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Non-ferrous Metals Manufacturing: Vision for 2050 and Actions Needed

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Non-ferrous metals manufacturing: Vision for 2050 and actions needed
This foresight study used a qualitative methodology engaging with a wide variety of stakeholders to define a 2050 vision for the European non-ferrous metals manufacturing industry and propose actions addressing challenges related to trade, innovation, resources, business integrity and skills.

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Executive summary

Context and objectives

One of the key priorities of the current College of the European Commission is to **strengthen** its **industrial base**. The objective is to bring back the industry's weight in the EU's GDP to 20 % by 2020. Taking the appropriate actions today in that direction requires anticipating the long-term needs of European industry.

The European non-ferrous metals manufacturing industry is an **important and strategic sector** directly employing 500 000 people and supplying products for numerous crucial downstream industrial sectors, such as public and private transport, energy production, construction and aeronautics, to name a few. As a capital intensive industry, its investment horizon spans over decades and is thus particularly in need of adopting a long-term strategic perspective.

The **objectives** of this foresight study are twofold. First, it aims at defining a long-term vision for the non-ferrous metals manufacturing industry: it proposes indeed an aspirational, achievable and clear view of where the sector aims to be in 2050. Second, the goal is to propose concrete actions that the industry itself, but also policy, research and other stakeholders can take to address the challenges faced by the sector on its path towards the vision. Special attention was given to aspects related to advanced manufacturing techniques.

Methodology

The study used a highly **participatory, qualitative methodology**: two workshops were organised and gathered representatives of the non-ferrous metals industry, research institutions, policymakers, trade unions and stakeholders from upstream and downstream sectors. The *Industrial Landscape Vision*, in particular, was used as a tool to prompt future, systemic thinking among the workshop participants. Virtually all insights generated in this report come from the collective interactive discussions that took place during these two workshops, along with a thorough literature review.

Key conclusions

The **vision statement** states that, by 2050, the non-ferrous metals manufacturing industry aims at being a valued and trusted world leader in delivering sustainable, innovative and competitive non-ferrous metals-based solutions traded globally. It intends to be a key player in closing resources loops, in acting and setting the bar for the highest social, environmental and ethical standards, in meeting evolving customer and societal needs while bringing social benefits through investments in Europe and top environmental performance, increasingly relying on renewable sources of energy and retaining and developing essential skills and know-how.

Four clusters of **challenges** were identified as relevant for the sector to reach its vision, along with appropriate **actions** to address them:

(1) **Trade and competition**.

The lack of a level-playing field, mainly due to different environmental and social standards and different energy costs across regions, is a crucial challenge for the sector to be a world leader. For some non-ferrous metals, the sector's dependence on import of raw materials is also problematic, especially given that it is a price-taker.

Proposed *industry* actions to address these challenges include defence measures against protectionism, vulnerabilities and volatility, differentiating non-ferrous metals products through quality, ethical and environmental added value and geographical expansion. There is a call for *policy* to further develop trade policies favouring a level-playing field, including enhancing transparency in the global pricing of raw materials, developing trade defence measures, and further negotiating free trade agreement to offset protectionism. European standards are a key component to address the identified challenges, by not only setting them but also promoting them at international level and ensuring their harmonised enforcement.

(2) **Innovation**

The non-ferrous metals industry faces some challenges to reach the innovation component of its vision: it is a relatively old industry and only indirectly meets end-consumers' needs as it produces

semi-finished products for downstream industrial sectors. It also faces challenges related to investment leakages and the difficulty to roll out innovations.

Embracing a culture of innovation to better understand end-consumers' needs, thinking systematically across the value chain, collaborating with smaller players in the downstream sectors, and using communication and marketing tools all contribute to the *industry*'s efforts to develop and sell innovative solutions. *Technological innovations* are also crucial: they include, for instance, hybrid solutions combining non-ferrous metals and new composites, smart materials with embedded intelligence, new processes allowing flexible manufacturing and big data analysis. *Policy* has a central role to play by providing a long-term innovation- and investment-friendly support to the industry, not only at the early stages of the research and development process. There is also a call for more flexible and adaptable regulations regarding materials classification to allow a quicker deployment of innovations.

(3) **Resources**

The vision's objectives of closing resources loops in a circular economy perspective, of increasing energy efficiency, and of relying on renewable energy sources, face several challenges. Regarding circularity, they relate to the proper collection, disassembly and reprocessing of scrap in line with the highest environmental and social standards. The issues around energy encompass among others the intermittent nature of renewables and the difficulty to store energy in a cost-effective way.

To address the circularity challenges, the *industry* should take full control of materials throughout the value chain by developing, for instance, take-back schemes and toll contracts. Together with policy actors, the industry ought to raise public awareness regarding the value of secondary materials and the need to sort and return them. Regarding energy, reducing its costs, investing in energy efficiency, acting as a virtual battery or as a grid stabiliser and pressuring for competitive prices for renewables are other possible actions. *Technology* is crucial to improve recycling processes and to trace and capture secondary raw materials. As to *policy* actions, deploying the full potential of the Energy Union, understanding and incentivising consumer's behaviour for scrap sorting and collection, and adopting risk-based rather than hazard-based regulations are among the actions proposed.

(4) **Business integrity and skills**

In order to be a trusted world leader, the non-ferrous metals sector faces challenges regarding its image, hampered by the sometimes poor social and environment conditions of primary raw materials production in third countries, the perceived negative environmental impacts of the industry and the misconceived scarcity of non-ferrous metals. The *industry* needs to invest further in raw materials traceability and transparency, in internal audit and external accreditation, as well as in communication efforts to showcase success stories, raise awareness about the importance of the sector and re-brand it. *Policy* actions can also contribute by developing global standards on responsible sourcing and identifying responsible suppliers, supporting fair trade, and mapping areas of conflict materials.

To retain and develop its essential skills and know-how, the industry faces similar image-related challenges that hamper its ability to attract qualified skills, as well as specific challenges regarding the transmission and the up-skilling of knowledge. The *sector* itself may improve pay and working conditions and promote gender equality to attract talent. Internal trainings, joint initiatives with vocational educational institutions and joint research and doctoral programmes with universities are also identified as tools to preserve and develop skills.

1 Context and objectives

A new political impetus for European industry

Since 2010, the European Commission has been calling for strategic, smart, inclusive and sustainable growth. In 2015, restoring the strength of European industry was presented as a critical part of the response to the economic crisis. Indeed, the first of the 10 priorities of the political guidelines of Commission President Jean-Claude Juncker ([1]) is a *new boost for jobs, growth and investment*, including the creation of favourable conditions for the **revival of European industry**. The fourth priority is a deeper and fairer internal market with a **strengthened industrial base**. The headline target is to bring the share of industry in EU GDP from 15 to 20 % by 2020, ensuring that Europe maintains its global leadership in strategic industrial sectors with high-value jobs.

The European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW) has already worked on the identification of barriers to the uptake of manufacturing technologies ([2]). In 2016, it also took the initiative to launch a platform ([3]) that brings together the various actors from the Commission and beyond to promote industrial modernisation at regional level and to support the efforts of EU regions committed to work together for developing a pipeline of investment projects related to industrial modernisation.

Objectives

In this context, it is strategically crucial to *define long-term objectives* for European industrial sectors and to understand the challenges they face, in order to best *anticipate the actions needed* today. However, the European manufacturing industry is very diverse and achieving the overall target will require developing shared long-term visions at sector level to mobilise all relevant stakeholders in a meaningful and coordinated way. Participatory foresight processes are well suited to this type of exercises. DG GROW appointed the Joint Research Centre (JRC) to develop and apply a foresight methodology on various manufacturing industrial sectors. Following a first case study ([4]) on the textile and clothing sector, this second and present study within this project focuses on the non-ferrous metals manufacturing industry.

The objectives of this study are twofold. The first goal is to **define a long-term vision** for the sector in order to provide a clear direction not only for industrial actors, but also for policymakers, researchers and all stakeholders alike. In a second step, the study aims at **identifying challenges** on the path towards achieving the long-term vision, as well as **actions** that could enable a successful transition to overcome these barriers.

In line with the Europe 2020 strategy, the present project is particularly interested in the potential of **advanced manufacturing** ([5]) and more broadly of new technologies, to maintain Europe's global leadership in strategic sectors with high-value jobs. Advanced manufacturing technologies may indeed enable the development of clean and competitive manufacturing industry in Europe by improving environmental performance and economic efficiency, allowing the use of a wider range of materials or bringing new flexibility to the manufacturing process and an increased ability to customise products and processes.

([1]) Juncker, J.-C. (2014), *A New Start for Europe: My Agenda for Jobs, Growth, Fairness and Democratic Change. Political Guidelines for the next European Commission*

([2]) European Commission (2016), *An analysis of drivers, barriers and readiness factors of EU companies for adopting advanced manufacturing products and technologies*, ISBN: 978-92-79-64467-2

([3]) European Commission - Joint Research Centre - Institute for Prospective Technological Studies (2016), *Industrial Modernisation - Smart Specialisation Platform.*

([4]) Bontoux, L., and Boucher, P. (in press), *Textiles and Clothing Manufacturing: Vision for 2025 and Actions Needed*, European Commission - Joint Research Centre: Science for Policy Report.

([5]) Advanced manufacturing are 'manufacturing technologies and production processes which have the potential to enable manufacturing industries to improve productivity (production speed, operating precision, and energy and materials consumption) and/or to improve waste and pollution management in a life-cycle perspective' (European Commission (2014), *Staff Working Document — 'Advancing Manufacturing — Advancing Europe' — Report of the Task Force on Advanced Manufacturing for Clean Production*).

2 Methodology and process

This study used a qualitative, highly *participatory* and future-oriented methodology, organised around *two workshops* gathering representatives from the non-ferrous metals sector, researchers, policymakers and other relevant stakeholders. Annex I lists the companies, sectorial organisations, research institutions and trade unions represented at both workshops. With the exception of references to the existing literature, all the insights presented in this report entirely build upon the output generated from these workshops and represent therefore the views of their participants.

To generate insights, the two workshops applied a variety of interactive methods (e.g. 'world café', plenary sessions, focus groups) and visual tools. A foresight tool, the *Industrial Landscape Vision* ([6]), was used to foster workshop participants' future-oriented thinking.

Specifically, the methodology followed a five-step process:

(1) Selecting a sector: assessing the relevance of the European non-ferrous metals manufacturing sector on the basis of five main criteria;
(2) Engaging with the selected sector and its stakeholders and recruiting study participants;
(3) Developing a systemic understanding of the future industrial landscape and a long-term vision for the sector (workshop 1);
(4) Identifying challenges to achieve the vision;
(5) Proposing actions to address the challenges (workshop 2).

The full details of the approach and how to apply it are described in a separate report ([7]).

2.1 Assessing the relevance of the sector

The non-ferrous metals manufacturing sector was selected based on economic, statistical and qualitative data around five main criteria: (1) significance of the sector in the EU economy, (2) industry structure (i.e. proportion of small vs big players, level of concentration), (3) manufacturing and technology intensity, (4) future potential in terms of growth and re-shoring and (5) the potential of the sector to engage actively in the case study.

2.2 Identifying key actors and stakeholders

An important task before conducting the workshops consisted in identifying the key actors of the sector, in understanding its structure, dynamics and positioning, and in engaging with it. An advisory committee comprising five representatives from Eurometaux, European Aluminium, the European Copper Institute and DG GROW was set up. This committee offered crucial support throughout the case study and in particular to reach out to the sector as a whole to invite relevant participants to the two workshops.

([6]) Scapolo, F., Churchill, P., Viaud, V., Antal, M., Córdova, H., and De Smedt, P. (2014), *How will standards facilitate new production systems in the context of EU innovation and competitiveness in 2025*, European Commission's Joint Research Centre Foresight Study. doi:10.2788/80985.
([7]) Bontoux, L. and Boucher, P. (in preparation). Future of Industry: Developing and Applying a Foresight Participatory Methodology for Industrial Sectors. European Commission - Joint Research Centre: Science for Policy Report.

2.3 Developing a systemic understanding and a long-term vision for the sector (workshop 1)

Outline

The opening session of the first workshop included an introduction to the team and the project, a brief description of the project and an icebreaker to place participants into an interactive and future-oriented mind-set. The bulk of the first workshop was then dedicated to (1) understanding the long-term landscape in which the sector will operate in the future and (2) developing a long-term vision for the sector.

