Minerals Policy Guidance for Europe

Policy Laboratory 3 Report: Innovations and supporting policies for mineral and metallurgical processing

Luleå, 18-19 May, 2017

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Author:

Anders Sand, Jan Rosenkranz, Johan Frishammar (Luleå University of Technology)

With contributions by:

Andreas Endl, Gerald Berger (Vienna University of Economics and Business)
Roberto Tomasi (GOPA Com.)

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MIN-GUIDE Project Partners

Institute for Managing Sustainability, Vienna University of Economics and Business (Coordinator)

Vienna, Austria

Policy Studies Institute, University of Westminster

London, United Kingdom

Montanuniversität Leoben

Leoben, Austria

Luleå University of Technology, Department of Civil, Environmental and Natural Resources Engineering

Luleå, Sweden

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Brussels, Belgium

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Zagreb, Croatia

Ministry of the Employment and the Economy

Helsinki, Finland

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Introduction

This MIN-GUIDE Policy Laboratory Report provides information on the inputs, discussions and outcomes of the **3rd MIN-GUIDE Policy Laboratory: Innovations and supporting policies for mineral and metallurgical processing, which took place in Luleå, May 18-19, 2017.**

The **MIN-GUIDE Policy Laboratory 3** was the third in a series of stakeholder workshops organized within the MIN-GUIDE project. The main objective of Policy Laboratory 3 was to provide an overview of, and reflect upon, **innovation and supporting policies in mineral and metallurgical processing, including recycling**. Therefore, the workshop had a twofold approach: informing participants about the most recent progress and steps in the development of the MIN-GUIDE online Minerals Policy Guide, and to facilitate an exchange and learning on recent innovations and their link to policy in mineral and metallurgical processing.

For the purpose of framing the content, the project team used the results of the MIN-GUIDE Deliverables D4.1 and D4.2 (which is still in progress), and especially innovations in mineral and metallurgical processing and recycling. In doing so, the MIN-GUIDE team has selected and elaborated on good practice cases for each of these three streams, allowing for interactive, in-depth exchange and learning.

After a general "Opening and orientation" Session, the structure and flow of the third MIN-GUIDE Policy Laboratory focused on the following aspects. The scene was set with a session on **"innovation challenges and policy responses in mineral and metallurgical processing",** including an industry perspective on challenges and drivers, as well as an update on the stocktaking of enabling policies and good practice conducted within the MIN-GUIDE project. This was followed by **three parallel working groups** (see figure 1 below). On the second day, the results of the working groups were presented followed by a final session on **"discovering future pathways for innovation and supporting polices in mineral and metallurgical processing".**

To access the documentation of the 3rd MIN-GUIDE Policy Laboratory, including the (i) Policy Laboratory Agenda; and (ii) the presentations given by the keynote speakers and the presenters from the Parallel Policy Laboratories, please visit the project website: http://www.min-guide.eu/content/policy-laboratory-3.

In total, 45 participants from 13 European countries took part in the workshop that was moderated by Gerald Berger (*Institute for Managing Sustainability, Vienna University of Economics and Business, Austria*). The distribution of participants to stakeholder groups (excluding MIN-GUIDE project partners) can be seen in Figure 1 (right).

Figure 1. The 3rd Policy Lab event in Luleå, May 18-19 ,2017.

