Grow, GSEU, FutuRaM) with significant contributions from GSEU experts. Ultimately, GSEU and FutuRaM recommendations are planned to be integrated into one unique template.

The UNFC Europe template will be the designated tool for the systematic collection of comprehensive data and metadata on European mineral resource projects which have been classified according to UNFC. The template defines a minimum set of criteria to be addressed when collecting the data. The background of the template is an excel sheet that is related to a database yet to be developed. It is expected to be used for the provision of data on critical raw materials (CRM) in the frame of the European CRM Act. However, it also represents a valuable basic data collection sheet for serving data of different resource types to the EGDI. This latter aspect is under development in co-operation with GSEU WP7 (Chapter 9). The purpose of the template is to ensure that the collected data is uniform and complete, ready to be entered into this database.

Following a UNECE proposition, the initial data collection and UNFC classification shall be carried out by EU Members State administrations or mandated agencies in order to provide CRM data to the EC DG GROW. At the same time, GSEU project partners can use this template for their own data keeping and management. Preliminary data updating shall be performed each year on March 1st using data from the end of the previous year (cut-off date December 31). An equivalent template for secondary RM is currently developed by the FutuRaM project consortium.

7.2. Results

Based on a first version of the template provided by UNECE and GSEU experts, and following multiple discussions on the needs for CRM data provision in the context of the CRM Act, a detailed assessment was carried out by GSEU experts considering the results of the UNFC baseline assessment.

Partners who contributed to the template include Zoltán Horváth (SARA), Antje Wittenberg (BGR), Meta Dobnikar (GeoZS), Guillaume Bertrand (BGRM), Pasi Eilu and Janne Hokka (GTK), Sebastian Pfleiderer (GeoSphere Austria), Tom Bide and Eimear Deady (BGS), Francisco Javier González Sanz (IGME-Spain).

The extended version of the template contains topics to describe the background and circumstances of CRM data provision as follows:

- UNFC EU template for Mineral Resources Data Collection (1. project metadata, 2. classification background information, 3. UNFC Cases of resources)
- Other considerations (data collection methods, data analysis methods, data quality assurance, data confidentiality / ethics considerations, data management, timelines, contact information, exploration, monitoring, references)

Obligatory fields are marked with a star (*).
The template is presented in Annex 7.
The template was tested on existing CRM projects in Hungary for barite (SARA), in Finland for lithium (GTK) and in the United Kingdom for lithium and tungsten (BGS).

Recommendations for further developments and finalization of the template include:

1) **One or more options to be chosen**: In some cases more than one permit might be valid on a site but to keep the template simple and to focus on the main commodity and main activity, the responsible expert/data provider needs to decide on main and integrated or parallel projects. This way the most mature or the most relevant stage of permits should be indicated (more options only in compelling reasons). It is always possible to fill out a second template for the same site, specifying other parts of the project with a different development stage or permit. Different commodities can already be accommodated in one template.

2) **Acronyms and glossary recommended**: EIA: Environmental Impact Assessment, TOP: Technical Operation Plan. A glossary with definitions of e.g. Product, Commodity, Multi-commodity, "strategic" project and "monitoring" project should also be included. Data quality should be standardized. Consideration of using the expression: "pre-active" (exploration).

3) **Commodity/Product**: product instead of commodity can be supported (mining waste), but further discussion is needed to harmonize with UNFC 2019 IV.D. (product definition).

4) **INSPIRE code** in the EU thematic template for RM (UNFC module) is relevant and appropriate. **INSPIRE compliant commodities should be used** at least for EGDI data service, but to EC DG GROW it would also be practical and compatible.

5) **Drop-down menu for many of the topics are useful** (for mining waste at the reference point exploration, processing, extraction/recovery, reuse/recycling, disposal, deposition, categories needs to be discussed with FutuRaM).

6) **Consideration of using m^3** in case of volumes as an option (kt and t is commonly used).

7) **In the pan-European seas**, most of the occurrences of seabed minerals (691 in the MINDeSEA database) represent **results of research projects** (European and national projects on marine geology and seabed minerals). Therefore, they are at the base level of knowledge for UNFC system. In the future our knowledge of seabed minerals in some areas of the European seas can be significantly increased (by their economic, environmental and research/technological interest) and these occurrences will be the scope of exploration projects. For seabed minerals in international waters under the International Seabed Authority-ISA jurisdiction, exploration should be understood with commercial interest (polymetallic nodules, Co-rich ferromanganese crusts and seafloor sulphides). In the international waters, for now, only the exploration regulations have been developed. Being in line with the ISA/UNCLOS regulations also in the EEZ is important. When using UNFC in the Exclusive Economic zones (EEZ) it has also a commercial interest. Exploitation rules and The Mining Code – International Seabed Authority (https://www.isa.org.jm/) need to be considered.

8) In case the representation of seabed mineral projects in European seas has an importance (prognostic project with UNFC EFG: 334), at the present stage **research should be included** here with reference on results e.g. on scientific research, publication etc. (not representing clear economic interests, only as a first stage of knowledge). Even if there might be few projects in the Baltic Sea with a more developed stage, but in general the race for seabed exploration/ exploitation is at the beginning. **National legislations for seabed minerals exploitation** are pending for most of the European countries.

9) **In the exploration activity for seabed minerals** can be included specific technics: geophysical (e.g. multibeam, backscatter, seismic, electro-magnetic, gravimetric); observation and sampling (ROV, AUV, benthic dredges, cores, CTD, oceanographic rossete, gliders).

10) Further explanation is necessary when the **risk monitoring module** needs to be filled in - and also what risk is being referred to.

11) **Recycling is indicated at the type of activity** as a reference for secondary RM projects. Recycling sub-project may be involved within a main primary RM project on the same site.

8. Application of UNFC to other resources in GSEU

8.1. Secondary raw materials (including mining waste)

The application of UNFC to secondary raw materials in mining and metallurgical residues can be done in analogy to primary raw materials. The resource estimates need to consider specific mining waste related considerations such as separated exploration reports on CRM content of the mining waste and feasibility studies that might include environmental, social, technical economic and legal information. The recent version of the template that is presented in this report (Chapter 7) will contain proper elements that are necessary to identify CRM recovery projects in UNFC. Inventories or datasets for mining wastes on national and regional levels were mainly developed according to the implementation of the 2006/21 Mining Waste Directive. The primary goal of the operation of these databases is the identification of environmental risks and support of appropriate measures to mitigate or eliminate these risks. If sufficient information on the quality and volume of CRM content (UNFC G axis) and on the related social, environmental and economic considerations (UNFC E axis) and technical feasibility (UNFC F axis) is available, the correct UNFC database can be developed in alignment with the proposal of the CRMA. The related CRMA Article (26) prescribes the proper quantity and quality data collection for mining wastes for EU Member States that will contribute to the better knowledge on G category for CRM in mining wastes.

As a basic concept to provide UNFC information to mining waste occurrences the "Anthropogenic Material System" by the MIEA project is guide for further developments within the GSEU project (Figure 23.).
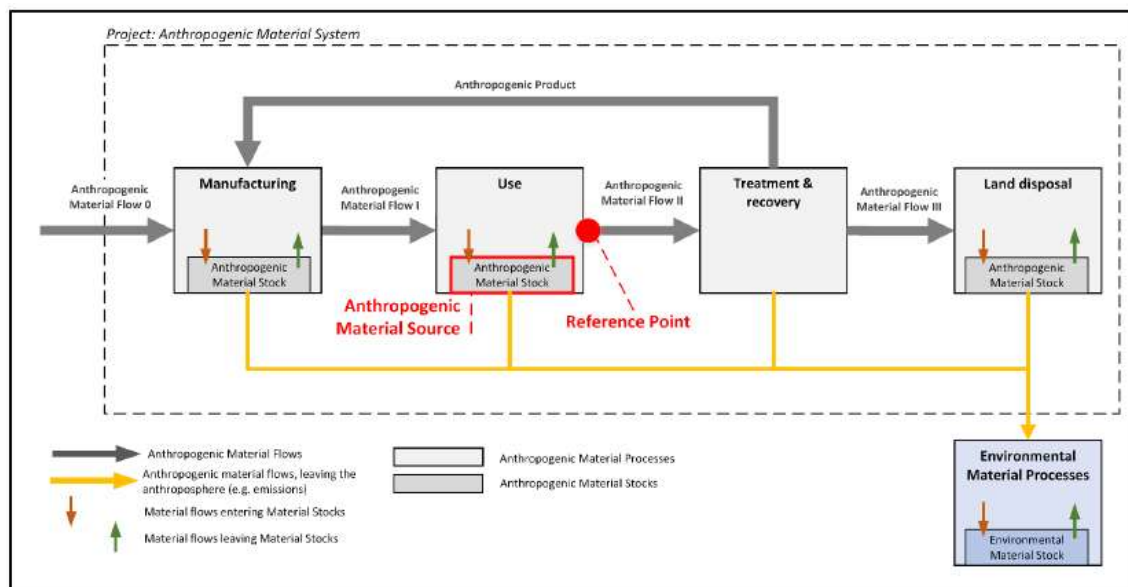
Figure 23. Example of a specific Anthropogenic Material System at project level including the location of the Reference Point. The default for the Reference Point shall be the location in the sourcing process at which the reported quantities of Anthropogenic Material Products are measured or estimated (UNECE 2019)

Considering the results of the COST-MINEA project there are some basic data required for UNFC classification that are necessary to integrate into databases and mineral inventories. To the resource

assessment following data are required: location, volumes or masses, chemical specification, material composition, particle size and distribution, water content and leachates. Regarding material sources data need to be collected for waste rock, for low grade stockpiles, for tailings or for metallurgical residues. The identification of target materials is important even if these are previously mined minerals, non-previously mined minerals or new materials. Regarding the maturity level of a project an interpretation is needed whether the project is a research work, prospect study or operating. Evaluation factors are economic feasibility, environmental impact, market acceptance, socio-political acceptance, legal accessibility to resource, technical recoverability, infrastructure and legal compliance (Carlo 2021). Technical feasibility (F category) can be proved by Technical Operation Plans or similar approved technical documentations. E category can be characterised based on feasibility studies (mainly economic calculations) and in a more matured licensing phase of the project the existence or the lack of different permissions are suitable for identifying E category. Comparing the classification of primary and secondary RM by UNFC the latter can be more complicated if LCA and MFA are needed.

Summary

The application of UNFC for secondary RM with a focus on mining wastes can also be done based on similarities for UNFC application for primary RM and by considering specific mining waste related considerations such as separated exploration reports on CRM content and the related feasibility studies that might include assessment on Life-Cycle Analysis (LCA) and/or Material Flow Analysis (MFA). The UNFC template will contain proper elements that are necessary to identify CRM recovery projects in UNFC. Inventories or datasets for mining wastes on national and regional levels were mainly developed according to the implementation of the 2006/21 Mining Waste Directive. The primary goal of these databases is the identification of environmental risks and support of proper measures to mitigate or eliminate these risks. In case of proper information on resource assessment with regards to the CRM quality and volume (G category) and on external considerations (social, environmental and economic, technical feasibility) a UNFC database can be developed. The related CRMA Article (26) prescribes the methodology for the collection of quantity and quality data collection for mining wastes for EU Member States that will contribute to the better knowledge on G category for CRM in mining wastes. GSEU partners and data manager, responsible organizers need to use the UNFC Guidance for Europe (2022) for secondary RM (MW), and national guidance documents need to take into consideration both primary and secondary RMs.

8.2. Geothermal energy and injection projects for the purpose of geological storage

Based on discussions between WP2 and WP3 experts (GSEU-UNFC on 29th of June 2023), one of the conclusions was that the "traditional" use of UNFC is designed for the classification of a single project, whereas majority of WP3 activities focus pan-European assessment of geo-energy capacities, which can be considered as a hypothetical or notional project(s). The Pan-European geothermal energy database and geological storage databases will be an important basic data source for UNFC category G, but site-specific information is typically needed to determine E and F classes at project scale. This may be overcome by developing national and regional maps with typical barriers such as potential interferences with e.g. nature preservation areas, groundwater protection areas and surface uses that are hampering the development of projects. Experts agreed that the major potential in UNFC application in the future will be the "upgrading" of the projects. i.e. to mature a hypothetical project on the play-map, identify the hurdles in project realization and to test how these hurdles can be mapped to the various E, F and G axis categories and how can this be translated to decision support information for policy makers.

Considering the UNECE guidance and further specifications (2017, 2022b) similar data types and information (identification, name of property, existence or lack of environmental permissions, feasibility studies, TOP plan, resource and reserve data if any) is required for geo-energy projects as compared with primary RM (CRM) projects. There are some differences such as the replenishing nature of the geothermal energy as a source, utilization types, technological details of injections and heat or electricity transfer, project lifetime, etc. The Reference Point is also important when considering the UNFC classification of a geothermal project or a potential for it.

8.3. Groundwater

Based on discussions between WP2 and WP4 experts (GSEU-UNFC on 29th of June 2023), the UNECE guidance for groundwater resources that is in progress will be an important basic document for the application of the UNFC in the frame of the GSEU project and to provide data to the EGDI. Similar datatypes and information required for groundwater projects when compared with primary RM (CRM) projects (identification, name of property, existence or lack of environmental permissions, feasibility studies, technical operation plan, groundwater body volumes). Differences, such as the designation of groundwater protection body (based on research and exploration data), utilization of groundwater, modelling and monitoring of the groundwater flow system, hydraulic communication with surface waters, water production also need to be considered. In the second phase of the project, detailed assessments will be done for the identification of E, F and G categories (e.g. groundwater resource estimation and quality data: e.g. salt content, conductivity) in the frame of co-operation with WP 4. We plan to discuss on further specifications regarding the geological setting of groundwater bodies and the project related technical, environmental, economic and social considerations based on the recently available template for raw materials. Sharing experience on UNFC methodology for RMs and on groundwater will contribute to the proper UNFC data provision to the EGDI.

9. UNFC in the EGDI

EGDI is the largest geoscientific database in Europe that is operated by the members of the EuroGeoSurveys. In the frame of the EuroGeoSurveys, new research and data management activities were developed, and statistical data, inventories, and other relevant data on Europe's raw materials were compiled through the GeoERA project, MINTELL4EU. Through EuroGeoSurveys' EGDI (www.europe-geology.eu), availability of these compilations is ensured after the closure of these projects (e.g. Jørgensen et al 2023). EGDI is not only a tool to serve geoscientific data through a web portal, but also a digital infrastructure that collects, organizes, stores and diffuses the information. For mineral resources, the MIN4EU database compiled mineral resources data that is collected ("harvested") via web services from national databases developed and maintained by European geological survey organisations (Jørgensen et al. 2023). Reliable information and comparable data are key to such an instrument. EGS Members and other responsible raw materials data provider organizations need to be prepared for a raw materials data service using UNFC in both EGDI and to the EC DG GROW critical raw materials database. These databases should be linked directly.

In the frame of WP2 T2.4, next to the development and application of a joint guidance for serving raw material project data in UNFC, also important are the identification of proper datatypes available recently in the EGDI and determination of additional types that are important at least for the CRM data service to the EC DG GROW.

Based on many physical (Ljubljana) and on-line conversations, WP2 T2.4 partners provided a preliminary draft of the planned database structure for CRM within the EGDI and started to discuss with WP7 partners to finalize the 'CRM database UNFC' structure. It is in harmony with the EC DG GROW CRM database structure and thus with the UNFC template for raw materials that will be used to the CRM data provision in the mirror of the CRMA (

Basic data															
ID	Country	Main commodity	Other commodities	Main commodity for map display	Property	Latitute	Longitude	Owner	Webpage	Country owner	Type of Activity	Type of the extractive activity	Origin of the resource	Development Stage	State of activity
UNFC															
UNFC most mature status	111 (thousands of tonnes)	112 (thousands of tonnes)	221 (thousands of tonnest)	222 (thousands of tonnes)	223 (thousands of tonnes)	321 (thousands of tonnes)	322 (thousands of tonnes)	323 (thousands of tonnes)	334 (thousands of tonnes)						
Classiciation, contact, production															
UNFC 341 (thousands of tonnes) to C1	UNFC 342 (thousands of tonnes) C2	Reserves (tonnes)	Resources (tonnes)	Original classification scheme	Comments	Production data availability	Contact person for production data	Email of the contact person for production data	Production of metal (t/yr)						
Other															
Ores and concentrates (tonnes)	Average grade for ores and concentrates	Metal quantity (tonnes)	Primary metal content	Primary metal content	Secondary - Metal content (tonnes)	Comments2									
(A)	(B)	(C) = (A)* (B)	(produced FROM the extraction site)	(produced from OUTSIDE the extraction site)											

Figure 24.).

Basic data															
ID	Country	Main commodity	Other commodities	Main commodity for map display	Property	Latitute	Longitude	Owner	Webpage	Country owner	Type of Activity	Type of the extractive activity	Origin of the resource	Development Stage	State of activity
UNFC															
UNFC most mature status	111 (thousands of tonnes)	112 (thousands of tonnes)	221 (thousands of tonnest)	222 (thousands of tonnes)	223 (thousands of tonnes)	321 (thousands of tonnes)	322 (thousands of tonnes)	323 (thousands of tonnes)	334 (thousands of tonnes)						
Classiciation, contact, production															
UNFC 341 (thousands of tonnes) to C1	UNFC 342 (thousands of tonnes) C2	Reserves (tonnes)	Resources (tonnes)	Original classification scheme	Comments	Production data availability	Contact person for production data	Email of the contact person for production data	Production of metal (t/yr)						
Other															
Ores and concentrates (tonnes)	Average grade for ores and concentrates	Metal quantity (tonnes)	Primary metal content	Primary metal content	Secondary - Metal content (tonnes)	Comments2									
(A)	(B)	(C) = (A)* (B)	(produced FROM the extraction site)	(produced from OUTSIDE the extraction site)											

Figure 24. Preliminary proposed UNFC related datatypes to the EGDI

In the framework of the co-operation with experts of EGDI, UNFC experts discussed the data model structure especially for UNFC-related datatypes that are recently available in the EGDI, and that need to be developed. The so called 'Requirements Analysis' that is a questionnaire survey on products that are aimed to be delivered on EGDI, helps both EGDI experts and UNFC experts to find solutions for the most suitable UNFC data services via EGDI. Table 3. shows some selected topics of the Requirement Analysis.

In principle, automatic UNFC classification based on INSPIRE/MIN4EU properties (mineStatusType and explorationActivityType) is possible (UNFC Guidance for Europe). Even if MIN4EU datasets contain this information, it provides lower resolution estimates than required by EC DG GROW. An 'automatic pre-classification' has also been considered that requires confirmation by experts, but it might be interesting to speed up the process.
These are further reasons to have two separate products in EGDI. At the same time, they should not be handled separately, because they contain data related to the same mining features that must not be contradictory.

A specialized tool (for internal use) may be developed to check if MIN4EU data is usable for UNFC classification. If yes, it may provide an initial template for EC DG GROW that can be refined manually.

Table 3. Preliminary results on planning the CRM UNFC data service to the EGDI

EGDI elements	Preliminary plan (answers for EGDI IT questions)
Description	The product provides basic Mining Project information together with UNFC resource estimates. Fields to be exposed are defined by EC DG GROW database which contains 43 fields. The background dataset for the EC DG GROW database consists of two parts: 1. 27 data fields are part of the GE ERML/MIN4EU standard dataset provided by Geological Surveys and harvested by the usual EGDI procedure 2. 16 Additional dataset fields are EC DG GROW-specific The two datasets are linked together by unique identifiers
Product type	Dataset in EGDI platform following data specification (Product type 3) Another option is to have two separate products: • product type 3 for the GE ERML/MIN4EU (MIN4EU) standard data adding new records to the existing EGDI system. • product type 2 for the EC DG GROW data providing details not covered by the standard.
Use case	1. Harvest EC DG GROW data content from EGDI 2. Provide EGDI layers to query and show CRMs based on MIN4EU properties. 3. Provide EGDI layers to query and show CRMs based on UNFC categories. More use cases to be added in the next phase.
Added value	This database would be uniform, INSPIRE-compliant for all elements including spatial data, commodity name, status of the project, UNFC classes, etc. instead of national and regional differences. Former EU-funded and national level projects are harmonized for most European regions for the EGDI data service (e.g. MINTELL4EU, GeoERA) but this database should be in line with the CRM data provision to the EC DG GROW. Confidentiality is an issue not only for resource and reserve data, but regionally other data can also be sensitive (e.g. semi quantitative size of resource volume that is partially solved with specific ranked legend).
New component/New functionality	Data does not require a new component and/or new functionality not already existing in the EGDI platform to display or use UNFC-related data.
Standardization	Data is not yet standardized according to a data model (GE ERML/MIN4EU)
Fitting to standard	Additional 16 parameters must be stored in a separate EC DG GROW database
Specification on topics and the fields properties	16 topics need to be integrated into the data model currently: Main commodity for map display, owner, webpage, origin of the resource, development stage, UNFC most mature status, contact person for production data, contact person for production data, production of metal (t/yr), primary metal content (produced from the extraction site), primary metal content (produced from outside the extraction site), secondary - metal content (tons)
Specification of the type of information	To be uploaded to EGDI platform. Spatial Information to be displayed in EGDI viewer. Metadata information to be integrated into the EGDI metadata catalogue
Volume of information	Several thousand MineralOccurrence, Mine, and MiningActivity records with additional EC DG GROW data.
Format of file	ESRI Shapefiles (will be uploaded to the EGDI platform)
Specification the Spatial Reference	(EPSG Code) Web service that EGDI has to collect to integrate the CRM product into the EGDI platform.EPSG:4258: ETRS89 / ETRS89-GRS80 https://epsg.org/crs_4258/ETRS89.html
Extent	Europe

Update frequency	Web service that EGDI must collect to integrate products into the EGDI platform should be updated at least yearly in accordance with the UNFC template and the CRMA.
Use of file to be uploaded to the EGDI	Internal use in case of confidential data; external use is viable only with F.A.I.R. data (differentiation between external and internal access of data is planned)
License type	In the frame of the GEOERA program, CC BY-and CC-BY-ND-SA were agreed and applied. for UNFC CRM database as a product within the GSEU, other licenses may be identified considering F.A.I.R or confidential data
Downloading	CRM data base with all the related data is expected not to be downloadable in case of confidential content depending on national legislation. F.A.I.R. data will be downloadable.
Link to website of any existing themes	EGDI scientific theme: Mineral Resources (https://www.europe-geology.eu/scientific-themes/mineral-resources/)
Relationship of spatial information	Harvested MIN4EU MineralOccurrences and Resources should be linked to EC DG GROW records.