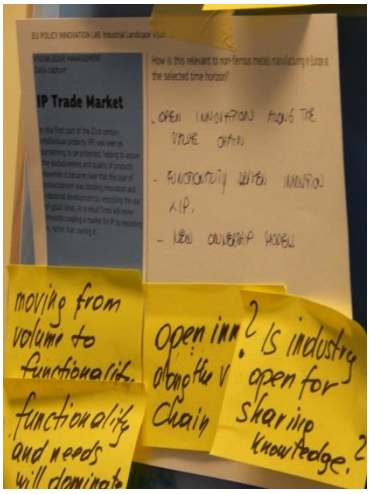
Time horizon

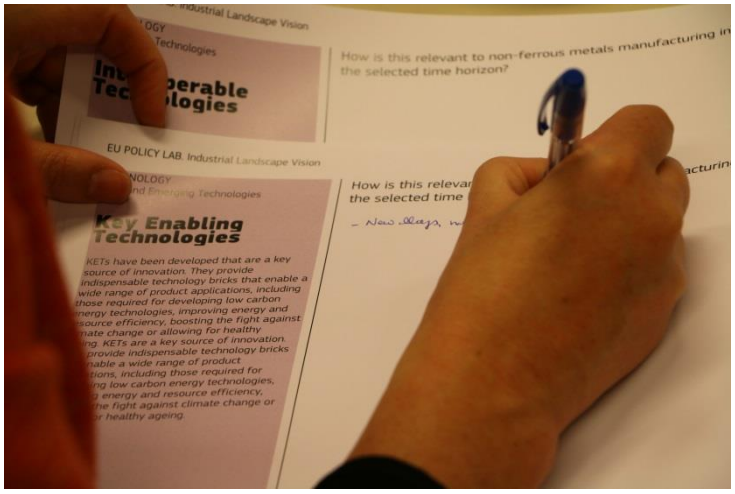
As a consequence of the capital intensive nature of the sector, it was considered that the standard 10-year time horizon used for previous case studies was too short. This opened a debate among workshop participants: while a clear consensus emerged that 2050 would be an appropriate time horizon for the vision building exercise, many participants felt that it would be more realistic to adopt a time horizon of 2035 when formulating recommendations for actions. As a consequence, the rest of the case study was performed taking this double time horizon into account.

Developing a systemic understanding of the industrial landscape

Participants were walked through the *Industrial Landscape Vision* (ILV), a qualitative, participatory tool designed to understand and capture the long-term context affecting the future of the sector. The ILV includes three intertwined layers: (1) the external layer refers to the 'Agents of Change', i.e. the long-term social, technological, environmental, economic and policy (STEEP) trends likely to affect the future of the sector; (2) the 'Production and Consumption System', at the core, relates to how people are likely to produce and consume in the future; and finally, (3), the 'Enablers and Constraints', connecting the two previous layers, are the factors affecting the evolution of the industrial landscape.

During two 1.5-hour sessions, participants analysed the various components of each layer of the ILV and considered whether and how they were relevant to the European non-ferrous metals manufacturing industry in 2050. For instance, participants reflected on the impact of factors such as ageing population, increasing global migration, faster product turnover, urbanisation, regionalism in policy, global pricing and rising demands for water and food.





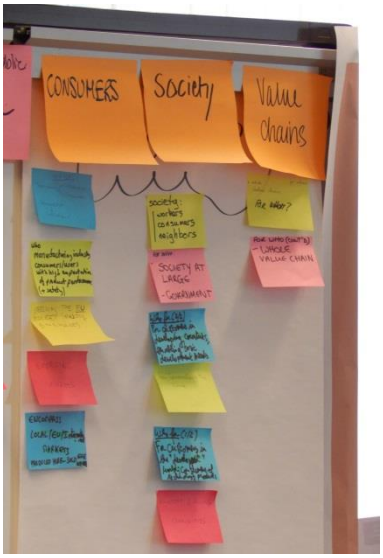
By populating the 2050 industrial landscape, participants were able, on the first day of the first workshop, to describe the long-term context of the sector. Doing so allowed them to adopt a forward-looking systemic perspective which was subsequently used to develop a vision statement. The purpose of the vision statement is to identify where the sector would like to be in light of the context identified in the industrial landscape.

Figure 1. *2050 Industrial Landscape* for the non-ferrous metals sector

Developing a long-term vision

To collectively develop a 2050 vision for the EU non-ferrous metals industry, participants were first asked to propose individually *keywords* representing important features of where they would like the sector to be in the proposed time horizon. The facilitators then consolidated and organised these keywords into a draft vision statement. In an interactive plenary session, the participants were then invited to develop and amend the draft vision collectively, define it into greater details and identify its key elements.

The *draft vision* produced during workshop 1 contained all the elements necessary for the exercise but there was still room for improvement in terms of drafting and the expression of the right nuances. Therefore, following the first workshop, the vision statement was refined on the basis of the first draft and notes taken at the workshop. All workshop participants were then consulted and their comments taken into account to finalise the *vision statement*.



Between the first and the second workshop, a comprehensive *vision narrative* was drafted in order to clarify the vision statement by developing each of its key elements into longer descriptions. The text of the vision narrative was developed based on (1) the insights generated during the first workshop, (2) further interactive in-depth discussions with the workshop participants and other stakeholders (via email and through an online community set up for the purpose), and finally (3) a thorough literature review.

2.4 Identifying challenges towards the vision

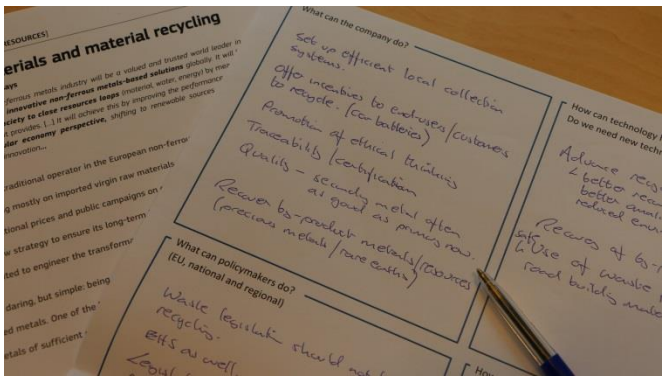
The next step of the process was to identify challenges and opportunities facing the sector on its path towards pursuing the vision. The outcomes of the discussions around the future industrial landscape in the *Industrial Landscape Vision* (ILV) formed the basis for this exercise, which had to be performed in preparation of the second workshop. In particular, the relevant components of the Agents of Change and the Production and Consumption System were analysed, together with relevant literature from the sector. The four clusters of challenges were (1) *trade and competition*, (2) *innovation*, (3) resources, and (4) *business integrity and skills*.

2.5 Proposing actions to address the challenges (workshop 2)

The final step of the process consists in developing responses, concrete actions that specific actors can take to capitalise on opportunities and overcome the challenges faced in achieving the vision. This task was the objective of the whole second workshop. The opening sessions included an icebreaker and a panel of short presentations from experts. The remainder of the workshop consisted of four 'Challenge Stations', one for each of the four clusters. A focus group method was used and repeated three times, with participants choosing which three of the four 'Challenge Stations' they wanted to attend and in which order.

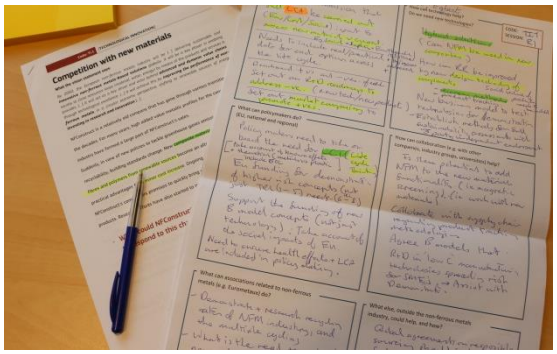
At each '*Challenge Station*', a moderator introduced discussion of the cluster to make sure everyone had a similar understanding of the issue. For each cluster — trade & competition, innovation, resources and business integrity & skills — three mini-scenarios had been prepared (reproduced in full in Annex II) describing a semi-fictionalised non-ferrous metals company facing a specific opportunity or challenge. Participants were then split into groups of three or four and each of these groups was given one mini-scenario to examine. The groups were given 30 minutes to discuss and develop their ideas and propose concrete actions that specific actors could take in order to overcome the challenge or capitalise upon the opportunity. At all 'Challenge Stations', a specific effort was made to collect information on technology needs.

Moderators were available to offer support where necessary and participants were given a *response sheet* to work with. This sheet provided separate spaces for participants to suggest actions that different actors — the company in the mini-scenario, policy actors, researchers, associations and other stakeholders — could take, prompting them to consider how technology and collaboration could form part of an effective response. It was designed specifically to keep the participants on-topic and to guide them towards the generation of ideas formatted to be easily recorded and extracted for subsequent use.



Once the allocated time elapsed, each sub-group presented their mini-scenario to the rest of the participants at the 'Challenge Station' and explained the ideas for actions that they came up with. This was an opportunity for challenging, amending and complementing the ideas that were generated, as well as for further discussion of the broad topic. The results from all mini-scenarios were compiled by each challenge station moderator into one summary response sheet. At the end, participants joined other 'Challenge Stations' according to the schedule they had chosen so that each was repeated from the beginning three times. The 'Challenge Stations' were populated by a different mix of people at every change. Each session required progressively less time as the participants became more comfortable with the task, requiring less guidance and working with greater confidence.

In an attempt to make the recommendations generated by this project as concrete and practical as possible, the second workshop was concluded by a plenary session dedicated to a reflection on how the ideas generated in the previous journey around the various 'Challenge Stations' could be put in practice with concrete *instruments*.



3 Relevance of the non-ferrous metals sector

The non-ferrous manufacturing industry deals with the production and transformation of metals that do not contain iron as a main ingredient, such as copper, aluminium, zinc, tin, nickel, lithium, precious metals, and minor metals. Non-ferrous metals are used for their specific materials properties, such as non-magnetism, resistance to corrosion, recyclability, durability and/or electrical conductivity. The clients of the sector include numerous and diverse industries such as electronics, mobility, batteries, construction, energy and packaging.

The term 'manufacturing industry' ([8]) is used in this report to reflect the focus of the present case study on smelting, processing into semi-manufactured products, and recycling, thereby excluding mining and final goods manufacturing. The study, however, does take into account the major importance of the upstream and the downstream sectors.

The following criteria were taken into account to select this industry:

- **Significance of the sector in the EU economy** ([9]). The non-ferrous metals manufacturing industry accounted for 1.25 % of EU manufacturing in 2010 and its turnover now reaches EUR 120 billion (1.8 %) ([10]). The sector directly employs more than 500 000 people. Regarding the demand side, the EU is one of the biggest consumers of non-ferrous metals worldwide.
- **Industry structure** ([11]). As a capital intensive industry, it is mainly made out of big players. In 2007, large enterprises (250+ employees) indeed accounted for 65 % and medium-sized enterprises (50-249 employees) for 26 % of the total turnover of the sector. While there is no more recent data available, we have no indication that this has changed significantly. The average size of the companies is contingent on the stage in the production process, with mainly large players for smelting, but many more SMEs for rolling, extruding and recycling. Because of the large volume of recycled materials and the low profitability of their transportation, large-scale concentration has not taken place in the secondary production of non-ferrous metals. The sector is also relatively concentrated, with the largest 10 producers worldwide representing approximately 50 % of the total production. In addition, it is a much diversified industry, with each non-ferrous metal facing specific challenges and opportunities. Aluminium, copper, zinc, nickel and lead represent the largest share in the manufacture of non-ferrous metals. This case study will often disregard the peculiarities of each non-ferrous metal and take instead a cross-cutting perspective.
- **Manufacturing/technology intensity**. Manufacturing is at the core of the sector. As a consequence of the very energy-intensive nature of this industry, high energy prices in the EU discourage investment in primary production, pushing the sector to develop recycling technologies.
- **Future potential**. For a number of non-ferrous metals (with the notable exception of aluminium), the EU has been losing share of the world market and its dependence on imported raw materials for the production of non-ferrous metals and metal products is growing rapidly. However, increasing transport costs, the sector's proximity to European end-users, and the growing importance of recycling represent opportunities for growth and re-shoring.
- **Engagement potential**. It was expected that the case study would benefit from the strong engagement of stakeholders from the sector. Initial contacts with Eurometaux (the association representing a large part of the European non-ferrous metals industry) confirmed the interest of the sector and the association's ability to mobilise different stakeholders in the case study.

([8]) To lighten the style, however, the report sometimes refers to the 'non-ferrous metals industry'.
([9]) European Commission – Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (2016), *Non-ferrous metals*.
([10]) Eurometaux (2017), *Key Industry Data*.
([11]) Ecorys (2011), *Competitiveness of the EU Non-Ferrous Metals Industries*.

4 Vision for 2050

The final text of the **vision statement** for the non-ferrous metals manufacturing industry is reproduced in Box 1.

