Lighthouse Sustainable Discovery and Supply

Position Paper, September 2019, v1.0

Enabling smart sustainable and innovative solutions to boost Europe's exploration, mining and processing activities in accordance with the United Nations Sustainable Development Goals and under a Social License to Operate.

EIT RawMaterials GmbH
Publication date: 02 December 2019

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1. Executive Summary

Discovery & Supply

Minerals and metals are the lifeblood of our modern society and the key to a more sustainable and carbon neutral future. Europe is facing the challenge of an increasing demand for raw materials combined with a high import dependency and increasingly demanding exploration, mining and processing scenarios. In this context, European stakeholders have to address strategic issues such as the supply of critical raw materials (CRM, Figure 1 and 2), the social acceptance of the primary raw materials sector, resource efficiency in mineral processing and valorisation of waste and tailings. Responsible investments to boost exploration and mining efforts and to strengthen processing capabilities through smart and sustainable solutions are further key aspects of this ambitious but much-needed initiative.

Innovation, social engagement & investing in Europe's future

In this context, the Lighthouse Sustainable Discovery and Supply acts as a broker for innovation, technological advancement, knowledge transfer and entrepreneurial spirit. Moreover, the Lighthouse is actively engaging in an open and transparent dialogue to emphasize the benefits of a strong raw materials sector in Europe with a Social License to Operate. Its main goals are:

Specific strategic & operational actions can be found on page 5-6.

- Unlocking the potential for a renewed raw materials sector in Europe as a driver for domestic raw material value chains
- Building on Europe's existing strengths in industry, research, innovation and infrastructure within and outside EIT RawMaterials' diverse portfolio
- Establishing trust, credibility and recognition (from local communities to industry and legislation) through expertise, transparency and positive engagement
- Providing clear advice for decision makers and fostering innovation by creating, transferring and applying knowledge and driving the application of research outcomes through to stakeholder engagement
- Boosting responsible investments in the raw materials sector and invigorating the European start-up and junior company environment by fostering entrepreneurial talent
- Reducing the footprint of the raw materials sector (waste-water-energy-emissions)

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Revitalizing Europe's raw materials sector with our partners

The Lighthouse Sustainable Discovery and Supply aims to revitalize the European raw materials sector for primary and secondary mineral and metal resources by supporting strategic innovation in exploration, mining and processing via effective engagement of industry, civil society, legislation and research. Education and technology and the establishment of new markets and search spaces through responsible investments are key instruments to reach these goals. Smart solutions based on innovative technologies will enable our extensive and continually growing partner network to optimize existing processes, to educate the next generation of entrepreneurs and innovators and to drive new developments to market maturity.

Aligning with UN Sustainable Development Goals

A complete raw materials value chain for minerals and metals make Europe attractive for a renewed exploration, mining and processing sector. In this context, the Lighthouse Sustainable Discovery and Supply will interact closely with the other two EIT RawMaterials Lighthouses (Circular Societies and Future Mobility) to addresses the identified societal, ethical, environmental, technical, and economical challenges to develop raw materials into a major strength for Europe. Hereby, we are aligning ourselves with the UN Sustainable Development Goals (SDGs), and specifically SDG12 – by 2030, achieve the sustainable management and efficient use of natural resources – to achieve a better and more sustainable future for all. Within the scope of the Lighthouse we have identified the following key challenges:

1. Resource Efficiency and Process Optimisation: Smart solutions that significantly reduce water and energy consumption are of critical importance to achieve more sustainable mineral processing operations that will have a positive impact along the entire value chain. Decreasing ore grades combined with larger volumes at smaller grain sizes are further challenging aspects that require new innovative ideas and cost-effective solutions for optimized performance and valorisation of waste material.
2. Artificial Intelligence and Data Integration: The raw materials sector is still at a hunter-and-gatherer stage when it comes to data—in its 2018 Flagship Report, the Joint Research Centre (JRC) states that '…the digital transformation of society has just begun…'. New innovative solutions are required to fully integrate existing data from all sources and scales of observation and to apply the latest developments in AI and machine learning to create reliable exploration models, ensure ethical sourcing (certification) of raw materials and to lead the way to Industry 4.0 and beyond.
3. Safe and Sustainable Mining under a Social License to Operate: How do we create and operate the mine of the future—from remote and deep-seated deposits to mining in populated areas and the valorisation of tailings—in a safe and sustainable fashion? This topic is at the interface between technology, society, legislation and industry and therefore requires smart multifaceted approaches (from mine development to operation and maintenance to remediation) to yield tangible results within the framework of a social licence to operate.

EIT RawMaterials call for Innovation Projects (KAVA Call 7) will be the first opportunity for partners and new potential members to submit proposals that address this Lighthouse.

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1.1. Strategic and Operational Actions

Table 1 Lighthouse Sustainable Discovery and Supply overview of strategic and operational actions.

Taking action to develop RM into a major strength for Europe.