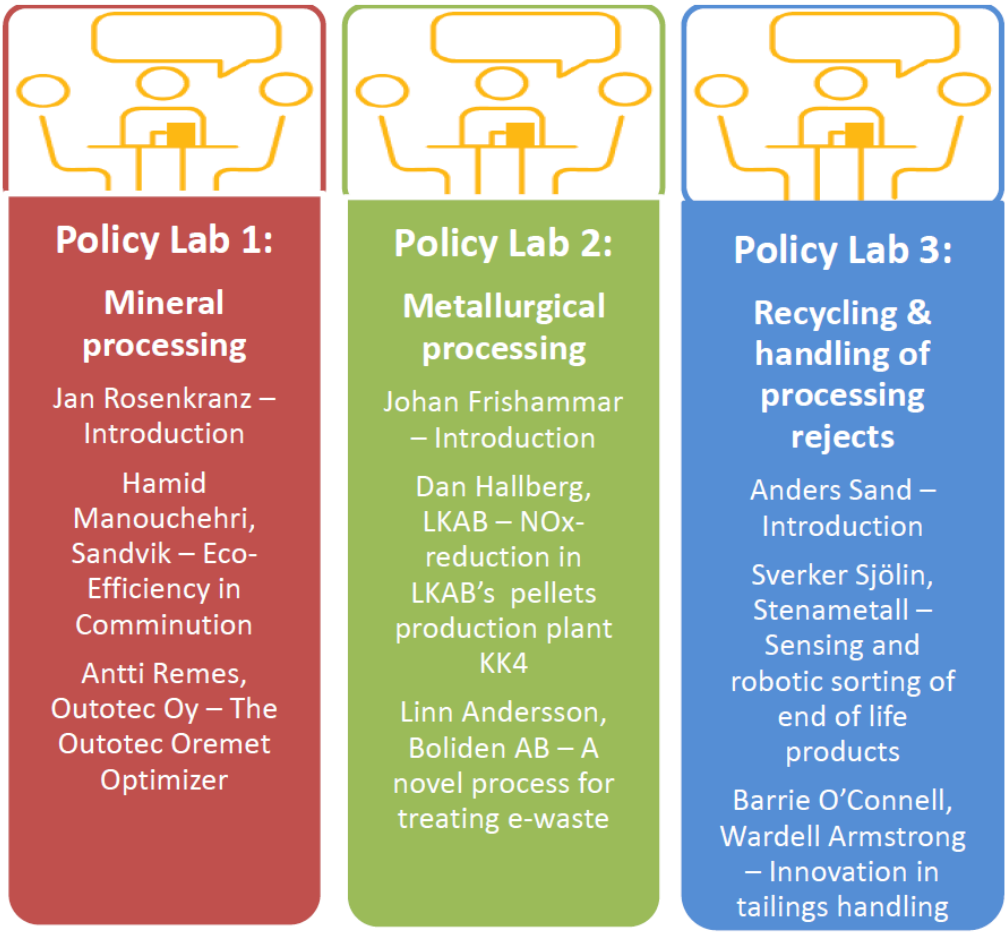

Figure 2. Policy Laboratory parallel working groups (Policy Lab sessions).

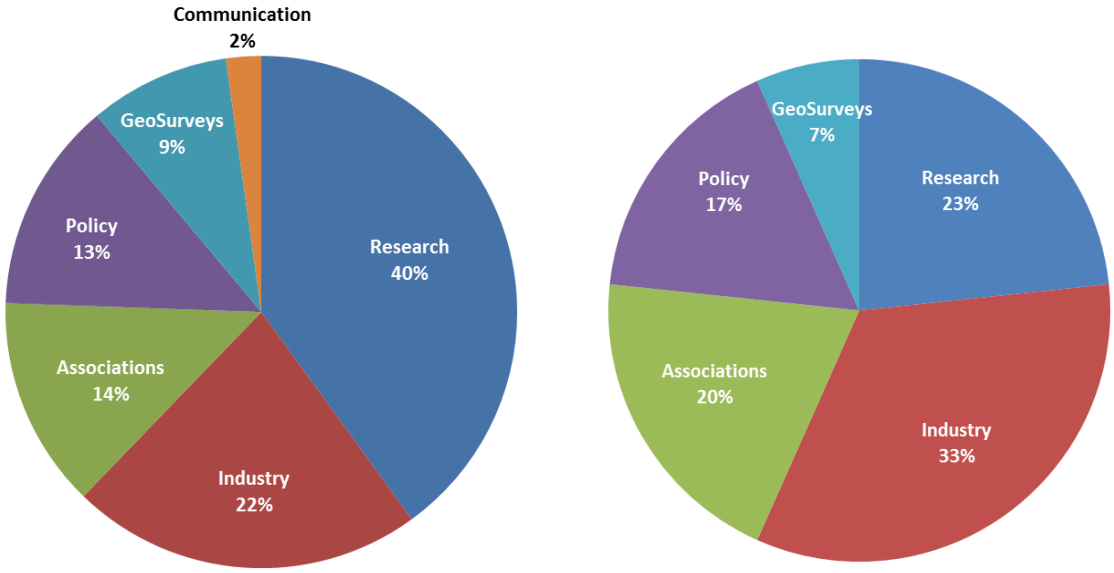

Figure 3. Distribution of participants at event (including the MIN-GUIDE consortium to the left, and without the MIN-GUIDE consortium to the right).

