# PRIORITY 1: Fostering a sustainable supply of raw materials to feed new and existing value chains

The acquisition of primary raw materials through mining, quarrying, timber logging and harvesting have been sustaining human civilisation since history began. Also in the foreseeable future, the gathering of metals, minerals, aggregates and biotic materials from natural sources will be essential to supply most manufacturing operations. However, the palette of raw materials seen today is likely to change drastically, as new consumer patterns evolve and technologies that allow for various substitutions of scarce materials or for climate friendly processes develop.

Today, demands for raw materials along with increasing economic and environmental public demands for sustainability and resource efficiency require new technologies, digital solutions and decision-making tools to support more accurate sourcing and transportation of raw materials from mines and forests. Therefore, this priority area focuses on research and innovation activities to leverage several practical challenges; collecting raw materials most often relies on heavy machinery and the working environment is hazardous. The operations are capital-intensive with relatively low margins. Harvesting operations and open mining operations are susceptible to shifting weather conditions and typically the primary collection is at low concentrations and has to be separated from waste and slag, raising environmental concerns.

***Research and innovation areas***

*1.1 New exploration and harvesting technologies for a sustainable supply*

*1.2 Mobilising an increased supply of raw materials from EU sources*

## 1.1 New exploration and harvesting technologies for a sustainable supply

#### Rationale

**Abiotic:** Globally, the mining industry faces multiple challenges: higher costs for deeper exploration and extraction, extended time for permitting, and the technological and economic feasibility of mine development are challenges to tackle in Europe as well as anywhere in the world. Land use for mining and quarrying is an important environmental challenge: sites make, changes to land, some are irreversible and increased volumes of traffic are associated with the industry. New mine and quarry applications are rejected on the grounds of various environmental issues and in some countries existing operations only get a few years permit at a time. Moreover, the industry produces noise and dust, which is a nuisance to local communities.

**Biotic:** To maintain and strengthen the competitiveness of the European forest-based sector, it is crucial to secure efficient, sustainable and high quality raw material supply. The provision of raw materials and the further development of efficient and environmentally-friendly forest operations for biomass supply chains are core activities of the forest-based sector.

#### State of play

**Abiotic:** Already today, some of the world’s smartest, and most energy- and resource-efficient mines and quarries are operating in Europe. However, Europe’s mineral potential is under-explored both with regard to subsurface, particularly deeper than 150 meters, and at sea in the EU Member States exclusive economic zones.

**Biotic:** The EU’s growing stock is increasing. In 2010, the annual increment of Europe’s forests was 768 million m³, while the annual harvest was 484 million m³, equivalent to 63 % of the increment [LINK]. Though variation is large, in no EU country does the harvest exceed increment. Still, the supply of woody biomass is far from evident for economic reasons as well as environmental concerns. To increase sustainably and economically viable supply of biomass, there is a need to improve operational efficiency resulting in added-value less waste, lower operational costs and reduced environmental loads.

#### Expected achievements by 2030

By 2030, Europe has developed further technological leadership aiming at economically viable and environmentally sound mineral extraction and forest harvesting operations. Full automation and autonomous equipment is a reality. New autonomous mining and harvesting systems have increased productivity and improved the working environment for operators. Enhanced health and safety measures taken in the mines and harvesting have significantly reduced number of days lost due to workers’ sickness or injuries

**Abiotic sector:** The newly developed exploration technologies for land- and sea-based mineral deposits have been up-scaled and piloted. Tools to assess the resource potential in technical infrastructure and products put on the market have been developed across Europe. New technological extraction methods have been tested on extended pilot scales and have been applied across a series of minerals. Novel process control through intelligent use of IT has been implemented, as well as sensors in extraction and mine processing has been installed. Larger mines have reached a certain degree of automation with driver-less drill rigs and vehicles in surface and underground mines and quarries managed from computer consoles. In small deposits mining, the “mine-to-go” for selective, small-scale mining has been piloted. Recovery and use of geothermal energy from deep mines have become regular. Innovative, energy-efficient transportation in the mine and quarry have been implemented. The sector has achieved the target ‘zero-impact’ mining and quarrying and has evolved performances in the areas of sustainable management of water, health and safety conditions.