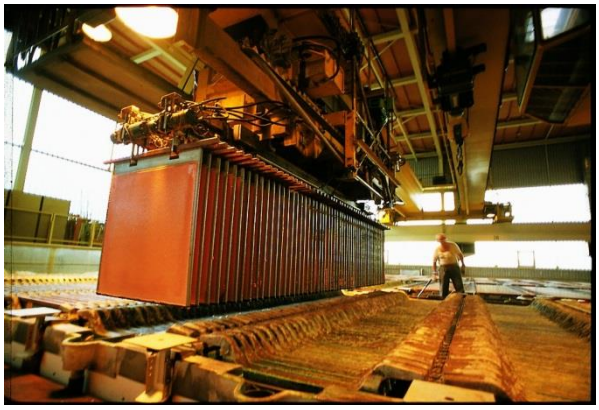
Box 1. Vision statement for the European non-ferrous metals manufacturing industry

By 2050, the European non-ferrous metals manufacturing industry will be a **valued and trusted world leader** in delivering **sustainable, innovative and competitive** non-ferrous metals-based **solutions** traded globally. It will be a key player in enabling society to **close resources loops** by means of the products and services it provides.

Not only will it act according to the highest **social, environmental and ethical standards** in the global sourcing of raw materials and in the trade and manufacture of non-ferrous metals, but it will endeavour to **set the bar** for these standards based on the best evidence.

It will serve both a strong European market and the global markets by **meeting** constantly evolving **customer and societal needs** in Europe and beyond, while providing social benefits through **investments in Europe** and **top environmental performance**. It will act as a key driver and actor behind advanced and dynamic value chains through technological excellence.

It will achieve this by optimising the performance of its non-ferrous metals-based solutions in a circular economy perspective, **shifting to renewable sources of energy**, investing in **research and innovation**, and **collaborating with all important stakeholders** in different value-chains, including employees, trade unions, policymakers, governments, citizens, consumers, academia and interest groups, while **retaining and developing essential skills and know-how.**



The **vision narrative**, which provides a more comprehensive picture of where the sector aims to be in 2050, is presented in Annex III.

5 Challenges on the way towards the vision and actions proposed

5.1 Introduction to the challenges

A number of challenges and opportunities for the non-ferrous metals sector were identified and clustered into four themes:

- **Trade and competition**. On its path towards achieving the objectives set out in the vision statement, particularly those related to competitiveness on global markets, the non-ferrous metals sector will face many challenges which mainly relate to the lack of a global level-playing field. As a price taker, the European non-ferrous metals sector is particularly vulnerable to trade distortions resulting from different environmental and social standards applied by different countries around the world. Geopolitical vulnerabilities in supplying countries, protectionism in overseas markets, and stagnating demand in the EU for some non-ferrous metals are other challenges tackled.
- **Innovation**. The vision statement ambitions that the European non-ferrous metals sector will be a world leader in delivering innovative solutions. This theme brings together many challenges to reach this objective, such as the need to adapt solutions to evolving end-consumers' needs, the competition with non-metallic materials, the need for more flexible and energy-efficient production processes and services, as well as the difficulty to implement innovations and to avoid investment leakages.
- **Resources**. As for all industrial sectors, resources are a major challenge, covering both energy and raw materials. The vision for 2050 clearly states that the non-ferrous metals industry wants to be a key player in closing the resource loops. The challenges here relate to the collection, disassembly and reprocessing of scrap, as well as the reduction of the need to import raw materials. The vision's objective to shift to renewable sources of energy presents numerous challenges regarding their intermittent nature and energy storage. More generally speaking, energy efficiency of production processes is a major challenge tackled in this cluster.
- **Business integrity and skills**. The image of the sector can sometimes suffer not only because it can be perceived as a remnant of old and dirty industries, but also because it can be affected by unethical mining operations in developing countries. The challenges towards becoming a 'valued' world leader 'setting the bar for social, environmental and ethical standards' are therefore both large and numerous. One of them relates to the public distorted perception of scarcity and non-renewability of non-ferrous metals. The difficulty to develop and attract workers is also an issue discussed in this theme, in light of the vision's objective to retain and develop skills and know-how.

This general description of the themes does not take into account the specificities of each metal. The picture for aluminium, for example differs significantly for this description in some aspects. This will be covered in more detail in the relevant sections.

The next sections describe the challenges facing the sector into more details and the proposed responses. Both the challenges and the actions to address them are inherently intertwined. For instance, developing innovations in the field of new alloys can overcome trade barriers and bring competitive advantages with regard to other materials. Similarly, strengthening resource information systems can address both the ethical challenges linked to raw materials sourcing and the collection and sorting of secondary raw materials. As much as possible, the suggested actions are presented in the most appropriate challenge section in order to avoid redundancies.

5.2 Trade and competition

The challenges

The vision for 2050 has the ambition of making the European non-ferrous metals manufacturing industry a world leader for *competitive solutions exchanged globally*. The vision also insists that the sector should rely on a *strong European market*, besides world markets.

The sector faces three intertwined challenges to reach this vision. Firstly, it must remain competitive in relation to *emerging economies* so that its solutions are traded globally. This is clearly a challenge, as there is currently a **lack of global level-playing field**. Smelters located in these countries usually have better access to raw materials, cheaper energy and, most of all, they often benefit from *lower environmental and social standards*. These differences are often exacerbated by subsidies and dual pricing of energy in competing world regions. These trade and price distortions result in the EU having a net trade deficit for most non-ferrous metals ([12]).

Secondly, **geopolitical vulnerabilities** create major challenges for the European non-ferrous metals manufacturing industry on its path towards the 2050 vision. These challenges not only hamper the sector when it comes to importing raw materials, but also for exporting its solutions. Political, economic and financial instabilities in countries where raw materials are produced, as well as natural disasters, make the costs of resources fluctuate. For instance, due the intertwined global supply chains, economic cycles in China and India have major impacts on the industries in Europe. In addition, the European non-ferrous metals manufacturing sector depends heavily on *imports of raw materials*, for which it is a *price-taker*: because the non-ferrous metals market is global, metals prices are set at the London Metal Exchange. Smelters, however, cannot transfer these fluctuating costs down the value chain, resulting in potential competitive losses for the sector. Therefore, a key challenge for European non-ferrous metals manufacturers is to build resilience to global risks related to volatile resources prices while trying to minimise them as much as possible.

Finally, a possible future challenge is the combination of the **slowing demand in the EU** and **protectionism** in overseas markets. While the vision states that the sector should mainly serve a strong European market, it is possible that further demand contractions for a number of metals may occur in Europe and in other traditional markets such as the USA and Japan. This possible limited domestic demand growth is linked to a *stagnating population* and *slow economic growth*. Likewise, European society is expected to increasingly demand *robust and long-lasting* non-ferrous metals-based solutions, which may affect the demand curve since there will be less new products needed. *Cloud-based technologies* may also decrease the demand for non-ferrous metals, as fewer internet servers are needed. New economic models based on *sharing rather than owning* (e.g. car sharing) should further limit the demand growth for non-ferrous metals in the EU.

These possible contractions of the European demand may only concern specific non-ferrous metals because changing economic models are likely to boost the demand for some others. For instance, aluminium's unique properties make it a key enabler for the low-carbon and circular economy that Europe is building, such that demand forecasts for aluminium-based solutions are still on the increase. So far, demand for aluminium is driven not only by the light-weighting trend in mobility – aluminium usage in car manufacturing is expected to double by 2025 ([13]) – but also by the need for energy-efficient buildings, light packaging and other applications (e.g. engineered products). The increasing demand for rechargeable batteries, likewise, is likely to boost the demand for cobalt and lithium.

([12]) Ecorys (2011), *Competitiveness of the EU Non-Ferrous Metals Industries*.
([13]) EYGM Limited (2014). *Business risks facing mining and metals 2014–2015*.

In contrast to Europe, faster economic growth in emerging economies, driven by faster *urbanisation* and the increasing number of *middle-class consumers* in the world, will stimulate the global demand for non-ferrous metals. Presently, the European non-ferrous metals industry mainly produces in Europe for the European market. In the future, the growing presence of consumers of non-ferrous metals in emerging economies will lead it to seek to export its solutions to these markets. *Protectionist measures* imposed by third countries (e.g. tariffs), however, may hinder the sector's efforts to export its innovative solutions.

Industry actions

Defence against protectionism, vulnerabilities and volatility

The industry, together with its sectorial associations, can call EU and national policymakers to act within the global trade framework to *strive for fair and undistorted trade* conditions. For clients located in vulnerable regions, *export protection* against non-payment can help, as well as ensuring that trade documentation is subject to international standards. Regarding price volatility of raw materials, the sector can regain its status as **'value' keeper**: besides gold and silver, copper, aluminium and other non-ferrous metals could also be stockpiled to a greater extent with a view to mitigating the fluctuation of commodity prices.

Ethical, social and environmental differentiation

Although policymakers have a critical role to play in fostering a global level playing field for the trade of non-ferrous metals-based solutions, the industry itself must take action as well. To counter the different standards applied worldwide, the industry can **stimulate the demand for sustainable non-ferrous metals** among end-users. Evidently, this is contingent on the industry's ability to guarantee the highest social and ethical standards of extraction, production and sourcing thanks to traceability (see the section on business integrity and skills). Sectorial actions such as the Aluminium Stewardship Initiative can contribute to this.

Raising end-users' awareness of and concern about the origin of raw materials can lead them to be willing to *pay a price premium* for products complying with — or even exceeding — the highest environmental and social standards. Doing so would allow considering non-ferrous metals as **more than commodities**, but rather as solutions with extended attributes, thereby contributing to integrating aspects other than price in the global competition for the trade of non-ferrous metals. This would obviously lead to a competitive advantage for EU-based non-ferrous metals manufacturers. However, at this stage, it is uncertain whether end-consumers are ready for this shift in their product choice criteria.

To stimulate the demand for sustainable non-ferrous metals, the industry — together with sectorial associations and other actors — can use two possible instruments. Firstly, it can create *fair trade or green labels*, as it is already the case for tin, to make end-users more aware of where materials originate from. Secondly, metal exchanges (e.g. the London Metal Exchange) could develop a *new price index* for raw materials meeting higher ethical and environmental standards. Associations related to non-ferrous metals have a clear role to play in supporting and coordinating these actions and in interacting with policymakers.

Quality differentiation

In order to overcome tariff barriers imposed by emerging economies, the European non-ferrous metals manufacturing industry needs to differentiate its solutions through quality. This may be achieved by (i) developing *new alloys* with better mechanical, thermal or electrical properties, (ii) designing *innovative solutions* (see the section on innovation) and (iii) developing *marketing actions* to promote the quality of its solutions in emerging economies.

New business models

If European demand for some traditional non-ferrous metals-based solutions slows down, or even decreases in the decades to come, the industry needs to reinvent itself. New business models based on **knowledge and service** may prove more successful: instead of selling products, the industry could start selling its services, its expertise, its skills and its technological solutions both in Europe and in the rest of the world.

For instance, with the construction of ever more durable buildings in Europe and the retrofitting or renovation of existing buildings, it may be that the sector specialised in non-ferrous metals for construction will face decreasing or changing demand. To cope with this, the sector may invest in emerging markets to export this knowledge. Similarly, exporting expertise in recovery of materials may help it remain profitable with less

European mass demand. Likewise, a *service-based business model* — centred for instance on recovery of materials or refurbishing — may complement the current one to ensure profitability in the face of lower aggregate demand.

Geographical expansion

Although its value added is currently in Europe, over the long run, it may be beneficial for the European non-ferrous metals sector to **serve emerging markets** and their growing demand. Doing so would help in addressing the challenges of stagnating EU demand for some non-ferrous metals and protectionism in third countries, while harvesting the potential for growth of emerging economies. Proximity with customers is a major competitiveness factor in this industry and it is therefore worthwhile not to stretch the value chain too far.

Three levels of actions are possible for geographical expansion.

A first step would be to develop close *cooperation with customers* in these regions, thereby allowing the building of trust and long-term relationships, while gaining insights into local end-consumers' needs and expectations, which may vary substantially compared to Europe.

A second, more elaborate action is to develop *partnerships with local players*. These collaborations can take various forms and serve different objectives, such as gaining access to the local markets, (re)using patents, generating energy (e.g. for water desalination), using clean development mechanisms to develop investment proposals for local technology development (e.g. using existing ETS structures), or designing service-based business models (e.g. using lease or product co-service) to support the shift to a circular economy.

Finally, a more thorough action is to invest in *new production facilities* in these emerging economies. This strategy would benefit from being deployed first in nearby markets.

Technology needs

Within the realm of challenges related to trade and competition, technology can only help indirectly. For instance, technological innovations can help *develop game-changers* likely to contribute to breaking trade barriers. They can also make the European non-ferrous metals manufacturing industry more competitive in relation to emerging economies, thanks to cheaper and *more efficient energy production* and use as well as thanks to enhanced *resource efficiency* (see the section related to resources challenges).