Opening and Orientation

The Director of the CAMM – Centre for Advanced Mining and Metallurgy at Luleå University of Technology, **Pär Weihed**, welcomed participants to Luleå and the university. In his opening address he talked about the recent development of the university in research and education, its role as the Swedish mining university and the ongoing Swedish programmes for research, development and innovation in the mining sector.

Andreas Endl (*Institute for Managing Sustainability, Vienna University of Economics and Business)* then gave an overview of the MIN-GUIDE project. He presented the project's goal of "contributing to an innovation friendly policy framework for a secure and sustainable supply of minerals" and provided an outline of the 3rd policy laboratory's agenda and objectives, i.e. to find the most relevant innovations in mineral and metallurgical processing and what policy framework is needed to support them.

Karen Hanghøj (*Chief Executive Officer of the EIT Raw Materials*) presented the EU's current raw materials policy framework for securing the supply of mineral raw materials, involving the Raw Materials Initiative (RMI) and the European Innovation Partnership on Raw Materials (EIP RM), and how these address framework conditions. Particular emphasis was put on the establishment of the EIT Raw Materials as a Horizon 2020 instrument for bringing together the three sides of the "knowledge triangle": business, education and research.

Innovation challenges and policy responses in mineral and metallurgical processing

Kent Tano (*Principal R&D expert, Research and Development, Luossavaara-Kiirunavaara AB*) was setting the scene on innovation challenges from an industry perspective. In his presentation he talked about the general challenge of economic growth and sustainability and specific challenges the mining industry is facing. Kent referred to improving production efficiency as a response to an increased metal demand while metal grades are decreasing, and the importance of the social licence to operate. Further, he illustrated what is needed in terms of RDI infrastructure but also business processes and organisational structures in order to develop tomorrow's metal mine.

Jan Rosenkranz (*Head of the Division of Minerals and Metallurgical Engineering, Luleå University of Technology)* followed with a presentation of initial results from the MIN-GUIDE stock-taking on innovation enabling policies and good practice mineral and metallurgical processing. Jan introduced his presentation by a description of the aims and the scope of the work package WP4 on "Innovative processing" and by explaining the approach chosen in the investigation. Based on the MIN-GUIDE definition of innovation types and the identified sector-specific innovation needs, the European and national policy and legislation framework was analysed with respect to its catalysing and inhibiting elements.

Parallel Policy Laboratories on Innovation and Supporting Policies for Processing - Introduction

Anders Sand (**Luleå University of Technology**) presented further details of the work within WP4 and the purpose and relevance of the parallel policy laboratories as an input to this work package. Deliverable D4.1 (published in December 2016) contained a listing and description of approximately 30 innovation cases, out of which 3 were selected for further analysis as part of a proof of concept procedure. This analysis also included the connection to policies and legislation. For the second stage of the work, which will be reported in deliverable D4.2, the outcomes of the policy laboratory will be one important constituent. The innovation cases covered during the policy laboratories encompass the full value chain network within innovative processing as defined in D4.1, with cases covering mining companies, metallurgical industries, recycling companies, consultancies and equipment suppliers.

Parallel session 1 on mineral processing includes a case by **Outotec** (**Antti Remes**) on the OreMet Optimizer, which integrates economical calculations with process simulation tools. **Sandvik** (**Hamid-Reza Manouchehri**) presented a case on Eco-Efficiency in Comminution that takes an integrated approach to equipment design, material selection, process control, etc., in order to improve crusher circuit performance.

Parallel session 2 on metallurgical processing covered a case on reduction of NOx emissions in **LKAB**'s pellet production (**Dan Hallberg**) and a presentation on **Boliden's** work to develop and operate its metallurgical process for treating E-waste (**Linn Andersson**).

Parallel session 3 on recycling and handling of processing rejects included a case from the recycling industry, where **Stena Metall** (**Sverker Sjölin)** has integrated a machine vision-based system for sensing and robotic sorting of end of life electronic products. **Barrie O'Connell** of **Wardell Armstrong** presented paste-making and backfilling as a case on innovative tailings handling for the mining industry.

The facilitator **Gerald Berger** (**WU Wien**) explained the two parts - part I "Listening, exchanging, and learning" and part 2: "Exploring transferability" - of the Policy Laboratories process for which participants split into three groups according to their interests.