Lighthouse Sustainable Discovery & Supply	Strategic Actions & Goals	Operational Actions
	Create a Lighthouse advisory board with strong industry engagement and with at least 1 meeting per year to define requirements, develop strategies and strengthen cooperation (SA, CLC, partner level).	Coordinate with CLCs to set up a kick-off meeting. Reach out to existing industry partners such as Epiroc, Sandvik, Outotec, LTU, Boliden, KGHM, Umicore, etc. and to potential new partners such as Agnico Eagle Mines (involved in iMines, MinExTarget project), Rio Tinto, or ETF Mining Equipment. Deliver at least 2 LH success stories per year starting 2020.
	Strengthen the role of EIT RawMaterials in relevant legislative and industry alliances (e.g., DG Grow, Euromines).	Closely collaborate with DG Grow to coordinate efforts and increase synergies (including the RawMatCop programme)
	Boost investment & provide business opportunities through matchmaking and networking, facilitation of industry alliances, start-up support and funding feasible upscaling projects with the aim to significantly increase Europe's exploration spending from currently 2-3% (of global exploration budget) by 2030 – with a particular focus on the ESEE region.	Meetings with EBRD to discuss potential partnership or other ways of collaboration. Build on the existing strengths with project partners such as Pluto Investments (IncluESEE and EnEx project) and approach them about extending their role.
	Foster projects and invite proposals that specifically address the Social License to Operate including legislative measures.	KAVA Call Knowledge Creation & Dissemination has a dedicated topic – Sourcing Raw Materials and Social License to Operate (SLO). Ensure that KAVA Call Texts and the Lighthouse Agenda address SLO. Invite political and legislative parties to events (i.e., Lighthouse Launch and Expert Forum).
	Contribute actively to the data innovation community that addresses current and future data tools and AI (predictive modelling & machine learning). InfoCentre. Knowledge Creation & Dissemination KAVA Call.	Collaborate with KIC Digital (Cross-KIC Activity) on Digitalisation Expert Forum. Build on existing strengths within the portfolio, e.g., HZDR - Richard Gloaguen), Talpasolutions (SmartHub project), and invite them to join the Expert Forum on Digitalisation (January 2020).
	Interlink data along the Raw Materials Value Chain (Cross-Lighthouse & Cross-KIC) and contribute to the InfoCentre.	Continue close collaboration with DG Grow (European Raw Materials Database, RawMatCop). Establish a working relationship with KIC Digital and KIC Climate. Continue the close collaboration with EIT RawMaterials' other Senior Advisors and Lighthouses.

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	Strategic Actions & Goals		Operational Actions
	Develop strategies, approach potential new stakeholders and assist our partners to become leaders in their field or to maintain their leading position in: (1) automated, autonomous & electrified technology, (2) identifying, characterizing and assessing new resources, (3) resource efficiency (extracting all metals from ores, tailings and waste), (4) Safe operation, (5) Energy and water use & reuse, (6) minimizing the footprint of the raw materials sector (from exploration to processing).		Reach out to ProExMin (specialist for Iberian exploration) as a potential new project partner. Establish contact with RioTinto. Employ Lighthouse to focus on most strategically important developments (i.e., projects) to foster smart solutions for a more sustainable future and to reverse the negative trend in terms of growth in the European exploration and mining sector.
	Foster the new generation of highly skilled & entrepreneurial professionals and support life-long learning and wider society learning projects		Liaise with Education team, provide technical feedback and attend Education events (RawMatCop, IGSC RawMaterials University Days) to promote EIT RawMaterials and the Lighthouse. Kava Call text and portfolio management. Support events that foster young researchers and entrepreneurs in the raw materials sector (e.g., GOOD Meeting).
	New search models developed by LH projects will lead to at least 1 major new discovery in the next 5 years. (Exploration Goal)		Follow UpDeep, UNEXUP, REESERVE and other ongoing and upcoming projects that address greenfield exploration and communicate success stories among partners and the wider public. Portfolio management.
	LH projects/partners are involved in the opening of at least 1 mine in the next 3 years. (Mining Goal)		Follow the development of the Sakatti (Finland, Anglo American) and Wolfsberg (Austria, European Lithium) projects. Collaborate with EBRD and other investors and link them with projects that show high potential, specifically in the ESEE region. Analyse the European exploration sector using internal and external intelligence and select short list of projects and approach corresponding industry representatives.
	LH projects contribute to significant energy/water savings and/or resource efficiency improvements in the European RM sector within the next project cycle. (Processing Goal)		Follow relevant projects and communicate success stories among partners and the wider public. Portfolio management.