Policy actions

To meet the trade and competition challenges, policymakers probably have the most important role to play. Most of these actions are already taken on board by EU and national policymakers, but further deployment is still needed.

The non-ferrous metals industry supports free trade, as long as it is fair trade. Suggested policy actions revolve around three axes: (1) developing and enforcing **trade policies** aimed at providing a global level playing field and at facilitating exports; (2) setting, harmonising, promoting and enforcing social, environmental and ethical **standards** within the EU and globally; (3) ensuring trade-friendly **classification** of non-ferrous metals.

Trade policies

More agile and effective **trade defence** measures are encouraged to ensure a level playing field. Effective trade defence requires, among others, *anticipating, proactively monitoring* and addressing cases of *dumping* as early as possible. In that regard, China's recent adaptation of export taxes on raw materials (e.g. lead) may be a sign of its willingness to build overcapacities and to flood EU markets in the coming years..

The industry calls for *clarification* of the new *EU anti-dumping methodology* to ensure its successful implementation in practice, in coordination with its main trade partners (e.g. the USA). The burden of proof for anti-dumping cases should be placed on the exporting country, rather than on the shoulders of the European producers. In the context of the modernisation of the *Trade Defence Instruments* (TDI), the industry advocates the *abolition of lesser-duty rule* (whereby the rate of the duties offsetting dumping is based on the injury when it is lower than the dumping margin) in case of raw materials distortions.

Strong trade defence is still needed, in particular regarding China, to address the circumvention of import duties through the intentional use of *wrong trade codes* (e.g. re-melted coils and bars).

Policymakers are also encouraged to better *coordinate national trade agencies and initiatives* across Member States. In the case of the conflict minerals regulations, for instance, many national and EU initiatives are launched in parallel. This lack of coordination causes difficulties for the industry in monitoring and adapting to different initiatives. Along the same lines, all Member States are required to ensure the control of the origin of raw materials at their borders, but implementation is costly, difficult, and may differ between national authorities. Therefore, the industry is in favour of the creation of a European agency coordinating the implementation of regulations concerning conflict minerals.

Standards

Promoting EU standards at worldwide level is seen as a key tool to ensure a global level-playing field for the European non-ferrous metals sector. Levelling up international standards, rather than lowering them, would obviously give a relative competitive advantage to the European industry. The EU needs to be proactive in this task of promoting its own standards, as other competitors are defending other options.

Besides, there is also a call to ensure that *imported materials and products comply with the same standards* as those extracted or produced in Europe. Failing to do so creates unfair competition. Similar to what the US does, the EU may want to strengthen chapters on social rights in bilateral trade agreements so that EU standards for workers' rights and protection are enforced not only for Europe-based workers, but also for those in competing economies. To really ensure a global level-playing field, there should be a move from the current 'advised' enforcement to a mandatory enforcement.

A true intra-European level playing field also requires a *harmonised* **enforcement** *of standards*, which is currently the responsibility of Member States. For instance, the competition between European harbours is based to some extent on how quickly customs procedures can be cleared. The local customs thus often have an incentive to speed up as much as possible their checks of standards compliance. The harmonisation at EU level of customs clearance practices in harbours would thus ensure a better intra-European level playing field.

Classification

Manufacturers of non-ferrous metals semi-finished products (e.g. brass or other alloys) sometimes have to face **non-tariff based barriers** to trade, which are typically caused by specific technical legislations and different approaches regarding alloys labelling and classification. This may particular be the case for exports to the United States.

The EU has been indeed facing internal discussions and different positions between Member States regarding the harmonisation of (non-ferrous) metals classification. EU regulations regarding classification (e.g. the Classification, Labelling and Packaging Regulation) are already applicable to liquids or powders, but have not been validated yet for non-ferrous metals, or special mixtures containing non-ferrous metals such as alloys. This is not only creating issues in the EU market but, in a fast moving global market, is leaving room to other initiatives outside the EU that create barriers to the EU non-ferrous metals industry to export. California's Proposition 65, which requires the labelling of products that contain lead or other potentially hazardous substances regardless of how those products are classified in the EU, in an example of such classification initiatives outside the EU creating non-tariff based barriers to trade.

The industry therefore advocates appropriate and harmonised validation methods within EU regulations for the classification of metals and alloys, beyond liquids and powders.

The proposed actions for policymakers are further detailed in Box 2.

Box 2. Suggestions of policy actions for trade and competition challenges

Trade policies

- Negotiate (free) **trade agreements** to offset protectionism, with both supplying countries or blocks and new markets for exports.
- Better ensure **fair access** to (critical) **raw materials** needed for very advanced technology applications.
- Develop more **agile and effective trade defence** measures (e.g. new anti-dumping methodology, trade defence instrument modernisation)
- Consider implementing an approach to **carbon emissions taxation** that allows costs to be passed on to the consumer.
- Support cases against **breaches** of agreements or **failures to comply** with WTO obligations by raising joint cases with multiple actors.
- **Coordinate national trade** agencies and policies across Member States (e.g. conflict minerals regulations)
- Enforce policies for illegal trade practices by providing more **precise implementation conditions** (e.g. regulation on shipments of waste)

Standards

- Set standards:
  - Create standards that **build customer trust** (e.g. on recycled materials or end-products quality) so that competition is not only based on price.
  - Find a **right balance** for **environmental standards:** high enough for customer trust without harming competitiveness unduly.
- Promote and harmonise standards globally:
  - Promote and defend **EU standards in non-EU markets**, even the *acquis*: incentivise the **raising of standards** rather than price reductions.
  - Promote and defend Best Available Techniques Reference documents **(BREFs)** at the OECD level and in other international fora.
  - Lobby to **equalise** global **standards on product safety** and chemicals management (REACH)
- Enforce standards:
  - **Harmonise enforcement** of standards at regional and national levels within the EU (e.g. imports clearance practices in ports).
  - **Embrace whistleblowing** in case of unfair practices related to standards enforcement.
  - Impose the mandatory (vs advised) enforcement of EU standards for **workers' rights** through their inclusion in bilateral trade agreements.

Classification

- Develop appropriate and harmonised **validation methods** within EU regulations for the **classification** of non-ferrous metals and alloys, beyond liquids and powders.
- **Avoid classifications** that **hamper the image** of some non-ferrous metals (e.g. copper as active substance under the Biocidal Directive)

Other actions

- Take political action to **reduce political instability** in emerging markets.
- Protect **intellectual property** adequately and transparently, including in REACH regulation.

5.3 Innovation

The challenges

One of the objectives set out in the vision statement is to be a world leader in delivering **innovative solutions** that meet evolving customer and societal needs. In the decades ahead, several megatrends are likely to shape **new needs** that will require the sector to innovate more and more. These large-scale changes include, for instance, the rise of *urbanisation* and the related need for public transportation, an *ageing population* in most regions, ubiquitous *computing*, as well as the development of a *consuming class in emerging economies* and its associated changes in needs of convenient, fast, abundant and always new products and services. Most of these megatrends present **both threats** to the sector as well **as opportunities to innovate**.

Perhaps the most influential trend for the non-ferrous metals manufacturing industry is the increasing public awareness of environmental issues and the correlated **demand for more environment-friendliness**. The sector may take advantage of this pressure to innovate in areas such as recycling, energy storage, renewable energy generation and clean mobility. While the trend towards low carbon manufacturing presents threats (e.g. taxes on carbon emissions hamper competitiveness in the short run), it can also offer favourable conditions for innovation (e.g. development of new materials for wind turbines and electric vehicles). Nevertheless, the opportunities arising from this trend may relate more to materials in general (e.g. silver for solar cells, zinc and copper for wind power, aluminium for lightweight cars, lithium for batteries) rather than to European manufacturing industries specifically.

In this context, the industry faces three challenges if it wants to achieve the vision of delivering innovative solutions. Firstly, **new materials** based on non-metals may put non-ferrous metals under fierce competition. Composite materials based on renewable sources may be favoured by a society worried by a (perceived) scarcity of some materials. Secondly, the *pressure for cleaner and more energy efficient manufacturing* and recycling technologies will pose a challenge to an industry already under strong competition with other regions of the world. A major difficulty in this context will be to reach zero-emission manufacturing by 2050. Thirdly, even if the industry manages to propose innovative solutions, their initial high costs may render them uncompetitive. Innovative solutions, such as 3D printing of tailor-made parts using advanced alloys, new water cleaning technologies or recycling techniques for composite materials, are indeed difficult to take out of the lab. **Rolling out** the products of R & D to make them actual *marketable innovations* thanks to economies of scale is thus a major challenge. Given the lower production costs in other regions of the globe, another major challenge is to avoid **investment leakages** whereby the initial phases of innovation would be carried out in Europe with the support of governments, but actual investments in production facilities based on these innovations would occur elsewhere.

Industry actions

Embracing an innovative mindset

A prerequisite to innovate is to have a **culture of innovation**. The non-ferrous manufacturing industry is an old industry, with the first primitive smelters starting to operate 5 000 years ago. Unsurprisingly, inertia may

thus hinder changes to existing practices. Inertia may also result from relatively long investment cycles and technology development compared to other industries. A change of mindset with less reluctance to change is a first step towards addressing the challenges of innovation. Sectorial associations can help by constantly highlighting and stimulating possible technological breakthroughs.

Understanding end-consumers' needs

Another reason for the difficulty to innovate is the fact that the sector manufactures semi-finished products: as a business-to-business sector, it is not directly responding to end-consumers' needs, often the ones generating the pressure to innovate. Rather, it meets the needs of downstream goods manufacturers in extremely diverse sectors such as electronics, transport, batteries, construction, energy, etc. A new paradigm whereby *end-consumers are given more attention* can help innovation materialise. The 2050 vision statement is fully aligned with this philosophy: the sector is expected to deliver *'solutions' (rather than 'products')* to 'meet customer and social needs'. Focusing on **functionalities rather than volumes** also contributes to this deepened understanding of end-consumers' needs.

Thinking systematically across the value chain

Multidisciplinary approaches are at the base of innovation. Developing new alloys, for instance, requires collaboration across sectors, within sectors and beyond. Therefore, a value-chain management approach may help: to look at problems more *systematically*, getting different down- and upstream stakeholders involved may indeed produce better innovations than isolated initiatives. Such industrial partnerships may be especially needed for common issues related to societal challenges such as the need for a circular economy. Important flagship projects (e.g. the development of spare parts factories using 3D printing) can be a good opportunity to innovate across the value chain. Collaborations can take various forms, such as public–private partnerships. **Open innovation** requires new models of social relationships and, although this system raises fears of intellectual protection, there are opportunities to open source specific technological innovations to try and solve major societal challenges (e.g. the development of cheaper earthquake-resistant constructions).

Upstream, this entails exploring partnerships for the sourcing of special alloys needed for innovation. *Downstream*, collaboration may help to better grasp and anticipate the demand side. Here, one can identify the customers who are the leaders in driving the innovations and develop partnerships with them. Some downstream sectors also have more margins for innovations than other. There is, for instance, still ample room for developing recyclable constituents for aircrafts. Finally, engaging with *designers and architects* for specific lines of materials would contribute to developing meaningful innovations.

Win–win collaborations between SMEs and big players

The end parts of the value-chain are characterised by SMEs that are relatively close to end-consumers and agile enough to spot needs for innovation. They often lack, however, the financial and time resources or the scientific capacities to fully develop their ideas or, more often, to take them to the market. In contrast, the non-ferrous metals manufacturing industry, which produces semi-finished products for these SMEs, consists mainly of big players that have better access to financial resources and research facilities, but have less sense of opportunities for innovations.

In this context, **symbiotic relationships** between large and small players can help overcome the challenges of rolling out innovations. *Knowledge sharing to exploit ideas* may take different forms of innovation partnerships. The difference phases of development and marketing (e.g. research, licensing, and commercialisation) need to be shared so as to reach more win–win situations.

Communication and marketing efforts

To address the challenges related to the competition with non-metals-based materials, the industry can take two approaches. One is to look for *weaknesses in the new materials*, e.g. regarding durability, recycling, safety, handling and storage. Making life cycle comparisons of competing materials, including social and safety aspects, may also prove useful. A second line of action is to develop a communication strategy to *emphasise the advantages* of the current non-ferrous metals-based solutions. Another approach to challenge competing materials is detailed in the 'technology needs' section.

The same actions can be used to address the issue of taking innovations to the market to reach economies of scale. Making innovations known requires extensive *marketing efforts*, which nowadays inevitably use online channels.

Technology needs

There are obviously endless technology needs to respond to the innovation challenges. The following paragraphs detail those most directly linked to achieving the desired long-term vision.