In each of the three Policy Labs, after listening to innovation case presentations, participants were asked to split up and participate in table group discussions. Each of the group discussions revolved around one out of the three innovation cases discussed at the specific Policy Laboratories. Each group received a case sheet (i.e. flipchart paper with predefined structure) on which participants wrote down policy and non-policy factors they found most relevant for their particular case. In part II "Exploring transferability" participants were then asked to go one step further and discuss the transferability of these factors into other contexts, for example in another country or other innovation case context. Participants, after noting down important points of their transferability discussions on the flipcharts, presented their discussions to the other two groups within their respective Policy Laboratory.

The section below presents the case sheets from each policy laboratory, with the key outcomes summarized by the parallel session moderators in a feedback session on day 2.

Parallel Policy Laboratories on Innovation and Supporting Policies for Processing – Outcomes

The outcomes of the Policy Lab group discussions are presented below. Further analysis of the results, conducted by the session moderators, is presented in the section Feedback from the Policy Laboratories. Non-policy factors are considered enabling unless otherwise stated.

Policy Laboratory 1: Mineral processing

Case 1: Eco-efficiency in comminution, Hamid-Reza Manouchehri, Sandvik, SE

Non Policy Factors	Transferability Aspects
• Competition in the market leads to innovation	• Easily transferrable
• Talented humans with the ambition to provide smart products (”Thinking better”)	• Easily transferrable

Supporting Policies	Transferability Aspects

• RDI and infrastructure for research in joint ventures industry / academia
  ○ Today less than 1%
  ○ Evaluation by independent external experts
  ○ Fiscal stimulus
	• Yes, possible by
	  ○ Partnership with others
	  ○ International/national research programmes
	  ○ Centres of excellence

• Environmental policies and legislation (reduced emissions)	• Yes

Case 2: The Outotec OreMet Optimizer, Antti Remes, Outotec Oyj, FI

Non Policy Factors	Transferability Aspects
• Intention to guide company decision-making for long term mining project development	• Proof of compatibility in different context, country specific environmental legislation

• Data availability for input into the ore assessment
  ○ In-house
  ○ External/confidential
	• Guidance to data access/availability needed
	  ○ Manual for use/ what the calculation should include
	  ○ Broad acceptance standards
	  ○ Standards for lab test work, up-scaling

Supporting Policies	Transferability Aspects
• Requirements of environmental impact assessment legislation	• Authorities need to accept modeling tools based on experimental data ○ Trusted methodology

• Legislation that regulates/defines use of standards, transparency, objectivity	• Standard/guidance needed for reporting, analysis and process calculation
	  ○ Integration into the legislation
	  ○ Metallurgical laboratory

	• Exploration data, quality • Role of competent/qualified person

Policy Laboratory 2: Metallurgical processing

Case 1: NOx reduction in LKAB's pellet production plant KK4, Dan Hallberg, LKAB, SE

Non Policy Factors	Transferability Aspects
• Platform of exchange to build trust (engineering, technical, political, local interest groups)	• National strategic policy • Company(ies) one-stop-shop
• Business case a driver for LKAB	• Authorities to "allow" a development phase to figure out what is technically possible and feasible to achieve

Supporting Policies	Transferability Aspects
• National emission ceiling directive (NEC)	• Harmonized implementation across EU
• National legislation (limiting NOx emissions)	• Global competitiveness & playing field

Case 2: A novel process for treating e-waste, Linn Andersson, Boliden AB, SE

Non Policy Factors	Transferability Aspects
• Definition & interpretation of risk (risk reduction) • Knowledge asymmetries (inhibiting factor)	• Competitors for e.g. students and architects (to get new ideas for new products from waste materials)
• Business case: Technical feasibility vs. economic possibilities • Process iron from iron sand or remove impurities	• Work with completely new types of companies to find novel applications for iron sand (one idea was table-tops)

Supporting Policies	Transferability Aspects
• Wish for harmonized EU legislation for waste/by-products	• Clearer rules & more transparent standards in non-ferrous industries
• Financing/government funding for development phase (re. iron sand applications)	• Deployment policies for effective scale-up (EU-level)
• Better coordination of multiple levels of government	• Involve authorities in continuous discussions

Policy Laboratory 3: Recycling and handling of processing rejects

Case 1: Innovation in tailings handling, Barrie O'Connell, Wardell Armstrong International, UK