**Biotic sector:** Research and innovation towards new, highly productive machine technology, including semi-automation and full-automation harvesting and terrain transport systems, measurement and processing technology have made forest harvesting and transportation considerably more efficient. New supply-chain standards, remote sensing technologies and accessible GEO-data has made all forest machines closely integrated and coordinated with customers manufacturing processes. Improved machine technologies and ICT systems have reduced rutting problems and assists forest operations regarding retention patching, concern of cultural heritage, water protection areas and other environmental concerns. The monitoring systems in the harvesting machines have also had a great impact on efficiency and environmental concern in following silvicultural operations, enforcing and continuously recording the sustainability of all forest operations.

#### Expected achievements by 2050

**Abiotic sector:** By 2050 larger mines should have reached full automation with driver-less drill rigs and vehicles in surface and underground mines and quarries managed from computer consoles. Larger mines should have introduced robots to conduct flexible tasks. The full exploitation process will be automated from extraction to product delivery and will be managed in real time and by one central hub, while smaller mines should have achieved a certain degree of automation. There will be no more people underground or in the quarries themselves. In marine mining, environmentally sound and sustainable extraction of identified sea deposits has been made possible. In deep mining, mines and quarries across Europe have zero-impact on water and climate change. Dedicated technologies for space mining and urban mining have been proposed and tested.

**Biotic sector**

*To be developed*

#### Required Research and Innovation Actions by 2030

**The abiotic and biotic sector**

1. Identify technologies required to sustain smart and automated mining and harvesting operations

**The abiotic sector**

1. Improve geochemical and geophysical exploration methods and prospecting techniques with a view to increasing the resource diversity in Europe.
2. Enhance drill logging technologies to obtain more cost-efficient and more environmentally friendly exploration.
3. Reprocess current soil and residue samples using modern analytical techniques for higher recovery of old mine tailings and other deposits.
4. Improve systems to collect and predict ore-body information, including seam and grade definition
5. Investigate hydraulic hoisting technologies to reduce energy consumption on haulage
6. Explore technologies that enable alternative mining sources, including space mining, e.g. asteroid mining.
7. Develop technologies and methods that allow for exploring and extracting minerals from sea bed deposits, deep-sea mining and mining under special conditions
8. Improve hard rock cutting techniques and deploy continuous cutting machines for [automated] and efficient operations within small deposits, deep-sea mining and special conditions mining
9. Test new, and adapt conventional, design layouts and operations to suit automation to decrease the number of workers in quarries and mines
10. Develop configurable, open, integrated interactive planning systems using new ICT
11. Make data available across operations with a view to increase efficiency and safety
12. Investigate means to create stability of automated mining operations at greater depths.
13. Apply new improved health, safety technologies: electrification of haulage machinery for rough terrain

**The biotic sector**

1. Develop efficient ICT systems for precision quantification and characterisation of forest-based wood materials i.e. precision inventory
2. Develop efficient ICT systems for planning of precision deliveries to industry customers taking the entire value and supply chains and customers into consideration
3. Develop forest-based standardised information systems like StanForD (Communication with Forest machines), papiNet Forest Wood Supply & Bioproducts, WoodX, Packaging, Pulp, Paper, Fine paper, Logistics, Label stock, Recovered paper, Logistics etc.
4. Apply ICT to develop precision forestry to enhance harvesting and silviculture operations for next generation trees
5. Develop intelligent forest operation systems and smart solutions for human-machine-terrain interactions.
6. Analyse and monitor changes in forest ownership and their implications for forest management, new opportunities and markets.
7. Develop new tree breeding strategies that include quantitative and molecular genetic tools aiming at sustainable and high yield of biomass, improved wood quality and resistance to stress.
8. Assess the economic, social and environmental benefits and risks associated with the use of genetically-improved trees.

#### Required Research and Innovation Actions by 2050

*To be developed*

## 1.2 Mobilising an increased supply of raw material from EU sources

#### Rationale

Due to the increasingly deeper mines, the haulage of the ore is one of the main energy consuming factors. At the same time, the transportation of the ore underground and in the pit as well as transportation of the product leaving the mine to the customer come with a number of emissions that are undesirable and costly. Furthermore, empty loads are a waste. Therefore, new transportation means and organisation are required.For secondary resources collection, transportation and delivery of final recycled material/product to market is critical.

**Biotic sector:** The intelligent and efficient production and use of biotic raw materials and the further development of precision forestry[[1]](#footnote-1) for efficient and environmentally-friendly operations, transport systems and management models for biomass supply chains are core activities of the biotic value chains. Improving technology for managing and utilising growing forest resources can be achieved through the measurement and planning systems adding value at a minimum environmental load while contributing to developing highly productive harvesting and transport systems integrated with general and specific industry requirements.