One way to address the competition of renewable, non-metals-based materials is to develop *hybrid solutions* whereby non-ferrous metals would be used in new composites. This innovation would, of course, present numerous challenges, for instance in terms of end-of-life disassembly.

Smart materials may provide two key benefits. First, *embedding intelligence* in products through smart materials can make full traceability possible. This technology would allow knowing where and when materials were sourced and manufactured as well as their composition, thereby responding to the ethical and environmental sourcing challenges. Secondly, designing smart materials that facilitate *design for disassembly* would help achieve a fully circular economy. Similar to what was done in the early 2000s in the electronics sector, there may be extensive opportunities to disassemble composite materials. In any case, materials science should *avoid over-engineering* and focus instead on the core function of products.

Technological innovations can also contribute to addressing the challenges of resource efficiency and zero-emission manufacturing. **Big-data analysis** across the value chain, grid technologies, and captive low carbon primary production are valuable avenues to pursue. Innovations allowing *flexible manufacturing processes* are needed to reach the objective of almost exclusively relying on renewable energy, especially for energy intensive smelters.

Finally, the last domain of discussion on technology needs for innovation relates to manufacturing processes. In particular, there is a call for processes that would allow a more **modulated production**, thereby allowing for an easier way to match production to demand, a call to improve refining technologies (to be able to deliver all material qualities demanded by the market) and a call for integrating technologies. This would render the production of non-ferrous metals solutions more flexible in the perspective of an increasing diversity of products to be supplied to the downstream industries.

Policy actions

Policymakers have an important role to play in order to support innovation. At EU level, the Framework Programme Horizon 2020 already supports the development of innovations, including for non-ferrous metals-based technologies. The SPIRE project (Sustainable Process Industry through Resource and Energy Efficiency) is an example of the EU's support to innovation, in this case in the form of a public–private partnership. Participants in the workshops, however, proposed several lines of recommendations to better meet the innovation challenges in view of moving towards the 2050 vision.

Firstly, there was a clear general call for more **long-term innovation policies** to contribute to a fertile ground in Europe for innovations to be both developed and deployed. As a capital-intensive industry, the non-ferrous metals sector sorely needs predictable visibility of how the development of innovations will be supported by policymakers. Current tools for public support of innovations are seen as too oriented towards the short-term compared to the 20-30 year time horizon for investments in the non-ferrous metals sector. Given the industry's vulnerability to volatile economic cycles, predictable public support to innovations is essential to mitigate their inherent risks.

Secondly, to address the risk of investment leakages whereby innovative production would be rolled out outside of Europe, the stakeholders of the non-ferrous metals sector advocate not only long-term predictability of innovation policies, but also public support in the **later pre-market stages** of the innovation ladder (i.e. beyond the technology readiness levels typically financed by the EU framework programmes for research), including the building of pilot plants and the commercialisation step.

Thirdly, **regulations** must create favourable conditions for investments in innovative solutions. One of the difficulties encountered by non-ferrous metals companies is the slow speed at which the authorisation process for innovation solutions (e.g. new metals recycling methods) is carried out. The Reference documents for the Best Available Techniques (BREFs), in particular, may benefit from more quickly embedding new technologies in order to speed up the authorisation process.

Finally, policies related to *standards*, *public procurement* and *skills* can all contribute to help the non-ferrous metals industry meet the innovation challenges for the next 30 years.

The proposed actions for policy are further detailed in Box 3.

Box 3. Suggestions of policy actions for innovation challenges

Supporting innovation

- Design consistent, predictable, **long-term, and innovation-friendly** policy enabling and mitigating risk-taking
- Ensure a coordinated approach amongst all stakeholders
- Beyond research, support also the building of pilot plants and commercial deployment, in order to **address the 'valley of death' challenge**.
- Grant EU funding for pre-market demonstration of high-risk innovative solutions, including for Technology Readiness Levels 6-8
- Encourage the development of new markets through a more active role (e.g. recycled materials)
- Strongly enforce the **respect of patented technological innovations** in Europe and beyond
- Further set up and promote **technological platforms** for horizontal and vertical partnerships innovation development
- Fund large-scale research and development projects that **incentivise collaboration** throughout the value chain, between small and large actors
- Set new safety, sustainability and performance **standards** to drive demand for new products meeting the upgraded standards, thereby driving innovation
- Create the first demand for innovative solutions by introducing specific requirements for sustainability or performance into **public procurement**, so that novel technologies are deployed in the field

Providing innovation skills

- Expand innovation skills in academic curricula
- Further propose innovation skills in lifelong trainings

Innovation-friendly regulation

- Introduce **regulations that promote innovation** (e.g. eco-design, extended producer responsibility)
- Reduce the time needed for **innovations to comply with REACH**, by making Best Available Techniques Reference Documents (**BREFs**) more **open to innovation** (e.g. adapt them more quickly to innovations) and encourage pioneers

5.4 Resources

The challenges

Resources — including raw materials, water and energy — are fundamental for all manufacturing industries and a key aspect of the future of manufacturing in the European Union. The importance of resources is especially true for non-ferrous metals in view of the large dependency of European companies on imports of raw materials and fossil fuel from third countries. Overall, the European non-ferrous metals industry faces higher energy and raw materials costs than its global competitors, but this picture is subject to variations as specific circumstances affect various metals differently.

The vision statement developed in this study states that the industry 'will be a key player in enabling society to close resources loops' ([14]) and that it 'will act according to the highest social, environmental and ethical standards in the global sourcing of raw materials and in the trade of non-ferrous metals'. It also states that 'it will achieve this by optimising the performance of its non-ferrous metals-based solutions in a circular economy perspective'. Finally, the vision and the vision narrative also express the ambition that the sector will rely almost exclusively on renewable energy by 2050.

To reach the resource-related objectives of the vision, the sector will likely face various challenges, but may also benefit from some opportunities.

Firstly, regarding **circularity**, the main challenges are those linked to the proper **collection, disassembly and reprocessing of scrap**. Locally recovering scrap of sufficient quality is indeed, for some non-ferrous metals such as copper, difficult to secure. This being said, in the future, the concentration of end-users thanks to rising *urbanisation* may facilitate scrap collection and so is the case of the increasing public awareness of environmental issues. Beyond recovery, appropriate disassembly and reprocessing of scraps are currently problematic, as the EU is currently a net exporter of non-ferrous metals scrap. Scrap disassembly is further complicated by the development of *complex alloys* and composite materials, along with the production of more and more *sophisticated products* for end-consumers. Another main challenge of circularity is to promote *'closing the loop' within Europe* rather than (illegally or unfairly) exporting scrap to third countries with lower environmental and social standards for recycling.

While the circular economy is important to reduce the EU dependence on imports of non-ferrous metals in general, the picture is not the same for all metals. For aluminium, for example, the biggest problem is not the availability of raw materials, as bauxite is widely available, but rather the unfair competition from other regions (see section on trade). The increasing demand for aluminium, coupled with the long-life of many applications (e.g. buildings, mobility) prevents recycled production from covering the demand, making primary production still necessary.

Secondly, the challenges related to **energy** resources are numerous. **Renewable sources** of energy are often distrusted by energy-demanding sectors such as non-ferrous metals, in particular because of *unreliability of supply*. The difficulty to find cost-efficient technologies for *energy storage* poses other problems. Small production units — whose relevance is expected to grow in the future — are not resource efficient enough compared to larger plants.

Participants identified many actions that the industry itself and policymakers could undertake, in coordination with other organisations such as industry associations or research bodies.

([14]) The EU aims at recycling at least 65 % of its waste by 2030 (Vella, K. (2015), *AFEP COP 21 side-event on Circular Economy and Climate Change, in Paris*.)

Industry actions

Taking control of materials

From a circular economy perspective, closing material loops is at the core of the discussion. Reaching the goals expressed in the vision statement requires that the industry takes **full control of material flows**. In terms of business model, some companies may start to re-envision themselves as *materials management companies*, based on leasing and refurbishing solutions rather than selling them. This is not so much a technical issue as an organisational issue in terms of reverse logistics.

There is a lot the industry can do to this end, such as developing *deposit-return*, *leasing* and '*take-back*' schemes ([15]), investing in scrap collection (particularly, in separate collection) and developing tools and *big data* for traceability. Internally, the sector needs to invest in refining capacity and capability to increase not only the quantity but foremost the range of materials that can be profitably recycled to the right standards of quality. Identifying local recyclers and establishing long-term relationships with them is also part of the approach needed to secure local access to properly sorted secondary raw materials. Expanding the use of '*toll contracts*' can also be a way for the industry to retain ownership of non-ferrous metals and to get back recycled materials complying with quality standards. Toll contracts are agreements, in this case between a supplier and a recycler, to process a specified amount of material over a given period of time in a particular facility. The supplier of the metal retains ownership of the metal and pays the recycler a recycling fee.

Raising public awareness

End-users have a major role to play in increasing the efficiency of circularity for non-ferrous metals: recycling is deeply linked with *citizens' behaviour*. Consumers are currently not sufficiently aware that scrap is a highly valued resource. Too many drawers and too many attics are full of unused electronics, batteries and small appliances, and landfills are full of usable, but not sorted, secondary raw materials.

The industry, in close collaboration with sectorial associations and policymakers, should further *raise consumers' awareness* of the **need to sort and return** their used non-ferrous metals-based products. Likewise, end-consumers need to be further motivated, for instance with *financial and non-financial incentives*, to correctly sort their waste so that non-ferrous metals can be recycled. These types of actions require the integration of various actors, both along the value chain (e.g. municipal landfills) and across industry sectors, but also of industrial associations, all in close collaboration with policymakers.

Decarbonising and using energy resources efficiently

Energy is central to the non-ferrous metals manufacturing industry. As such, the questions of decarbonisation and energy efficiency lie at the core of the path towards the 2050 vision. The best energy is the energy that we do not use. Therefore, **investment in energy efficiency** sits at the top of the concerns. Addressing this challenge requires investment capacity that must be generated by the sector as well as the development of adequate technologies (see the sub-section on technology needs). **Reducing energy costs** is also important.

Proposed actions in this area range from securing access to energy production assets to acting as '*virtual battery*': according to this concept, the sector would be part of the management of energy assets and would be used to store energy, which would ease the use of renewable energy. The flexibilisation of the aluminium electrolysis process ([16]), in particular, can contribute to make this concept a reality. The sector could also act as *grid stabiliser*: as an energy-intensive industry, it could in theory regulate to a certain extent its demand of energy to stabilise, when needed, the overall grid. Interruptability clauses in energy supply contracts and the storage of energy in times of weak demand can help the non-ferrous metals sector support energy demand management. Furthermore, the sector can also partner with renewable energy experts to facilitate the transition to renewable sources of energy. It could also put pressure on electricity producers to gain *access to renewable energy at competitive prices*. Increasing energy efficiency can be achieved both directly (in the production of non-ferrous metals) or indirectly (e.g. by making buildings more energy efficient).

([15]) 'Take-back schemes' consists in producers financing the collection and treatment of their end-of-life products, Esenduran, G. and Kemahlıoğlu-Ziya, E. (2015), *A Comparison of Product Take-Back Compliance Schemes*,, Production and Operations Management*:* 24: 71-88, doi:10.1111/poms.12213.

([16]) Depree, N., Düssel, R., Patel, P. and Reek, T. (2016), '*The "Virtual Battery" — Operating an Aluminium Smelter with Flexible Energy Input*', in *Light Metals* 2016 (ed E. Williams), John Wiley & Sons, Inc., Hoboken, NJ, USA, doi: 10.1002/9781119274780.ch96.

Technology needs

New technologies are clearly needed to address the resources challenges faced by the non-ferrous metals sector to reach its 2050 vision.

Firstly, to address the **circularity** challenges, beyond the paramount need for technologies to *improve* the non-ferrous metals *recycling processes*, calls are made to develop technologies that are able to *trace and capture materials post-use* (e.g. information management), to *sort materials* and to *disassemble* products containing materials of interest.

Secondly, more innovation efforts have to be made on **energy**. The required shift to renewable energy sources calls for a range of adequate technologies which are still missing. In particular, technologies that can tackle the issue of the *intermittent nature of renewable energy* sources such as solar or wind are crucial. More specifically, there is strong call for better technologies to remove fossil fuels from casting. Overall, technologies that can *optimise energy efficiency* are strongly encouraged. In particular, research is needed to take advantage of *waste heat recovery*: because of the large amount of energy embedded in non-ferrous metals, these can also be seen as an interesting way to store energy.

New materials are another domain for technology development, especially regarding new alloys and less strict purity standards to make it easier to work with a wider range of alloys. This requires tackling related environment, health and safety issues. Technologies for importing raw materials from *space and deep-sea* may also help reduce Europe's dependence to emerging economies.