Non Policy Factors	Transferability Aspects
• Public aspects (high social acceptance for backfilling)	• Easily transferrable – possibly seen as beneficial – reduce subsidence in built-up areas • Possibility of storing waste from other sources, no national boundaries
• Sustainability (mine and resource recovery)	• Maximise resource recovery • Potential for processed reject to be used as a resource (now or later)

Supporting Policies	Transferability Aspects
• MWEI Policy (Management of Waste in the Extractive Industries Directive)	• Yes, but intrinsic difficulties in "translating" policies • Lack of transparency – also an obstacle to innovation • Yes, in principle but not easy due to conservative attitude of industry
• Equator Principles (better access to funding)	• Company policies more easily implemented trans-nationally

Case 2: Sensing and robotic sorting of end of life products, Sverker Sjölin, Stena Metall, SE

Non Policy Factors	Transferability Aspects
• Had the right partners in the value chain (magnet producer) • Demand for specific waste fraction (hard drive magnets) • Wanted to ensure/explore long term security of supply	• Demand can be created by other means, (e.g. landfill taxes, incentives, …) • Create long-term demand • World-accepted index for price/quality such as introduction on LME (London Metal Exchange)
• Private owner – opportunity for strategic decision making, financial	• Key stakeholders: private + public • One needs to find the appropriate/

	resources, ability to focus longer term	strongest lever for your context

Supporting Policies	Transferability Aspects
• CO2 footprint reductions and supporting instruments encouraging move from fossil fuels, energy efficiency	• These factors are probably all fully transferrable, but need to consider scope for extending more broadly around the world (e.g. including engagement, collaboration with Chinese, industry, etc)
• FP7 – for the partners collaboration (across borders and markets) • (few producers/manufacturers in SE)	• Need to break down silos, harmonise objectives and support rather than to complicate
• Raw Material Initiative (could there be an end material initiative?)	•

Feedback from the Policy Laboratories

On the second day, the three Policy Laboratory Facilitators **Jan Rosenkranz**, **Johan Frishammar** and **Anders Sand** (Luleå University of Technology) summarised and analysed the results of their respective Policy Laboratory for all the participants in a joint session. The facilitators also answered questions and received comments from the participants. The feedback from each Policy Lab is shortly summarised below:

Policy Laboratory 1 on mineral processing was summarized by Jan Rosenkranz. The two innovation cases were both presented by technology supplier of equipment for mineral processing but quite different in nature. In the Sandvik case several incremental innovations (involving changed machine design, wear resistant material, and advanced process control) have been packaged to provide a concept for more efficient crusher operation. These measures are suited to increase crusher productivity and wear protection lifetime. Outotec's OreMet Optimizer is about a software innovation that uses the company's process simulator as the backbone for conducting geometallurgical studies. The product allows optimization of the processing routes for variations of the ore properties, leading to improved resource efficiency and increased operating profit. It can also be a valuable tool in environmental impact assessment.

The main challenges as drivers for innovation were, however, rather similar in both cases, i.e. primarily the need for improved resource efficiency and higher productivity. It was also pointed out that lowering energy demands simultaneously serves environmental objectives. Non-policy factors that fostered the innovation cases at hand were market competition and the ambition to provide better product or service solutions to the mining industry. Discussion on supporting policies revealed that the environmental policies and legislation, particularly those aiming at reducing emissions, were important factors. Further, financial instruments that support RDI infrastructure and joint ventures between industry and academia were considered as relevant drivers.

Transferability of the supporting factors to other innovations and EU MS was assessed to be not an issue with respect to most of the identified policies and non-policy factors. Competition for this technology is transnational and both suppliers serve the world market. National requirements with regard to environmental protection are already guided by European directives. Anyhow, differences between the country specific environmental legislations have to be taken into account and the compatibility with the respective context needs to be considered. The importance of the latter point was also emphasized for achieving social acceptance or the social licence to operate.

Another aspect that was discussed in this context is that standardization is needed when it comes to geometallurgical studies and the acceptance of using modelling tools and experimental data in the assessment of mineral processing operations. This refers to data quality (exploration data, metallurgical test work) and process calculations.