#### State of Play

**Abiotic sector:** Currently most transportation is not electric and developing and introducing electric vehicles is not without challenges. Electrified train haulage of ore is still under development.

**Biotic sector:** More precise information systems to guide harvesting operations are under development, relying on technologies such as remote sensing, navigation systems and geographic information systems. In addition to providing knowledge about the quantitative and qualitative performance, more knowledge is needed concerning the effects of forest operations on general biodiversity and different species, recreational preferences and trade-offs between different management regimes.

#### Expected Achievements by 2030

By 2030, Europe has further developed a comprehensive intra-EU database of primary resources on minerals and metals, and carried out the assessment of economic value for these identified resources.

**Biotic:** A new generation of resource inventory systems and flexible planning tools, enabling precise information on quantity and quality on local, regional and global scales, has evolved. New forest management and wood supply systems have improved the integration along value chains from forest to end-product, shortening lead times, increasing capital turnover, improving profitability of forest ownership and reducing environmental impacts. Small-scale private forest and land owners have been provided means to actively manage forests for wood production and other new services with the support of ICT tools.

The consequences of changing ownership structures for wood supply are better understood and this knowledge is used to advise on policy, reducing the negative impacts of these changes.

#### Expected Achievements by 2050

By 2050, Europe has completed the inventory and classification of EU primary and secondary raw materials sources. In terms of exploration and inventory of mining resources, the database has been updated with the results of the 2nd and 3rd actions.

#### Required Research and Innovation Actions by 2030

**The abiotic and biotic sector**

1. Develop incentives for small-scale private forest and land owners to actively manage forests for wood production and other new services with the support of ICT tools that enable forecasting earning opportunities based on multiple options of forest management.
2. Develop new (or adapt existing) ICT solutions for new, smart and integrated transport and logistics systems from local and regional to global scale, including road trucks and multimodal transport solutions and technology
3. Investigate opportunities to increase capacity to transport low weight loads, while reducing the number of modals in transit and minimising environmental impacts on the soil, CO2 emissions, and energy consumption.
4. Foster training and capacity building of technicians for efficient management of logistics with innovative ICT solutions
5. Create standardisation systems for new, smart and integrated transport and logistics systems that also include indicators on sustainability and security, with a view to ensuring fair competition among traditional players and fostering implementation of such systems by SMEs.
6. Develop tools and measurement techniques that provide the industry with fair and correct information on different raw material alternatives and their economic, social and environmental considerations
7. H. Monitor emotional and fact-based societal perceptions of forest management practices, reused and recycled wood-based products, bio- and nanotechnology and its derived products.

**The abiotic sector**

1. Develop concepts for long term successive land use planning for the whole life cycle of the extractive operation.
2. Compile a modern database and economic assessment of primary and secondary resources across the EU *(to be continued until 2050)*

**The biotic sector**

*Text to be developed*

1. Assess and develop scenarios for the availability and valorisation of forest-based raw materials in Europe in the global context under changing economic, social and climatic conditions.
2. Develop new inventory techniques for determining quantity, quality, dimensions and specific properties of forest resources.
3. Explore new space technologies to generate forest-related data, including high resolution space data, LIDAR-, IR- and radar data and to present those data layers together with relevant trade and climate change data
4. Improve sustainable short-term rotation management schemes for woody biomass production.
5. Develop flexible planning and decision support tools for obtaining sustainable wood supply from multipurpose forest landscapes.
6. Monitor emotional and fact-based societal perceptions of forest management practices, reused and recycled wood-based products, bio- and nanotechnology and its derived products.
7. Develop efficient technology for harvesting, extraction, processing and sorting terrain transportation to road side, including new ICT-systems, novel forest machine felling head measurement technology and models for processing characterisation, semi- and full automation support for increased harvesting and log processing efficiency.
8. Develop efficient technology for low soil impact, minimize rutting and increase accessibility to wood resources where soil bearing capacity is limited.

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#### Required Research and Innovation Actions by 2050

1. Complete modern database and economic assessment of primary and secondary resources across the EU
1. The concept of precision forestry takes advantage of best available knowledge and applied ICT. Standardised production records (thinning and final cut) from Cut-To-Length (CTL) harvesters can be intensively utilised for planning of next harvesting operation (thinning records and selection harvesting records) and silviculture operations for next generation trees (Final cut operation records for soil fertility, but rot and other potential pest and insect problems, mobility problems etc.)). [↑](#footnote-ref-1)