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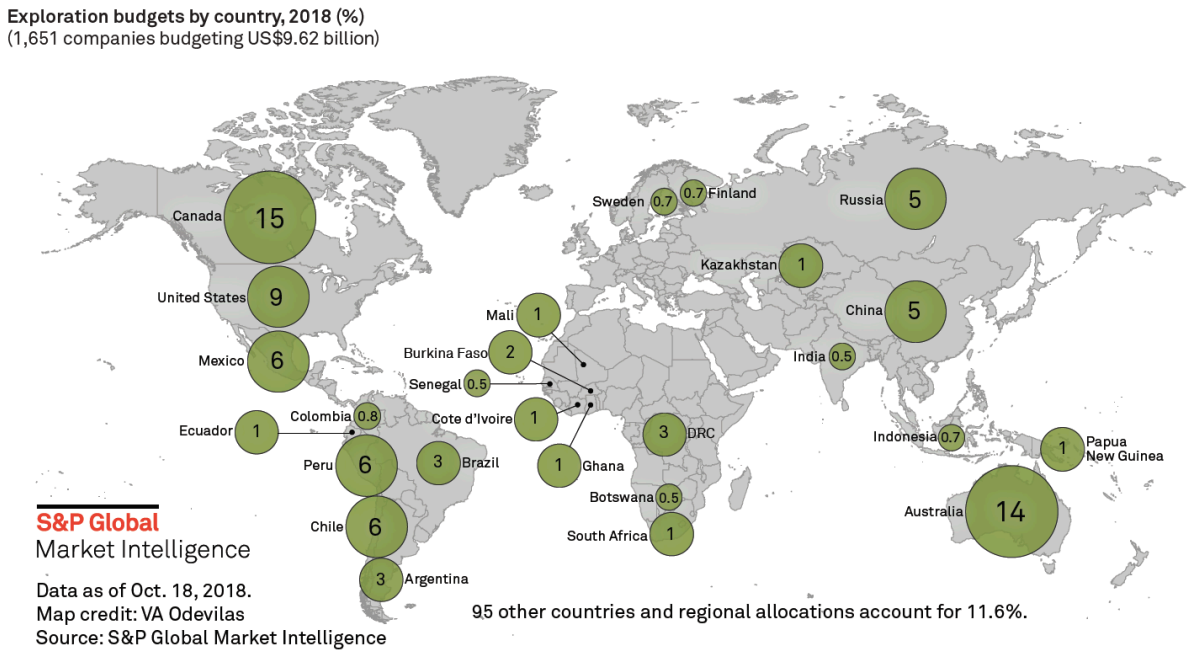

Figure 1. Exploration budgets by country. Europe, including its main contributors Sweden and Finland accounts for less than 2% of the global exploration budget.

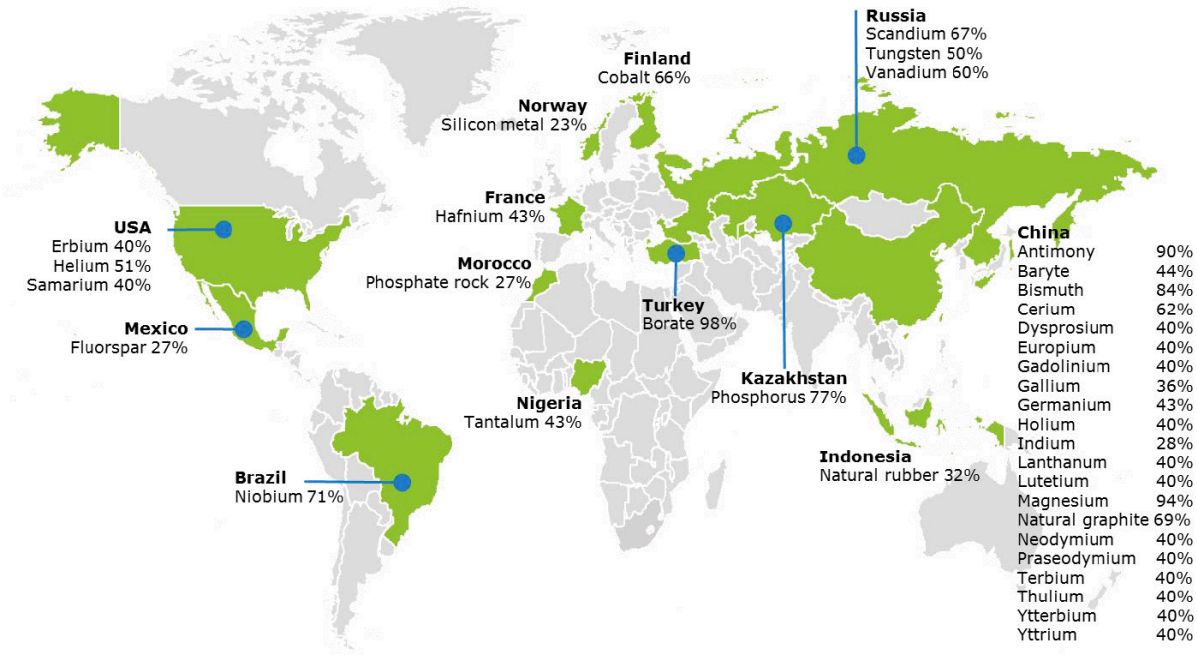

Figure 2. EU suppliers of critical raw materials (EU Commission 2017).