Policy Laboratory 2 on metallurgical processing was summarized by Johan Frishammar. Policy laboratory 2 contained two cases, both presented by managers from mining companies engaged with metallurgical processing (Boliden and LKAB). The case from LKAB centered on NOx cleaning for a new pelletizing plant, KK4. KK4 was the first pelletizing plant in the world that implemented NOx cleaning technology, which were adopted and adjusted from another process industry to fit

pelletizing. The Boliden case centered on a novel process for treating e-waste, situated at the Rönnskär copper-smelter plant, where ironsand is received as a by-product from copper production. Boliden has recently suffered severe consequences when ironsand were “re-classified” as waste rather than by-product, which implied a completely new set of legislations that apply. In particular, ironsand was no longer allowed as landfill for building roads, which led to massive pile-ups of this material.

While the two cases were very different as such, the main drivers for innovation were surprisingly similar. That is, the need for improved efficiency and productivity. LKAB tried to find a cost-effective cleaning technology, and Boliden tried to work out the classification issue to have their waste and/or by-product used in the most cost effective way while still complying to policy framework. The non-policy factors that fostered the innovation cases were construction of solid business cases in both firms, firm-internal competence development, and research and development efforts to learn about new cleaning technologies and relevant policies. Both cases also underscore the need for harmonized EU legislation. That is, ironsand is a byproduct from all copper smelters throughout Europe, and also other pelletizing plants beyond the KK4 would benefit from NOx cleaning. Therefore, in theory, harmonized EU legislation would create transparency and clear rules. Government may also support by deployment policies (for scaling up process to larger scale, i.e. process innovation) or through public funding of R&D programmes to solve these and similar problems.

Transferability aspects highlight a couple of interesting insights. Again, both companies seek for harmonized EU-level policies. Second, both companies underscore the need for close interaction and “joint development” together with relevant authorities. In particular for the LKAB case, this was mentioned as a key success factor when implementing new technology (LKAB could then figure out what was technically and economically feasible to do, and government what was feasible to expect). Boliden also asked for such close dialogue, but here relationships with government bodies were currently not as close. This closer way of working with government may be particular success factor for the Nordic countries where trust between government and industry tends to be high, so its future implications for transferability is interesting to look at for other parts of Europe (i.e. what can be implemented, and what cannot).

In the feedback on **Policy Laboratory 3**, **Anders Sand** briefly recapped the two cases to the participants in the joint session. Particularly interesting was that the **Wardell Armstrong** case on Backfilling actually could be seen as a fully sustainable approach, as it is a socially accepted way of handling mine tailings, reduces environmental risks compared to standard tailings dams and can provide some economic benefits (resource efficiency) as it increases mine recovery. In the **Stena** case on sensor-based sorting and robotic handling of hard drives in recycling, the key success factors were the long term view and stable conditions provided by the private company owner. Another success factor was also that they were able to build a partnership with an electronics producer which was interested in the particular waste fraction from the process. From the cases it was also learnt that Europe currently seems to be in a situation where mainly large resourceful companies can operate efficiently in the raw materials sector, and that new business models and partnerships likely will be key factors for implementation of new technology.

Transferability of these successful innovation cases to other technologies or EU Member States were concluded to be particularly straightforward if all sustainability criteria are fulfilled.

There might also be some potential for "outside-box-thinking", where perhaps social or environmental acceptance can be increased if the company can connect their innovations to various synergies with the surrounding society. In the recycling sector, it is the price of the material extracted that dictates how much it can be treated or how expensive such treatment can be. It was suggested that there should be a marketplace (such as for instance London Metal Exchange) where specific material fractions could be priced and suppliers could link up with customers.

The main policy-related success factors were in the case of tailings handlings was deemed to be the Equator Principles imposed by a large number of financial institutions, the Management of Waste from Extractive Industries Directive. The WEEE directive was mentioned as important for the recycling sector, while the FP7 programme and Raw Materials Initiative likely played some role for both the cases.

On a general note regarding transferability of policy aspects, it was found that company policies might be more easily transferable than government policies, that the main problem with transferability is that there is such a vast amount of interacting policies and legislation which makes the situation complicated and difficult to oversee. A solution for this might be some form of Government Support Centre or Guidance Documents that can help companies navigate the legislation. Also, in a globalised market where the best partners might often be found outside Europe, transferability could be improved by expanding EU RDI programmes (e.g. H2020) to other countries as well.

