Vision

VERAM
Vision and roadmap for European raw materials
DRAFT: 15 March 2017

The EU Raw Materials sectors need to foster a **sustainable supply and use of Raw Materials** to feed existing and new value chains, while ensuring base loads from **EU resources**, decreasing **import dependencies** and ensuring resilience of the EU industrial base through **resource diversification**.

Outlook

The EU Raw Materials sectors will need to:

1. Provide and improve **sustainable supply** and use of primary, secondary and renewable RMs throughout the values chains.
2. Strengthen the EU economy, develop and reinforce the position of **EU sourced** primary- and secondary obtained RMs by decreasing import dependencies and ensuring base load supply trough diversification at source.
3. Embrace **digitisation** & manage technical and practical applications of digitisation in the sector. Traditional value chains will be revolutionised; Current processes will change radically and become data-driven. New business models will develop.
4. Develop and implement improved and better adapted measurable scientifically based values/indicators/**standards** associated with sustainability through the whole value chain where needs have been identified using newly developed data management systems.
5. Improve scientific and technical **dialogue** along and across business lines, exchange experiences, advance and leverage good practices.
6. **Cross-disciplinary integration** between academia and business for identification and development of new, cross-sectorial value chain opportunities.

The EU raw materials sector will foster security and sustainability of access to raw materials from within Europe by:

- Increasing EU production to ensure base load supply for the EU economy and reduce import dependencies;
- Improving access to resources in every possible way to attract more investments;
- Exploring investment possibilities outside of Europe to facilitate future access to resources and increase sustainability globally;
- Creating new jobs in the mining and mining services sector to compensate for loss of jobs through closure of coal mines in Europe and automation;
- Developing further the technical leadership worldwide and maintain global competitiveness in sustainable technologies.

The European forest-based sector can sustainably increase its primary wood production by 30%. This would strengthen the EU industrial base while adding around €100 billion in annual turnover to the EU economy.
Recirculation and reuse of biotic raw materials might have similar impact on the raw material security of the EU economy.
Together with light-weight, resource efficient products and materials it can reduce the carbon footprint to a fraction of what it is today.

Supply

Sustainable RM supply in EU entails:

1. Supply of the **precise quality of RM** from a balanced provision of primary, secondary sourced RMs and renewables.
2. Increased **EU RM supply** will be possible through development of new, highly precise, artificial intelligent, high yield exploration and harvesting/mining techniques of all type of resources with minimal impact on eco-system and sustainable land-use management.
3. Viable **supply routes for more diversified RM**s need to be further developed. Accurate material identification and continuous traceability throughout the value chain are required and enable development of new RM supply business models.
4. Research and new technologies to **retain RM properties** in re-use.

Enabling supply of EU RM sources through:

- Data management: inventories & classification, enabling data and information flow throughout the values chains.
- Technology: new exploration, new better yield extraction and beneficiation technologies for large and small deposits/ quantities of RMs, deep-sea mining and others, harsh-condition mining, asteroid mining technologies, quality secondary resources through novel recycling technologies, improving worker's and communities' health & safety through automation and reduced exposure.
- Access to Resources: Sustainable and integral land use planning and management avoiding sterilisation of mineral deposits.
- Management of Resources: Maintaining/improving/tracing qualities and properties throughout the value chains in order to enable optimised use/reuse of RM and its downstream products.

"**Precision forestry**" can maximise yield while further minimise the impact on the ecosystem. Precision forestry means that new remote sensing technologies and intelligent and sometimes autonomous technologies allow traditional forestry operations to be executed with tree precision, uninhibited by terrain- and weather conditions, while data on every valuable tree is collected and carried forward through each step of the value-chain from forest to end-product.

Processing

Step changes required in RM processing include:

1. Technologies enabling **resource efficient processing**; highest possible yield and per raw material usage while development use and valorisation of processing side material streams and by-products flows.
2. Smart technologies enabling **seamless data communication** and exchange along the value chain from exploration down to the production of more complex, durable, miniaturized & raw material efficient products, fit for a circular economy.
3. Integration of processes for industrial **symbiosis.**
4. Innovative primary & secondary conversion and processing technologies enhancing and **continuously determining RM quality** and performance.