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2. Challenge

Then & now – Europe is facing tough challenges

Historically, Europe was the breeding ground for mineral exploration, discoveries, and subsequent mining of primary resources. Presently, public acceptance of the sector is low, and Europe is highly dependent on raw materials that are predominantly sourced overseas (Figure 1 and 2). Europe is using 23% of the world's mine production for metals and minerals but only produces 2-3 % itself. Similarly, only around 9% of the global production of critical raw materials (CRM) is provided by European countries. Hence, Europe is vulnerable to scarcity and supply shortage and there is a need and political will for increased exploration activity and the development of mining operations and processing capabilities. Hereby, a reliable and conducive legislative framework is indispensable. Furthermore, the positive impact that exploration, mining and processing have on our economy and their critical role in a sustainable circular society have to be clearly communicated. Social opposition to mining remains one of the biggest hurdles to investment and development in the raw materials sector. Critical public framings have to be addressed in an open and transparent dialogue to build credibility and eventually trust on local, national and international levels to achieve a Social License to Operate.

Creating synergy and momentum

Innovative research, entrepreneurial spirit, infrastructure, legislative actions, public support and a readily available skilled workforce are important prerequisites to create momentum and synergies that are essential to invigorate the raw materials sector and its social acceptance – specifically a safe and sustainable supply of CRM that are linked to industry needs and key societal and environmental challenges such as climate change, E-Mobility and a Green and Circular Society.

Industry 4.0 – Transforming potential to value

Mineral resources exist in Europe (Figure 3) but are under-explored or not fully exploited. The growing demand for strategic minerals and metals is met by growing concerns over the sustainability of exploration, mining and processing operations. Industry 4.0 is at the centre of this discussion and is striving to provide ethical solutions that protect the environment, provide competitive and profitable business opportunities with highest safety regulations and added value for the entire society. Digitalization, autonomous mining, resource efficient processing and operating in challenging environments with minimal environmental impact and maximum safety are further key areas that present opportunities for the European raw materials sector. Innovation and smart solutions to optimize existing processes and develop new leading-edge technologies that benefit stakeholders along the entire value chain are instrumental in this transition and play toward Europe's strengths.

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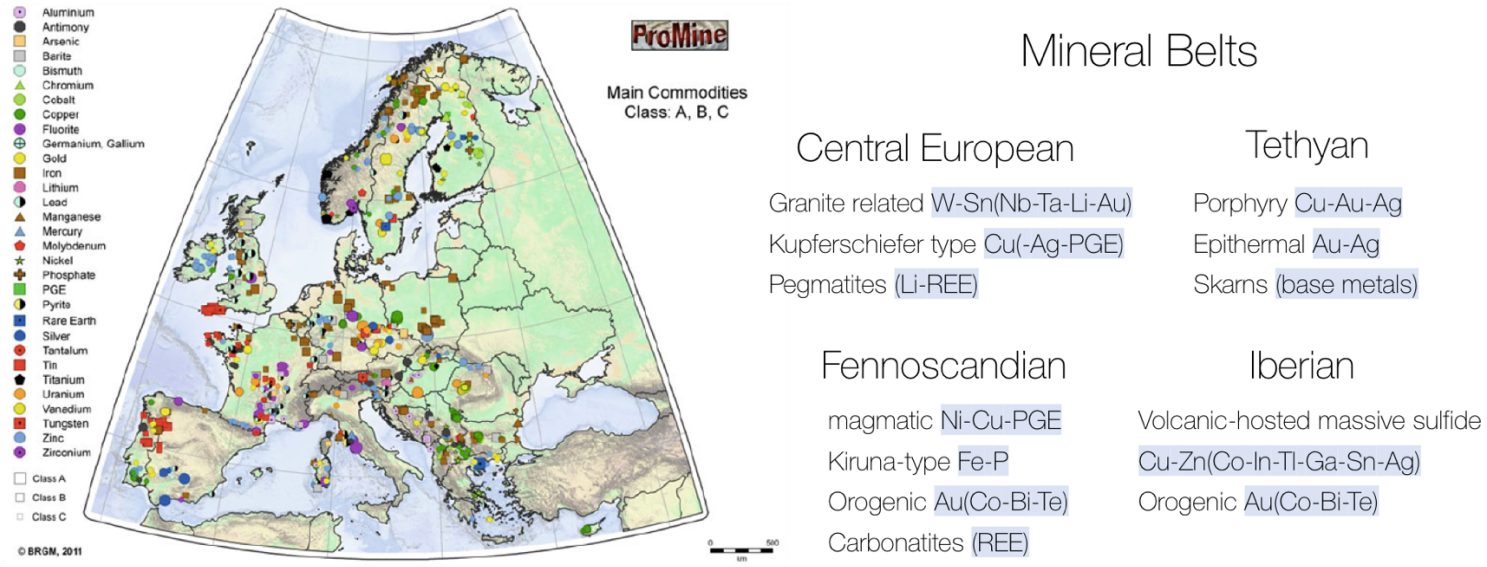

Figure 3. Europe's raw materials potential. Distribution of mineral deposits in Europe (BRGM 2011) and main commodities by mineral belts.

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3. Scope

Thematic focus areas – A multifaceted approach

The scope of the Lighthouse is to boost sustainable discovery and supply of strategic raw materials in Europe as a driver for domestic raw material value chains. To address the geographic and thematic diversity within the scope of the Lighthouse we will engage in a multifaceted approach that addresses specific aspects of current and future developments in five overlapping areas (3.1.) securing resources (geology), (3.2.) technology, (3.3.) environment, legislation and society, (3.4.) education and (3.5.) economy. Innovation in technology, service, product development and knowledge creation and transfer will facilitate the identification and targeting of new European raw material resources as well as ensuring low environmental impact and social acceptance of mining and processing operations. This needs to be enabled by a supportive legislative environment and responsible investments in the European raw materials sector as part of a strategic framework that is tailored to industry requirements and societal demands.