The role of universities in R & D is clearly recognised, especially to develop design standards, to speed up technological innovation and to develop new manufacturing and recycling processes.

Policy actions

Box 4 summarises the policy actions that were proposed to address the resources challenges for the non-ferrous metals manufacturing industry. They address both general issues and sectorial domains such as energy, R & D, market structures, waste management and public perception.

There are already current policy initiatives at EU level that contribute to addressing the non-ferrous metals' resources long-term challenges, including the Circular Economy Action Plan ([17]) and the recent modernisation of the fund of the EU Emissions Trading System ([18]), which now offers financing opportunities for the industry to develop and build new, more energy-efficient plants.

Regarding **energy**, there was a call to develop the full *potential of the Energy Union* to decrease energy costs, as well as to support the long-term stability and predictability in energy contracts. Supporting the non-ferrous metals industry in its objective to move to renewable energy is also crucial.

To address the **circularity** challenges, policymakers need to contribute in three ways. Firstly, by addressing the *urban mine challenge*, that is, by ensuring that scrap is correctly collected and sorted, for instance through environmental-based rather than labour-based *fiscal policy*, through *awareness-raising* programmes for citizens and financial and non-financial incentives for consumers, and through better *anticipation of long-term recycling needs.* Secondly, *discouraging the exports of scrap* through better enforcement and clarification of current regulation (e.g. waste shipment regulation) or through fiscal policy would ensure that secondary raw materials are re-entered in the production system within Europe. The issue of scrap collection and recycling is particularly strategic for critical raw materials, given the limited EU primary production and the difficulty to ensure a fair and secure access to non-EU sources. Finally, adapting the regulation to facilitate recycling is crucial. The fact that the REACH regulation, in particular, is hazard-based rather than risk-based impedes the industry from recycling, both from an economic and a regulatory points of view: adopting a *risk-based approach to (waste) classification regulation* entails taking into account not only the inherent toxicity of secondary raw materials, but also their exposure, which can be controlled to a large extent. This change in regulatory philosophy is a difficult task because Europe is traditionally risk-averse. A more pragmatic approach, however, would allow the non-ferrous metals industry to take fuller advantage of the benefits of the circular economy. The same philosophy of risk-based (rather than hazard-based) regulation is encouraged for other regulations such as the Directive on end-of life vehicles and the Directives on safety and health at work.

([17]) European Commission (2016), *Circular Economy Strategy*.
([18]) European Commission (2017), *The EU Emissions Trading System (EU ETS)*.

Box 4. Suggestions of policy actions for resources challenges

Energy

- Develop an ambitious and coherent EU energy policy by deploying the full potential of the **Energy Union**
- Strengthen EU energy policy for the shift to renewables
- Invest in **energy infrastructures** and **energy storage**
- Support long-term **stability and predictability** in energy contracts
- Include embedded energy when assessing environmental footprints

Circularity

- Develop clear policies to **support collection, sorting and recycling** of metal scrap
- Use **fiscal policy** to support the circular economy (e.g. by discouraging exports of scrap)
- Understand and incentivise **citizens' and consumers' behaviours** for scrap sorting and collection
- Facilitate the EU-wide **trading of scrap** and its processing within Europe
- Remove **barriers from regulation on waste** to non-ferrous metals recycling
- Create **new markets** for recycled materials through procurement and standards
- **Anticipate** the quantities of metals that will have to be recycled in the decades ahead (e.g. solar panels or wind turbines)
- Clarify and better enforce the regulation on waste shipments
- Set **standards** to support high quality recycling and eco-design
- Adopt **risk-based** rather than hazard-based **regulations** for recycling (e.g. REACH, End-of-life vehicles, health and safety standards)

Environment

- Develop tools to **certify** resource-efficient materials
- Use public procurement to support 'green' metals
- Promote *extended producer responsibility*

5.5 Business integrity and skills

The challenges

Trust in the sector

The very first sentence of the vision statement is straightforward: the non-ferrous metals manufacturing industry aims at being a **trusted** world leader. In order to be perceived as trustworthy by its customers, by policymakers and, more importantly, by society at large, the vision proposes that the sector would contribute to *setting* the highest social, environmental and ethical *standards* in the global sourcing of raw materials and would *act according to these standards*. The tools put forward to reach this goal include providing social benefits through *investments in Europe* and *top environmental performance*, as well as collaborating with all important stakeholders.

Several challenges stand in the way of making these aspects of the vision a reality.

Firstly, ethical scandals which occurred in the past seriously damaged the **image of the sector**, hampering its trustworthiness. The general public is shocked to read the headlines of newspapers describing the sometimes very *poor social* (e.g. exploitation of local workers) *and environmental conditions* in which ores are extracted in developing countries. The *conflicts* surrounding the production of raw materials and their exchange on global markets have further negatively impacted people's perception of the sector. With social media quickly spreading news, any future problem in the sourcing of raw materials is going to be reported more quickly and more widely. Even though the industry has taken sustained measures to improve the ethical profile of its products, a major difficulty lies in the fact that any isolated misconduct affects the whole industry and the whole value chain.

Secondly, trust is difficult to acquire and maintain among the general public as people tend to associate the industry with **negative environmental impacts**. Smelting is perceived as posing challenges to clean water and as substantially contributing to national carbon emissions. Moreover, people often fear a — *misconceived* — *imminent scarcity* of ores for non-ferrous metals. As a result, European citizens and politicians alike increasingly advocate instead the use of biodegradable materials, at the expense of non-ferrous metals, despite their recyclability.

Skills

Finally, the vision statement also stresses the importance of retaining and developing essential skills and know-how. This covers two issues: (i) how to *preserve long-held know-how* which will remain relevant for the long-term; and (ii) how to *acquire* the *new skills* needed to engage successfully in the technological transformation implied by the long-term vision objectives of closing material loops, becoming more energy efficient, switching to renewable sources of energy and developing better user-centred solutions.

To **retain its essential know-how**, a challenge for the industry is to keep *transmitting its 'on-site' knowledge* as many aspects of the smelting process are acquired 'on the job'.

The second challenge related to this issue is the industry's ability to **attract qualified skills** into its workforce. Although the expected increase in *global migration* may enlarge pools of labour, the industry may encounter difficulties in this domain, likely due to the ethical and environmental dimensions of the sector's image. For computer-savvy individuals, the industry may also be seen as a blue-collar, conservative sector with little opportunities to innovate. For maintenance and manual profiles, the expected extension of automation may entail some reluctance to start a career in the sector. Unless the image of the sector evolves, it is expected that the sector will face a skills shortage. **Up-skilling** its current **workforce** through *retraining* constitutes another important challenge for the sector to ensure the development and uptake of technological innovations.

Industry actions

Multiple actions from various stakeholders, but always with strong involvement of the industry, are required to deal with the identified challenges related to business integrity and skills.

Traceability and transparency

Although difficult to achieve on a practical level, a prerequisite to restore and improve the credibility of the sector is to ensure full transparency and full traceability of materials throughout the value chain. The

engagement of all industrial stakeholders at all levels of the hierarchy is therefore crucial. The industry may want to involve and partner with NGOs in addition to institutional and industrial actors in its efforts to improve traceability and transparency.

Innovative metals *impact assessment technologies* and **embedded digital tools**, such as the Internet of Things or big data, can be used for tracing the materials and their use (see also the recommendations mentioned for the resource challenges). The industry should also develop and promote standards for global sourcing, while ensuring a global playing field (cf. section on trade and competition challenges). The industry, together with organisations linked to non-ferrous metals such as trade associations, could also take advantage of creating and *promoting platforms for best practices*. Small private initiatives, such as the one by the Fairphone Company, could be used as a leading example. Finally, *voluntary certification schemes* can also contribute to the advocated full transparency.

Audit and accreditation

In parallel to developing traceability, the industry needs to develop and implement *internal control systems* to verify its supply chain. Besides these internal audit schemes, *independent accreditation* of responsible supply is of paramount importance for public credibility. As with other actions proposed for business integrity challenges, this one also requires the involvement of different stakeholders as well as sectorial associations.

Communication actions

Once it is able to guarantee the ethical and environmental profile of its products, the non-ferrous metals manufacturing industry needs to invest in communication actions. Establishing proper communication strategies based on ethically sound success stories should help **reshape the sector's image**, as well as engaging in sustainability reporting in cooperation with the relevant stakeholders. Environmental protection efforts would benefit from being visibly promoted.

More broadly speaking, creating community acceptance requires *raising awareness* among both policymakers and the public about the importance of non-ferrous metals for everyday life and for development challenges. A radical **re-branding** strategy, explaining non-ferrous metals' *value to society* and clarifying the industry's long-term plans, would help. Finally, the sector can further tout its recycled products as 'green' metals and position itself as a *job provider*.

The skills issue

For the **preservation of essential know-how**, the logical recommendation is to involve experienced staff in the *internal training* of new recruits. As to the **attraction of workers** with the relevant skills, there is also a need to improve the *pay and working conditions* in the sector to attract talent. Promoting and acting on *gender equality principles* would also definitely help in attracting more female workers to the sector.

The recommendations regarding the acquisition of **new skills** follow four lines:

- Develop training programmes for (older) employees to update their skills in a context of evolving technologies and external demands on the sector;
- Send (young) employees on internships and courses to learn new skills;
- Introduce innovative and life-long training schemes, making employees move around departments, visit mines, other plants, understand the downstream sectors;
- Engage with universities and technical institutes to support apprenticeship and to develop joint private–university research and doctoral programmes.

There is also a call for improving the technical profile of the people involved in the collection, separation and trade of secondary metals. Trade organisations can play a significant role here.

Technology needs

In the domain of business integrity and skills, participants also identified a number of needs for technologies and technical capacities. Linked to needs for developing a clear life-cycle understanding of products and for certification of products and practices, robust methods for *environmental impact assessments* (including LCA approaches and sustainability assessment) are urgently needed. Similarly, there is a demand for good *methods to benchmark companies* according to the required standards. Information and communication technologies have a large potential to help fulfil these needs. As mentioned earlier, the industry must also learn to use *big data* and the *Internet of Things* to solve the issue of traceability.

Policy actions

Establishing ethical supply chains for non-ferrous metals is in line with the values promoted by the EU and should therefore be supported by the EU at its highest level. Indeed, President Juncker's political guidelines presented to the Parliament and the European Council state that the EU is founded on **values**: respect for human dignity, freedom, democracy, equality, the rule of law and respect for human rights. Promoting them is a main objective of the European Union in order to make a successful exit from the economic crisis, find new sources of economic development and social cohesion to renew our social market economy, advance a people's Europe with freedom and security, and open a new era for global Europe. This resonates with the policy actions recommended by this study (Box 5).

Box 5. Suggestions of policy actions for challenges related to business integrity and skills

Standards

- In cooperation with the industry, contribute to develop and promote global **standards** on responsible sourcing
- Develop and incentivise 're-education' programmes to make the sector operate according to the new standards

Ethical issues

- Support the development of **price indices** for materials exceeding current ethical standards
- Promote and enforce **fair trade**
- Develop a **list** of certified responsible suppliers of raw materials
- Uphold environment protection and human rights
- Map **areas of conflict minerals**
- **Reward** publicly the actors playing by the rules to promote them

Ex post auditing

- Set up third party independent audit schemes
- Promote life-cycle thinking and good end-of-life practices for all materials

Skills

- Help make **working conditions** in the non-ferrous metals industry attractive
- Support **education**, offer scholarships for new needed skills
- Focus on **vocational training** to recalibrate senior workers' skills according to evolving needs of the industry

Actions for other stakeholders

More than any other challenges, issues related to business integrity and skills require deep collaboration with other stakeholders. In particular, the industry's efforts in this area (e.g. audit and accreditation, communication actions) should be supported by sectorial associations. Trade organisations could interact with public authorities and the policymaking world to define and get agreement on *common needs of the non-ferrous metals industry for ethical standards and skills*. Downstream players should also be involved to a large extent.

Regarding the skills challenges, collaboration with schools and universities is necessary. Beyond training needs and research, these collaborations can also be used to create open innovation platforms.

6 Conclusions

The non-ferrous metals manufacturing industry is an **important and strategic sector** for Europe that supplies solutions for numerous and crucial sectors such as energy production, construction, electronics, transport equipment, and batteries. It is a very diverse industry transforming different materials such as copper, aluminium, lead, nickel, lead, zinc, but also precious metals and minor metals.

In a policy context of renewed importance of EU manufacturing, this foresight study was commissioned by DG Internal Market, Industry, Entrepreneurship and SMEs (DG GROW) to provide a **long-term perspective** as to the objectives and the needs of the non-ferrous metals sector.