Overview of the MIN-GUIDE website and the Online Policy Guide

Roberto Tomasi presented the updated version of the MIN-GUIDE website (http://www.min-guide.eu). The website is a key output of the MIN-GUIDE project since it is the virtual repository of: minerals and related policies (Online Policy Guide), country profiles, innovation cases, reports and promotional materials.

The **Online Policy Guide** contains over 600 entries of minerals and related policies at the EU and national level. For each policy a webpage has been created. The webpage contains: a short description of the policy (in English), information about the impact on the mining value chain, the type of the instrument, the country, the year and the reference number of the policy. When available, the webpage provides a link to the official legal document of the policy.

A total of 29 **country profiles** can be accessed via the website. They include country-specific information on: mineral and related policies, governance mechanisms, innovation cases and national focal points.

In addition, there are 9 **industrial innovation cases** available, and during the course of the project more will be added. Each innovation case describes a product, system or process that fostered innovation in the mining sector. It includes information on: good practice areas, impact on the mining value chain, organisations involved, linked policies, transferability, innovation categories as well as drivers of and barriers to innovation.

A section is dedicated to all the **reports and deliverables** of the project including **promotional materials** that can be used by both consortium partners and stakeholders to enhance the visibility of the project and promote it among their network.

The website also contains information and reports from past and upcoming events to keep stakeholders engaged and up-to-date with the achievements and activities of the project.

The main objectives of the website update are: improving the user experience; making content more accessible and easy to consult; and optimizing the search function.

Discovering Future Pathways for Innovation and Supporting Policies in Mineral and Metallurgical Processing – Part 1

During the subsequent group discussions, which followed much the same format as the interactive activities in the Policy Laboratories, participants were asked to form groups of six participants. The objective of the activity was for participants to reflect upon the needs, gaps and future pathways on the topic of innovation in exploration, extraction and deep sea mining. Each participant was then requested to spend five minutes in a silent 'brain-writing' exercise, in order to reflect upon these topics and capture three responses addressing the needs and gaps within these areas. These responses were then collected within the individual groups. Each group was then tasked with discussing the needs and gaps they had written down, thus cross-fertilizing the ideas and perspectives of the different individuals. After discussing amongst themselves, they were required to select the three most important needs and gaps. Participants then wrote down the three most important aspects, and were subsequently asked to discuss the necessary 'next steps' for the three most important needs and gaps they chose. The results of this activity were then presented to the entire group. The results from each group can be seen in the following charts.

Group 1

Needs & Gaps	Future Steps
Time – better predictions	Roadmap – standard
Education – common standards and alignment	Make feasibility study
Categorizing the development logic for various segments of mineral- and metallurgical processing	Pragmatic; what works and what does not work

Group 2

Needs & Gaps	Future Steps
Better definitions of what is waste	Look at alternative innovation lessons from other sectors
More innovation requires less policy	When policy is present, it should focus on creating stable and transparent framework conditions

Absence of transparency in the concept of waste	Master policy/one-stop.shop

Group 3

Needs & Gaps	Future Steps
Lack of specification (tailings utilization, how to build a tailing dam, tailings management, standards).	Standards, market rules for by-products/secondary products/waste
Lack of harmonized procedures	Test work, process design calculations, upscaling, estimation of potential
Lack of fast decisions	Better permitting procedures

Group 4

Needs & Gaps	Future Steps
No existing set of definitions in industrial waste; need for better classification (qualitative, quantitative, risk, safety, use, assessment of potential)	Stakeholder consultation (EU and national level), EU and national funding, compilation of good practice (maybe also international standard on industrial waste).
Gaps in communication, coordination, education, knowledge and trust, inspector training and education	Harmonisation among levels of government/authorities, and between authorities and industry
Need for: Comprehensive inventory, flexible policy, innovation and start-up, tools – not restrictions, evaluation of environmental goals (remove roadblocks to circular economy)	Policy development for flexible research and launch of new ideas in industry

Group 5

Needs & Gaps	Future Steps
Legislation – not more but better (Harmonized, hard, soft, coordinated, aligned, policy integration)	Policy integration, vertical + horizontal
Co-production & involvement (stakeholders, legitimacy & social acceptance, coherence and	Need for co-production, dialogue & consensus, democratic decision making

sustainability)	
Access to finance (risky investments, high-TRL, upscale through R&D lab, pilot plants, demonstration plants, long-term vision.	Enhance funding for long term objectives, One-stop-shop system, clear process to access policy knowledge