1.2. Securing resources (Geology)

Current geologic models for mineral deposits can be enhanced with more comprehensive and integrated datasets that allow for a more targeted exploration at depth and in remote locations. This includes multisource real-time data collection and an integrated data exploration approach. Data availability and quality in a geological context are hereby paramount to reach meaningful conclusions. Smart and innovative data collection and management (i.e., comprehensive and consistently reliable data) allows for better decision making which translates into a more efficient and sustainable industry. We need to get better at defining regions/areas/prospects where strategic raw materials exist based on smart, timely and cost-effective characterization of the geological context, including grade, tonnage and secondary minerals. Additionally, and no-less importantly, the re-evaluation of existing geological data, decommissioned mines and tailings represent further significant opportunities for the European raw materials sector—strategic raw materials may be available and extractable at comparatively low costs and with manageable environmental impacts.

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1.3. Technology

In addition to existing strengths in industry, research and infrastructure, innovative technologies are required to further enhance mining and processing capabilities (Mining 4.0) in Europe while reducing their environmental footprint, i.e., decreasing water and energy consumption combined with a sustainable waste and emissions management and positive post-mining scenarios (remediation). Furthermore, smart integrated solutions are required to target and extract raw materials from deep-seated deposits, in remote areas (including deep sea and extra-terrestrial environments), and in decommissioned mines and tailings using innovative technologies. Real-time advanced geochemical and geophysical methods, advanced reconnaissance and exploration drilling, integration of increasingly complex multi-source datasets through machine learning/artificial intelligence, life cycle assessment, augmented/virtual reality, as well as portability, automation and remote operation will have an increasingly positive impact on the European raw materials sector and help to make smarter, more timely, cost-effective and accurate decisions—leading to new discoveries and improved mining and processing operations and waste valorisation. Technology also needs to provide sustainable solutions in areas where infrastructure (water, power, transport, processing facilities, etc.) is non-existent or under-developed and create safer working environments, decrease environmental impacts and advance economic development. In this context, traceability of raw materials and technological solutions such as blockchain will also become increasingly important and represent a real opportunity for the European raw materials sector to build trust and to increase social acceptance.

1.4. Environment, legislation and society

The Lighthouse is positioning itself in accordance with the UN Sustainable Development Goals. Mineral resources have to be found, extracted and processed in ways consistent with Europe's strict environmental regulations and ethical standards and with a Social License to Operate to achieve a better future for all. Social engagement is a key aspect in creating a wider public acceptance for the raw materials sector in Europe. For this to be successful, down-to-earth and succinct core messages need to be formulated, including a strong visual component. The wider public and NGOs as well as legislators and politicians have to be included in a transparent and multilateral dialogue to positively influence decision makers, from regional to international level. Linking internal and external stakeholders to tackle legislative and permit related issues is a further critical area to achieve a Social License to Operate.

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Although external supplies (i.e., non-European) of raw materials will remain necessary, these should be obtained from sources that guarantee high safety for their workforce and maintain strict environmental regulations and financial transparency that align with European standards. If these requirements are not met, we must support these suppliers in the improvement of the condition of exploration and extraction, in terms of safety, environment and human rights.

1.5. Education

Education is critical for raising awareness and communicating the benefits of a strong raw materials sector in Europe. It is instrumental when it comes to establishing a Social License to Operate. Like many other industries, the raw materials sector is facing a wave of retirement, difficulty to attract young people, a mismatch between the education provided by the universities and the real needs of the industry and—with the transformation towards digitalization—the necessity to train the current workforce. In order to address all these aspects, the Lighthouse will support actions in the three dimensions of the RawMaterials Academy: Wider Society Learning (WSL), high education and Life-long Learning (LLL). EIT RawMaterials will also participate actively in the Erasmus+ project on a sectorial blueprint for the relevant sector to catch the trends and support the industry for skilled employees.

1.6. Economy

A thriving raw materials sector relies on financial incentives and the condition that mineral resources can be found and extracted at a profit within a conducive legislative framework and with a Social License to Operate. To address this, a number of vital questions have to be answered. Is the market present for discovery? What are the specific added societal- and market-values? Stimulating the creation and development of start-ups, junior companies and SMEs through matchmaking and networking events, workshops and targeted funding is one important course of action to stimulate the economy in this area. Furthermore, the Lighthouse will aim to build trust and motivate key players to invest in innovation and the much-needed expansion of European exploration, mining and processing efforts to advance economic development for the benefit of all stakeholders and the wider society and to meet demands of a circular economy.

4. Impact

Smart & Sustainable. Reducing dependencies and establishing a social license to operate.