The study was organised around two **participatory workshops** that brought together stakeholders from across the value chain, including representatives of the industry, upstream suppliers and downstream customers, trade unions, academics and policymakers. This qualitative, participatory methodology made use of the *Industrial Landscape Vision*, a tool developed by the JRC to create a systemic understanding of the sector and to identify the relevant trends likely to shape its long-term future.

Vision for 2050

The *vision statement* provided in Section 4 highlights the ambitions of the European non-ferrous metals manufacturing industry for 2050. Key features of this vision include the sector's willingness to be a **valued and trusted world leader** delivering *sustainable, innovative, and competitive solutions* for European and global markets. Fully closing *resources loops*, adapting to constantly evolving customer and societal *needs*, and relying almost exclusively on *renewable sources of energy* are some of the sector's most ambitious goals. The importance of social, environmental, and ethical *standards* is also acknowledged in the vision, both to act according to them and to set the bar for them. Several paths are proposed to reach this vision, including product performance optimisation, research and innovation, collaboration with stakeholders, and the development of essential skills and know-how.

A more complete *vision narrative* for the sector is to be found in Annex III (Section 7.3).

Challenges and actions needed

Four key **challenges** emerged in the study as being faced by the sector in the coming decades on its way towards the 2050 vision: trade and competition, innovation, resources, and business integrity and skills.

Industry actions

Obviously, the industry itself has a major role to play in addressing these challenges. Industry actions to tackle trade and competition challenges include, for instance, differentiating its solutions on global and European markets based on *quality* and **ethical, social, and environmental added value**, as well as raising end-users' awareness so that these attributes *beyond price* are integrated in the competition. *New business models* based on knowledge and services are also proposed.

To deal with the innovation challenges, the industry needs to embrace a more proactive mindset by better understanding **end-consumers' needs** and by collaborating more closely with downstream sectors.

For resources challenges, the recommendations for the industry include taking full **control of materials flows**, raising public awareness about the value of secondary raw materials, investing in energy efficiency and reducing energy costs.

Regarding business integrity issues, there's a need to invest in **traceability** in full transparency, to undertake external *accreditation schemes*, and to change the way the sector communicates about its social added value. Skills can be maintained and enhanced by working on the **sectors' image** and by more closely cooperating with universities and vocational schools.

Policy actions

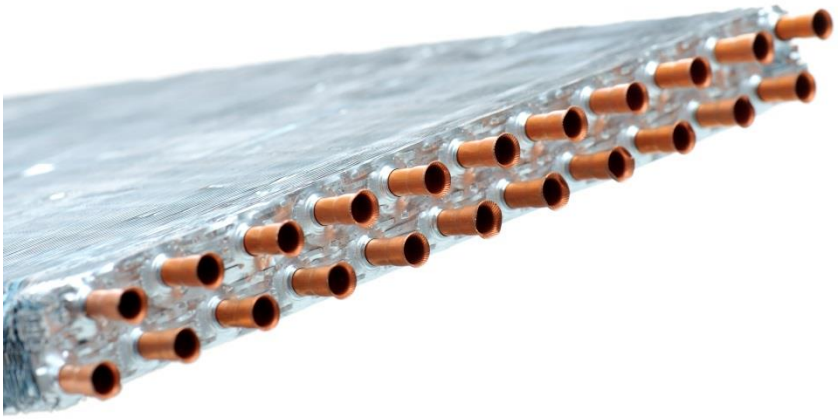
Stakeholders stress the need for taking long-term perspectives in policy (20-40 years), as the non-ferrous metals manufacturing sector is very capital intensive and follows long investment cycles. This requires, in turn, **stability, predictability and readability** of policies over long periods to give the opportunity to the sector to steer its long-term future and keep investing in Europe. There is also a clear call for policymakers to

show reasonable *leadership* and ensure *coherence* across policy areas. *Political will* and *prioritisation* are considered as very much needed to really promote the reindustrialisation of Europe.

To assist the industry in addressing trade and competition challenges, policymakers must create a global **level playing field** on the basis of high environmental and ethical standards promoted internationally and their actual, harmonised enforcement at international level. Trade defence policies to address protectionism and dumping cases continue to be highly relevant to that respect.

Regarding resources challenges, the strategic importance of circularity requires that policies remove any barrier to materials recovery and recycling created by waste legislation. Embracing a more pragmatic philosophy for materials classification, based on risk rather than on hazard (thus taking exposure into account), can contribute to helping the sector reach its circularity objectives. Understanding and incentivising citizens' behaviour for scrap sorting and collection is also needed. Policy actions to support innovation are, to a large extent, similar to those addressing the resources challenges.

Mapping areas of conflict materials, rewarding actors playing by the rules, identifying responsible suppliers of raw materials, and promoting life-cycle thinking are among the actions recommended to address the sector's business integrity challenges. For challenges related to skills, policymakers are advised to help make working conditions attractive and to focus on vocational training for upskilling.



Actions for other stakeholders

Actions taken by other stakeholders could facilitate significantly the actions taken by the industry and policymakers to address the different challenges. For example, trade organisations need to play an important role in creating non-competitive platforms for technology development, development and promotion of design standards or benchmarking best practices. They can also play a significant role in developing and promoting certification schemes, and preparing position papers. Finally, they can also help by raising awareness in society, educating policymakers and promoting compliance with standards and legislation. A wider range of actors can also contribute: consumers acting more responsibly, schools adapting education, and all actors in the value chain acting more responsibly and in better coherence.

Technology needs

To address all of these challenges, technology is crucial. Its contributions relate to generating a better life-cycle understanding of materials, tracing and controlling materials, improving process flexibility and energy efficiency, and facilitating the transition to renewable sources of energy. Smart materials with embedded intelligence, big-data analysis, waste heat recovery are among the technological innovations that may contribute to these goals.

Box 6 presents the main outcomes of this study related to advanced manufacturing and technological innovation.

Box 6. Key barriers and opportunities for advanced manufacturing and technological innovation

Key barriers to advanced manufacturing

— The *capital intense* nature of the sector entails a relatively *slow uptake of new manufacturing technologies*, in relation to other, more agile, industrial sectors.

— As the prices of non-ferrous metals are set at global level, the international competition between manufacturers is mainly based on cost. This makes the *lack of global playing field* an acute problem for European non-ferrous metals manufacturers and diverts efforts from investing in advanced manufacturing. This cost competition often leads to diverting investments away from the EU to regions with lower environmental and social standards.

— The sometimes controversial *image of the sector* decreases its attractiveness to workers with relevant skills for advanced manufacturing, such as digitalisation.

Key opportunities for technological innovation

— Working in closer *collaboration with downstream* goods manufacturers represents an opportunity for the sector to innovate by better understanding end-consumers' evolving needs to deliver *'solutions' rather than 'products'*.

— Society's *pressures for more environmentally friendly* manufacturing and the need to *depend less on imports* of raw materials from outside Europe push the sector to further innovate towards more circularity.

— *New business models*, for example, based on leasing rather than selling, made possible by technologies embedded in materials and by the new 'sharing economy' represent significant opportunities for the sector to innovate and increase control of materials flows in a circular economy perspective.

— The need to develop and use *ethical and social distinguishers* incentivises technological innovations for traceability.

7 Annexes

7.1 Annex I — Organisations represented at the two workshops

Aalto University	Research institution
ABVV-Metaal	Union
ACV-CSC Metea	Union
Agoria	Association
AIT Austrian Institute of Technology	Research institution
Albermarle Europe	Company
Asturiana de Zinc (Glencore)	Company
Aurubis	Company
Boliden	Company
Connexis AG	Consultant
Deloitte Conseil	Consultant
Eurometaux	Association
Euromines	Association
European Aluminium	Association
European Commission — DG GROW	Policy
European Commission — JRC	Policy
European Copper Institute	Association
European Electronics Recyclers Association	Association
Fauris GVC	Consultant
Flemish Institute for Technological Research	Research institution
Fraunhofer Institute for Systems and Innovation Research	Research institution
International Copper/Lead/Zinc/Nickel Study Group	Association
International Magnesium Association	Association
International Zinc Association	Association
KU Leuven — Faculty of Engineering Science	Research institution
Minor Metals Trade Association	Association
Netherlands Metallurgical Association	Association
Nickel Institute	Association
Novelis Europe	Company
Nyrstar	Company
Ramboll Environ	Consultant
European Association of the Portable Rechargeable Batteries Industry	Company
Rio Tinto Aluminium	Company
Tatasteel	Company
The Cobalt Development Institute	Association
Umicore	Company
University of Creative Arts	Research institution
University of Patras	Research institution
University of Zaragoza	Research institution

7.2 Annex II — Scenarios

Trade and competition

Scenario 1: Barriers associated with competition by emerging economies

QualMetal is a large metals production company that has embarked on an expansion of its production. Over the next 5 years, they want to increase economies of scale, reduce energy costs and conquer new markets to remain competitive. However, QualMetal is facing increased competition for raw materials due to higher market participation by emerging economies. One of the biggest difficulties relates to the fact that different environmental and social standards apply globally, with competitors from these emerging economies applying lower cost practices.

Q: How could QualMetal and other stakeholders respond to this challenge?

Scenario 2: Geopolitical vulnerabilities and protectionism

NFM Products Corp. is a large metals production company that has embarked on an expansion of its production. Over the next 5 years, they want to increase economies of scale, reduce energy costs and conquer new markets to remain competitive.

Given the low demand in Europe, NFM Products Corp. aims to adapt its solutions to the needs of other regions of the world, such as Southern America. While the demand for NFM Products Corp.'s technologically advanced products is high in the region, trade barriers impede its full expansion. As in other parts of the world, Southern America has increasingly relied on self-sufficiency thanks to its energy independence. Nationalistic pressures have also incentivised local politicians to raise protectionist trade barriers with other blocks of the world.

Africa is another potential market for NFM Products Corp.'s products. However, due to its vulnerability to severe droughts caused by climate change, the continent is still subject to recurrent political unrest, resulting in unsecure trade with the area.

Q: How could NFM Products Corp. and other stakeholders respond to this challenge?

Scenario 3: Low demand in the EU

NFM Products Corp. is a large metals production company specialised in solutions for the building industry. Over the next 5 years, they want to increase economies of scale, reduce energy costs and conquer new markets to remain competitive.

Although the company has so far mainly relied on local European demand, it is now clear that the latter is stagnating due to a number of factors. The natural population increase has been barely positive for decades and, during the same period, there has been virtually no significant economic growth in various countries. Furthermore, pressures on sustainability have led to the construction of extremely durable buildings, which means that the demand has shifted from the construction of new buildings to the maintenance of existing ones.

Q: How could NFM Products Corp. and other stakeholders respond to this challenge?

Innovation

Scenario 1: Competition with new materials

NFConstruct is a relatively old company that has gone through various transitions over the decades. For many years, high added value metallic profiles for the construction industry have formed a large part of NFConstruct's sales.

Suddenly, in view of new policies to tackle greenhouse gases emissions and improve recyclability, building standards change. New composite materials based on carbon fibres and polymers from renewable sources become an alternative that offers practical advantages for a minor cost increase. Ongoing R & D performed by NFConstruct's competitors promises to quickly bring down the cost of these new products. Research efforts have also started to make them recyclable.

Q: What could NFConstruct and other stakeholders do to respond to this challenge?

Scenario 2: New metal products thanks to 3D printing and new alloys

Metallix is a relatively old company that has gone through various transitions over the decades. For many years, Metallix has made a large part of its sales with high added value metallic profiles for the construction industry.

After a strong earthquake hit southern Europe, an imported EU-supported aid and reconstruction package was launched, calling for the application of the latest anti-seismic techniques and encouraging the use of new technologies and construction concepts. This tragic event has also brought attention on the need to retrofit many (sometimes very) old buildings in other vulnerable zones and make them resistant to earthquakes before a new catastrophe occurs.

MetalliX products contribute to the stability of new buildings and the company has been involved in a past EU research project aiming at developing technologies to increase the earthquake resistance of existing buildings. The project achieved its stated aims and came up with a prototype system based on 3D printing tailor made parts using advanced alloys. This is still too expensive for MetalliX to use it at large scale and most traditional building contractors are unfamiliar with it. Finally, in case the product becomes successful, you would rapidly need to increase production of the special alloys needed.

Q: How do you approach this potentially large business opportunity? What could Metallix and other stakeholders do to respond to this challenge?

Scenario 3: Cleaner manufacturing technologies

For many years, high added value profiles for the construction industry have formed a large part of MetalOris's sales. Most of its products are standard profiles made in two large factories Europe, using high quality materials.

Governments and citizens organisations put pressure on the construction sector to limit carbon emissions, including for the manufacturing of construction materials. MetalOris believes that responding to these pressures by reducing its emissions as much as possible could lead to a significant competitive advantage in the future: procurement for public buildings will soon include this criterion for tenderers and the general public is more and more willing to pay more for housing using zero-emission manufactured materials.