If confidential EC DG GROW data is going to be harvested from EGDI instead of accessing MIN4EU datasets, they should be authenticated. Another option is that confidential resource information is not stored in the MIN4EU system, but in the separate EC DG GROW dataset along with some additional attributes that are currently not available in the EGDI, but exist in the EC DG GROW CRM database. Code lists in the EC DG GROW data models are partially overlapping with existing INSPIRE/MIN4EU code lists. On the other hand, full harmonization is not possible, because EC DG GROW is focusing more on UNFC and has code list items that don't exist in INSPIRE/MIN4EU. Mapping between the two dictionaries must be clarified.

Summary
The most important preliminary steps were taken to determine the proper UNFC data model within EGDI in co-operation with WP2 & WP7 Partners. This joint work will contribute to the establishment of the proper UNFC data service to the EGDI. In relation to the CRMA, it will facilitate the CRM data service to the EC DG GROW. Further specification of the CRM Database UNFC will be done within the process of the Requirement Analysis by WP7.

10. Summary

As a preparation phase, in order to assess the baseline understanding of UNFC within Europe, observations have been made on the most recent UNFC-related activities as well as national and regional backgrounds that influence the applicability of UNFC. The following topics have been addressed: updates on mineral resource management; the integration of sustainability into the legislation for primary and secondary RM; access to E, F and G category-related data and information; data management; involvement of different types of experts into the resource data management in GSOs; competence and past/recent and future activities with UNFC.

Based on a questionnaire and on sharing experience of developing national and regional UNFC methodologies, we conclude that the adaption of the UNFC Guidance for Europe on regional and national levels is the most appropriate solution to the implementation of the CRMA. The preparation of a national guidance document in non-EU European countries who are partners via GSOs or other

organizations is also important to facilitate the CRM data provision into the EGDI in the context of the GSEU project objectives. Finalization of the template, in co-operation with the UNFC Coordination Team led by UNECE and including EC DG GROW, GSEU and FutuRaM representatives, is in progress, but the recent version of the template serves as a proper base to identify the most important data types, data sources, data access for UNFC classification, and the related decision mechanisms to identify E, F and G categories. Preliminary results on comparisons between the UNFC Guidance for Europe and available national and regional UNFC methodologies, or UNFC opportunities in countries where only initial steps have been taken for mapping UNFC have been compiled. It is important to note that countries that provided UNFC methodologies (Austria, Czech Republic, Finland, France, Hungary, Norway, Portugal, Slovenia, Sweden, the United Kingdom and Ukraine) on GSO or authority level have UNFC-related data collection based on legislation or based on internal measures to improve databases.

In the frame of the development of the EU International Centre of Excellence – Sustainable Resource Management (EU ICE-SRM), which will deliver capacity building, preparation of training materials and networking of GSEU partners and other external stakeholders, proper expertise and skills will be developed to establish and finalize national guidance documents for the coherent and consistent application of UNFC across Europe.

The application of UNFC for secondary RM, with a focus on mining wastes, can also be done based on major similarities for UNFC application for primary RMs and by including specific mining waste-related considerations (MFA, LCA). Existing inventories or datasets for mining wastes on national and regional levels have been mainly developed according to the implementation of the 2006/21 Mining Waste Directive.

In the case of geoenergy, similar data types and information are required when compared to primary RM (CRM) projects (identification, name of property, existence or lack of environmental permissions, feasibility studies, technical operation plan). Differences include the designation of geothermal protection bodies, utilization of geothermal energy, technological details of injections and heat or electricity transfer, project lifetime, and modelling. The reference point is also important when considering the UNFC classification of a geothermal project or potential.

For groundwater, the recently available template is a proper base for development of the adaption of UNFC for groundwater projects. Similar datatypes and information are required for groundwater projects when compared with primary RM (CRM) projects (identification, name of property, existence or lack of environmental permissions, feasibility studies, technical operation plan, groundwater body volumes).

In the second phase of the project, further co-operations will develop the UNFC application for geoenergy and for groundwater projects based on resource specific considerations.

In the frame of the co-operation between GSEU WP2 and WP7, the most important data types were identified that are suitable for the UNFC classification of a project and can also be integrated into the EGDI. EGDI is prepared to integrate UNFC data and the final data model for UNFC needs to be interlinked with the UNFC template for raw materials. In this way, most fields of the data base also need to be mappable to the EC DG GROW CRM database.

In the next steps, national guidance documents will be developed by partners in each European region based on the results of the first 10 months and on the template that was developed for European CRM data provision in UNFC to the EC DG GROW. The aim is to facilitate bilingual guidance in all European

regions for primary and secondary RM (here mining wastes). Experience for primary RM and mining wastes will allow partners, in the frame of co-operation between WP2, WP3 and WP4 and WP7, to develop and finalize details of the data provision for geoenergy (geothermal energy), groundwater resources to the EGDI. National datasets containing inventories for earth resources that are compliant with INSPIRE requirements and harmonization with UNFC and utilising proper quality control will also contribute to coherent and consistent data management. In this way, sustainable resource management can be achieved (Figure 25.).

Figure 25. Interdependent subtasks in theT2.4. (UNFC task)

Acknowledgements

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12. Appendix I - Abbreviations

Abbreviations	
CRIRSCO	Committee for Mineral Reserves International Reporting Standards
CRM	Critical Raw Materials
CRMA	Critical Raw Material Act
EC	European Commission
EC DG GROW	European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and Hydrogen
RMSG	Raw Materials Supply Group
EGDI	European Geological Data Infrastructure
EGRM	Expert Group on Resource Management
EGS	EuroGeoSurveys
EU	European Union
EU ICE SRM	European Union's International Centre of Excellence on Sustainable Resource Management
F.A.I.R.	Findable Accessible Interoperable Reusable (data)
FutuRaM	Future Availability of Secondary Raw Materials (project)
GDPR	General Data Protection Regulation
GSE	Geological Service for Europe
GSEU	The Geological Service for Europe project
GSO	Geological Survey Organisation
H2020	Horizon 2020
IT	Information technology
JORC	Joint Ore Reserves Committee
LCA	Life Cycle Analysis
MFA	Material Flow Analysis
MREG	Mineral Resources Expert Group

MS	Member states
MW	Mining waste
NEEI	Non-Energy Extractive Industry
NGOs	National Geological Survey Organizations
NoPE	Network of UNFC Practitioners - Europe
PERC	Pan European Reserves and Resources Reporting Committee
RM	Raw Materials
RMSG	Raw Materials Supply Group (EC DG Grow)
Q&A	Question and Answer
SDGs	Sustainable Development Goals
SLO	Social Licence to Operate
SRM	Sustainable Resource Management
EGRM	Expert Group on Resource Management
UNECE	United Nations Economic Commission for Europe
UNFC	United Nations Framework Classification for Resources
UNFC CT	UNFC Coordination Team (UNECE, EC DG Grow, FutuRaM and GSEU projects)
UNRMS	United Nations Resource Management System
WP	Work Package

13. Appendix II – Consortium Partners

	Consortium partners		
	Partner Name	**Acronym**	**Country**
1	EuroGeoSurveys	EGS	Belgium
2	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	TNO	Netherlands
3	Sherbimi Gjeologjik Shqiptar	AGS	Albania
4	Vlaamse Gewest	VLO	Belgium
5	Bureau de Recherches Géologiques et Minières	BRGM	France
6	Ministry for Finance and Employment	MFE	Malta
7	Hrvatski Geološki Institut	HGI-CGS	Croatia
8	Institut Royal des Sciences Naturelles de Belgique	RBINS-GSB	Belgium
9	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy	PGI-NRI	Poland
10	Institut Cartogràfic i Geològic de Catalunya	ICGC	Spain
11	Česká Geologická Služba	CGS	Czechia
12	Department of Environment, Climate and Communications - Geological Survey Ireland	GSI	Ireland
13	Agencia Estatal Consejo Superior de Investigaciones Cientificas	CSIC-IGME	Spain
14	Bundesanstalt für Geowissenschaften und Rohstoffe	BGR	Germany
15	Geološki zavod Slovenije	GeoZS	Slovenia
16	Federalni Zavod za Geologiju Sarajevo	FZZG	Bosnia and Herzegovina
17	Istituto Superiore per la Protezione e la Ricerca Ambientale	ISPRA	Italy
18	Regione Umbria	Regione Umbria	Italy
19	State Research and Development Enterprise State Information Geological Fund of Ukraine	GIU	Ukraine
20	Institute of Geological Sciences National Academy of Sciences of Ukraine	IGS	Ukraine
21	M.P. Semenenko Institute of Geochemistry, Mineralogy and Ore Formation of NAS of Ukraine	IGMOF	Ukraine
22	Ukrainian Association of Geologists	UAG	Ukraine
23	Geologian Tutkimuskeskus	GTK	Finland
24	Geological Survey of Serbia	GZS	Serbia
25	Ministry of Agriculture, Rural Development and Environment of Cyprus	GSD	Cyprus
26	Norges Geologiske Undersøkelse	NGU	Norway

27	Latvijas Vides, ģeoloģijas un meteoroloģijas centrs SIA	LVGMC	Latvia
28	Sveriges Geologiska Undersökning	SGU	Sweden
29	Geological Survey of Denmark and Greenland	GEUS	Denmark
30	Institutul Geologic al României	IGR	Romania
31	Szabályozott Tevékenységek Felügyeleti Hatósága	SZTFH	Hungary
32	Eidgenössisches Departement für Verteidigung, Bevölkerungsschutz und Sport	VBS (DDPS)	Switzerland
33	Elliniki Archi Geologikon kai Metalleftikon Erevnon	HSGME	Greece
34	Laboratório Nacional de Energia e Geología I.P.	LNEG	Portugal
35	Lietuvos Geologijos Tarnyba prie Aplinkos Ministerijos	LGT	Lithuania
36	Geosphere Austria - Bundesanstalt für Geologie, Geophysik, Klimatologie und Meteorologie	Geosphere Austria	Austria
37	Service Géologique de Luxembourg	SGL	Luxembourg
38	Eesti Geoloogiateenistus	EGT	Estonia
39	Štátny Geologický ústav Dionýza Štúra	SGUDS	Slovakia
40	Íslenskar Orkurannsóknir	ISOR	Iceland
41	Instituto Português do Mar e da Atmosfera	IPMA	Portugal
42	Jarðfeingi	Jardfeingi	Faroe Islands
43	Regierungspräsidium Freiburg	LGRB	Germany
44	Geologischer Dienst Nordrhein-Westfalen	GD NRW	Germany
45	Landesamt für Geologie und Bergwesen Sachsen-Anhalt	LfU	Germany
46	Vlaamse Milieumaatschappij	VMM	Belgium
47	Norwegian Petroleum Directorate	NPD	Norway
48	United Kingdom Research and Innovation - British Geological Survey	UKRI-BGS	UK

14. Annexes

Annex 1. Summary of national resource management with a focus on UNFC

Annex 2. Summary on national and regional UNFC activities mainly by geological survey organizations

Annex 3. Direct and indirect involvement of GSOs in the CRM data provision to the EC DG GROW

Annex 4. UNFC E, F and G category data availability and missing data at GSEU partners

Annex 5. Barriers and solutions for implementing the UNFC on national and regional levels

Annex 6. Selected national and regional UNFC methodologies in 2023

Annex 7. Europe UNFC template for Raw Materials (with GSEU contributions)

Annex 2. Summary of national resource management with a focus on UNFC

Country	Brief description of resource management with reference on UNFC
Albania	The sustainable development in Albanian mining policy is addressed in legislation programs and action plans (Sokol Mati 2017). National legislation covers resource management. The mining legislation was published before 2022.
Austria	Mining legislation (23 acts/laws based on EC DG GROW 2016) covers resource management. The Austrian Mineral Resources Plan (AUTMINPLAN) was prepared by the Minister of Economy which strives to achieve a broad consensus among the federal government, the federal states, and businesses for safeguarding the supply of mineral resources (RMIS). To ensure the responsible and secure supply of Austria with primary and secondary raw materials, the BMLRT prepared a basic paper which serves as a basis for an Austrian Mineral Resources Strategy 2030 (https://info.bml.gv.at/en).
Belgium	Flanders and Wallonia there are 30 acts/laws (EC DG GROW 2016) that covers the resource management. These decrees concern mining, concessions, minerals management & technical safety: -Flemish Decree on Surface Mineral Resources (04/04/2003) and amendments -Order of the Flemish Government laying down rules for the implementation of decree on surface mineral resources (VLAREOP) (26/03/2004) and amendments -Flemish Decree on Gravel (14/07/1993) and amendments More concrete vision is given in the "General Surface Mineral Resources Plan" ("AOD"). https://rmis.jrc.ec.europa.eu/uploads/legislation/MINLEX_CountryReport_BE_2019UPDATE.pdf.
Croatia	There are 110 acts/laws (EC DG GROW 2016) for resource management. It is prescribed by law that Croatia should have a national strategy on resource management. Croatian Geological Survey had been charged with the task of creating the strategy and has finished the draft version.
Cyprus	There are 25 acts/laws (EC DG GROW 2016) in the frame of resource management. GSD in collaboration with the Committee on Sustainable Development of Mineral Resources prepare the Study for the Strategy for Sustainable Quarrying and Mining development of Cyprus 2001- 2025 and 2025-2050 and updated recently for the period.
Czech Republic	National raw materials policy, and regional raw materials policies with 7 acts/laws (EC DG GROW 2016) for resource management covers the resource management. UNFC is addressed in yearbooks of Mineral Commodity Summaries of the Czech Republic.
Denmark	Resource management is governed by 30 act/laws (EC DG GROW 2016). Central Denmark Region has published the Sustainability Strategy 2030 for Central Denmark Region in 2021 that addresses raw materials and wastes in the mirror of the SDGs.
Estonia	There are 22 acts/laws for resource management (EC DG GROW 2016) and an important document is the General principles of Earth's crust policy until 2050. (https://envir.ee/media/907/download).
Finland	There are 19 acts/laws for resource management (EC DG GROW 2016). The strategic objectives of Finland's mineral strategy are solutions for global mineral chain challenges, promoting domestic GROWth and prosperity, and mitigating environmental impact. For more information: http://projects.gtk.fi/minerals_strategy/index.html.

Country	Brief description of resource management with reference on UNFC
France	There are 30 acts/laws for resource management (EC DG GROW 2016). Resources for France Plan (2018): Road map circular economy 2018 is a five-year planning policy designed to characterise and reduce the reliance on natural resources for production and growth. The policy is embedded in a 2015 national framework strategy „Energy transition for green growth law". It is also part of an effort to regulate and develop a circular economy (https://www.iea.org/.
Germany	There are 46 acts/laws for resource management (EC DG GROW 2016). Resource strategies exist on federal level and on the level of several German States (e.g. Saxony; Bavaria; Baden-Württemberg). Raw materials strategy of the Federal Government: Securing a sustainable supply of non-energy mineral raw materials for Germany is a framework policy first put in place in 2010 and last updated in 2019 (https://www.iea.org/policies).
Greece	There are 46 acts/laws for resource management (EC DG GROW 2016). The National Policy for the strategic planning and exploitation of the mineral resources, acknowledges the importance of the Mineral Raw Materials (MRM). The Ministry of Environment and Energy at national level and the 7 De-centralized Administrations and 13 Administrative Regions at regional, are the competent authorities for resource management. The Geological Survey (HSGME), acts as consultant, supervises, evaluates and conducts exploration work on public areas on behalf of the Ministry (https://mrmguide.eagme.gr/. UNFC classification is not addressed in the legislation enforce.
Hungary	There are 63 acts/laws for resource management (EC DG GROW 2016). Mineral resource management is based on the Mining Law (Act No. XLVIII. 1993 on Mining) and other related legislation on mining, environment, and land use planning. The National Sustainable Development Framework Strategy (2013) addresses raw materials. Energy raw materials are described in the Energy Mineral Resource Utilization and Resource Management Action Plan was published in 2017. UNFC is addressed is the legislation (https://net.jogtar.hu/jogszabaly?docid=a2200020.stf) and UNFC is integrated into the resource reporting form.
Ireland	There are 26 acts/laws for resource management (EC DG GROW 2016). The Government's policy is set out in the „Policy Statement on Mineral Exploration and Mining - Critical Raw Materials for the Circular Economy Transition" (2022). https://www.gov.ie/en/publication/3a2bb-policy-statement-on-mineral-exploration-and-mining/.
Italy	There are 96 acts/laws for resource management (EC DG GROW 2016). Regions have independent policies regarding resource management.
Nether-lands	There are 22 acts/laws for resource management (EC DG GROW 2016). There is a mining law, mainly concerning Oil, Gas and Geothermal Resources.
Norway	Mineral strategy regarding land-based mineral activities was published by the Norwegian Government on 21 of June 2023 with a goal of developing Norway's sustainable mineral industry. The strategy primarily focuses on critical and strategic metals and minerals, with a key emphasis on expediting Norwegian mining and mineral projects. It necessitates the Geological Survey of Norway to produce an inventory aligned with the United Nations Framework Classification for Resources (UNFC) (https://unece.org/media/news/380591) this way UNFC is addressed in the legislation.
Poland	There are 51 acts/laws for resource management (EC DG GROW 2016). On 1st March 2022 the Council of Ministers have adopted the National Raw Materials Policy to 2050. The document is a strategy for building an efficient and effective system for the management of all types of minerals and mineral resources along the value chain

Country	Brief description of resource management with reference on UNFC
	(https://www.gov.pl/web/climate/national-raw-materials-policy; Annex to Resolution No. 39 of the Council of Ministers of 1 March 2022 (item 371). The area of resources policy on resource management is within the scope of activity of the Ministry of the Environment. It is the body responsible for resource management in Poland – within the scope of management, concession issuing, etc. There are official bodies entitled to help the Ministry – one of them is Polish Geological Institute – National Research Institute. UNFC is addressed in annual yearbooks of Mineral Resources of Poland.
Portugal	There are 25 acts/laws for resource management (EC DG GROW 2016). Presidency of the Council of Ministers Resolution of the Council of Ministers No. 78/2012 approved the National Strategy for Geological Resources — Mineral Resources (https://www.ccdr-a.gov.pt/docs/desenv_regional/2014-2020/EstrategiaNacionalRecursosGeologicos.pdf).
Romania	There are 36 acts/laws for resource management (EC DG GROW 2016). The National Agency of Mineral Resources (NAMR) is responsible for data collection. Data on resources and reserves held by NAMR complies with the UNFC classification system. Since 1998, the UNFC classification system has been used in Romania. The Mining Law and the Norms for applying to resources/reserves evaluation - http://www.namr.ro/wp-content/uploads/2014/03/MLaw_85.pdf; http://www.namr.ro/wp-content/uploads/2014/03/MNorms1208.pdf
Serbia	There are 25 laws/decrees and 3 strategic documents presented on the webpage of the Ministry of Mining and Energy that is in charge of the operations of the State Administration related to mining, energy, and natural resources development (http://ems-undp.rs/en-us/Blog/LawsAndBylaws). Within each of these spheres and their specific resources, the Ministry creates the strategies and development policies, conducts the research about sustainable use of resources and their exploitation, deals in safety, monitoring and other operations as defined by the Law.
Slovakia	There are 63 acts/laws for resource management (EC DG GROW 2016). In Slovakia the legal framework relevant to minerals permitting comprises mainly the Mining Law and the Geological Law. National policies regarding the quality of resources (measured, indicated, inferred, prognostic resources).
Slovenia	There are 26 acts/laws for resource management (EC DG GROW 2016). National Mining Strategy (Mineral resources management) https://www.gov.si/assets/ministrstva/MzI/Energetika/Rudarstvo/Rud_Stat_final_2018.pdf .
Spain	There are 112 acts/laws for resource management (EC DG GROW 2016). Mining operations are governed by the Mining Law, in force since 1973 , . although there is a proposal to reform it, the draft of which has been submitted to public consultation for possible allegations. The 17 Spanish Autonomous Regions may enact additional mining rules. All mineral deposits and geological resources are public domain goods, thus mining activity can be performed by holding a permit or concession (RMIS). Mining operations are governed by the Mining Law. The 17 Spanish Autonomous Regions may enact additional mining rules. The Andalusia Mining Strategy 2013-20 was built in 2013. (https://www.oecd-ilibrary.org/sites/197f0fc0-en/index.html?itemId=/content/component/197f0fc0-en). On the other hand, the Government of the Principality of Asturias also presented the Raw Materials Strategy on 24 March 2023 (http://www.asturiasparticipa.es/wp-content/uploads/2023/04/EGSMP-PA-DOC-FINAL.pdf). In addition, Spain has approved in 2022 the Road Map for the sustainable management of mineral raw materials.

Country	Brief description of resource management with reference on UNFC
Sweden	There are 35 acts/laws for resource management (EC DG GROW 2016). Sweden's mineral strategy: https://www.government.se/reports/2013/06/swedens-minerals-strategy-for-sustainable-use-of-swedens-mineral-resources-that-creates-growth-throughout-the-country/ Mineral deposits of national interest: https://www.sgu.se/en/products/maps/map-viewer/bedrock-map-viewers/mineral-deposits-of-national-interest/
Switzer-land	The Swiss Geological Survey plans to have a strategy at federal level, but the 26 Swiss cantons are by law responsible for the underground resources within their Canton's boundaries. They have little influence on the cantons' strategies (if any) as there is no federal mining law regulating the management of mining activities (and reporting of Resources and Reserves)
Ukraine	The Law of Ukraine on the approval of the State-wide program for the development of the mineral and raw material base of Ukraine for the period until 2030. The national program for the development of the mineral and raw material base of Ukraine for the period up to 2030. The Law of Ukraine on Development of Mineral Resource Base adopted on 2012 (https://zakon.rada.gov.ua/laws/show/75-95-%D0%BF#Text....Ukrainian). Ukraine has mandated the use of the UNFC as the foundation of its national resource management based on UNFC-1997 approved by the regulation (Resolution 1997). On 19 September 2018, Ukraine amended its national classification (Resolution 1997) to be aligned with the latest version of UNFC. This amendment makes Ukraine's classification up-to-date with international standards and comparable globally (UNECE 2008). However, the UNFC is not yet applied in full to the materials inventory of the country.
United Kingdom	Supporting strategies exist (CM strategy, https://www.gov.uk/government/publications/uk-critical-mineral-strategy) but no formal strategy currently exists. Reports provided to UK Gov on UNFC and UNRMS as part of the CMIC program https://ukcmic.org/reports.html. In the UK Critical Raw Material Strategy (the Critical Raw Material Information Centre, CMIC, is hosted by BGS) following actions are planned: a preliminary national-scale assessment of the UK's geological potential for critical mineral extraction; in 2023, CMIC will begin a programme of public engagement on the importance of critical minerals; criticality assessment update to reflect the dynamic nature of global supply chains and mineral markets.