The Lighthouse will promote and support the benefits of a strong European exploration-mining-processing sector and emphasize the key role of sustainably sourced-mined-processed raw materials for the transition towards a green and circular society. The Lighthouse aims to find innovative solutions for securing and processing (from exploration to mining to mineral processing) strategic mineral resources. This will be achieved through fostering activities that drive knowledge creation and transfer, collaboration and stakeholder engagement and responsible investments. Furthermore, a sustainable raw materials sector requires smart decision making based on improved knowledge, data and advanced technologies. This will reduce import dependency and also significantly contribute to economic growth, specifically in regions where new exploration projects, mining operations and mineral processing facilities can be developed or expanded. Social engagement through education, networking and liaising with all involved stakeholders and the wider public will play a pivotal role in raising awareness and increasing acceptance of a renewed raw materials sector in Europe.

Taking action to develop RM into a major strength for Europe.

Table 1 summarizes strategic and operational actions. The Lighthouse's officially launch will be at the 12th Fennoscandian Exploration and Mining conference in Levi (29 - 31 October 2019) with plenary talks and workshops that address the challenges and potential solutions for the European exploration, mining and processing sector. During the following KAVA 7 Call partners will have the opportunity to submit proposals that align with the Lighthouse Agenda and can become part of its portfolio.

Within the scope of the Lighthouse we plan to focus on different themes over time. This will be coordinated with other EIT RawMaterials Calls (e.g., Jumpstarter) and events and be reflected in the communication and outreach of the Lighthouse. In this context, an Expert Forum will be held once a year to address specific strategic issues. The first one is planned for January 2020.

1st Expert Forum (20 - 22 January 2020): Data integration, machine learning, augmented/virtual reality and artificial intelligence – Bit by bit to a more sustainable future. Leoben, Austria

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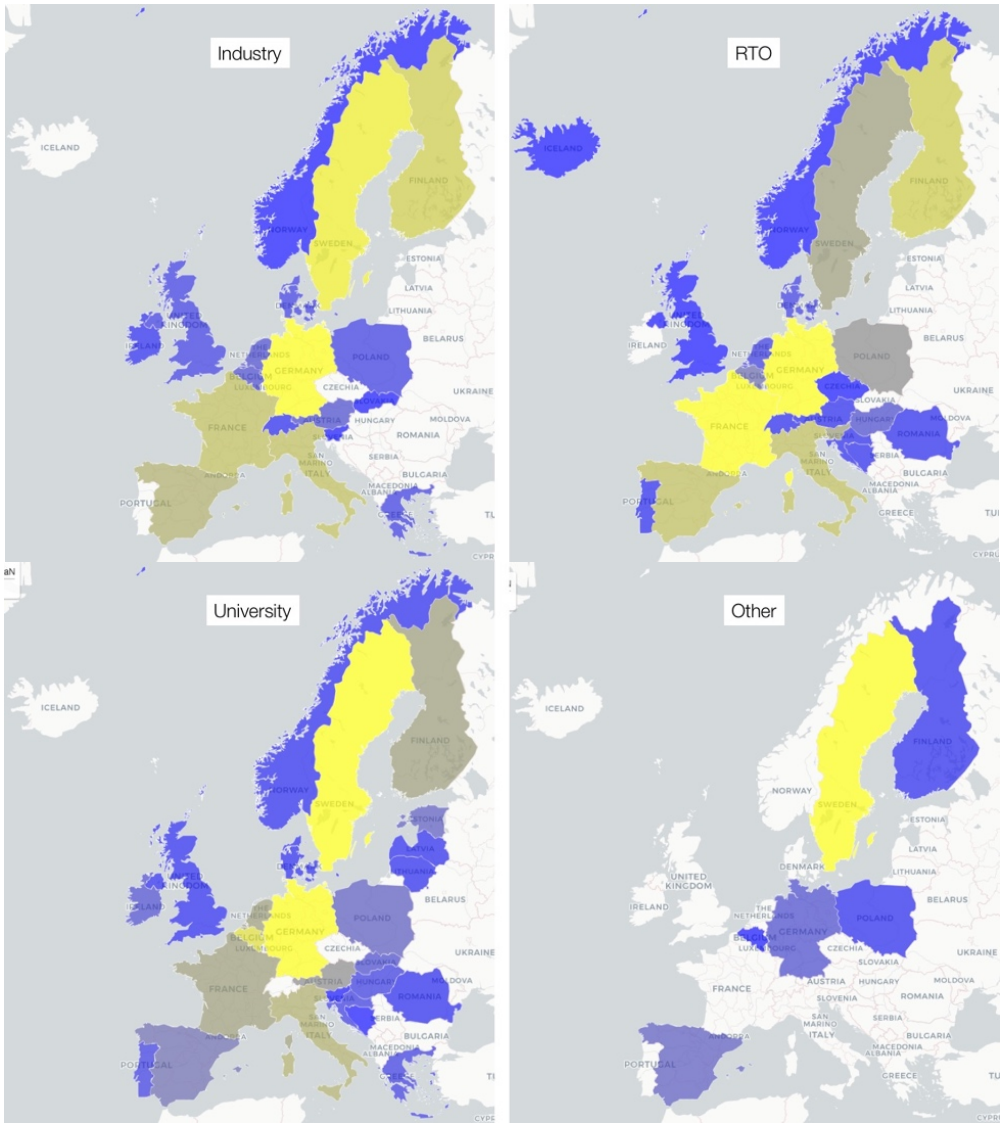

Status quo – room for improvement.