To respond to this trend MetalOris has started to consider investing in advanced manufacturing and recycling technologies that are much cleaner and more energy efficient and that allow to produce a much wider variety of products. The end goal is to reach zero-emission manufacturing within the next 20 years.

Q: What could MetalOris and other stakeholders do to respond to this challenge?

Resources

Scenario 1: Building a business with a circular model

After having been a traditional operator in the European non-ferrous metals business for 50 years and suffering not only the vagaries of international prices and ethical sourcing for raw materials, but also environmental legislation, MetalStar SA is looking for a new strategy to ensure its long-term future in a sustainable world. A new CEO has been recruited to engineer the transformation. The objective is daring, but simple: being able, in 20 years, to operate on at least 90 % locally recovered metals on a fully circular model using 100 % recyclable raw materials.

Q: Considering that MetalStar SA is starting this transformation on the basis of today's circumstances, how can it do it? What is needed to make this possible?

Scenario 2: Shifting to renewable energy

The non-ferrous metals industry is a very energy intensive sector essentially relying on fossil fuels. MetalStar SA has been a traditional operator in this sector for 50 years. In its search for a new strategy to ensure its long-term future in a sustainable world, MetalStar SA realises that operating on 100 % renewable energy would not only allow it to achieve the mandated greenhouse gas emission reduction targets, but would also free it from a range of geopolitical risks and ensure it a stable energy price. However, oil prices have been very low since 2014 and the necessary energy technologies and infrastructures are not yet in place and renewable energies do not have a strong track record in being a trusted provider for highly concentrated energy demands. Questions arise around energy storage, reducing energy demand, reliability of renewable energy supply …

Q: What should MetalStar SA do? What is needed to ensure a successful transition?

Scenario 3: Sourcing materials and material recycling

After having been a traditional operator in the European non-ferrous metals business for 50 years, working mostly on imported virgin raw materials and suffering the vagaries of international prices and public campaigns on ethical mining, MetalStar SA is looking for a new strategy to ensure its long-term future in a sustainable world. A new CEO is recruited to engineer the transformation.

The objective is daring, but simple: being able, in 20 years, to operate on at least 90 % locally recovered metals. One of the key challenges is how to secure enough supply of local waste metals of sufficient quality. Another challenge is to switch to large scale recycling …

Q: What should MetalStar SA do? What is needed to ensure a successful transition?

Business integrity and skills

Scenario 1: Attracting new workers with relevant skills

NFM Products Corp. is a large metals production company that has embarked on an expansion of its production. Over the next 5 years, they want to increase economies of scale, reduce energy costs and conquer new markets to remain competitive. However, to reach its target, NFM Products Corp. needs to optimise its production processes by investing in and developing innovative technologies. This requires both transmitting traditional know-how to a new generation of workers and hiring highly skilled workers capable of successfully integrating innovative technologies. Although this will require a significant initial investment, NFM Products Corp. has secured sufficient funds.

NFM Products Corp. foresees two main challenges which may prevent it from reaching its target. First, up to a quarter of the existing staff will have to undertake significant retraining or be laid off. Second, the company has consistently experienced difficulties in the past in attracting the relevant skills into its workforce. Highly qualified, computer-savvy individuals, indeed, are reluctant to work in an industry they see as not particularly trendy.

Q: What could NFM Products Corps and other stakeholders do?

Scenario 2: Ethical sourcing

NFMet is a medium-sized company that produces rolled and extruded non-ferrous metal products mainly for electrical applications. Its clients include manufacturers of cables, transformers, electronic components and switchgears. Further downstream, a major European technology company, AdamsApp uses these electronic components for small domestic appliances, audio and healthcare products.

After long investigations, journalists have found out about the dubious origin of AdamsApp's components. As it turns, some of the components are made out of non-ferrous metals (e.g. tin and tungsten) that were extracted in the poorest environmental and health conditions for local miners. In addition, the supplying mines have been in the hands of malicious militias and rebel groups for various years now.

The story has received massive media coverage and consumers have called on social media for a boycott of AdamsApp's products. NFMet, as one of its indirect supplier, has also been splashed by the scandal, but claims that it was not aware of the exact origin of its metal imports.

Q: What could NFMet and other stakeholders do?

Scenario 3: Impacts on biosphere balances

Public perception of the European non-ferrous metals industry has been deteriorating over the last decade. European citizens persistently associate the industry with its use of non-renewable materials and they are convinced that there is an imminent scarcity of raw materials. Medias and politicians alike keep promoting biomaterials as these are renewable and biodegradable. This results in an increase in the demand for biomaterials at the expense of non-ferrous metals.

In Europe, a succession of extreme weather events altering usual patterns is straining water resources in some regions. With water being a critical resource for all metals operations, this situation of increased water scarcity has further contributed to the negative image of the industry. This has consequences in the industry's ability to establish new factory sites without facing local resistance.

MetalLoyal is a small, family-run company in the metal sector, which has been operating for around 30 years. The company has consistently invested in improving its day-to-day operational resource efficiency and in maintaining good environmental standards. MetalLoyal fears that it might soon suffer negative spill over effects from the general negative perception of the industry's environmental impacts. MetalLoyal is keen to help improving the public perception of the sector, but anticipates that it won't have enough power if acting alone and is unsure about what actions to take.

Q: What could MetalLoyal and other stakeholders do?

7.3 Annex III — Vision narrative

The vision narrative complements the vision statement by developing each of its key elements into longer descriptions.

Valued and trusted world leader

The European non-ferrous metals manufacturing industry is an innovative sector employing around 500 000 people and generating an overall yearly turnover of close to €120 billion in 2010 ([19]). It is well integrated into global value chains and holds a strategic position in the European industrial landscape, feeding very diverse raw materials into countless downstream users, while operating under strong global pressure.

Reinforcing the manufacture of non-ferrous metals in the EU would offer many opportunities. Constantly evolving manufacturing technologies lead the European non-ferrous metals manufacturing industry not only to cleaner and safer production systems, but also to processes that are more resource efficient and better able to continue closing material loops. The European non-ferrous metals manufacturing industry is already operating at high standards, making it a **global leader**. This helps make European industry more circular (where the production and consumption system cycles resources, reduces waste and reduces EU dependence upon imported raw materials). Recycling and responsible sourcing help base more production in the EU, thereby ensuring **trust** by stakeholders, while at the same time offsetting risks and costs associated with long-distance supply chains.

Delivering sustainable, innovative and competitive non-ferrous metals-based solutions

Thanks to their diversity, their endless potential for making alloys, their diverse chemistry, new production technologies and materials innovation, non-ferrous metals will remain an essential building block of many solutions used to continue the drive towards **sustainability**.

The strategic value of the EU non-ferrous metals manufacturing industry could be strengthened through the development of highly **innovative** metals-based solutions that find their natural place among all materials to engineer the best new and **competitive** applications in a sustainable development perspective.

Enabling society to close resource loops

Unlike organic materials and provided that good collection and enough energy are available, non-ferrous metals can be recycled indefinitely. Changing economic paradigms and new technologies (both process and digital) are creating new opportunities for moving towards the circular economy.

Improving recycling requires that, together with all the relevant stakeholders, the non-ferrous metals manufacturing industry encourages the enhancement of collecting and sorting systems used in material streams. **Digital technologies** and sensors can help trace material flows and render sorting more automatic. New service-based business models also offer the opportunity for companies to keep ownership of materials, thereby facilitating collection and improving knowledge of the materials being collected. **Servicizing** (the shift to a transaction combining products and services, where satisfaction of customer needs is achieved by selling the function of the product as a solution rather than the product per se and/or by increasing the service component of the offer) facilitates the establishment of a circular model, where products are leased on a long-term basis and **eco-design** facilitated to be able to collect and separate the materials of interest more easily.

Set the bar for social, environmental and ethical standards and act accordingly

The mining of non-ferrous metals is sometimes plagued with reports of unethical practices, adverse health effects and environmental degradation in both the extraction and recycling of mineral resources, mostly outside of Europe. By 2050, the EU non-ferrous metals manufacturing industry wants to be in a position not only to respect but also to be a major player in setting the bar for global, evidence-based **ethical and environmental standards** for minerals sourcing, trade, first transformation and recycling. The sector also wants to be a world standard setter for the respect of high **social values** (in particular respect of fundamental rights of workers, protection of future generations' interests, 'good corporate citizenship', etc.).

([19]) European Commission – Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (2016), *Non-ferrous metals*.

Knowledge and **data management** will be crucial in providing a factual base to realise these ambitions. Data and knowledge management techniques can be used not only for process optimisation, product development and market analysis but also to monitor supply chains, as well as to track and trace products from raw material processing to delivery, increasing supply chain transparency.

Meeting customer and societal needs

While being positioned mostly upstream from many industry sectors, the non-ferrous metals manufacturing industry is in a key position to enable downstream product innovation meeting ever more **demanding customer and societal requirements**. Constant innovation in downstream sectors is also setting up **opportunities** for the non-ferrous metals manufacturing industry to come up with new materials that are able to meet the constantly evolving downstream needs. Being able to respond to these demands is crucial to ensure the long-term existence of the non-ferrous metals industry in the EU.

Demand for non-ferrous metals-based solutions comes increasingly from specific needs for **resource efficiency** and **renewable energy** technologies (e.g. wind mills, photovoltaic panels), as well as from needs linked **megatrends** of a growing world population, like housing and mobility.

Investments in Europe and top environmental performance

Today the European non-ferrous metals manufacturing industry is largely dependent on imports of raw materials from around the world. In the future, as world population grows, global demand for raw materials is likely to increase and geopolitical factors might affect trade flows. This, coupled with technological developments and the drive to close material loops, will incentivise the optimum use of local resources from scrap and complex secondary materials. Together, these factors may create incentives for **investing** smaller scale non-ferrous metals **production and recycling** facilities **in Europe**, located as close as possible to their markets. This can happen in coordination with local authorities to allow long-term investment security and to build strategic **industrial clusters**. Such clusters can take advantage of local situations to develop capacity to produce energy, build resilient material resource bases, and pool the necessary skills.

As this could lead the industry to operate in closer proximity to population centres, excellent environmental performance will be essential to avoid suffering from the **'not-in-my-backyard'** syndrome. This can be achieved through advanced manufacturing techniques and technologies.

Collaborating with all important stakeholders

To realise the vision described above, the non-ferrous metals manufacturing industry will have to engage deeply with all its **main stakeholders**, all the way from the international mining sector upstream, through the numerous customers and employees to the neighbours of the facilities downstream and the policymakers. Collaboration with policymakers will be essential to ensure consistency and coherence in legislation. It will also have to invest in increased transparency including in global trade aspects.

Collaboration with **customers** for product co-creation allows the development of higher value products. Collaboration is also needed **across sectors** and disciplines especially beyond packaging, automotive and construction, requiring interdisciplinary expertise. Collaboration with **educational institutions** will also be required to train the new generation of workers, managers and regulators needed for a sustainable EU non-ferrous metals manufacturing industry.

Collaboration with **policymakers** is also crucial in order to encourage the development of a stable, consistent and risk-based regulatory framework taking regulatory costs into account. Finally, collaboration with **unions** is essential to maintain and improve working conditions.

Shifting to renewable sources of energy, investing in research and innovation

Policies to reduce emissions of greenhouse gases and to mitigate climate change are already creating pressure on energy use, driving energy efficiency and the move away from fossil fuels. The non-ferrous metals manufacturing industry is an energy intensive sector. Largely through materials innovation, it is itself already contributing to improving resource efficiency but it will have to shift towards relying **almost exclusively on renewable energy** sources, including intermittent ones. This challenge will require specific **R & D efforts** in addition to the efforts needed for materials and process innovation.

Retaining and developing essential skills and know-how

The EU non-ferrous metals manufacturing industry is home to a large pool of traditional and embedded **know-how** that makes it one of the world leaders. With an ageing European population, strong international competition and sometimes the image of an old industry among 'millennials', the industry may risk not being able to attract young talent. It needs however to transmit its know-how and ensure its long-term survival.

Automatic systems and robots with increased capabilities and intelligence will enable non-ferrous metals smelters to further optimise their production processes. This will lead to an even more high-tech industry, requiring **higher skills** from employees, who will also benefit from safer positions.

The shift towards **advanced manufacturing systems**, technologies and concepts will lead to a production paradigm that is, for most functions, **less labour-intensive** and more skills-intensive. The direction of the sector calls for a new generation of employees and entrepreneurs that are ready to operate in the industrial facilities of the future, to manage data and knowledge at unprecedented scales, and to forge effective collaborative partnerships based upon cross-disciplinary understanding.

Collaboration with educational and vocational institutions and with workers representatives will be essential to address these issues.

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