Source of the Minlex data (2017): based on data collected by this study available in the country reports. Note: between brackets and next to each MS appears the sum of the number of laws per category, i.e. the total number of laws per MS relevant for NEEI permitting procedures. Germany´s total number of laws is incomplete because, in terms of decentralised laws (laws of the federal states), it only includes the example of Mecklenburg-Western Pomerania. The UK includes laws for England, Wales, and Northern Ireland. (EC DG GROW 2016).

Annex 2. Summary on national and regional UNFC activities mainly by Geological Survey Organizations

In Albania in the Albanian Geological Surveys the UNFC activity for raw materials has just started within the GSEU project (there are other results for geothermal energy: https://unece.org/sed/documents/2023/04/presentations/albanias-geothermal-sector-case-study-unfc-and-unrms).

In Austria the Geological Survey of Austria (GBA, GeoSphere Austria since 2023) together with the Mining Department (Ministry of Finances) have applied UNFC to some Austrian deposits. A systematic, nationwide application of UNFC to aggregate resources is currently underway.

In Belgium, in the Geological Survey of Belgium only pilot study on phosphate was done for the GeoERA project.

In Croatia the experts from HGI-CGS are familiar with UNFC and UNRMS, but all activities related to them (including its translation to national language) are under the jurisdiction of the Ministry of Economy and Sustainable Development. In the Geological Survey of Croatia experts became acquainted with the UNFC classification relatively quickly after discussions began on the topic. Over the past few years, they have further educated themselves, studied, and discussed how to implement it in the Republic of Croatia. In the Mintell4EU project, they presented a case study related to a specific geographical area. In doing so, they used GIS tools to determine corresponding values. Subsequently, in 2022, guidelines for implementing UNFC were issued, which they also familiarized themselves with. However, they have not yet worked on specific examples. All of the aforementioned relates solely to the so-called preparation phase. Furthermore, the Ministry of Economy and Sustainable Development in Croatia is responsible for implementing such a classification system. Therefore, the conclusion is that Croatian experts are acquainted with UNFC, slowly preparing materials, but implementation is still relatively distant. The activity on an UNFC guidance preparation is traced back to the 5 years.

In Cyprus the GSD worked on the related data harmonization for 2 years, the time at which UNFC was implemented under the Mintell4EU project. GSD Officers are studying UNFC (2019) and UNFC and Guidance for Europe (2022). Through our participation in Mintell4EU we prepared the Cyprus mineral resource database based on UNFC. Our first contact with UNFC was the participation in the ORAMA project. Preliminary training of the GSD′s staff, Mine Service, Energy Service staff, will be carried out by a GSD Officer who participated in the "Resource Management Week 2023". For further training, entering in more detail, an expert will be invited.

In the Czech Republic some occasional activities were done since 2004, e.g., a project resulting in a submission of a CRIRSCO compatible system for Czech Republic was developed, but the system was never officially accepted. A study comparing the national stock assessment system with the PERC and JORC methodologies was reported in 2016. This activity does not lead to any official bridging or mapping document, neither to any official acceptation/adoption of UNFC to the Czech classification system. The plan for 2023 is to elaborate methodology of UNFC usage within the legislation framework of the Czech Republic. A group of experts is being currently set up under the auspices of the Ministry of Industry and Trade. This expert group will be trained in UNFC by experts of GTK Finland. Selected Czech experts will have experience in JORC/PERC reporting as well as the Czech national system (not CRISCO compatible). Following the UNFC training the group will elaborate the methodology of UNFC for Czechia.

Representatives of CGS are participating at the NoPE regular meetings. WP5 of ongoing Horizon EU project SEMACRET will apply UNFC on potential sources of strategic and critical raw materials of the orthomagmatic type of deposits (Cu, Ni, Co, PGE, V, Ti, Cr), CGS is leader of the WP5.

In Denmark, in the Geological Survey of Denmark experts have been working for the past 4 years mainly related to the GEOERA program, MINTEL4EU project.

In Finland, in the Geological Survey of Finland GTK experts have participated in/will participate in the preparation of the Guidance for the application of the UNFC-2009 for mineral resources in Finland, Norway and Sweden (2017), preparation of the UNFC Guidance for Europe (2022), the UNECE working groups (Minerals Working Group) related to UNFC, participation in EGRM (participation in Deploying UNFC in Europe Seminar). GTK experts actively participate in the Network of Practitioners Europe (NoPE). Translating the UNFC guidelines into Finnish is a work-in-progress. GTK experts provide external UNFC-training courses within Europe and participate also in FutuRaM and EIS projects for UNFC related topics.

In Germany BGR has been active since 1991, with interruptions and in different working groups. Working with UNFC in the BGR does not take place continuously. Continues work has been taking place for the last 5 years. While work on fossil fuels and mineral resources has been discontinued in the meantime, work has been done on injection and groundwater issues; other groups such as the Association of German Geologists are active in producing guidance documents. Following UNFC activities are identified in Germany: membership and activities within UNECE ERGM and NoPE; EU-funded projects i.e. GeoERA and FutuRaM; DE-translation of UNFC documents and development of guidance documents for application; preparation and conduction of internationals and national conferences and networking.

In Hungary the involvement in the UNECE EGRC (later on UNECE EGRM) can be traced back to the mid 1990's with effective contribution to the development of the UNFC and with many results and publications on the potential application of the UNFC on national level. Between 2012 and 2020 the modernization of the Mineral Resource Inventory (MRI) was performed, considering the national and international reporting standards (CRIRSCO type JORC, PERC, Australasian for geothermal and SPE-PRMS for hydrocarbons) and UNFC. Based on the results, as well as on the case studies and other related publications, the government decree on the implementation of the Mining Act was supplemented in 2020, in order to meet the requirements for an up-to-date classification of mineral resources. The supplementation contains clear description of resource and reserve categories based on CRIRSCO terms and UNFC categories but also considering the traditional Hungarian classification system.

A so-called bridging document as a special volume of the Hungarian Geological Society was published in Hungarian with English summary in 2016. An English version of an individual Bridging Document is in progress. Changes are made according to the national and international project experience. The finalization of the Bridging Document will probably be done during the lifetime of the GSEU project, based on comparison between the UNFC Guidance for Europe (2022) and the Hungarian classification, reporting and handling of the Mineral Resource Inventory and the Register of Mining Areas, considering GSEU experience too. SARA expert was involvement in the UNECE EGRM and there is an active expert in the NoPE. UNFC (2019) in Hungarian was published on the UNECE webpage. The translation of the UNFC Guidance Europe by the UNECE into Hungarian is in progress. Based on it the aim is to develop a national guidance to apply UNFC in accordance with the national law that addresses UNFC. This way the mineral resource inventory can be developed.

In Ireland, in the Geological Survey of Ireland has been dealing with UNFC since it became a topic of interest at EGS (2015). An initial plan for GSI to develop UNFC guidelines particularly for mine waste.

In Italy, in the Geological Survey of Italy the UNFC activity has started in 2022 and ISPRA is involved in the Geological Service for Europe even dealing with UNFC classification and UNRMS issues.

In the Netherlands, in the Geological Survey of the Netherlands there is no activity with UNFC for CRM. In relation to geothermal energy there is UNFC activity (case study on Rotliegend-3 Geothermal Project, UNECE, 2017).

In Norway the Geological Survey of Norway started working with UNFC in 2016 and has since then participated in several projects and initiatives. NGU published a Nordic guidance together with GTK, SGU and SweMin in 2017: Geological Surveys of Finland, Norway, and Sweden and SweMin. (2017). Guidance for the Application of the United Nations Framework Classification for Resources (UNFC) for Mineral Resources in Finland, Norway, and Sweden. NGU participated in ORAMA and contributed with several case studies. In Mintell4EU, NGU headed the work package in on UNFC. Several UNFC case studies have been made with various Norwegian mineral resources. A case on the Norwegian Graphite resources have been reviewed by UNECE . The Norwegian Petroleum Directorate has been working with UNFC applied to petroleum resources since 2004/2005. In 2020, as the part of Mintell4EU project UNFC was tested and applied on all graphite deposits, phosphate deposits, and aggregates in Norway. An UNFC on Natural Stone was performed as a part of Eurolithos. The UNFC coding was applied on the Bjerkreim-Sokndal deposit (P-Fe-Ti -V) and the Forsand gravel deposit during the ORAMA project in 2019. Recent and future activities include implementation and classification of UNFC on both primary and secondary resources, including CRMs.

In Poland since 1990s UNFC activity has been in operation. Polish representatives were active and made substantive contributions to all efforts regarding mapping of the UNFC and the Polish national system of resources classification. The latest mapping of the UNFC 2019 and the Polish system was presented in the publication "Mineral Resources of Poland" available at http://geoportal.pgi.gov.pl/surowce/mineral_resources_of_poland.

In Portugal, in the National Laboratory of Energy and Geology (LNEG) has been working with UNFC for the last 25 years. With the aim of systematizing the study of national mineral resources, the Information System of Occurrences and Portuguese Mineral Resources – SIORMINP was created in 1997. Between 1997 and 2002 according to the UNFC (1997) was used for the development of the SIORMINP including 2,292 mineral occurrence, identified resources and reserves. Regarding recent and future UNFC activities the aim is to convert to UNFC the data on CRM deposits/occurrences- The Portuguese Institute for the Sea and Atmosphere (IPMA) is active in the GSEU project T2.4. UNFC Task and the contribution of the IPMA regarding the development of UNFC for offshore areas is important.

In Romania, in the Geological Institute of Romania recently there is no specification for UNFC activity. The National Agency of Mineral Resources (NAMR) (www.namr.ro) is responsible for data collection. Data on resources and reserves held by NAMR complies with the UNFC classification system. Since 1998, the UNFC classification system has been used in Romania. Prior to this and in older publications/reports a national classification system similar to other 'Eastern Europe' systems was used. According to the Mining Law nr. 85 2003, NAMR issued technical instructions regarding the classification

of reserves into categories based on grade and other economic criteria. In addition to collecting mineral resources and reserves statistical data, NAMR also has other relevant data in the form of a mineral occurrence database, mines and quarries information and mineral resource maps. All mineral licence holders have a statutory obligation to report on their production, exploration results, changes in resources/reserves (using the UNFC classification system) and the quality characteristics of the mined/explored resources, for all commodities, on an annual basis. The reporting takes the form of reports (data sheets), supplemented by other data sets/information (explanatory notes) (https://ec.europa.eu/assets/jrc/minventory/country-summariesfe99.html?country=Romania).

The National Agency for Mineral Resources is the entity in charge of validation of reserves/resources evaluated for different perimeters (during permitting/licencing operations), also in charge and issuer for guidance preparation – already in operation since 1998 (reviewed in 2008) and for technical instruction no. 85 08/1998 Classification and evaluation of mineral resources/reserves of solid mineral substances. The role of bridging / liaison between the regulatory area and the actors in the mining area is related to the Ministry of Economy.

In Serbia, the Geological Survey of Serbia has been working with UNFC since 2015. One of the colleagues is involved in the Network of Practitioners Europe. Also there is a pilot project regarding correlation between UNFC and National Code for resource and reserve reporting.

In Slovenia, the Geological Survey of Slovenia (GeoZS) experts have been engaged from the very beginning of the development of the UNFC in the UNECE. (Few of them were amongst initiators). Based on many data UNFC data harmonization and case studies bridging documents are under preparation. GeoZS experts participate in NoPE as national members. The UNFC "manual"/ guidance is in translation into Slovenian language.

In Spain, the Geological Survey of Spain (IGME-CSIC) has been working with UNFC and data harmonization of CRM since XXX, 2017 within the framework of the ORAMA project and in collaboration with the BGS a case study was developed for countries without a national reporting code titled 'Technical Guidance Note worked example for conversion of Spanish copper resource data to UNFC'. In 2018 we also participated in the MINTELL4EU project. After that, in 2021 we joined the Network of Practitioner – Europe. And finally, Right now we also collaborate with the Ministry for the Ecological Transition to complete and classify the EU database of CRM Project according to UNFC.

In Sweden, the Geological Survey of Sweden has been working with UNFC and the related data harmonization since 2015, but first draft of guidance document was available from 2017 (Lax et al, 2017) and approved by the UNECE EGRM in 2018. The UNFC activity in the SGU is focused on case studies based on Mintell4EU, secondary resources (mapping selected secondary resources and designing a database prototype that will be tested) based on a government assignment to SGU and the Swedish Environmental Protection Agency, involvement in the NoPE and work in the GSEU.

In Switzerland, in the Swiss Geological Survey according to the lack of prospect of CRM extraction there are no official UNFC activities are planned, but SwissTopo is involvement in UNFC related tasks within the GSEU project. The maintenance of the UNFC development in other countries that have similar situation with UNFC can contribute to further UNFC development in Switzerland.

In Ukraine, the Geoinform of Ukraine and other relevant organizations has been working with UNFC since 1997 after adoption in Ukraine the Resolution 432 which introduced the National Classification

based on UNFC. However, only in 2011 State Inventory of Mineral Resources of oil and gas was finally bridged to UNFC. Inventory of solid minerals and water are still conducted in Soviet classification. It is planned to bridge Inventory of solid minerals into National Classification based on UNFC in current year. The aim of the Geoinform is to bridge CRM reserves and resources estimated under soviet classification into UNFC, since 1997 all deposits are estimated under UNFC. DKZ has developed appropriate bridging document. The vision is to develop web interface which enables to get all available information about reserve and resources of the deposits, such as protocols, geological reports, licensing information, available geospatial data of the deposits, land plots, national reserves, and parks in one place. This web interface will be comfortable tool for DKZ employee to bridge about 3500 deposits of solid minerals and create final document as a result. Main tasks are: 1. Bringing the amount of reserves and resources of solid minerals, underground water, therapeutic mud, and brine into compliance with the Classification of reserves and resources of minerals of the State Subsoil Fund of objects that are accounted for by the State Inventory and are not provided for use. 2. Formation in the State Balance and State Water Cadastre databases of information on reserves and resources of mineral deposits in accordance with the Classification of Mineral Reserves and Resources of the State Subsoil Fund and the mineral classifier, which corresponds to the Resolution of the Cabinet of Ministers of Ukraine dated 12.12.1994 No. 827. 3. Creation of a list of deposits of solid minerals (metallic, non-metallic, solid fuels) registered by the State Inventory that cannot be developed due to their location in nature protection, water protection zones, sanitary zones, under construction areas, etc., with the aim of transferring their reserves (resources) to categories (classes) corresponding to the level of economic, social and industrial importance (axis E) and categories according to the degree of technical and economic study and readiness for development (axis F) of the real state of such objects.

In the United Kingdom, the British Geological Survey has been using UNFC actively for minerals since 2018 (during the H2020 ORAMA project) prior to this the classification was known of but not actively used. No other government agencies have been using UNFC in the UK with regard minerals BGS also has some experience with UNFC for carbon capture and storage and academic institutes in the UK lead on UNFC for anthropogenic resources (principally University College London and also renewable energy. BGS was WP leader on ORAMA, and is represented in the NoPE. BGS has committed to using UNFC for any future resource inventory that will be produced.

Annex 3. Direct and indirect involvement of GSOs in the CRM data provision to the EC DG GROW

Country	Answer
Albania	**In Albania** the Albanian Geological Survey (AGS) and the National Agency of Natural Resources (AKBN) contribute to the data provision depending on the Ministry of Infrastructure and Energy (MIE). AGS is a government agency that supervises and monitors the use of natural resources in Albania. Its purpose is to maintain the interests of the State in the fields of hydrocarbons, minerals, and energy. The agency oversees the development and rational use of natural resources and monitors their post-use. MIE is a department of the Albanian Government, responsible for national climate policy and international cooperation on climate change, as well as energy issues, meteorology and national geological surveys, electricity, water, wastewater services and industry in Albania.
Austria	In Austria the Mining Department (Bereich Bergbau) is currently part of the Ministry of Finance (https://www.bmf.gv.at/themen/bergbau.html). The Mining Department consists of 6 units including the "Montanbehörde" which is responsible for exploration and mining licences. In addition, there is the unit of "Mineralrohstoffpolitik" ("Mineral politics"). This unit is the main point of contact to the GeoSphere Austria regarding issues related to mineral raw materials research and mineral potential analyses. This unit also publishes the annual reports of mineral production in Austria as well as the "World Mining Data" compilations. The unit of "Mineral politics" of the Mining Department in the Ministry of Finance provides the representation of Austria in DG GROW and other European organizations such as the RMSG. The (historic) resource data regarding Austrian mineral deposits are held by this unit in particular in cases where such data are not publicly available due to private company interests. All public information regarding mineral occurrences and deposits are presented on the GeoSphere Austria homepage in the IRIS (interactive raw material information system): iris.geologie.ac.at. This is also the primary source for all reporting into EDGI and other EU wide data bases such as Min4EU. However, data input for the RMSG CRM database is handled by the Mineralrohstoffpolitik unit.
Belgium	In Belgium the Geological Survey of Belgium provides raw materials data through EGS. The Government of Flanders - Department of Environment & Spatial Development participates in the Raw Materials Supply Group, and also gives advice to the Minister responsible for raw materials. Team Geology and Environment of the Flemish Department of Environment & Spatial Development collects the CRM data for Flanders and provides this directly to the RMSG. Flanders will also be responsible for the exploration plan for Flanders of the CRMA when the Act is published.
Croatia	In Croatia employees at the Ministry of Economy and Sustainable Development have been made contacts to the EC DG GROW RMSG. They deliver data directly to RMSG on demand. HGI-CGS does not serve data to RMSG, or data to the Ministry to serve to RMSG. Raw materials data provider organizations have a good cooperation with the Sector for Mining of the Ministry for Economy and Sustainable Development. HGI-CGS has a good cooperation with the Sector for Mining as well, and interacts with it often, mostly in relation to technical reports and data exchange.
Cyprus	In Cyprus the Ministry of Agriculture, Rural Development and Environment will decide on the organization that would contribute to the CRM data service to the EC DG GROW. At the moment the GSO is studying the UNFC and will train the stakeholders. Based on the exploration licenses the raw materials data provider is obliged to summit to the supervisory authority the data. In 2022 the data providers are asked to classify the data based on UNFC classification system.

Country	Answer
Czech Republic	In the Czech Republic the Czech Geological Survey (CGS) works as the state geological survey (SGS) and performs related tasks as authorized by the Ministry of the Environment (MoE) by virtue of Act No. 62/1988, on geological work. An important task with regards to the mineral resource management and resource classification is the fulfilling the duties of an organization charged with safeguarding and inventorying of unexploited reserved mineral deposits and management of an inventory of reserves of reserved mineral deposits by virtue of Act No. 44/1988, on the protection and use of mineral resources (Mining Act), and management of the inventory of prognostic mineral resources according to Act No. 62/1988, on geological work. Some form of data (mostly aggregated) and/or if there is not/was not exploration/mining license of the private company at the deposit can be provided upon the official agreement of the Ministry of the Environment. As was probably the case of previous projects like Mintell4EU, GeoERA etc. The data from these previous projects were provided by the INSPIRE system to EGDI.
Denmark	In Denmark, for Greenland, there is a close cooperation between GEUS (The geological survey of Denmark and Greenland) and the Ministry of Mineral Resources of the Government of Greenland (MMR). GEUS is the national geological data centre and MMR is responsible for the management of raw materials in Greenland (licensing etc.).
Estonia	In Estonia the supervisory authority is the Ministry of the Environment. Environmental Board is directly responsible for collecting production data. Land Board is collecting production data from Environmental Board and exploration reports from companies. All reports end up at the repository of Geological Survey of Estonia.
Finland	In Finland the data provider organisation TUKES (Finnish Safety and Chemicals Agency) operates under several Ministries, the Ministry of Economic Affairs and Employment being in charge of the ministerial governance and supervision. In addition, the Ministry of Economic Affairs and Employment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the Ministry of the Interior, the Ministry of Social Affairs and Health, and the Ministry of the Environment collaborate to contribute to the governance in their respective sphere of operations. Data collection on primary raw material resources and reserves is accomplished by the TUKES. However, the GTK is responsible for data on all primary raw materials (Construction, Industrial and Metallic minerals). GTK is responsible for reporting the data to DG GROW.
France	In France the Ministry of the ecological transition and of the cohesion of territories mandated the BRGM to collect and provide the data.
Germany	In Germany a strong connection towards DG GROW is already established and data that can be shared has been made available. Data collection for raw materials varies within Germany and depends on the mineral resources considered; in some German States the task is with the mining authority (e.g. Saxony; Lower Saxony), in some cases it is with the Geological Survey of the State (e.g. Baden-Württemberg) or with the Ministry of Environment and subordinated Agencies (e.g. Hesse), for Bavaria: Bavarian Environment Agency / Bavarian Geological Survey.
Greece	In Greece the HSGME (Geological Survey) reports directly to the YPEN (Ministry of Environment and Energy). The latter is entitled to report to the EC DG GROW. Representatives from both the organizations participate in the relevant WG of the EU on CRMs.
Hungary	In Hungary experts of the SARA and its predecessors have been involved in the EC DG RMSG since the last decade. There is also a representation of the Ministry of Energy Affairs from the past years. This direct contact between the EC DG GROW RMSG and the Ministry and the SARA allows operative work.
Ireland	In Ireland the Geological Survey Ireland is a line division of the government parallel with the regulatory office who are responsible for mining and RMSG.
Italy	In Italy ISPRA usually collects data and delivers them to the EC DG Grow RMSG.