Figure 4. Geographic distribution of existing EIT RawMaterials partners from Industry, RTOs, Higher Education and others (Yellow=large number of funding partners, dark blue=small number of funding partners, blank=no funding partners) highlighting areas that are under-represented (i.e., ESEE region).

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5. Current portfolio status

Many existing ongoing Innovation Projects (KAVA Projects), executed by partners of EIT RawMaterials, are already contributing to invigorate the European raw materials sector. However, there are still under-represented geographic regions (Figure 4) and important strategic and operational gaps or weaknesses that have to be addressed by new Upscaling (Acceleration), Education and RIS projects. The current EIT RawMaterials portfolio analysis (status as of early September 2019) highlights these areas to be covered by the new Lighthouse Sustainable Discovery and Supply. Furthermore, cross-lighthouse engagement with the other two EIT RawMaterials Lighthouses will be encouraged to create synergy along the entire raw materials value chain among all partners and stakeholders.

The current portfolio status within the selected themes is illustrated in Tables 2-4 for the main themes 1. Exploration, 2. Mining, and 3. Processing which are associated with the Lighthouse Sustainable Discovery and Supply. Figure 5 shows ongoing Upscaling, RIS and Education projects that cover important strategic topics outlined in Chapter 3.

Table 2. Overview of all ongoing and upcoming projects in the theme Exploration.

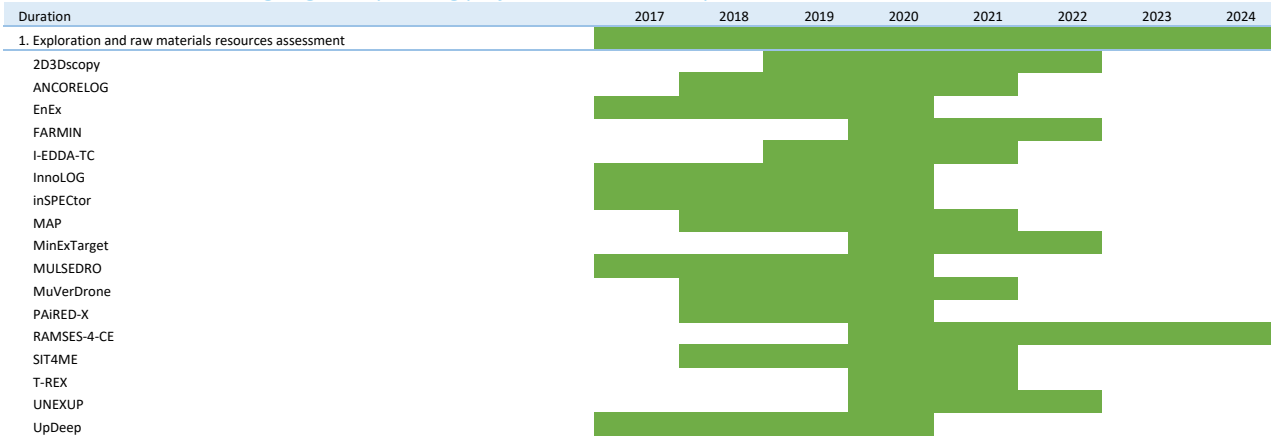

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Table 3. Overview of all ongoing and upcoming projects in the theme Mining.

Duration	2016	2017	2018	2019	2020	2021	2022	2023
2. Mining in challenging environments								
AMICOS								
AutoBoltReload								
BlueHarvesting								
Closurematic								
FIREM-II								
HARSHWORK								
HoloMine								
INSite								
MaMMa								
MineTALC								
NITREM								
OPMO								
Rock Vader								
SAFEME4MINE								
SERENE								
SmartHub								
SO4Control								
STINGS								
TrolleyTruck								
UNDROMEDA								
X-TRIM								

Table 4. Overview of all ongoing and upcoming projects in the theme Increased resource efficiency and mineral processing (note that this includes projects from the metallurgical processing which are incorporated in the Lighthouse Raw Materials and Circular Societies and not in the scope of this Lighthouse).

Duration	2016	2017	2018	2019	2020	2021	2022	2023
3. Increased resource efficiency in mineral and metallurgical processes								
2sDR								
3DMPWIRE								
BATTERFLAI								
CONSENSO								
CORTOOLS								
Credit								
DESULF								
DIGISERplus								
ENDUREIT								
EuGeLi								
EWT-CYNCOR								
FLAME								
Go-4-0								
GREENY								
IDEAL								
LiRef								
MICRO ECOS								
Morecovery								
PD-EEDC								
ReclaMet								
RECOVER								
RED_SCOPE								
REGENERATION								
SAMEX								
SAMOA								
SELISI								
SlagVal								
TETALEAD								
ThermoSpray								
WhISPER								