Group 6

Needs & Gaps	Future Steps
Find the "golden way" between the needs of the private sector and government regarding legislation	Improve legislation by using guidance based on stakeholder consultations, develop joint language, harmonization, raise public awareness
Adequate sustainable resource management systems	Based on links between relevant policies and taking into consideration environmental and social challenges (UNFC)
Knowledge based as a pillar of policy	Increase knowledge based on basic research (by NGOs and others), develop a sustainable resource management system for deep sea

Discovering Future Pathways for Innovation and Supporting Policies in Mineral and Metallurgical Processing - Part 2

Aurelia Shtiza (IMA Europe), **Linda Wårell** (Luleå University of Technology, Economics), **Dan Hallberg** (LKAB), **Karin Beland Lindahl** (Luleå University of Technology, Political Science) participated in the panel discussion, moderated by **Gerald Berger** (WU Wien). Regarding innovation in the mineral and metallurgical sectors, and the links to policies and legislation, Aurelia Shtiza in her introductory speech pointed out the need for appropriate and pragmatic legislation for the minerals sector, and exchange of best practices between countries. Interaction with civil society could be improved through some form of technical forum. Linda Wårell argued that the free market in general is the most efficient to adapt to changed conditions, but that policies play a role to correct any possible market failure. There is a gap regarding environment versus access to minerals which in turn may inhibit innovation. In terms of societal aspects, there is currently no good way of weighing land uses against each other to find the most appropriate use, and mining-nature-society tradeoffs are still a controversial topic. Representing the industry side, Dan Hallberg stressed the need for predictability and clarity in the legal system for being able to carry out long term planning and initiate new projects. The policy system should allow for flexible innovation and take into consideration how to overcome company-internal barriers. A problem with the current system is that policies are introduced additively, which eventually creates a system impossible to overview. Obsolete or counter-productive policies should be possible to remove. From the social science perspective, Karin Beland Lindahl has been active in studying mining conflicts and public perceptions on mining in

northern Sweden. She would like to expand the understanding of the innovation concept to also include social innovation. This is needed since technical innovation is often also driven by social aspects. Education and information will in itself not solve conflicts or offset disadvantages caused to other stakeholders. Therefore, there are some actors that will never change their opinions regardless of how much they are informed. The main role of policies is to help make the trade-off between conflicting stakeholder interests.

The role of minerals and metals for society was discussed. Aurelia added that society needs to see the added value of raw materials through considering the full value chain and end products useful for society. This for instance includes medicines, toothpaste, plaster, etc. Legislation and policymaking should of course consider protection of nature, but should not end up as “no-access”-legislation. The economists’ solution to planetary boundary issues is the price level according to Linda, i.e. the market will adjust itself according to these boundaries. This interaction in itself is spurring innovation, and can also put a price on non-priced goods such as the environment. The dichotomy is that we want the products of society, jobs, and growth, but we don’t want the mines that facilitate this. Mining activities are often driven to countries with weaker environmental framework and less consideration for health and safety. As the marketplace is global, Dan pointed out that even if LKAB doubles its production it is still much smaller than large international players as for instance Rio Tinto. The price per ton is the driver both for innovation and for development of new projects. Currently it is also more or less impossible for smaller players to start mining operations on their own, given the heavy investments needed. Karin who has also studied similar issues in the forest sector mentioned that they have gotten farther in their social work, as they have earlier been subjected to criticism from environmentalist groups. This has for instance led to certification procedures and better dialogues with stakeholders. There are clear risks with policy redundancy and additivity of policies. There is therefore need for integration and prioritization. It will be good enough if many enough stakeholders consider the minerals sector as sustainable. Areas still in need of overview are lack of clarity on indigenous people’s rights, streamlining of permitting processes, more inclusive politics and policies to avoid court and civil actions as only resort for parties not included in the decision-making.

Conclusions and Next Steps for MIN-GUIDE

In the concluding session of the workshop, the facilitator, **Gerald Berger**, congratulated the participants on a very intense and interactive two-day workshop! He gave a reminder about the **4th MIN-GUIDE Policy Laboratory on "Innovative Waste Management and Mine Closure",** to be held in **Athens, Greece,** on **September 21-22 2017**. Participants should also be aware of website updates and regular newsletters.