Country	Answer
Netherlands	In the Netherlands from TNO- Geological Survey of the Netherlands no formal relation has been established regarding raw materials.
Norway	In Norway NGU is a public agency under the Ministry of Trade, Industry and Fisheries (NFD) and report to the ministry. The Ministry of Trade, Industry and Fisheries has a dedicated person in Raw Materials Supply Group as does the Confederation of Norwegian Industries. NGU serve data to EDGI.
Poland	In Poland PGI-NRI is not directly involved in the CRM data service to the EC DG GROW.
Portugal	In Portugal LNEG reports directly to the Ministry of Environment and Climate Action.
Romania	In Romania the Geological Institution of Romania doesn't play role in the CRM data provision to the EC DG GROW. The only way we communicate this information are through EGS.
Serbia	In Serbia the Geological Survey of Serbia as data provider working under supervision of Ministry of Mining and Energy.
Slovakia	In Slovakia the Geological Survey (Štátny geologický ústav Dionýza Štúra) is responsible for reporting deposit reserves and mining to Ministry of Environment, but decision-making and licensing authority on mining is Ministry of Economy. Štátny geologický ústav Dionýza Štúra is making advisory services for both Ministries when asked.
Slovenia	Geological Survey of Slovenia performs Mining public service for the ministry, responsible for mining. In this framework GeoZS collects and manages data on all mining sites. GeoZS also represents Slovenia in RMSG and reports to the relevant ministry.
Spain	In Spain the IGME is involved directly to the CRM data provision and update to the EC GD GROW
Sweden	In Sweden the SGU oversees activities conducted by raw materials data provider organizations. Data from raw materials data provider organizations are handed over to the Statistics Sweden (SCB) and SGU uses the national SCB database. SGU provided a list of ongoing CRM projects in Sweden to RMSG.
Switzerland	In Switzerland CRM data provision to the EC DG GROW is not applicable.
Ukraine	In Ukraine the Ukrainian Geological Survey (UGS) coordinates its activities through Minister of Environmental Protection and Resources of Ukraine. Geoinform of Ukraine it is a part of UGS, which conducts accounting of reserves and resources, is a repository of geological reports, conducts license data base. The Ukrainian Geological Survey is officially in charge of all processes respecting CRM.
United Kingdom	In the United Kingdom the CRM data provision to the EC DG GROW is not a relevant topic due to the post Brexit state of the UK, however the BGS does still supply data when appropriate to European data platforms (and does to EGDI). Through the CMIC there are regular briefing meetings and data requests, including ad-hoc and planned delivery of data.

Annex 4. UNFC E, F and G category data availability and missing data at GSEU partners

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
Austria (GBA-GeoSphere)	Regarding active projects and projects being evaluated or developed: The Mining Authority (Ministry of Finances) holds all necessary information for the derivation of the E category of primary mineral resources (such as permit applications, economic feasibility studies, environmental impact assessments, information on stakeholder involvement, mining and exploration licenses; online map viewer BergIS (https://bergis.rmdatacloud.com/Start). None of this information is shared, apart from the location commodity of active exploration or mining areas e.g. with GeoSphere Austria (former Geological Survey). For each polygon, commodity type and surface area are given. For former projects: Former mining areas do not appear in the Mining Department's online map viewer BergIS. Closed, abandoned or historic mining sites and all documents made available to GeoSphere Austria during the permitting procedures at the time,	Regarding active projects and projects being evaluated or developed: Mining operational plans and technical feasibility studies are made available to GeoSphere Austria in the course of permitting procedures and are to be treated as *confidential*. The Mining Authority (Ministry of Finances) holds all necessary information for the derivation of the F category of primary mineral resources. Mining operational plans and technical feasibility studies are made available to GeoSphere Austria in the course of permitting procedures, albeit only at the final stage when technical feasibility is given.	Regarding active projects and projects being evaluated or developed: Some exploration data (drillings, samples, lab analyses) and geological descriptions of the deposits are made available to GeoSphere Austria in the course of permitting procedures i.e. when exploration is completed, and are to be treated as *confidential*. Geo-statistical information is not made available. Grades, tonnages or volumes of resources rest with the Mining Authority and are not shared. The Mining Authority (Ministry of Finances) holds all necessary information for the derivation of the G category of primary mineral resources. Grades, tonnages or volumes of resources as well as the certainty associated with these numbers, rest with the Mining Authority and are not shared. However, geo-statistical information is not made available, which rules out the	E category: The Austrian national mineral resource classification system (G 1050) contains three classes of economic feasibility (economically feasible / potentially feasible / unassessed) and three classes of 'mineability' (occurrence is mineable / not currently mineable / unassessed considering technical, socio-economic and legal aspects). Unfortunately, the E category of UNFC cannot be directly derived from this because these classes mix aspects of the E and F axes. Missing data for E and F categories: For secondary mineral resource (mining waste) classification, no information exists at the Mining Authority or at GeoSphere to derive the E category. Missing data for G category: The Austrian national mineral resource classification system (G 1050) contains five classes of

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
	are kept in archives and in a mining sites database at GeoSphere for internal use. Data which can be made public (location, commodity type, relative size based on production) are shown on GeoSphere's online map viewer IRIS (https://iris.geologie.ac.at). Grades, tonnages, volumes are sometimes published in scientific literature or mentioned on web sites.		derivation of the G category by GeoSphere Austria. At GeoSphere Austria, an inventory of waste deposits from historic metal mines exists which contains information on location, time of operation, commodities, minerals, adits, shafts, size & location of waste heaps and for some sites even chemical analyses. However, data is too sparse to derive the G category. For potential sources: GeoSphere Austria has carried out regional studies on the general resource potential of some commodities / areas. These studies do not reach the same level of detail as predictive maps but constitute assessments based on geophysical and geochemical surveys, on geological maps and on compiled information of active and previously active mine sites. The studies do not allow the quantification of grades, tonnages or volumes of deposits. The studies do not facilitate the classification of E and F categories apart from	geological confidence (estimates of quantity are reliable / preliminary / tentative). This may enable the development of bridging guidelines to the G axis of UNFC. Classification results of Austrian mineral resources according to G 1050 rest with the Mining Authority and are not shared. For secondary mineral resource (mining waste) classification, no information exists at the Mining Authority or at GeoSphere to derive the F category.

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
			sand and gravel deposits where environmental, social, economic and technical aspects can be assessed in principle using spatial plans and land use data, as well as information from former pit operations.	
Belgium (VPO)	Data provider = VPO (Flemish Planning Bureau for the Environment and Spatial Development) DOV = Database of the Subsurface of Flanders Exploration areas and occurrence of primary raw materials in Flanders: - Delfstoffenverkenner: https://www.dov.vlaanderen.be/portaal/?module=public-delfstoffen (voxel models of coarse sand, gravel and loam), also in the DOV explorer - Delfstoffentoets in the DOV-explorer https://www.dov.vlaanderen.be/portaal/?module=verkenner (under tab "Delfstoffen"), for example: Polderklei https://www.dov.vlaanderen.be/portaal/?module=verkenner&bm=39323823-d944-4d49-ba68-3935d3afb8dc	See E: information on percentage primary raw material, cover, etc. is stored in the voxel models.	See E: a volume calculation can be performed with the voxel models.	Voxel models are not available for all primary raw materials. G category: reserve data is known for areas designated for primary raw material extraction (in spatial planning documents). For now not published online, but this is work-in-progress

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
	Active quarries: https://www.dov.vlaanderen.be/page/ontginningenatlas Metadata on all these models/maps on https://www.dov.vlaanderen.be/geonetwork/srv/dut/catalog.search#/home (for example: Polderklei https://www.dov.vlaanderen.be/geonetwork/srv/dut/catalog.search#/metadata/97c48572-1aba-476f-99db-bd6729d0099f)			
Czech Republic (CGS)	Spatial data with basic information about type of commodity/ies, rights holder, status (active/non-active) is accessible through Raw Materials Information System (SurIS) managed by Czech Geological Survey. https://mapy.geology.cz/suris/# The SurIS is connected to the database which contains following sub-registers that are continuously updated: - Exploration Areas: o valid Exploration Areas, o Exploration Areas up to 1 year after expiration, - Mineral deposits: o Reserved mineral deposits (sub-register B),	There are no obligations to provide feasibility or pre-feasibility studies. However, for mining permit it is necessary to deliver Technical Operational Plan (TOP) which is evaluated/approved by relevant Regional Mining Authority. Some information to the F category is available within the documentation for EIA (if relevant) and are available on EIA portal (publicly available): https://portal.cenia.cz/eiasea/view/eia100_cr	Sectoral statistical survey on resources and reserves run every year that should be delivered by organizations operating on deposit (exploration, mining, or even non-active projects). The survey is managed by the Czech Geological Survey (on behalf of the Ministry of Environment) that is responsible for data collection and processing into the state database – "Balance/records of reserves of reserved deposits of the Czech Republic" and "Records of reserves of (non-reserved) mineral deposits of the Czech Republic". Availability of both records is, however,	E category: Only aggregated data could be published for many commodities with active operations as data on resources and reserves are *confidential*. Probably some historical estimates would be possible to publish (e.g., closed mines for metallic ores). For individual mineral deposits where there is currently some organization operating would be possible to state what kind of classes are there but without numbers (e.g. deposit XY: commodity – feldspar UNFC classes 111-342) Valid also for F and G category.

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
	o Non-reserved mineral deposits (sub-register D), o Other unregistered mineral resources (sub-register N), o Approved prognostic resources of reserved minerals (sub-register P), o Approved prognostic resources of non-reserved mineral (sub-register R), o Other registered prognostic resources (sub-register Q), o Areas with negative exploration result and mineral occurrences (sub-register V), o Cancelled and exhausted objects (sub-registers Z, U), - Protected Areas for special intervention in the Earth´s crust, - Protected Mineral Deposits Areas, - Prior approval of the Ministry of Environment for mining lease (Mining Area), - Mining Areas (mining lease): o active Mining Areas o non-active Mining Areas o cancelled Mining Areas Some information to the E category with respect to the EIA approval status (if relevant) are available on EIA portal (publicly available):		restricted only to limited group of state administration. Aggregated data per commodity is published every year as ""Mineral Commodity Summaries of the Czech Republic" that is publicly available on CGS website in Czech and English with delay. E.g. 2021 data were published at beginning of 2023.	<u>Missing data for E category</u>: Within SurIS only very basic information could be found. And there is the link to the report in ASGI database (exploration reports). These reports are stored at CGS – Geofond. However, these data cannot be disclosed, only after the disclosure restriction time is over (max. 7 years after delivery to Geofond). Some uncertainties are with data on non-reserved mineral deposits. Even CGS has some data from statistical surveys, the validity of information should be done with relevant Regional Mining Authority (who issue the permit) and the Building Authority (who issues land use decision) Valid also for F and G category. <u>Missing data for F category</u>: TOP documents are classified – only if the company itself publish something it can be used publicly.

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
Croatia (HGI-CGS)	All relevant data/documents are contained at the Ministry of Economy and Sustainable Development: - Report and confirmation of reserves - Conceptual mining project - Environmental impact study - Study on Natura 2000 - Spatial plans harmonization study - Parts of feasibility study Environmental impact studies should contain assessments of social, environmental and economic impacts of the project and if the procedure is done correctly there should be no missing data.	Investors finance and keep feasibility studies. Main Mining Project is archived at the Ministry of Economy and Sustainable Development. It can contain parts of the feasibility study. The investor is not obliged to prepare the feasibility study as a separate document in the Republic of Croatia. Feasibility studies containing crediting and financing conditions are internal documents of investors that are often difficult to access. However, many investors, especially international ones, prepare such documents in the form of their internal ones. Parts of feasibility studies (but not all) are often included in major mining projects. It is believed that the F category also includes the resolution of property-legal relations, which are integral parts of the main mining	Mineral resource inventory and geological potential studies for counties, as well as archival data such as elaborates, studies, reports.	<u>E and F categories</u>: Concerning prospective prospects there is insufficient basis for making conclusions regarding spatial planning, environmental, social and economic point of views. <u>Missing data for G category</u>: Regarding G4 geological potential studies have not been prepared for all counties. So far, they have been completed only for 14 out of 21 counties. Also, the contents of the studies are not mutually compatible due to the changes in standards over the time they were created (20 years). Geological, geophysical and other earth scientific survey project results, as well as archive data may not fit recent standards, and should be used cautiously. Database is not aligned with the INSPIRE directive. HGI-CGS database on deposits and occurrences should be

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
		project, and must be resolved before the concession is issued.		updated with precise data on size, shape, etc.
Cyprus (GSD)	<u>For known sources</u>: Cyprus carries out geological surveys for possible future quarrying and mining areas. It faces social problems i.e., strong opposition from the residents of these areas, as well as reactions from environmental organizations and from areas close to Natura 2000. The GSD's and Mine Services GIS databases include the applications (and licensing) of quarries, mines and prospecting permits. There are old, printed GSD's exploration records for mining areas. Additionally, GSD has a report of abandoned mines and mines waste. Furthermore, GSD prepares Exploration Reports. Mine Services has data regarding restorations of closed quarries. <u>For potential sources</u>: Some companies, in their exploration's reports, don't include any information on environmental, social and economic perspectives.	<u>For known sources</u>: Cyprus is preparing techno-economic studies and making documentation of viability of the areas referred to E and based on the calculation and quality of reserves. The Feasibility and Techno-economic Studies are carried out for documentation of viability of the study areas. <u>For potential sources</u>: More detailed techno-economic studies / viability studies are needed, prior of the application for mining permit, face serious problems to obtain finance.	<u>For known sources</u>: Reserves are calculated from quantities extracted from boreholes. <u>For potential sources</u>: At the moment there are only speculations particularly for deep deposits. The Geological Survey Department completed a study which includes quantities of all the mining waste. The information regarding the resources and reserve are taken from the projects.	In the future the implementation of the UNFC will be reported according to the UNFC guidance for Europe and the results of the GSEU project. Also, the stakeholders will be informed about the UNFC. <u>Missing data for E category</u>: The Databases of the last year need to get updated. The reason why the databases are not uploaded is due to the fact that there are some technical problems (except the information from Mintell4EU project). <u>Missing data for F category</u>: There are some companies which they don't make any feasibility studies for some projects. For the F category the implementation of Financial standards / Financial reporting in the mining industry may be necessary.

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
				<u>Missing data for G category:</u> There are no information for some recent projects which have not been completed and stakeholders who have not submitted project report. For G4 category based on the lack of direct evidence, an estimation of qualities and quantities is not suitable and/or potentially misleading in mineral exploration. In such a case data from old GSD's explorations projects reports are taken and recent geophysical exploration projects.
Greece (HSGME)	Important data sources for this type of data are the mining companies' reports. The concerned authorities (Ministry and Regional authorities) have access to these data. There are issues with availability of relevant information for reasons of confidentiality. The same reasons of confidentiality apply to on going exploration projects and mining projects conducted by either the HSGME or private companies.	Important data sources for this type of data are the mining companies' reports. The concerned authorities (Ministry and Regional authorities) have access to these data. There are issues with availability of relevant information for reasons of confidentiality. The same reasons of confidentiality apply to on going exploration projects and mining projects conducted by either the HSGME or private companies.	Important data sources for this type of data are the mining companies' reports. The concerned authorities (Ministry and Regional authorities) have access to these data. There are issues with availability of relevant information for reasons of confidentiality. The same reasons of confidentiality apply to on going exploration projects and mining projects conducted by either the HSGME or private companies.	The UNFC classification system has not been applied yet in Greece and stakeholders are not thoroughly informed and trained. Therefore it is difficult at this point to fully assess the availability of necessary data. Moreover, a part of available data for all UNFC categories are confidential (e.g. regarding on going mining projects) and therefore their availability is questionable.

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
Finland (GTK)	Important data source: mining and exploration company public reporting. Mining Registry has up-to-date status of permitting with regards to each project. There are no major issues with availability of relevant information regarding E- and F-axis classification of projects. Projects that are no longer active / have no active project holder (=non-viable) are downgraded to "lower" classes.	Important data source: mining and exploration company public reporting. Mining Registry has up-to-date status of permitting with regards to each project. There are no major issues with availability of relevant information regarding E- and F-axis classification of projects. Projects that are no longer active / have no active project holder (=non-viable) are downgraded to "lower" classes.	Most mining and exploration companies use CRIRSCO-compliant reporting, allowing easy bridging into UNFC in most cases. There is a methodology for case specific classification of historic or non-compliant resources according to UNFC (only categories 3 and 4 in the G-axis).	
Hungary (SARA)	For known resources: Inventory of mining areas where data can be found for exploration areas and mines with permissions (Technical Operational Plans: TOP) and mine plots and on other mining activities (extraction, suspension, closure). With more details: The State Geological, Geophysical and Mining Data Store (e.g. original exploration reports). Basically there is no missing data types at SARA. At most contact is necessary to environmental authorities or to municipalities in some specific cases (complex cases, results of public	For known resources: Inventory of mining areas (see E category especially regarding TOPs). The State Geological, Geophysical and Mining Data Store (incl. exploration reports and other documents of geoscientific survey). Basically there is no missing data types at SARA. At most contact is necessary to environmental authorities or to municipalities in some specific cases (complex cases, results of public hearing/SLO) or	For known resources: Mineral resource inventory with resources and reserve data, and project results on potential assessments (predictive mapping with prognostic resources). Basically there is no missing basic data types at SARA, although archive data may not fit recent standards, and should be used carefully. For potential sources: geological research and exploration reports.	Inventory of mining areas (BATER) data (permitting stages, licenses for TOPs can be used for E and F category (further improvements according to the UNFC Guidance for Europe and GSEU project results will facilitate the updated national level guidance for UNFC). G category: For G4 geoscientific project results (predictive mapping: officially not submitted exploration reports and studies) may be used (internal identification of projects).

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
	hearing/SLO) or internet search are solutions (e.g. for feasibility studies).	internet search are solutions (e.g. for feasibility studies). In some specific cases internet search is a solution (e.g. for feasibility studies).	Secondary resources: The Inventory for Closed Mine Waste Facilities contains data for heaps and tailings from environmental point of view but the based on the development of the data base raw material and geochemical data can also be found that is suitable for preliminary estimation of potential resources. The Registry of Mineral Resources also contains data for the volume of available resources in heaps and tailings.	Missing data for primary resources (potential resources): E,F: There is insufficient basis for concluding on reasonable prospects from environmental, social and economic point of views. Missing data for secondary resources: regarding G category not all heaps and tailing have proper quality data that limits resource estimation. Regarding the E and F categories recently the number of feasibility studies is negligible, and environmental permits are handled by environmental authorities.
Italy (ISPRA)	Prospecting and exploration of mineral deposits require a license according to the Title II (Mines) – Chapter I (Mining explorations) of Royal Decree 1443/1927, to the Presidential Decree 620/1955 (competences decentralization concerning the release of concessions on mineral oils and liquefied petroleum gases) and to the Presidential Decree 382/1994 (permits and concessions). Thus,	Considering the Italian mineral data fragmentation, the Geological Survey of Italy (ISPRA) is building a Geological, Mining, Museum and Environmental Database (DB GeMMA, prototype) to collect all relevant information from national and regional/provincial public and private sources.	Database of Mining Sites (not updated) is INSPIRE compliant. The structure of this Db is based on that of the MINE4EU Project. With the funding of the New National Mining Map resources and reserves will be assessed and/or updated (in a long-term vision).	Italy has no legislation that takes into consideration the UNFC classification; every region decides how to classify raw materials.

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
	the research and the extraction operations can be performed only having an official permit. In regions with ordinary statute these permits are released by the Ministry of enterprises and made in Italy (MIMIT) while in regions with special statute, these procedures are released by the competent local offices. The exploration permit cannot be extended for more than three years and cannot be made over without the official authorization of the Ministry of enterprises and made in Italy. The exploration permit is subject to EIA Legislation. The holder of exploration permit, in case of positive outcomes, can request the mining license for ore exploiting. Some original exploration reports are stored in the archive of the Ministry of enterprises and made in Italy (MIMIT).	Preliminary estimation on numbers of exploration and mining areas especially for CRM, and other commodities can be addressed (Cu, polymetallic, Fe, precious metal, etc.), that are planned to be served to EGDI in the frame of the GSEU project.		
Norway (NGU)	Data providers: Municipalities and counties: - General land use plans and zonation plans	Data providers: Companies - Major finds in exploration - CRIRSCO compliant data - Feasibility studies	Geological survey of Norway (NGU), national databases on: - Mineral resources (metals, industrial minerals, natural stone, aggregates)	Extraction areas are described in zonation plans, which must be developed prior to obtain extraction licences/concessions.