- Smart technologies: Development of resource efficient processing & refining technologies for higher RM qualities tailored to market requirements (highest possible yields and beneficiation of by-products).
- RM valorisation: Production residue minimization & valorisation through optimized both metallurgical and constructive systems for the recovery of valuable elements from complex & low grade feed stocks and technologies for residual matrix valorisation, while providing safe sinks for toxic remnants.
- Industrial symbiosis: Turning "wastes" into "feed" materials across industrial value chains.
- RM purity/quality: Seamless data communication/exchange along the value chain from exploration down to the production of more complex, durable, miniaturized & material efficient products, fit for a circular economy.

- Significant developments in connectivity allow documenting each operational step and carry the information forward through each step of the value-chain.
- Regional businesses and infrastructure, including road networks are part of the system which creates additional jobs in local economies.
- Satisfying demanding consumers require a transition to agile production for mass customization. This in turn requires more flexible production and assembly processes, both for mechanical industries and process industries.

<table>
<tr><td rowspan="2">Markets & Applications</td><td colspan="2">Continuous availability of data in combination with precision purity RMs for advanced material engineering will enable one or a combination of Market Opportunities:
1. Development of more complex, higher functional density and increased reliable applications.
2. Multi-materials (layered or alloys), i.e. integrated and combined micro/nano use of many RMs for new or existing market applications while at the same time designing for up- and re-manufacturing, reuse and recycling.
3. Enabling technologies and addressing raw materials qualities and quantities, e.g. critical RMs, through new processes, other RMs or combination of RMs to provide the same, similar or even better performance.</td></tr>
<tr><td>Technological leadership:
• Industry 4.0: Tailored qualities and purities of RMs will enable development of new applications, new products, new functionalities as required for the Internet of Things.
• Enabling technologies: Where there is insufficient supply of critical materials new materials can be developed for new technology & energy applications including batteries, light, PV, consumer & professional electronics, materials for nanotechnology and biomedical applications, neuro-electronics and bionic applications.
• Eco-efficiencies: new advanced building materials that could ensure higher sustainability and durability.
• Circular economy aspects: new functional designs to improve the end of life products' qualities enabling functions/uses fit for remanufacturing/reuse/recycling/revalorisation and passing data along value chain to assist these processes.</td><td>Open access to data and unbroken traceability along the value-chain makes it possible to invest in a growing range of smart materials products and services. A global break-through for bio-based high-rise buildings is imminent and Europe should be in the forefront while creating but urban and rural business opportunities.

Mastering every aspect of the primary and secondary raw materials channels strengthens innovation and competitiveness. Examples: "Fibre takes on plastic, bio-based materials as an alternative of some ingredients used for producing concrete/building materials". Alternatives in materials and components can reduce the carbon footprint by providing resource efficient alternatives and employment opportunities in the green economy.</td></tr>
<tr><td rowspan="2">Closed Loops</td><td colspan="2">Managing material and product loops; re-use of processing side streams and by-products and maximising EoL product recycling back to RMs or products will require:
1. Life Cycle Assessment (LCA), standards, traceability and environmental performance can be measured easier and with better accuracy.
2. Materials identification or traceability techniques
a. Continuous and highly accurate (raw) materials identification or traceability techniques for precision raw material sorting.
b. Secondary raw material flows into the production cycle will require new separation technologies and new business models support to entrepreneurial efforts.
c. Agile sorting, recycling, refining, dismantling and reuse.
2. Development and implementations of logistics and/or development of and transition into new business models like:
a. Using a functionality and returning material or product after use, and/or
b. Sharing the use of a product.
3. Processing for the recovery of valuable elements also from complex & low grade feed stocks and technologies for residual matrix valorisation, while providing safe sinks for toxic remnants or reuse in other industries.</td></tr>
<tr><td>• Improving current recycling and revalorisation methods and increasing yields.
• Adapting recycling technologies to future complex and miniaturized products.
• Anticipating and developing adequate dismantling and sorting technologies for future designed products.
• Development of integrating assessment methodologies for balancing recycling costs and benefits and quantification of environmental, social, economic costs & benefits of increased recycling efforts.</td><td>To recycle the advanced products of tomorrow is a challenge we need to prepare for today. Biotic materials decay due to biological processes which require consideration when sorting, recycling, refining, dismantling or reusing. Secondary raw material flows into the production cycle require new separation technologies and new business models and support to entrepreneurial efforts.</td></tr>
<tr><td rowspan="2">Elements</td><td colspan="2">Metrics & Results</td></tr>
<tr><td colspan="2">Education, Training & Dissemination</td></tr>
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