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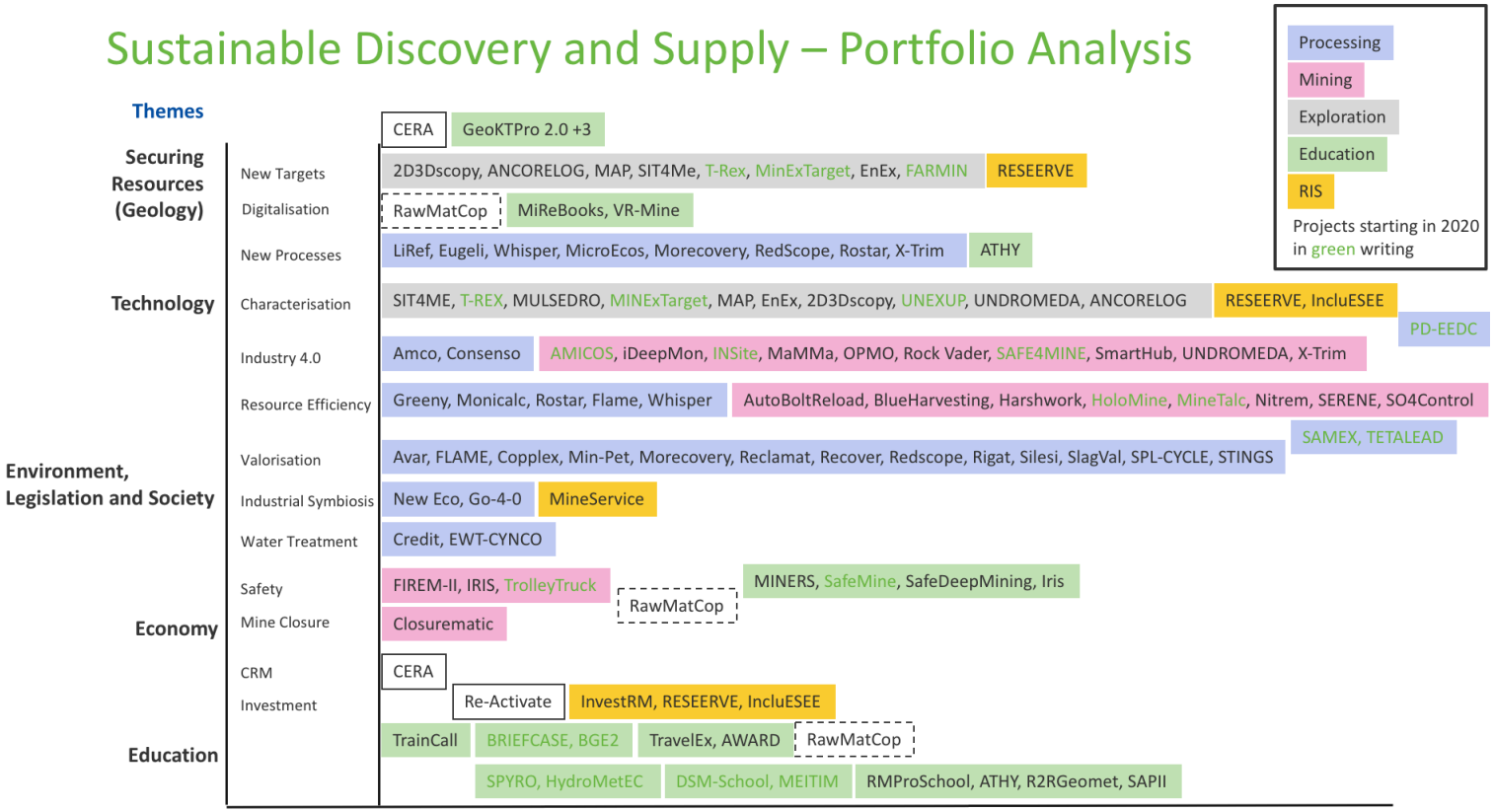

Figure 5. Overview of ongoing projects that align with the Lighthouse Agenda and match the selected topics.

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6. Advisory Board (Current members, as of 10 October 2019)

Last Name	First Name	Position		Affiliation
Nadoll	Patrick	Senior Advisor Exploration	EIT	EIT RawMaterials GmbH, EU
Häkkinen	Antti	Professor (Solid/Liquid Separation Technology)	University	LUT University, Finland
Moser	Peter	Univ.-Prof. Dipl.-Ing. Dr.mont.	University	Montanuniversität Leoben, Austria
Haschke	Michael	Manager R&D	Industry	DMT GmbH & Co. KG, Germany
Lahtinen	Raimo	Professor (Ore Geology, Mineral Economics)	RTO	GTK, Finland
Gloaguen	Richard	Professor (Exploration, Digitalisation)	RTO	HZDR, Germany
Benda	Tina Zajc	Manager at GeoZS	RTO	Geological Survey of Slovenia
D'Hugues	Patrick	Team Manager Waste and Raw Materials Unit	RTO	BRGM, France
Clausen	Elizabeth	Professor (Institute for Advanced Mining Technologies)	University	RWTH Aachen, Germany
Jurado	Maria Jose	Scientific staff	RTO	CSIC, Spain
Herrera Herbert	Juan	Professor of Mining Technology	University	TU Madrid
			Industry	
			Start-up	
			Industry	

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