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
	- Local or regional mineral resources strategies Norwegian Directorate of Mining with the Commissioner of Mines at Svalbard (DMF): - Exploration licences and mining licences. Various other governmental institutions providing data on - Nature protection -Water protection - Protected cultural heritage - Demography, etc.	Directorate of mining: - Mineral statistics	- on geology, geochemistry and geophysics. - Resource classification Data and information about mineral resources are publicly available through NGU's web map service and fact sheets. Companies - CRIRSCO compliant resource estimates	In addition, some municipalities have detailed regulatory zonation plans that include designated areas for short-term extraction, long-term extraction, and awareness areas for the future. NGU does not conduct CRIRSCO compliant resource assessments. If compliant numbers are reported and publicly disclosed by companies, NGU will store these assessments in the national resource databases. Missing data for E category: In general, different government and non-government organizations host national datasets on various subjects like nature protection, water protection, and cultural heritage which are available and can be used. Not all the relevant datasets are equally easy to obtain to be used in GIS analyses. Missing data for F category: Companies listed on stock

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
				exchanges may publish relevant data in press releases and feasibility studies. Finding these data from companies that no longer exist is a challenge. Mineral statistics are only available as accumulated numbers. They are not connected to mapped resources, but concession areas (not the complete resource). Company's data on production and sales, as well as waste production and resource/reserve are reported to The Norwegian Directorate of Mining with the Commissioner of Mines at Svalbard (DMF) on a yearly basis. Submitted data are not publicly available, and there is no requirement for the mining companies according to a standard or code. Data from some of companies can be aggregated from their websites. Missing data for G category: The data bases are based upon sources of various quality and age. Resource classification, such as public importance, is performed for national land use

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
				planning. In addition. NGU is in the process of classifying Norwegian resources according to the UNFC. Data from some companies can be collected from companies' websites.
Romania	Inventory of mining areas where data can be found for exploration areas and mines with permissions and mine plots and on other mining activities (extraction, suspension, closure). With more details: National Agency for Mineral Resources – NAMR, www.namr.ro	Inventory of mining areas. National Agency for Mineral Resources – NAMR, www.namr.ro	Mineral resource inventory with resources and reserve data, and project results on potential assessments (predictive mapping with prognostic resources). Partially: Geological Institute of Romania.	Regarding the E, F, G categories the only authority which keeps all the data related to the mineral resource activity is the National Agency for Mineral Resources. Missing data for F category: There are not public feasibility studies related to licensed specific mining perimeters. Only the environment reports/documents are public. Missing data for G category: Old/archive data may not be reliable and a new evaluation has to be done.
Slovakia (SGUDS)	SGUDS covers in so-called Geofond the registers of information on mining areas with data related to exploration areas and mines with permissions (Technical Operational Plans: TOP) and mine plots and on other mining	SGUDS has an inventory of mining areas, Old and Recent mining works. http://apl.geology.sk/geofond/sbd/	The SGUDS has been working for decades on metallogenic mapping based on extended projects funded by the state budged. This activity has provided both - maps and a publicly accessible database.	The SGUDS has its own information on permitting stages, licenses for TOPs that can be used for E and F category. The mining companies are obliged to disclose information on reserves and publicly available Slovak

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
	activities (extraction, suspension, closure). Such information is publicly available through SGUDS website: https://www.geology.sk/maps-and-data/mapovy-portal/geofond-registries/?lang=en	Other information about Geology, Geochemistry, Geophysics are available in SGUDS's databases.	Based on Slovak Geological Act all exploration and survey final reports are stored in the Geofond and are publicly accessible.	Mineral Yearbooks are issued on regular basis.
Spain (IGME)	IGME doesn't collect information on mining areas with data related to exploration areas and mines with permissions (Technical Operational Plans: TOP) and mine plots and on other mining activities (extraction, suspension, closure). On the contrary, this kind of information is often collected by Ministry for Ecological Transition and Demographic Challenge (through the General Subdelegation of Mines) and the Ministry of Regional Government (like Andalusia, for example) This information can be consulted on the database from these organizations	IGME has an inventory of mining areas and occurrences with information especially focused on the geology. Other information about Geology, Geochemistry, Geophysics can be in some IGME's database. https://info.igme.es/BDmin/. https://info.igme.es/Geoquimica/ http://info.igme.es/SIGEOF/	The IGME has been working for decades on its metallogenic mapping, which has provided both maps and a publicly accessible BDMIN database where, above all, the information is focused on the geology of the former mine or the occurrences.	The IGME does not have its own information on permitting stages, licenses for TOPs that can be used for E and F category. We have to ask to the local, regional and national organizations related to mineral resources to get this information. Moreover, the mining companies are not obliged to disclose information on reserves, so in most cases it is *confidential*. https://info.igme.es/BDmin/
Sweden (SGU)	For known sources: All necessary data can be found either from mining companies, SGU, Mining	For known sources: Most data can be found at the mining	For known sources: Except from Mining companies Data can be	

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
	Inspectorate or court/licensors. A national database is under construction at the SGU. Most of the data is public. Contacts with company might be necessary to clarify facts. Except from public data from the mining companies, data can be found in public documents linked to different permits at SGU, the Mining Inspectorate and different courts and licensors.	company or at the authorities. Data is public. However most of the data come from active companies.	found at SGU, archives and research data as well. Technical reports with CRIRSCO classifications often includes the necessary for classification of the G-axes. Apart from this data can be found in archives at SGU and when researchers are linked to the company, also at the university.	
United Kingdom **(BGS)**	<u>For known resources</u>: Local authority spatial planning documents. Status of planning permission from Local Planning Authorities. Maps of environmental designations. Information contained within publicly reported industry data. If projects have planning permission to operate then it can be assumed that E is 1. detailed data can often be found on Planning Authority databases, however these are not centralised and are time consuming. If no planning data or other environmental studies are available then E is assumed to be 3.	<u>For known resources</u>: *Status of planning permission from Local Planning Authorities*. Information contained within publicly reported industry data. If projects have planning permission to operate then it can be assumed that F is 1. See E.	<u>For known resources</u>: Mineral resource inventory. Note for the UK this has many data gaps and updated on an ad-hoc basis as there is no requirement from Government. For G4 the UK minerals inventory is compiled on an ad hoc basis from company reports, historical exploration data held by BGS (done by both industry and for research purposes) and regional data, mainly inferred from geological mapping in a GIS format.	<u>Missing data for G category</u>: For the UK regarding G category has many data gaps and updated on an ad-hoc basis as there is no requirement from Government. <u>Missing data for E and F categories</u>: Lack of centralised datasets for the UK, expert knowledge or web searches for local planning data or industry reports or news articles is required.

GSEU partner	E category data provider, database	F category data provider, database	G category data provider, database	Comments (methodology, missing data)
Ukraine (GIU)	Harmony with the Hungarian approach. <u>For known sources</u>: Inventory of mining areas where data can be found for exploration areas and mines with permissions on mining activities. Contact may be necessary between authorities if information is needed for environmental permits.	Harmony with the Hungarian approach. <u>For known sources</u>: Inventory of mining areas where data can be found for exploration areas and mines with permissions on mining activities. Contact may be necessary between authorities if information is needed for environmental permits. In some specific cases an internet search is a solution (e.g. for feasibility studies).	Harmony with the Hungarian approach. <u>For known sources</u>: Mineral resource inventory with resources and reserve data, and project results on potential assessments (predictive mapping with prognostic resources). <u>For potential sources</u>: geological research and exploration reports.	Data of inventory of mining areas (permitting stages, licenses for TOPs) can be used for E and F category (further improvements according to the UNFC Guidance for Europe and GSEU project results will facilitate the updated national level guidance for UNFC). <u>G category</u>: For G4 geoscientific project results (predictive mapping: officially not submitted exploration reports and studies) may be used (internal identification of projects). <u>Missing data for primary resources (potential resources)</u>: E,F: There is insufficient basis for concluding on reasonable prospects from environmental, social and economic point of views.

Annex 5. Barriers and solutions for implementing the UNFC on national and regional levels

This table presents some answers from Partners who responded for the call to identify some barriers for implementing the UNFC on national and regional level. Responded partners have also provided comments for potential solutions to overcome these barriers.

GSEU partner	What are the barriers for implementing UNFC in your country/region?	What do you see as the solutions to overcome these barriers?
Belgium (VPO)	Limited capacities	More training is needed
Austria (GBA)	Application of the Austrian national mineral resource classification system (G 1050) to metal and industrial mineral resources is currently mandatory for any mining company which operates in Austria and is not quoted at the stock exchange in order to be granted a mining license. However, the classification results cannot be bridged to UNFC since G 1050 does not separate environmental, social, economic, technical and legal aspects sufficiently. Nevertheless, UNFC can be applied to primary mineral resources in Austria on the basis of existing data for active projects, projects being evaluated or developed, and for former projects. As the necessary data are held by the Mining Authority and currently not shared, only this institution can in theory perform the classification. However, the Mining Authority does not have the mandate to classify resources according to UNFC and the required expertise and necessary resources may not exist in this institution. GeoSphere has the required expertise to perform UNFC resource classification at least for some commodities, but an agreement with the Mining Authority to share the necessary data would have to be put in place beforehand and personal / financial resources made available to implement UNFC in Austria.	Training of UNFC practitioners, personal and financial resources and a legal or official mandate are required for the implementation of UNFC in Austria. If any UNFC classification is to be performed outside the Mining Authority, data sharing and protection agreements are necessary.
Czech Republic (CGS)	The Czech Classification System is not compatible with any internationally recognized system (like JORC, PERC etc.) and not even compatible with former Soviet-based classification system. Implementation of UNFC would need a high level will from the Ministry of Environment and with that comes a high financial cost and staff capacity to implement the UNFC into the incompatible Czech classification system	Authorities, Ministries and/or Government would need to see the benefits behind implementation of UNFC – e.g., real positive impact on decision-making at national, regional and local level (benefit of data harmonisation at EU level is not a sufficient argument). More case studies/visually and content-

GSEU partner	What are the barriers for implementing UNFC in your country/region?	What do you see as the solutions to overcome these barriers?
		appropriate documents that would clearly document the usefulness of the UNFC as the pan-European system for reporting.
Croatia (HGI-CGS)	The division of jurisdiction over mineral resources is considered to be the biggest barrier in the implementation of the UNFC in the Republic of Croatia. Namely, not only is the legislative division made into "solid" and "non-solid" mineral raw materials, but it is also very difficult to describe the management of secondary mineral raw materials (resources), since they are managed in accordance with the Law on Sustainable Waste Management. Thus, there are as many as three administrative bodies under whose jurisdiction is the management of all mineral raw materials and resources in the Republic of Croatia. In addition, the HGI-CGS carries out research and maintenance of the database of mineral raw materials from the aspect of geological description of deposits and occurrences. The next barrier is the non-association of experts who deal with all mineral resources into a certain "professional group" of people. The level of knowledge of the UNFC is not clear for colleagues from other institutions´ level. The lack of a single database on mineral raw materials and resources is an equally important barrier that should be removed as soon as possible. Therefore, data on mineral raw materials and resources in the Republic of Croatia (primary and secondary) exist, but they are not harmonized into a single database. The absence of "bridging documents" is not a significant barrier (compared to those previously mentioned). In the event that the aforementioned barriers are removed, it is believed that it could also be solved relatively quickly.	It is believed that the UNFC classification for all mineral raw materials and resources (primary and secondary) in the Republic of Croatia should be implemented by one administrative body designated by the Government of the Republic of Croatia, which would create and maintain a unique base of mineral raw materials and resources. Alongside the previous step would certainly be the networking of experts from different administrative bodies into one "professional group" of people. The next step in removing barriers would be the projection of the need to create a sufficient number of experts followed by employment of them in such jobs. After creating a unique database of primary and secondary mineral raw materials and resources, it is necessary to create bridging documents.
Cyprus (GSD)	Cyprus has no legislation in order to be able to make comparison with UNFC Guidance for Europe (2022). Regarding the implementation of the UNFC there is no legislation in Cyprus and EU respectively. Information and education are at an early stage. The UNFC 2019 can be found in Greek language on the UNECE website and the UNFC Guidance for Europe (2022) is written only in English.	Recommended solutions: preparation of relevant legislation including the required specifications, training of competent authorities (data providing organizations), information and training of other stakeholders, integration of the UNFC and update of

GSEU partner	What are the barriers for implementing UNFC in your country/region?	What do you see as the solutions to overcome these barriers?
		the existing Database, the UNFC 2019 in Greek is available on the UNECE website and the UNFC Guidance for Europe (2022) is found only in English. The translation in all languages is needed. For the F category the implementation of Financial standards / Financial reporting in the mining industry may be necessary.
Greece (HSGME)	Non existence of a mandate in reporting according to UNFC classification. Lack of trained personnel. Limited access to confidential data. The application of UNFC to national mineral inventories requires a relatively big amount of effort and resources (both human and financial).	The translation of the UNFC Guidance for Europe (2022). Training (for national officers, experts in data provider organizations and private companies) to support the common use and deployment of UNFC. Proper communication channels between the public authorities, organizations, and the private sector is needed. Clear legal/regulatory framework with common (EU level) reporting forms are necessary. Development of an integrated national database with systematic update is a part of the progress. It is necessary to increase of resources (e.g., personnel).
Finland (GTK)	UNFC has already been applied to national mineral inventories by the Geological Survey of Finland. There are issues related to mining and exploration companies' reporting. For example, companies reporting only total reserves and total resources, or including reserves into resources, causing issues in direct bridging into UNFC, particularly in national aggregation. For example, if a company reports resources that include reserves, tonnages that should be classified as 111 would be included into class 221. Industrial mineral companies are not currently required to report any mineral reserve or resource, only annual production numbers.	Changes to mining legislation would be needed to require companies to report in a way that would allow for more accurate bridging of commodities into UNFC.

GSEU partner	What are the barriers for implementing UNFC in your country/region?	What do you see as the solutions to overcome these barriers?
Hungary (SARA)	Basically UNFC can be applied in Hungary, however contacting other authorities and searching on internet are limiting factors. Even if the legislation refers on UNFC and E,F and G categories and „G" category is in the reporting form some additional specifications are not yet available for UNFC E,F,G subcategories. Previous stakeholder consultations were useful, but they were organized few years ago. The translation of the UNFC Guidance for Europe (2022) is in progress. There is a limited capacity for a stable long term UNFC related data management.	Proper communication channels need to be developed even with integrated database for official decisions and capacity building with trainings for national officers, experts in data provider organizations and experts at companies and for decision makers. Further specifications in the legislation and in reporting forms are needed, and the translation of the UNFC Guidance for Europe (UNFC 2019 in Hungarian is available on the UNECE webpage) and trainings with training materials will support the common use and deployment of UNFC.
Italy (ISPRA)	In Italy the classification of raw materials is based on the PRODCOM / NACE classification referred to productive activities. It is not easy to talk about the application of the UNFC in Italy, as it is not a classification used by authorities or professionals in the field. Different classification methods are traditionally used which also originate from an old legislation of industrial and productive activities.	The organization of workshops and seminars and also interacting with the regional/local authorities, could favour the application of the UNFC classification (also at the level of existing databases) leading to a lively and constructive comparison with stakeholders, professionals and competent bodies that can help the application of the same UNFC also starting from other classifications.
Norway (NGU)	The UNFC serves as an effective resource management tool that can be utilized by Geological Survey Organisations and other governmental institutions. However, there are obstacles to its implementation, namely data confidentiality and unpublished data. Challenges are the following:	Collaboration between different government entities and the industry is vital for the successful implementation of UNFC. By improving data exchange practices, considering mandatory data sharing agreements, and establishing good communication, both industry and government can derive mutual benefits.

GSEU partner	What are the barriers for implementing UNFC in your country/region?	What do you see as the solutions to overcome these barriers?
	Mineral-producing enterprises who possess mining concessions are not obligated to report their resource assessments. The absence of reporting impedes the monitoring of sustainability in resource exploitation. The lack of datasets in readily usable GIS formats, from different stakeholders and institutions hinders the importation of data for UNFC analyses. There is a lack of clear national institutional mandates for systematic UNFC data collection and integration. Statistical data obtained from (often *confidential*) industry reporting of mine production are not integrated with data on in-ground mineral resources There are no established workflows for systematic integration of public industry disclosure with national mineral inventories, even though these data are in the public domain (e.g. stock market reports, company websites, corporate sustainability reports).	
Romania	Already implemented by legislation, even if we present the evaluation in 2 systems: UNFC and old Romanian classification.	Not applicable.
Slovakia (SGUDS)	National law prescribes the form and details of reporting.	Amendment of the legislation.
Sweden (SGU)	It is mainly a question of education, and information. Translated guidelines would help the authorities. The companies often need to be convinced of how useful the system is. An easy to use, national database is under construction and will help.	Education and information, a national/ international database. Translated guidelines.
Spain (IGME)	To date, UNFC classification has not been systematically applied nor in private or public projects. Currently, the application of UNFC codes is in an early stage, with limitations, in a project about CRM resources at the national level. In many cases, data about reserves and resources belong to private mining companies that only share production data with the mining authorities. The C.N. IGME performs inventories about mineral resources in Spain, but our researchers and technicians are not trained in the UNFC classification.	Proper communication channels need to be developed between national stakeholders in mineral resources research and production: national mining authorities, regional mining authorities, the geological survey and mining companies. It is crucial that national and mining authorities understand the importance of the application of UNFC classification

GSEU partner	What are the barriers for implementing UNFC in your country/region?	What do you see as the solutions to overcome these barriers?
		in the EU context. Improvement of the capacity building with trainings for national and regional officers, experts in data provider organizations and experts at companies and for decision makers is important.
United Kingdom (BGS)	The UK has no formal scheme for licensing mineral exploration, collecting data on minerals projects or collecting royalties (with some specific exceptions). As such it is difficult to implement UNFC in any formal way as there are no formal databases/structures. However, BGS does hold a great deal of minerals related data from all stages of project development and has developed an understanding of UNFC through having the opportunity to work with it on a range of funded projects which has allowed the organisation to build some level of experience. The main barriers in the UK are 1) a lack of a central system of minerals data to apply to and 2) the requirement for external funding to resources to allow continued work with UNFC.	The lack of a central system for managing minerals data and projects in the UK requires a significant government policy change so is considered unlikely. BGS was only able to gain experience in UNFC due to project funding allowing staff to spend the time to read the guidance documents and relevant literature and then have the opportunity to apply this to our own data. Without the time being made available BGS would not be able to develop capacity in UNFC.
Ukraine (GIU)	There are no barriers. Geoinform of Ukraine and other relevant organizations has been working with UNFC since 1997 after adoption in Ukraine the Resolution 432 which introduced the National Classification based on UNFC. However, only in 2011 State Inventory of Mineral Resources of oil and gas was finally bridged to UNFC. Inventory of solid minerals and water are still conducted in Soviet classification. It is planned to bridge Inventory of solid minerals into National Classification based on UNFC in current year.	-

Annex 6. Selected national and regional UNFC methodologies in 2023

UNFC in Austria - Legal framework, data availability and applications
(Sebastian Pfleiderer, Geosphere Austria)

Legal framework in Austria

Since 1989, mineral resource classification in Austria is standardized by the "Classification of re-sources and occurrences for solid mineral raw materials" (G 1050). Mining companies which operate in Austria and are not quoted at the stock exchange are requested to use this standard to classify their resources and reserves when filing for a mining license. This applies to deposits of metals and industrial minerals, not to hydrocarbons or construction minerals. Mining companies which operate in Austria and are quoted at the stock exchange on the other hand use international reporting codes as required (mostly PERC).

The Austrian Standard G 1050 was published in 1989 and is similar to early versions of UNFC. It distinguishes three classes of significance (occurrence is economically valuable / scientifically significant / not sufficiently investigated), five classes of geological confidence (estimates of quantity are reliable (with subclasses depending on data density) / preliminary / tentative), three classes of 'mineability' (considering technical, socio-economic and legal aspects, the occurrence is mineable / not currently mineable / unassessed) and three classes of economic feasibility   (resource is economically feasible / potentially feasible / unassessed).

Compared to UNFC, this classification does not separate environmental, social, economic, technical and legal aspects sufficiently as to enable any bridging to UNFC's E and F axes. However, the classification of geological confidence according to G 1050 is similar in the UNFC system which may enable the development of bridging guidelines to the G axis of UNFC.

The G 1050 classification results of mining companies rest with the Mining Authority (part of the Ministry of Finance) and are not made public or shared e.g. with GeoSphere Austria (former Geological Survey of Austria). In fact, the Mining Authority does not publish any company- (or deposit-) specific information. Only aggregated (yearly, country-wide) production figures are published by the Department of Resource Policies (also part of the Ministry of Finance) (https://www.bmf.gv.at/themen/bergbau/publikationen.html).

Data availability for classifying primary mineral resources according to UNFC

a) Active projects and projects being evaluated or developed

Concerning the E axis, active mining areas and areas with active exploration licenses are made public by the Department of Resource Policies via the online map viewer BergIS (https://bergis.rmdatacloud.com/Start). For each polygon, commodity type and surface area are given. Permit applications and accompanying documents such as economic feasibility studies, environmental impact assessments and information on stakeholder involvement, rest with the Mining Authority (Ministry of Finances) and are not shared.

Concerning the F axis, mining operational plans and technical feasibility studies rest with the Mining Authority but are made available to GeoSphere Austria in the course of permitting procedures, albeit only at the final stage when technical feasibility is given.

Concerning the G axis, exploration data (drillings, samples, lab analyses) and geological descriptions of the deposits are made available to GeoSphere Austria in the course of permitting procedures, i.e. when exploration is completed. Geo-statistical information however is not made available.

Grades, tonnages or volumes of resources rest with the Mining Authority and are not shared.

b) Former projects

Former mining areas do not appear in the Mining Department's online map viewer BergIS. However, closed, abandoned or historic mining sites and all documents made available to GeoSphere Austria during the permitting procedures at the time, are kept in archives and in a mining sites database at GeoSphere for internal use. Data which can be made public (location, commodity type, relative size based on production) are shown on GeoSphere's online map viewer IRIS (https://iris.geologie.ac.at). Grades, tonnages, volumes are sometimes published in scientific literature or mentioned on web sites.

c) Potential sources

GeoSphere Austria has carried out regional studies on the general resource potential of some commodities / areas. These studies do not reach the same level of detail as predictive maps but constitute assessments based on geophysical and geochemical surveys, on geological maps and on compiled information of active and previously active mine sites. The studies do not allow the quantification of grades, tonnages or volumes of deposits. The studies do not facilitate the classification of E and F categories apart from sand and gravel deposits where environmental, social, economic and technical aspects can be assessed in principle using spatial plans and land use data, as well as information from former pit operations.

In summary, the Mining Authority (Ministry of Finances) holds all necessary information for the UNFC classification of primary mineral resources for active projects, projects being evaluated or developed and for former projects. As the data are currently not shared, only this institution can in theory perform the classification. However, the Mining Authority does not have the mandate to classify resources according to UNFC and the required expertise and necessary resources may not exist in this institution. GeoSphere has the required expertise to perform UNFC resource classification at least for some commodities, but an agreement with the Mining Authority to share (and protect) the necessary data would have to be put in place beforehand and personal / financial resources made available to implement UNFC in Austria. Additional training of UNFC practitioners will be needed.

Data availability for classifying secondary mineral resources (mine waste) according to UNFC
For secondary mineral resource (mine waste) classification, an inventory of waste deposits from historic metal mines exists which was compiled by GeoSphere Austria, and which contains information on location, time of operation, commodities, minerals, adits, shafts, size & location of waste heaps and for some sites even chemical analyses. However, data is too sparse to derive the G category. No information exists to derive the E and F categories, neither at the Mining Authority nor at GeoSphere.

UNFC applications for classifying primary mineral resources in Austria
Currently, one research project by GeoSphere Austria is applying UNFC to sand and gravel deposits in Austria. It follows a methodology which was developed by GeoSphere Austria and approved and published by UNECE (Pfleiderer, 2022). This work has so far covered two thirds of the country area and will be completed by the end of 2024. Furthermore, two ongoing research projects plan to apply UNFC to selected graphite deposits and high-grade quartz mineral resources in 2024. For the graphite deposits, the applied methodology will likely be similar to Solberg & Gautneb (2022).

References are in the Chapter 11. (see above)
Implementation of UNFC in Finland by Geological Survey of Finland
(J. Hokka, T. Leskelä, P. Eilu, T. Eloranta & S. Aatos; GTK)

Introduction

Mineral resources in Finland are classified in accordance with the United Nations Framework Classification for Resources (UNFC) system. Geological Survey of Finland (GTK) has integrated the UN's classification guidelines and structure for mineral resources into Finland's mineral deposit database. Mineral resource and reserve data are stored to the database as CRIRSCO, non-compliant and UNFC; data bridging, mapping and aggregation is done through ETL-process (Extract, Transform and Load) and can be run regularly.

As a result, Finland's total mineral resources can be presented consistently and in a harmonised manner, considering the geology of each deposit, the technical work completed, permits, and financial and societal aspects, regardless of when or how mineral resources and deposits have been reported.

The aim of UNFC classification is not to re-assess or re-evaluate existing resources nor forecast changes in exploration and mining permitting, but only to harmonise the existing information under the UNFC in national mineral inventory purposes.

Mapping and harmonising resources to UNFC code

The databases contain both Active and Non-Active Projects which can be either Viable, Potentially Viable or Non-Viable. Non-Viable Projects are commodity endowments without consideration of economic viability in foreseeable future (Non-Viable Projects: closed and/or historic).

Mapping and harmonising all the resource and reserve estimates from the mineral deposit database to UNFC code was done with ETL-tool (Safe Software FME) (Eilu et al., 2022, Safe Software 2023).

Basically, three different data types were processed (Figure 1):

1. Active Project (Potentially Viable or Viable Projects) has Exploration Target, Mineral Resources or Mineral Reserves reported in accordance with CRIRSCO-style reporting standards (CRIRSCO, 2019). Hence, no reclassification is done, and the original resource (and reserve) categories are directly mapped by using the CRIRSCO–UNFC bridging document (UNECE 2015).

2. There is an active or a non-active Project with an old 'historic' resource or a resource otherwise not compliant with the CRIRSCO-family reporting standards, and it is obvious that the data density is low and/or not much of information is available on the resource, we map the resource into UNFC class 334.

3. Active or non-active Projects reclassified according to the UNFC code by GTK: no mapping is needed. These Projects are cases specifically evaluated by the GTK experts following the UNFC documents and internal guidance document (see below).

As a result, an aggregated mineral resources tonnage table is created where all the resource and reserve information are mapped and harmonised to the UNFC code. This aggregating process is run regularly (currently once a month) to have an up-to-date table of the mineral resources of Finland.
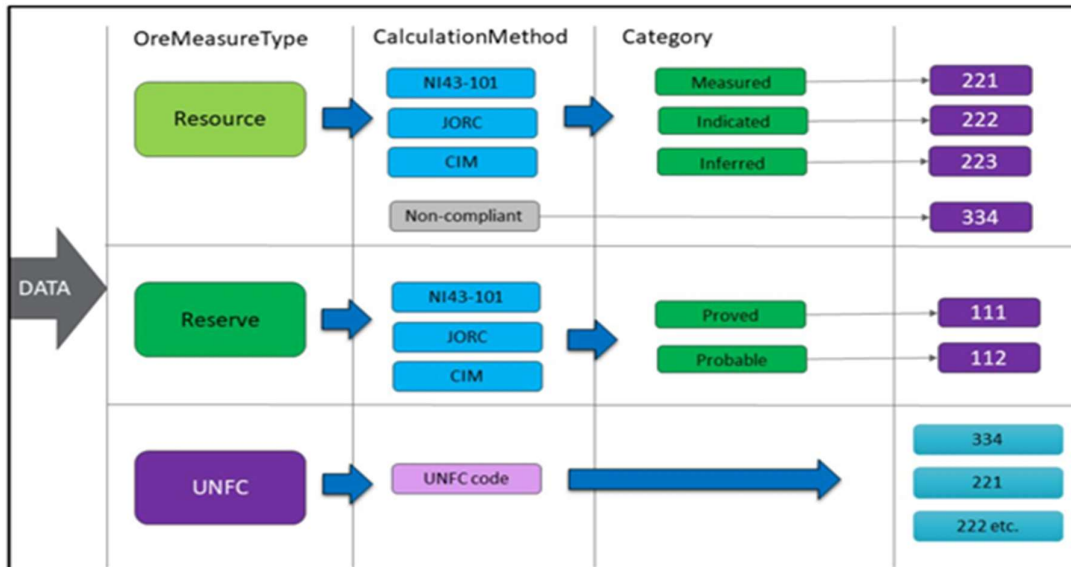
Figure 1. Simplified mapping process from the Mineral Deposit Database of Finland primary data to UNFC resource categories

Application of the UNFC resource code in Finland – Practical guidelines

Regularly updated GTK's UNFC guidance document (Hokka et al., 2020) assists GTK experts ('Qualified Experts') to classify current and historic raw materials projects in accordance with UNFC. The report provides specific Finnish case examples of active and non-active projects that have been reported either under CRIRSCO classification or are without any classification framework. The aim is to provide common methodology based on UNFC-2019 for coherent, consistent, and transparent national mineral inventories.

Mineral Deposits and Exploration map service (MDaE)

Practically all public information on mineral deposits in Finland is available in the GTK Mineral Deposits and Exploration map service (Mineral Deposit Database of Finland). The resource estimate of a deposit as stored in the database is shown in the 'Resources' and 'Calc_method' fields in the web map. 'UNFC_Classification' field shows the amounts of commodities mapped to UNFC categories. Each deposit is linked to a PDF report in the map service. This report contains all the information stored in the mineral deposit database for the deposit and links to original reports of data and information per deposit.

UNFC classification in problematic Projects

Commodities reported within the previous estimate but excluded from the updated resource estimate

- *For example, a Li-Be-Nb-Ta pegmatite deposit included Be, Nb and Ta on maiden resource estimate, but later only lithium was planned to be produced and only Li included in the later resource reporting. Thus, the by-product (Be, Nb and Ta) commodities were not technically tested any further. All permitting and technical testing is for Li extraction. The UNFC classification is as follows: 111+112; 221 + 222 + 223 for Li, but 343 for Be, Nb and Ta as* **Remaining Products not developed from identified Projects.**

- For further information, see UNFC Guidance Europe (2022) (Reported Resource Quantities and Quality, p. 26)

By-products and co-products which company has dropped from recent resource estimates

- Maiden Resource estimates that include several commodities which have later been dropped off from the resource estimate reporting (resource classification).
- Estimates of commodities which have been reported by the previous owner but not carried out under the new project holder's reporting.
- A Project (Uranium): Measured Resources 800.5 Mt @ 17 ppm U, Indicated 504 Mt @ 17 ppm U and Inferred Resources 748.3 Mt @ 18 ppm U. These resources were reported by the previous holder of the deposit, but are not confirmed by the current owner, hence the UNFC categories for U are downgraded into E3.3;F4;G1,2,3, respectively.

Outdated Resource estimate ('Ownership change')
- In situations where resources were reported in accordance with CRIRSCO-reporting system several years ago (>10 years old), since the company has left the project, and the possible new owner has not released a new resource nor confirmed the old resource.
- In such a case, the project must be looked at as non-active => Change from 221, 222, 223 to E3.2;F2.2;G1,2,3 or to E3.3;F2.3;G1,2,3 (=> compliant → non-compliant resource).
- For further information, see UNFC Guidance Europe (2022) (Annex II, Viable Projects Turn Non-Viable, p. 29)

Active Projects turn Non-Active
- Active project to non-active project: e.g., in case of mine closure (e.g., company goes bankrupt, or slump in commodity markets puts the mine in care & maintenance)
  - Option 1: Active project => Non-Active project (mine closure)
    - CRIRSCO: Mineral Reserves and Mineral Resources (RPEEE) no longer valid =>UNFC-2019: 111;112 and 221;222;223 => 321;322;323
  - Option 2: Active Project (mine in care & maintenance); company puts the asset on hold but there is no change in ownership
    - => CRIRSCO: Mineral Reserves => Mineral Resources, UNFC-2019: 111;112 to 221;222
    - => If company reports plans on mine closure, the UNFC classification changes accordingly, from 221 and 222 to E2;F2.2;G1 and E2;F2.2;G2.
    - =>Full closure of a mine E3.3;F2.3;G1,2,3

Mapping 'historic' resources into UNFC

- The project has currently no active status ('Non-Active Projects'). Projects are non-compliant to CRIRSCO and therefore Bridging document shall not be used.
- The estimates include the following deficiencies: 1. no competence and responsibility (Competent Person/Qualified Person), 2. missing description of Quality Assurance/Quality Control (if anything such was done at all), 3. chemical assay data may be outdated, 4. feasibility and beneficiation studies (if any done) may be outdated, 5. no permitting, and 6. references to commodity prices (sensitivity analysis) are outdated fully or for most parts.
- Holder of the deposit has been changed since, often more than once.
- These are typically quantities that may be classified either as Prospective Projects, Non-Viable Projects, or Remaining Products not developed from identified projects.
- **Non-Viable Projects** Sub-class **Development Not Viable** (INSPIRE Code Closed, Abandoned, Historic) can either be:

- A recently closed mine with asset holder (company), and focus is on mine closure or post-closure monitoring. The infrastructure (e.g., mine, processing plant, office buildings) are in active use.
- A historic mine which has been closed for a long time and the infrastructure in-place have little or no asset (value).

    A: The historic mine may be owned or held by a company which have plans to explore the remaining potential of the mineralization and, therefore, considered as Active Project

    B: The historic mine is not owned or held by any company and, therefore, considered non-Active Project
- •For many historic mines, the information for remaining resources is circumstantial only and not based on any direct evidence. This means that assumed resources should not be classified, at all, i.e., there is no resource one can give a UNFC category.

Industrial Mineral Project with data gaps
- Industrial mineral deposit of which only overall resources are published in, e.g., Environmental
- Impact Assessment (EIA):
    - all goes into 1,2,2 or 1,3,3 (if an active project or a mine, and permits are granted), or
    - 3,3,3 (if non-active and not permitted)
- Generally, if there is a historic estimate and no updated technical information in the public domain, the UNFC category is E3; F3. However, if the Project is currently owned by a company ('Active Project') with mining lease and environmental permits in place despite the historic estimate but, according to Mining Authority data, the Project is not under production, the UNFC codification is E2;F2.2;G1,2,3 or E2;F2.1;G1,2,3. Or alternatively E2;F1 or E1;F2.2.

Mineral company reporting with data gaps
- A mineral company that is not publicly traded (and thus is not required by Finnish law to follow reporting standards, CRIRSCO or otherwise) reports only total Reserves and total Resource
    - Reserves goes into 112 and resources goes into 223, meaning the "lowest" class corresponding to resource quantities in Viable and Potentially Viable Projects in UNFC.
- A mineral company reports JORC-compliant quantities and non-JORC-compliant ('interim estimate') quantities in the same reporting and combines them as a "grand total" of quantities from the same project:
    - Only the JORC-compliant reserves and resources are mapped into UNFC using the CRIRSCO bridging document.
    - The non-JORC-compliant reserves cannot be bridged with the CRIRSCO-UNFC Bridging Document (CRIRSCO, 2015) and are mapped the same way as historic estimates into class E3.2;F2.2;G2 "development unclarified".
    - The company "grand total" number is thus not mapped into UNFC classes, but the numbers used for classification are still the unedited numbers from the JORC-compliant and non-JORC-compliant fields in reporting.

References are in the Chapter 11.

Regional use of UNFC: Hungary (Zoltán Horváth, Gábor Kovács, László Sőrés, SARA)

Introduction

In Hungary the application of UNFC can be performed based on data collection enforced by law for volumes and quality of mineral resources and reserves. Production data and data for changes in volume is also collected and maintained in thematic inventories.

The Supervisory Authority for Regulated Affairs (hereinafter: SARA), as the body performing state geological tasks, was established by Act XLVIII of 1993 (hereinafter: Act on Mining). According to § 25 of this Act SARA and its legal predecessors have been maintaining the State Register of Mineral Resources and Geothermal Energy (MRI) since 1953.

Legislation with UNFC

The record of domestic mineral resources is based on mandatory data submissions by mining entrepreneurs, and the decisions issued by the regional Mining Supervision Departments of the Directorate of Mining Supervision of the SARA. Base data of the register:

• quantity and quality of mineral resources;

• the annual change in mineral resources (exploitation, exploration, reclassification etc.) according to the annual reports;

• the mineral resources left behind after the mine is closed or the field abandoned.

Extractable mineral resources enumerated in decisions establishing the mining plots, are listed in the register by occurrences, based on available data.

The Annex 1 of the SARA decree 20/2022 on certain rules for the implementation of the Act. (I. 31.) XLVIII of 1993 on mining: Hungarian categories of mineral resource classification, their correspondence with the terms of JORC international reporting standard, definitions of the JORC standard on the most important resource and reserve categories, the modifying factors, and some UNFC categories are specified.

UNFC methodology

There are two available methodologies for UNFC application:

1.Use of Bridging Documents (UNFC-CRIRSCO, FGU GKZ 2010, a guideline: Horváth et al. 2016) and integrated use of inventories of mineral resources (MRI) and mining areas (BATER)

2. Direct use of the UNFC Guidance for Europe (2022)

The methodology for primary raw materials to supply UNFC is based on two data types.

The Mineral Resource Inventory (MRI) contains proper mineral resource categories according to the traditional Hungarian resource classification (A, B, C1 and C2) that has roots to the Eastern European and Russian classification methodology and terminology. According to the Guidelines on Alignment of Russian minerals reporting standards and the CRIRSCO (2010) the A, B and C1 category mineral resources having lower or medium complexity correspond to Measured Resources, meaning G1 category. Higher complexity C1 mineral resources and C2 category mineral resources correspond to Indicated Resources, or G2 category. The Register of Mining Areas (BATER) is also maintained by the authority. This consists of data on mining lease and permitting stages of Technical Operation Plans (TOP). The knowledge on TOP (exploration, extraction of mineral raw materials, suspension of extraction and remediation, establishment, utilization and termination of barren pits, maintenance, utilization and abandonment of open areas) facilitates the classification of E and F categories, while

data stored in MRI on geological conditions and complexity of mineral deposits, and on level of confidence define position on the G axis. Regarding G categories, the base of identification of G1 and G categories is mainly resource data. Reserve data can be used in case the mineral deposit is in production or all the relevant permissions (e.g. TOP) are available to start the mining operation.

This way Viable Projects (on production, approved for development, justified for development), Potentially Viable Projects (development pending, development on hold) and Non-Viable Projects (mining activity has ended or development unclarified or development not viable) and remaining products not developed from identified projects can be classified according to UNFC.

Active projects in Hungary are projects that have a valid mining right, i.e., for exploration, for extraction or there is a decision to establish mine plots. Regarding projects that are not related to mining activity (e.g. processing, sale, trade) UNFC data need not be provided by organizations for geological research or mining supervision.

Non-active/Inactive projects in Hungary: mineral deposits that are registered in the Mineral Resource Inventory based on accepted exploration reports and do not have any mining rights or a mine plot (not established within a few years or the previously active mine closed a few years ago). These mineral deposits have 'free' status for further development.
Recently non-active projects are suspended and closed for a few years can be classified as UNFC E2F2G1,2,3 (Potential Viable Projects) or UNFC E3F2G1,2,3 (Non-Viable Projects).

Mineral deposits with no mining operation present for decades can be classified in UNFC with Bridging Documents (UNFC-CRIRSCO, FGU GKZ 2010, national: 2016) as E3F4G (1,2)3. These are remaining products not developed from identified projects. A special case of inactive projects are historic mines with remaining mineral resources that have been closed a few decades ago and E and F categories will not probably be developed to 3 (F) 2 or 1 due to environmental, social, economic or political reasons.
Additional factors necessary to take into consideration in specific cases: accessible periods for establishment of mine plots according to the relevant legislation, renewals of TOP, other permits: environmental decisions, availability of result on public hearing.

Secondary raw materials (mining waste) and UNFC
For secondary raw materials (here mining waste) the methodology is similar compared to the method for primary raw materials. However for mining waste proper and exact data on volume and quality is not complete due to the fact that the purpose of operation of mining waste inventories is the data collection for maintaining the changes in volumes by building a knowledge base on stored, sold or landscaped materials of heaps and tailings in case of active mines, and to fulfil the requirements of the Directive 2006/21/EC Mining Waste Directive from environmental risk assessment point of view in cases of closed mine waste facilities (heaps and tailings). This database would be proper for resource estimation. E.g. for specific CRM-s in case of further developments with data collection to apply UNFC for these objects as potential secondary raw materials. Only the type of material (e.g. heaps or tailings of polymetallic ore or bauxite) and the physical properties (e.g. area, heigh, slope) can be used for resource estimation, considering that in some cases there is geochemical data as well. It means that for mining wastes, G category cannot be higher than G4 or G3 recently. Regarding E and F categories the available repository of mining areas serves information on the permitting stages and status of mine waste facilities. Considering the recent knowledge on inactive or missing CRM recovery projects, E and F categories can be E3F3.

Table 1. UNFC codes with short descriptions for 7 types of projects identified in the BATER

	UNFC code	Description	UNFC name
1.	E1.1., F1.1., G1+G2	**Mining plot with extraction TOP.**	viable project
2.	E1.1., F1.2., G1+G2	**A newly established mining plot that does not have a TOP yet**. Within 5 years from the date when the authority's decision on establishing the mine becomes final, the licensee must submit the extraction TOP.	viable project
3.	E1.2, F2.2., G1+G2	**Mine that currently has no TOP, but neither tendering, nor new licensee, nor mine closure are not the case.** In this case, the mining authority obliges the licensee to submit a TOP.	potentially viable project
4.	E2, F2.1., G1+G2	**Mine or mineral deposit that has TOP for development or mine for which tendering is in progress.** After cancellation of mining right by the authority, it can be obtained again through a tender.	potentially viable project
5.	E2, F2.2., G1+G2	**Mine that has TOP for suspending mining activity**. After suspending activity, extraction can be restarted at any time.	potentially viable project
6.	E3, F3.2, G1+G2	**Mine that has TOP for mine closure and mine where mining activity has permanently stopped.** E.g., a mine where landscaping and reclamation tasks are carried out; or mine where implementation of the mine closure TOP has already been approved by the mining authority.	non-viable project
7.	E3.1, F2.3, G1+G2	**Mine without licensee, after failed tendering.** The mining right was tendered on two occasions, but both were unsuccessful.	non-viable project

Benefits: Practically all geological and mining related data is available in databases of SARA. TOP decisions are well suited to identify E and F categories in most cases.

Barriers: Proper communications channels need to be set up even with integrated databases for official decisions and capacity building with trainings for national officers, experts in data provider organizations and companies and for decision makers can facilitate the common use of UNFC. Further specifications in the legislation, in reporting forms and the translation of the UNFC Guidance for Europe (in progress; UNFC 2019 in Hungarian is available on UNECE webpage) and trainings can support the deployment of UNFC.

Potential solutions: Basically, UNFC can be applied in Hungary, although contacting other authorities and the amount of data available on the internet are limiting factors. Even if the legislation refers to UNFC and „G" category is in the reporting form some additional specifications are missing for UNFC E,F,G subcategories. Previous stakeholder consultations are not sufficient for application of UNFC for companies and at regional authorities and an updated national level UNFC guidance is still required (previously only in Hungarian).

Example for methodology

The following figure shows that if the GSO has proper datasets for raw materials including resource and reserve data and information for modifying factors (e.g. Technical Operation Plan) with a UNFC methodology that was earlier agreed on stakeholder consultations and published in 2016 national datasets via bridging through CRIRSCO reporting and to UNFC, the transformation of available data can be presented even on local, regional or national levels. The Figure 1 shows non-metallic mineral resources (mainly aggregates) in the original (A,B,C1 and C2) national classification, in accordance with the CRIRSCO reporting based on Bridging Documents (UNFC-CRIRSCO, FGU GKZ 2010, a guideline: Horváth et al. 2016) and in UNFC that fits to the CRIRSCO-UNFC alignment. This methodology was developed at the beginning of UNFC activity in the Mid 2010s.

To demonstrate the new methodology that takes into considerations in more details the E and F categories (there are many potential stages of permissions and licensees) for viable and potentially viable projects consist of confidential data. This way even if CRM data is served to the EC DG GROW (RMSG) new results are not public. It is also important to note that based on development of a UNFC National Guidance Document for Hungary based on UNFC Guidance for Europe (2022) and the experience (trainings, discussions, project results) within the GSEU project may also influence the proper application of the UNFC for primary and secondary RM especially in specific and complex cases.
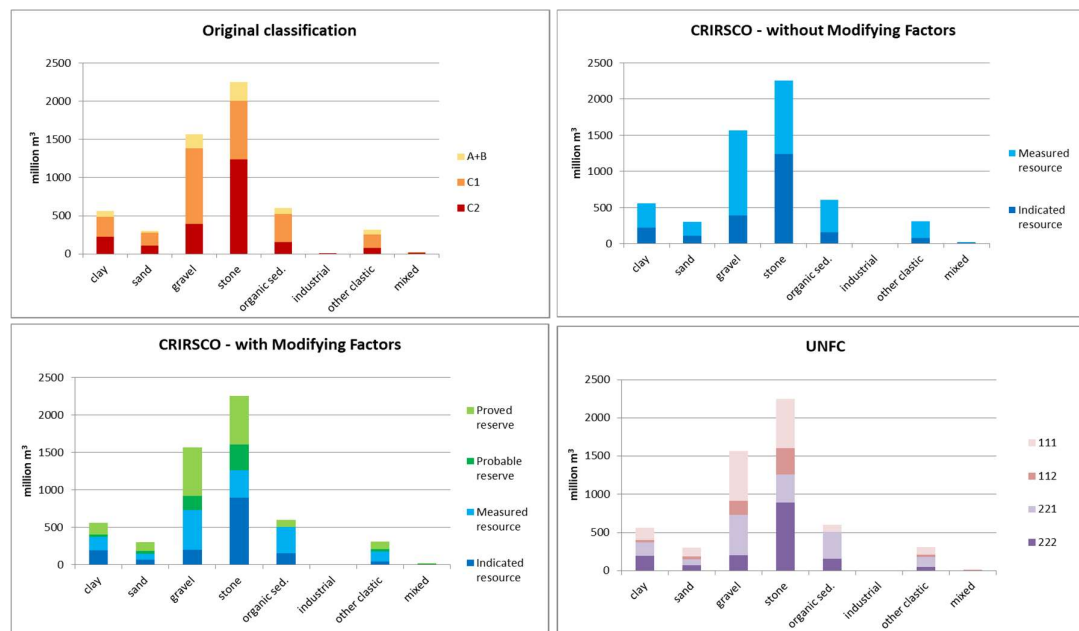

Figure 1. Harmonization between national classification, CRIRSCO type reporting and UNFC classification in Hungary for non-metallic solid minerals in NE-Hungary in 2016

References are in the Chapter 11.

Mineral data management and harmonisation to UNFC classification-Slovenia case
(Duška Rokavec GeoZS)

Background

In Slovenia all the mineral commodities are owned by the State (aligned to national Constitution). Ministry responsible for mining and minerals performs tasks related to mining legislation and licencing, strongly supported by GeoZS. Public Mining Service is established within GeoZS, authorised by the Government in accordance with the Mining Act in force (ZRud-1; Official Gazette of the RS, No. 14/14 and 61/17 – BA and 54/22). National Mineral Reserves Classification is in official use (derived from Russian classification). Reserves and resources are reported only for areas under concessions (with mining right). Aggregated data on production, reserves and resources on the national level are public. Within Mintell4EU (GeoERA) Slovenia compiled an inventory of national resource data using UNFC (data are referring to concession areas). Bridging documents into UNFC codes are created by GeoZS experts. GeoZS participates: INSPIRE expert group, EGDI expert team, UNFC network of practitioners (NoPe).

How Public Mining Service (GeoZS) support licencing procedure

Data are collected for primary raw materials by the Geological Survey of Slovenia (via the ministry responsible for mining). Web application Mining Registry Book https://ms.geo-zs.si/en-GB on national level is created and maintained by GeoZS. Data are free of charge. The Mining Act creates a statutory obligation on mineral operators/mining right holders to provide the data annually. Geological Survey GeoZS also takes care of material samples from the exploration work, including from drill cores.

Data collection, harmonisation and standardisation in Slovenia

Data are collected for primary raw materials by the Geological Survey of Slovenia (via the ministry responsible for mining). The data of all mineral commodities are provided annually by mineral operators/concessionaires on a national level. Mining Act creates a statutory obligation on concessionaires to provide the data annually on reporting forms for: reserves, resources, production, extraction/exploration area, performed or planned remediation. No metal mines are currently operating, but still have data on metal reserves and resources for closed metal and coal mines. Reserves data comply with a standard national code system (derived from the "Russian classification"). National Committee for Determining Mineral Reserves provides the statements of mineral reserves and resources on the national level. It is led by GeoZS experts. For the purpose of international reporting (EGDI platform) the mineral data are processed /summarized: production, reserves and resources data are available in agglomerated form on the national level for the particular mineral commodity. Reserves data are transformed (using bridging documents to UNFC codes) and harvested into the pan-European mineral intelligence system. Data reported to EGDI is INSPIRE compliant and spatially referenced.

Data accessibility

The data are held/owned by the relevant Ministry. They are stored on a national centralised database, and organised on a national scale. Web application "Mining Registry Book" contains official attributes (including .pdf of relevant permits) and graphical maps referring to all mineral deposits with mining concession and with the expired one. Data on production and reserves/resources for a particular deposit are not publicly accessible. All public data are in English and national language. Summarized mineral data on mineral production is accessed via an annual Bulletin Mineral Resources https://www.geozs.si/index.php/en/products/publications2/periodicals/mineral-resources. Aggregated

mineral data on production, reserves and resources on the national level are accessible on EGDI portal: https://www.europe-geology.eu/scientificthemes/mineral-resources/.

"Bridging" process for mineral data transformation from national mineral reserves classification into UNFC-2009

Initially Slovenian mineral data have been transformed from the national classification into the UNFC-2009 classification (Figure 1) in order to be incorporated into the EU Minerals Yearbook (created by Minerals4EU project, later used in Mintell4EU).

fundamental characterization	economic efficiency	categories (national classification)	UNFC E_{axis}	UNFC F_{axis}	UNFC G_{axis}
economic	proved reserves	A, B, C_1, C_2	1	1	1, 2, 3
potentially economic		A, B, C_1, C_2	2	2	1, 2, 3
non-economic	measured resources	A, B, C_1, C_2	3	2	1, 2, 3

Figure 1: Simplified transformation of Slovenian national classification into UNFC-9 as a "bridging document" case

The Slovenian mineral classification system is derived from the Russian mineral classification. Resources and reserves are divided into 3 classes:

1- economic, 2-potentially economic and 3- non-economic. Each of these classes is further sub-divided into the following categories: A, B, C1 (so called "reserves") and C2 (so called "resources"). The same reporting system is used for all types of mineral commodities including aggregates, because all minerals are in state ownership, managed by the government. Only reserve and resources within mining areas and exploration areas (where mining rights and/or exploration permits are granted) are classified. These reserves and resources are stated in the "Report of classification on reserves and resources" and determined by the national commission (Commission for determining mineral reserves).

The United Nations Framework Classification (UNFC) for Fossil Energy and Mineral Resources is a global classification system in which quantities are classified on the basis of the three fundamental criteria: economic and social viability (E), feasibility (F) and geological knowledge (G), using a numerical and language independent coding scheme. Combinations of these criteria creates a three-dimensional system. UNFC-2009 classification can either be applied directly or used as a harmonizing tool.

Extracted	Sales Production			
	Non-Sales Production[a]			
	Class	Categories		
		E	F	G[b]
Future recovery by commercial development projects or mining operations	Commercial Projects[c]	1	1	1, 2, 3
Potential future recovery by contingent development projects or mining operations	Potentially Commercial Projects[d]	2[e]	2	1, 2, 3
	Non-Commercial Projects[f]	3	2	1, 2, 3
Additional quantities in place associated with known deposits[g]		3	4	1, 2, 3
Potential future recovery by successful exploration activities	Exploration Projects	3	3	4
Additional quantities in place associated with potential deposits[g]		3	4	4

(Left vertical axis label: Total Commodity Initially in Place)

Figure 2. UNFC codes using in Slovenia

However, only designated UNFC-2009 categories (marked yellow in Figure 2) could be used for national reporting, transformed from the existing national mineral classification. For the rest of the categories, the balancing of mineral reserve data should be generated separately.

Currently the document "UNFC for Resources -update 2019" is being translated to Slovenian language for broader knowledge and use. Additionally, the general map for the country where all known mineral deposits (non-metals that could be extracted on the surface) are designated, is prepared. The mineral deposits are classified by E, F and G codes according to economic viability, socio.-environmental feasibility/acceptance and the level of geological knowledge. The volume of the raw materials in situ is only rough estimated for now. Reserves classifying is an on-going process; data are permanently up-graded.

Secondary raw materials (mining waste):

In Slovenia mining waste data have been collected and reported as comprehensive datasets as part of the implementation of Directive 2006/21/EC in the national judicial rules (Official Gazette RS, no. 43/08, 30/11, 64/21 in 44/22 – ZVO-2). Under the supervision of the former Ministry of the Environment (present Ministry of the Environment, Climate and Energy) an Inventory of closed (or in closing phase) and abandoned mines, open pits and mining waste sites in Slovenia was established by Geological survey of Slovenia. During ProSUM and ORAMA EU projects a first general selection of national mining waste sites, which could be interesting for secondary recovery, was accomplished. In addition, existing data on four largest mining waste sites of Mežica Pb and Zn mine were harmonized and shared in the common EU Minerals Intelligence Network for Europe (Minerals4EU). Up to date data on national mining waste sites have not yet been harmonized to UNFC standard. However, GeoZS participates in FutuRaM EU project, in which it will collaborate in a case study on exploration of secondary potential of a mining waste site from Serbia and on evaluation of the site according to UNFC classification.

Application of UNFC at the Geological Survey of Norway

(Kari Aslaksen Aasly, Janja K. Solberg, Mark Simoni, Tom Heldal, Annina Margreth, Agnes Raaness, NGU)

Background

The Geological Survey of Norway is the national institution that maps, investigates and documents the Norwegian onshore resource potential for future development and resource management. As a part of this NGU classifies the resources using e.g. UNFC. Databases on resources and other geological data are publicly available and are continuously updated. The Geological Survey of Norway operates the National Drill Core and Sample Archive, a national repository for drill cores and geological samples. Exploration and mining licences and concessions are administered by the Norwegian Directorate of Mining with the Commissioner of Mines at Svalbard (DMF). DMF is a department under the Ministry of Trade and Industry with a legal mandate for collecting and storing reported and in many cases confidential industry information associated with exploration permits and concessions for active mining operations.

Methodology

In 2019, 2020, within the projects financed and initiated by the EU (EuroLithos, ORAMA, Mintell4EU) several UNFC Case studies were produced with examples for applying the UNFC to Norwegian mineral resources, natural stone and aggregates. The UNFC code has been used, and different methods have been used to classify graphite and phosphate deposits on the national scale, Larvikite dimension stone (Table 1, Table 2) and Berakvam (Jelsa) aggregate on the regional scale, and individual deposits such as Bjerkreim-Sokndal (Ti-P-V) and the Forsand gravel deposit.

The data availability for UNFC classification commonly depends on the commodity, development stage and objective. Data availability thus may determine the best suited approach, such as bridging where CRIRSCO compliant data exist or where previous resource estimates are available, or other methods where these numbers are not available.

Spatial analyses (GIS) may be particularly useful both on a regional scale and for individual deposits where resource estimates are lacking. GIS allows for integrating geological (G-axis) information with other spatial data on the E and F axis (e.g. concession areas, land use conflicts) to classify and calculate UNFC quantities. However, such an approach entails various assumptions (e.g. which areas and excavation depths are to be considered for the volume calculation?) and categorisation of different datasets (which spatial data are relevant for classification, which may be disregarded?). Readily accessible spatial data are a prerequisite for GIS approaches, and the data compilation workflow needs to be well-documented for reproducibility. The benefit it is that the workflow is data-driven and may be automated.

UNFC application examples

Graphite and phosphate deposits:

Three deposits have been classified by using the bridging approach from CRIRCSO-compliant data as they had JORC compliant resource estimates. For the remaining deposits, the UNFC guidance (UNECE, United Nations Framework Classification for Resources - Update 2019) has been used for the application of the UNFC.

The classification of the G category was based on existing diverse geological data stored in the NGU database, as well as on exploration reports, publications, and company reports. G3 code was assigned to deposits which have low data resolution and tonnage estimation with a low confidence level, G2 to indicated resources, G1 to the mine in operation.

For the E axis, datasets from various thematic maps were used: flood and landslide hazard, farming areas, recreational areas, natural reserves, reindeer grazing areas, cultural heritage, municipality zoning plans, etc. GIS-data is accessible on governmental web map services, some of them are: Norwegian Water Resources and Energy Directorate, the Norwegian Directorate of Mining, municipality map.

Table 1: Larvikite dimension-stone

Classification, primary production	
Explanation	UNFC
Results from geological mapping: areas containing larvikite of assumed producible quality (possible resources), divided between six subtypes, are G3 or higher. Larvikite outside those are G4.	
Within those areas, there are active production connected to concessions, and more geological data (i.e. core-drilling).	E1.1, F1.1, G2
Within the same resource areas, the municipality has considered some areas more valuable to other uses than larvikite production.	E3-F4-G3
Within the same resource areas, the municipality has considered some areas to be suitable for future production.	E2-F2.2-G3
Within the same resource areas, there are quarries recently stopped producing, new activity pending.	E1.1-F2.2-G2

Table 2 Larvikite total primary production

	E	F	G	Sales tonnes	Non-sales tonnes
Larvikite total	1.1	1.1	2	63 729 961	835 609 094
	1.1	2.2	2	97 411	
	2	2.2	3	36 702 836	
	3.2	4	3	122 331 950	

Secondary production: The waste rock (non-sales) from primary production is utilized for several secondary products, such as drywall stone, armour stone, crushed aggregate and "other". Each of these generates a new UNFC classification. This can be calculated as a total (based on the resource volumes; (Table 3) or as a flow with annual estimates (Table 4).

Table 3 Stock model – use of non-sales total volume

	E	F	G	Non-sales tonnes	Dry-wall stone tonnes	Armour stone tonnes	Aggregate tonnes	Other tonnes	Left tonnes
Larvikite total	1.1	1.1	2	835 609 094	26 798 987	329 637 094	187 697 870	926 075	291 475 144
	1.1	2.2	2						
	2	2.2	3						
	3.2	4	3						

Table 4 Annual flow model, year 2018

2018	Annual primary production t	Block yield %	Primary blocks t	Dry-wall stone t	Armour stone t	Aggregate t	Other t	Disposed t
Dark larvikite	352 566	0,12	42 308			81 747	13 866	214 645
Medium larvikite	195 528	0,14	26 460	17 709				151 359
Light larvikite	710 973	0,06	42 658	16 045	363 980			288 290
Malerød larvikite 2018	175 318	0,095	16 655	6 500				152 163
Total	1 434 385	0,09	128 082	40 254	363 980	81 747	13 866	806 456

Calculation of volumes ("ore") for primary production
• Total volume from surface down to sea level
• Subtraction of 50% (will not be exploited due to pore quality and/or cannot be extracted due to technical issues)
Primary production "ore grade" calculated to ten percent.

For Forsand gravel deposit the UNFC category description is presented in the Table 5.

Table 5 Forsand gravel deposit

UNFC	Data source & explanation	Comment
G category	NGUs gravel resource database Areas with volume estimates were assigned code G1 to G3 depending on the confidence level for the estimate of the thickness of the deposit. areas without volume estimates were assigned code G3 (a rough estimate of resource volume was calculated by multiplying the area with the estimated thickness with lowest confidence level for this particular deposit).	
G1	Code G1 was designated for registered thicknesses with high confidence level (90% probability, e.g., 8 m)	
G2	Code G2 was used for thicknesses with moderate confidence level (between 90% and 50% probability, e.g., from 8 to 10 m)	
G3	Code G3 was ascribed to thicknesses of low confidence level (between 50% and 10% probability), e.g., from 10 to 25 m)	
F category	Information from the application for mining concession submitted to the Norwegian Directorate of Mining with the Commissioner of Mines at Svalbard (DMF). Local municipality area plans and zoning plans were consulted to assign codes on the F axis.	Information from the mining concession is not publicly available, therefore only information

UNFC	Data source & explanation	Comment
		provided in the application files could be used.
F1	Code F1 was assigned to areas which have mining concessions in place or for which the application files have been submitted.	Zoning plans need to be in place before applications for mining concession can be sent to DMF (code F1).
F2, F3	Areas categorized for general agricultural, nature and outdoor recreation objectives and reindeer husbandry were designated to codes F2 or F3.	
F4	All areas with other land management purposes were assigned code F4	
E category	A regional plan for resource management (for aggregates) Areas delimited for current or future potential aggregate extraction obtained from NGUs gravel- and crushed stone databases were further discriminated based on several topics that included amongst others: buildings, recreational areas, agricultural land, landscape, natural reserves, biodiversity, protected rivers and groundwater, and cultural heritage. Each of these topics was evaluated with a point system, in which negative points were assigned to potential land use conflicts and plus points were given when no land use conflicts were registered. Depending on the degree of land use conflicts (i.e., total sum of either negative or positive points) codes for the E-axis were chosen.	
E1	Areas with no or little land use conflicts	
E2	Moderate level of land use conflict	
E3	High degree of land use conflict	

Benefits

Harmonizing and standardizing mineral resource data though UNFC contributes to communicating national mineral resource endowments and the development status for mineral projects, thus also sustainable resource management. UNFC facilitates integration of information on the environmental, socio-economic viability (E), technical feasibility (F), and confidence level in project estimates (G). This, in turn, plays a vital role in establishing favourable operating conditions for the mining and processing industry. Furthermore, it aids in expediting lengthy planning and permitting procedures and attracting investments that improve the domestic supply sources of raw materials.

Challenges

Mineral resource data always refer to a real-world physical volume of material (material stock) that can be georeferenced in space and time. The physical in-situ material changes over time when material is extracted. To implement natural resource accounting workflows that allow for monitoring physical stock

changes and associated sustainability impacts over time, both spatial resolution and mass-balance consistency can be a solution. Many national databases are not designed for such accounting and cannot integrate reported production data with in-situ stock information. If not addressed, then the reported UNFC quantities (which correspond to a 'snapshot in time' valid only for a 'Reference Point' RP) are soon outdated whenever there is production taking place. Aggregating UNFC numbers with different RP across different deposits automatically introduces errors.

Moreover, data on production and on in-situ resources may be fragmented across different organisations that lack formal data sharing agreements, which further complicates consistent accounting.

General challenges are accessing data from other governmental institutions with less developed data infrastructures, relevant data being kept out of public space, and access to data from companies.

Datasets that lack metadata, are not regularly updated, or are collected for other purposes than UNFC classification are not necessarily suited for UNFC.

Potential solutions

Updated and well-documented data sources, increased data flow between various governmental institutions. Data confidentiality and security can be supported though formal data sharing agreements where appropriate.

International and national legal and policy frameworks need to be established to overcome poor data availability and interoperability, and to facilitate target data collection, management, and sharing.

Data value chains, workflows, and reporting templates must be developed to facilitate automation, improve consistency, and reduce costs of UNFC classification and aggregation across projects.

Further UNFC method development and cross-institutional capacity building and training are required to overcome the lack of a common understanding of the UNFC system, and to make the results more transparent, comparable and reliable.

It needs to be ensured that all the required geospatial EFG input data are collected and made available as interoperable datasets. This may be facilitated through public-private partnerships.

UNFC methodology in Sweden

(Magnus Johansson, Lena Lundqvist, Jonathan Hamisi, Erika Ingvald
Geological Survey of Sweden, SGU)

Swedish mineral resources classification and mining legislation

Currently Sweden has 12 operating mines. Sweden has no national coordinated mineral resources classification. Mining and prospecting companies active in Sweden report minerals reserves using classifications of the CRIRSCO family (e.g. PERC, JORC, NI 43-141). Since January 2023 mining companies operating in Sweden are obliged by the Swedish mining industry association Svemin to report using PERC.

Concession minerals are defined in the mining legislation, which also defines necessary procedures and permits such as prospecting tenure, mining licence. These are granted by the Mining Inspectorate (Bergsstaten), an independent government authority within the Geological Survey of Sweden (SGU) administration. Further Swedish common legislation such as environmental-, land- and construction code apply. Extraction of other materials such as industrial minerals, gravel, dimension- and crushed stone is only regulated by the common legislation.

Data on mineral deposits is collected by the Swedish Mining Inspectorate. Holders of land tenure (exploration permits) or mining licenses (exploitation concessions) are obligated to report findings. If a tenure or license is closed, all available data shall be handed over to the Mining Inspectorate. Agglomerated data is reported on national level to EGDI.

UNFC methodology in Sweden

Since about 2014, The geological Survey of Sweden SGU has been involved in the development of UNFC and has published several reports and guidance documents on UNFC classification in cooperation with among others UNECE, the Geological Surveys of Finland and Norway (GTK, NGU) and the Swedish mining industry association Svemin.

In 2021 SGU and the Swedish Environmental Protection Agency, EPA (Naturvårdsverket) were assigned by the Swedish government to investigate potential for sustainable extraction and recycling of critical metals and minerals from secondary resources. The associated report was published in spring 2023.

Four main objectives in the assignment:

1. SGU to investigate & assess potentially accessible mining tailings, ore grade and volume by field mapping (drilling and sampling of mining tailings, geophysical methods).
2. The EPA to investigate and conduct a Life Cycle Analysis system concept test on critical metals and minerals availability to improve long-term data reliability
3. SGU to design a concept, develop and deploy a UNFC database for resource classification using available recent and historical data.
4. SGU and the EPA to investigate and assess identified practical and economical obstacles for extracting secondary resources.

The first version of the UNFC database was built to classify primary and secondary mineral resources using a Swedish user interface. The database is however designed for further development, by adding multilingual user interface, incorporating other UNFC resource categories, adding enhanced project (map) search etc.. Further development pending.

Intended use of the SGU UNFC database

The UNFC classification and associated database is intended for comparison of different exploration and mining projects in Sweden. Initially SGU will add secondary and primary resources projects where relevant information is publicly available to the database and classify the deposits according to the UNFC system. Published projects of the database will be presented online on the SGU website database interface in read-only mode. The intention for the future is to provide a database login to facilitate mining and exploration companies to add their projects to the database themselves. SGU will then perform quality control before new entries are published and made available in the database online interface.

Current obstacles and uncertainties regarding use of UNFC in Sweden for secondary resources

Applying UNFC on secondary resources deposits reveals several uncertainties in the Swedish legal system. This does however not affect the SGU work on UNFC, but the legal framework is still a relevant control factor for the UNFC E-axis.

Prospecting and exploitation of secondary mineral resources is not clearly defined in Swedish legislation. At the moment there is no prejudicated project case. Generally, the intention of the mining legislation is that deposits of secondary mineral resources will not fall under its jurisdiction, meaning land tenure, mining license, concession will not apply. Mining and processing of secondary resources will thus be regarded as industrial activity (comparable to mining non-concession mineral resources such as limestone, gravel, dimension stone etc.). A company must hold the land to grant access rights to the deposit. Related projects will be subject to common legislation, such as environmental-, land- and construction code. Formal clarification of the legal setting by prejudicate will be provided once an application to extract and process the first secondary resource deposit is handed in.

Regional use of UNFC: UK
(Tom Bide, BGS)

The UK has no system for collecting mineral resource data and no specific standards or definitions are present in national legislation. Accordingly, the UK provides a good, if complex, example of how the UNFC system can be used to produce a national resource inventory, for more detail please refer to D1.5 of the ORAMA project (https://orama-h2020.eu/downloads/) or Bide et al., 2022 (https://doi.org/10.1016/j.resourpol.2022.102558) where more details on the processes followed and lessons learnt are given.

The first step in the BGS's classification process was to minimise subjectivity in classifying resources, to do this a systematic and objective decision-based process was adopted. To do this decision-support tools where developed to assist with decision-making for each axis of UNFC (Figure 1). Due to the unique features of individual mineral deposits and projects, the decision-support tools are not prescriptive but form a framework around which classification decisions can be made. The tools were developed as part of an iterative process with a range of stakeholders who supplied feedback as to their usefulness. The tools allow for identification of the main factors that delineate UNFC classes with simple yes/no answers to a range of common scenarios.

It should be noted that these decision trees were developed prior to the UNFC 2019 update and the European UNFC guidance document, which in many ways superseded them. In addition, in some cases they mis-categorise certain projects as F4 where in fact they should be F3. The decision trees also do not incorporate the UNFC sub classes, however, it is clear from recent UNFC documentation the use of sub classes adds a great deal of understanding to the classification.

One of the main issues encountered for the UK inventory was the wide variety of data that needs to be integrated, all with different issues. A situation typical of many national data sets held by organisations such as geological surveys. The UK data can be split into three categories:

- data supplied and/or published by the extractives industry
- historical data held in research reports and academic studies
- data created using geospatial analysis

Data supplied by the extractives industry
Industry data will frequently be classified to established standards, generally the CRIRSCO template, from where bridging documents to UNFC can be used. For the majority of the UK deposits these data are publicly available direct from individual company reports, on company webpages or in trade association commodity reviews.
Bridging from CRIRSCO to UNFC is not always a one-to-one association but a one-to-many association, i.e. a single category in CRIRSCO may bridge to more than one UNFC class. Each project needs to be individually considered to ensure it is correctly classified. Consequently, an additional decision-making tool to show how CRIRSCO-compliant data can be classified according to UNFC has been developed (Figure 2).
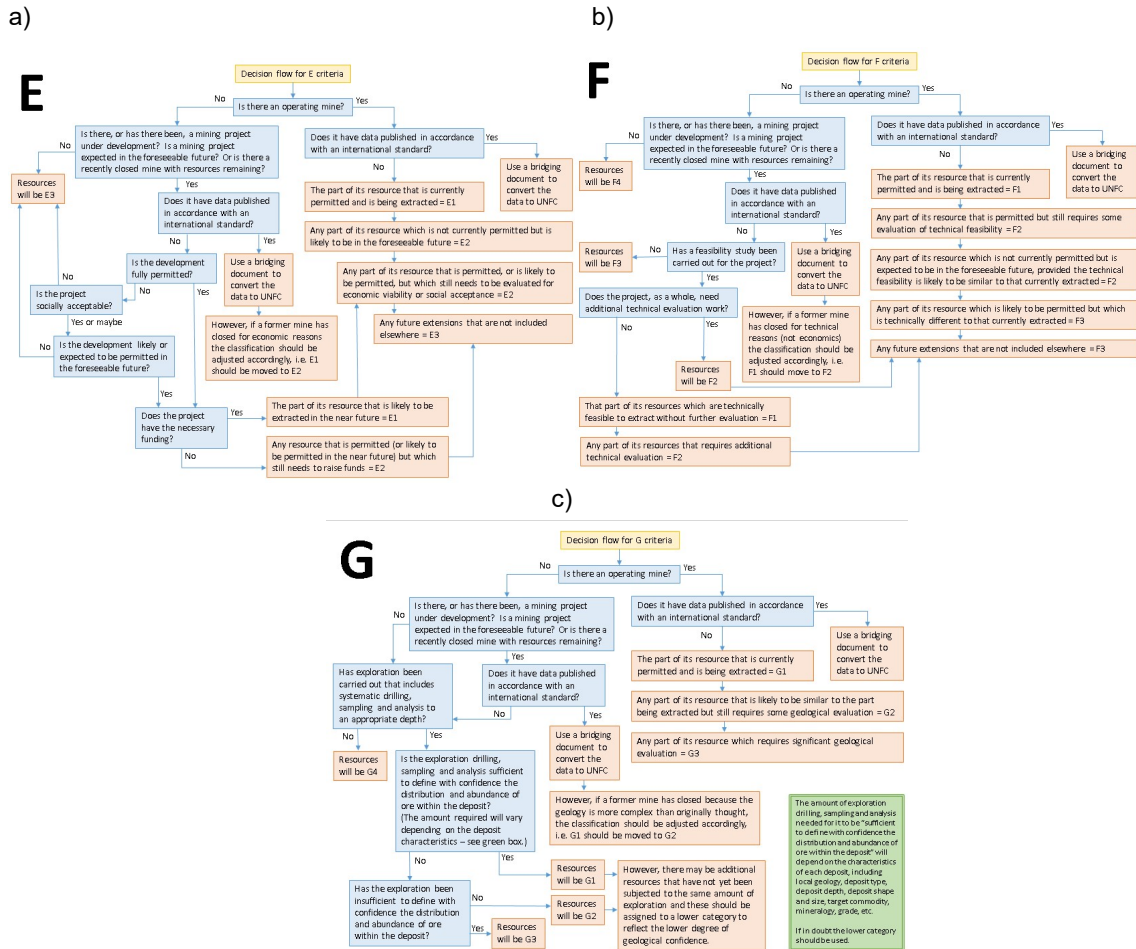
Figure 1. Decision-flow tools for determining UNFC classes: a) represents the E axis; b) represents the F axis; and c) represents the G axis. Blue boxes represent decision steps and orange boxes represent end points

It is important to note that there may be additional resources associated with a mineral deposit, which are not captured by the CRIRSCO template, and will be missing for these deposits as they may be considered sub-economic. In some instances, this 'missing' resource has been included in this analysis by the examination of historical estimates (detailed below) but in other cases it may not have been possible to quantify them.

For metallic mineral deposits, cut-off grades are often applied. In this study, where multiple cut-off grade values were reported for a particular commodity, the lower value was used. Data for CRIRSCO-compliant resources of metallic commodities in the UK are presented as metal content. These were calculated by multiplying tonnage by grade on a deposit scale before summation to generate a total for the UK. This has the disadvantage of losing the detail that can be obtained regarding the size and scale of a deposit from the metal grades.
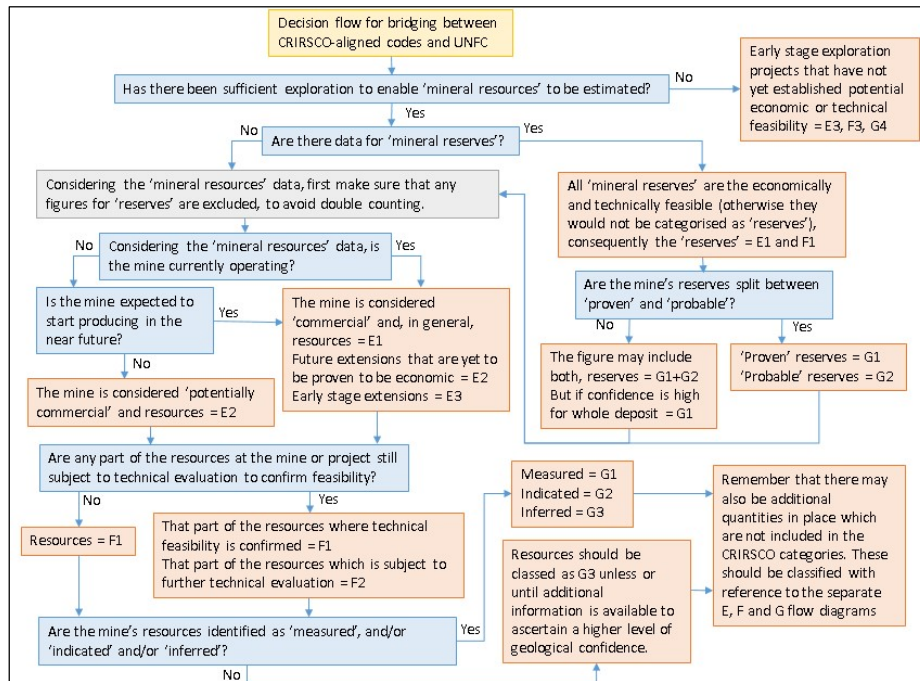
Figure 2. Decision-flow tool to bridge between CRIRSCO and UNFC

Historical data

National geological surveys, mining ministries and government departments commonly hold a wealth of information on mineral resources in reports of exploration activity, scientific studies and academic research. These historic data highlight gaps in knowledge not covered by modern CRIRSCO-compliant data.

Determining the appropriate UNFC category is challenging for such historic data because it is first necessary to assess what level of confidence one can have in the data in relation to the complexity of the deposit type. Therefore, no simple rules can be applied and a detailed knowledge of the mineral deposits, together with an understanding of the scope and capability of historic data, is required to understand the complexities when applying UNFC classes. For historical data it is unlikely that the E or F axis categories will be higher than 'E3' and 'F3' because any technical, economic or social considerations that were true at the time of reporting are unlikely to still be relevant.

Much of the historic data for metallic minerals has been classified to UNFC 'E3 F3 G3'. This seems most appropriate if deposit-specific exploration has taken place, but development is not expected in these areas in the foreseeable future. In the vast majority of cases, exploration was at too early a stage to adequately assess environmental and socio-economic viability, there is insufficient data to evaluate the technical feasibility of the deposit and quantities have been estimated with low levels of confidence. Often the geological evidence base for historical data will be incomplete making classification difficult, when in doubt the lowest confidence category has been applied.

Geospatial data

Due to the lack of a centralised or systematic collection of data for mineral resources in the UK, data for many commodities that are not reported for confidentiality reasons or were subject to historic exploration are not available. This is the case for many construction and industrial minerals. As a result, national

and regional level estimates have been made using geospatial data in a Geographic Information Systems (GIS) environment.

The geospatial analysis approach estimated resource quantities on a regional or national scale rather than on the scale of individual deposits. The results of such studies are difficult to integrate into the UNFC system as it is primarily designed for examining resource quantities at a deposit level. However, it is still possible to use such data within the UNFC framework where it will almost always be attributed to the '334' class due to low levels of confidence in all 3 axes.

The lack of deposit-specific data is common in the case of industrial and construction minerals where information regarding the size of deposits is often not publicly available for confidentiality reasons, especially where there is no requirement for public reporting, such as for private companies. Consequently, it is likely that data arising from the geospatial analysis approach relate to a range of categories on the E and F axes of the UNFC system.

Results of UNFC for the UK

Table 1 provides the full results of the classification of the UK minerals inventory according to UNFC. Individual cells have been coloured according to the attributed UNFC class to give a clear representation of the UNFC axes in a 2D format. For each commodity, this shows how the data move from high to low confidence from the top left to bottom right of each section. Generally, the quantity of the mineral commodity decreases as confidence increases, highlighting how the volume of resources available for extraction are significantly less than the overall quantity that may be physically present in the ground.

Although this inventory is as comprehensive as possible within the limitations of the available data, it must be recognised that for many commodities the data presented do not represent 'all there is' in the ground. It is likely further resources remain in undiscovered deposits, which are very difficult to quantify without further exploration. The results also included certain classifications as 'not quantified' where these were known to exist, and therefore needed to be recognised, however no data exist to quantify them.

Table footnotes: (a) This figure is an estimate for the entire outcrop in the UK. As limited information is available for the currently working operations, and it is impossible to differentiate between resources currently being worked and those that are not (and unlikely to be so under present economic conditions) this figure will likely also contain resources that will be E1 and E2, F1 and F2 and G1, G2 and G3 UNFC categories.

(b) Quantity shown here will include the E2 and E3 categories; also, the F2 and F3 categories and the G2 and G3 as well as G4.

This exercise shows the benefits of standardised national resource inventories created using UNFC. However, it is also critical to treat each dataset and deposit individually as each has a unique combination of geological, social and environmental factors that determine if it can be developed. It is also important to understand the limitations related to data gaps, consistency of approach and harmonisation of datasets from diverse sources.

Table 1 UNFC classes for the UK resource inventory (as of 1/1/2021)

Commodity	Quantity (tonnes)	UNFC class
Ball clay	46 200 000	111
Ball clay	54 100 000	221
Ball clay	2 000 000	221+2
Ball clay	132 000 000	222+3
Ball clay	4 500 000	223
Barytes	9 000 000	111
Barytes	7 500 000	223
Brick clay	Confidential	111
Brick clay	Not quantified	221+2+3
Brick clay	650 000 000 000	344 (a)
Celestite	1 257 000	343
Celestite	3 698 000	344
Copper	5	221
Copper	16 671	222
Copper	127 045	223
Copper	594 000	322
Copper	59 498	333
Crushed rock aggregates	4 500 000 000	111
Crushed rock aggregates	Not quantified	221+2+3
Crushed rock aggregates	7 000 000 000 000	334 (a)
Crushed rock aggregates	Not quantified	344
Fluorspar	4 515 000	111+2
Fluorspar	20 000 000	333
Fullers Earth	2 210 000	312
Gold	1	111
Gold	5	112
Gold	45	111+2
Gold	3	221
Gold	107	222
Gold	107	223
Gold	4	333
Gypsum	50 000 000	111+2
Gypsum	Not quantified	221+2+3
Gypsum	1 340 000 000	344 (b)
Kaolin (China Clay)	Confidential	111
Kaolin (China Clay)	Not quantified	221+2+3
Kaolin (China Clay)	245 000 000	223 (a)
Lead	46 085	222
Lead	60 064	223
Lead	728	333
Lithium	3 300 000	333
Lithium	Not quantified	344
Mica	Not quantified	334
Mica	93 000 000	344
Nickel	51 300	333
Offshore sand and gravel	349 570 000	111+2
Offshore sand and gravel	Not quantified	221+2+3
Offshore sand and gravel	13 600 000 000	223
Offshore sand and gravel	77 200 000 000	333
Offshore sand and gravel	506 200 000 000	334
Onshore sand and gravel	761 000 000	111
Onshore sand and gravel	Not quantified	221+2+3
Onshore sand and gravel	2 460 000 000	333
Onshore sand and gravel	47 750 000 000	334 (a)
Phosphate rock	2 201 420	343
Polyhalite	248 000 000	112
Polyhalite	39 000 000	221
Polyhalite	793 000 000	222
Polyhalite	2 450 000 000	223
Polyhalite	282 700 000 000	334
Potash	640 000	211
Potash	11 500 000	221+2+3
Potash	7 600 000 000	334
Salt	4 000 000	112
Salt	Not quantified	221+2+3
Salt	2 000 000 000 000	334 (a)
Silica sand	62 000 000	111
Silica sand	40 000 000 000	334 (a)
Silver	21	111+2
Silver	4	221
Silver	130	222
Silver	87	223
Silver	2	333
Talc	Confidential	111+2
Tin	8 910	211
Tin	1 560	212
Tin	8 000	221
Tin	35 550	222
Tin	25 800	223
Tin	32 400	334
Tungsten	56 430	211
Tungsten	11 700	212
Tungsten	71 820	221
Tungsten	29 920	222
Tungsten	121 240	223
Tungsten	65 520	223
Zinc	88 376	222
Zinc	101 659	223
Zinc	21 200	333

Annex 7. Europe UNFC template for Raw Materials (with GSEU contributions)

UNFC EU template for mineral resources data collection	
1. Project Metadata	
Name of project*	
Location (reference system: WGS84 decimal degrees) *	• Latitude……………… • Longitude……………
Licence owner	•
Company webpage (URL)	•
Main commodity*	•
Other commodities*	• •
Operational stage*	☐ Active ☐ Suspended ☐ Monitored closure ☐ Abandoned ☐ Historic
Type of activity I*	☐ Onshore ☐ Offshore
Type of activity II*	☐ Exploration report ☐ Strategic ☐ Monitoring ☐ Exploration ☐ Extraction ☐ Processing ☐ Recycling
	☐
	☐
	☐
	☐
2. Classification Background Information	
Classification used	• National • International • Bridged to UNFC
In case of international classification/reporting	
Reporting code*	• JORC • PERC • NI43-101 • Other:………………………
Citation for source document	• Author: … • Affiliation: … • Year: … • Title: …
If No (i.e., if this is a primary resource assessment and UNFC classification):	
Name and affiliation of qualified person	• … • …
Year of assessment	• …
Base data used for assessment	

Data set	Source	Year	Data holder	Data confidentiality	Data quality**

**data quality: inadequate / proper

3. UNFC Classes of Resources					
Commodities*	UNFC category*	Resource quantity (kt)	Resource quantity in other unit	Metal content in kt	Metal content in other unit
Other commodities*	UNFC category*	Resource quantity (kt)	Resource quantity in other unit	Metal content in kt	Metal content in other unit

OTHER CONSIDERATIONS (related to the thematic templates)

Data collection methods: This section should outline the methods that will be used to collect the data, such as surveys, interviews, observation, or secondary data sources.
EU MSs (and European countries in cooperation with the EU and EC DG GROW RMSG) need to collect data for primary and secondary RMs in order to implement CRMA. Raw material data collection is easier via centralized data collection by. geological survey organizations, mining, environmental and other authorities that are designated and legally authorized for primary and secondary RM data collection. Legally binding data collection on national and regional levels can be the most effective data collection method but other legally binding or recommended by guideline (interview, observation) can also support data collection. Electronic data collection via on-line data collection system is a modern method but other annual, monthly, other systematic data collection methods by designated organization(s) are proper for raw materials data management.

Data collection	
	Central reporting (legally binding)
	Central reporting (voluntary)
	Regional reporting (legally binding)
	Regional reporting (voluntary)
Method	Survey
	Interview
	Observation
	Project
	Ad hoc
	Other

	Monthly
	Quarterly
Frequency	Every six month
	Once a year
	Other

Data analysis methods: This section should describe how the collected data will be analysed, including any statistical or other methods that will be used.

Designated/Competent/Qualified/Authorized Experts/Persons as an employee of the data provider organization or external auditor experts on national level can analyse methods for UNFC classification.

Data analysis methods	
	By authorized expert (legally binding legal obligation)
	By authorized expert (recommended or voluntary)
Expert	Employee of the responsible organization
	External auditor
	Other
	Manual (using Guidance)
Method	Intelligence (statistical, algorithm-based, AI)
	Other

Data quality assurance: This section should describe how the accuracy, completeness, and consistency of the collected data will be ensured, including any checks or controls that will be put in place. Designated/Competent/Qualified/Authorized Experts/Persons as an employee of the data provider organization or outsider auditor experts on national level can analyse methods for UNFC classification. Uniform data collection system that is in harmony with the UNFC template for RMs is fundamental. A technical advisory group with potential members from the EuroGeoSurveys (ICE-SRM) with assistance of the UNECE EGRM can support permanently, periodically or occasionally the UNFC data provision to the EC DG GROW depending on financial and expert capacities of relevant organizations. Reference to the Guidance Note on Competency Requirements for the Estimation, Classification and Management of Resources.

Data quality assurance	
Accuracy	Audited
	Not audited
Completeness	Audited
	Not audited
Consistency	Audited
	Not audited
Involvement of expert	Yes
	No
Involvement of external auditor	Yes
	No
Expert	International expert
	National expert

No expert
Other

Data Confidentiality / Ethics considerations: This section should outline any ethical considerations that need to be considered during the data collection process, such as obtaining informed consent, protecting participant privacy, or ensuring that the data is used responsibly. Privacy of participants and all other related details on data confidentiality and ethical considerations need to be prescribed in legislation or in contract/agreement/guidance in case of lack of relevant legislation.

Data Confidentiality / Ethics considerations	
Obtaining informed consent	Yes
	No
	Other
Protecting participant privacy (GDPR)	Yes
	No
	Other
Responsible data collection (audited)	Yes
	No
	Other

Data management: This section should describe how the collected data will be managed and stored, including any software or tools that will be used.

Data management	
Data management	Legally binding
	Project base
	Ad hoc
	Other
	No data management
Data storage	Legally binding
	Project base
	Ad hoc
	Other
	No
Software/Database	Excel
	Access
	Oracle
	RazorSQL
	Microsoft SQL Server Management Studio
	MySQL Workbench
	TeamDesk
	TablePlus
	Sequel Pro

	phpMyAdmin
	Navicat a MySQL számára
	SQLyog
	Other
	No

Timelines: This section should provide a timeline for the data collection project, including key milestones and deadlines.

Timelines	
	Annual report
	More frequently updated report
	Less frequently updated report
Key milestones	Electronic
	Printed
	Other
	January
	February
	March
	April
	May
	June
Deadlines	July
	August
	September
	October
	November
	December

Contact information: Finally, the template should include contact information for the data collection team or individuals responsible for managing the project, in case anyone has questions or concerns.

Contact information	
Name of responsible person/expert	
Affiliation	
Email	
Phone	
Other	

Other

Exploration	
1. Project Metadata	
Name of project*	
Location (reference system: WGS84 decimal degrees) *	• Latitude……………… • Longitude……………
Licence owner	•
Company webpage	•
Main commodity*	•
Other commodities*	• • •
Operational stage*	• Active • Suspended • Completed
Type of activity I. *	• Onshore • Offshore
Type of activity II* (multiple choice)	• Surface preliminary • Surface detailed • Subsurface (shaft, tunnel, well) • Geological • Geophysical • Geological and geophysical • Other • Seismic • Serial-geophysical • Remote sensing • Other • Using previous exploration to closure reports
Development stage*	• Operation pending • Operation ongoing • Operation completed
Stage of permitting process*	• Exploration report exists • Technical operation plan (e.g. TOP) • Technical operation plan is pending (e.g. TOP) • Environmental permission (e.g. EIA) • Environmental permission is pending (e.g. EIA)
Degree of stakeholder involvement*	• Social licence to operate being negotiated • Social licence to operate in place

Monitoring	
1. Project Metadata	
Name of project *	
Location (reference system: WGS84 decimal decrees *	• Latitude……………… • Longitude……………
Licence owner	•
Company webpage	•
Main commodity*	•
Other commodities*	• • •
Operational stage*	• Active • Suspended • Completed
Type of activity*	• Surface monitoring • Subsurface monitoring • Surface technical • Subsurface technical • Surface environmental • Subsurface environmental
Development stage*	• Operation pending • Operation ongoing • Operation completed
Stage of permitting process*	• Technical operation plan (e.g. TOP) • Technical operation plan is pending (e.g. TOP) • Environmental permission (e.g. EIA) • Environmental permission is pending (e.g. EIA)
Degree of stakeholder involvement*	• Social licence to operate being negotiated • Social licence to operate in place

REFERENCES:

EU database of Critical Raw Materials projects: 2022 update (EC DG GROW)

Another option to provide resource / reserve data with UNFC classification

UNFC Classification for main commodities		Resource (kt)	Reserve (kt)	Metal content (kt)	Cut-off grade (%)
E axis Class* Sub-class Additional Information	• … • … • …				
F axis Class* Sub-class Additional Information	• … • … • …				
G axis Class* Sub-class Additional Information	• … • … • …				
Classification Background Information					
Original Reporting Standard (Yes/No) Original Scheme (if Yes) *	• Yes / No • …				
Reference / Source of Data (data holder)	• …				
Qualified Person/Competent Person/national expert	• Yes/no, name:…………………………………… • Company/affiliation:………………………				
Comment					