Results of the MIN-GUIDE stock-taking on
Innovation in mineral and metallurgical processing – Enabling policies and good practice

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WP4 ”Innovative processing” - Aims

• Identifying existing innovation facilitating and inhibiting elements in policy and legislation for processing including permitting procedures.

• Exchanging of good practices for innovation in processing and facilitating their transferability.

• Exploring future policy developments in order to foster innovation in mineral and metallurgical processing.

• Scope
  – Mineral processing
  – Metallurgical processing
  – Metal recycling and processing waste handling
WP4 “Innovative processing” - Deliverables

• Reports D4.1 and D4.2
  – Policy and legislation framework
  – Innovation promotion and inhibiting factors and examples of good practices

• Approach
  – Part 1: Topic overview (literature surveys, preliminary case studies and analysis)
  – Part 2: Extended study (interviews and questionnaires, in-depth analysis of policy, legislation and innovation cases)

http://www.min-guide.eu/project-results
Characteristics of the sector

• Large scale of production
  – Large investments in plant capacity involving long plant life cycles
  – Major process innovation may be taken for new production plants
  – Continuous innovation conducted after a plant is built (incremental)
  – Requires costly and time-consuming up-scaling procedures

• Investment framework for innovation
  – Affected by many unknowns in future supply (mineral exploration and reserves evaluation) and demand (level of population, standard of living)

• Traditionally a conservative sector
  – Slow adaption of new technology
Innovation types – MIN-GUIDE approach

• Product innovation
  – Introduction of new or significantly improved goods/services (characteristics, intended uses), e.g. new processing equipment.

• Process innovation
  – Implementation of new or significantly improved production processes or delivery method, e.g. integration of a novel mill type into a processing flowsheet.

• Marketing innovation
  – Implementation of a new marketing method (significant changes in product design or packaging, product placement, promotion or pricing)

• Organizational innovation
  – Implementation of new organisational methods in business/policy practices, workplace organization or external relations.

• System innovation
  – Innovations that result in significant improvements in the supply chain, or in another sector, e.g. utilization of iron ore pellets in metallurgical processing.
The stakeholder network - Processing

- Research institutions
- Mining company
- Metal producer
- CUSTOMERS
  - Distributors, retailers
  - Manufacturing industry
  - Process industry
- SUPPLIERS
  - Services and consultation
  - Equipment suppliers
  - Supplier of auxiliaries
- Metallic minerals, industrial minerals, etc.
- Aggregates, industrial minerals, etc.
- Recycling companies
- Policy makers
Complexity of innovation

adopted from Lager, 2002
Innovation drivers and challenges

- Resource efficient production process that keep production costs low
  - Recovery of products and by-products
  - Energy efficiency
  - Water management
- Productivity (increasing volume outputs) and product quality
- Closing the loops towards a circular economy
- Environmental legislation (related to emissions/climate impact and processing rejects)
- General (social) licence to operate
Innovation needs

- **Mineral processing**
  - New energy-efficient processes, particularly for ore comminution
  - New separation processes for treating finely dispersed, polymetallic ores and removing impurities
  - Optimize mineral beneficiation processes towards better resource-efficiency (reduction of waste rock and tailings, process water)
  - Suitable pre-treatment processes for separation close to mining production face
  - New processing routes for efficient separation of minerals and metals from by-product and waste streams (beneficiation and extraction plants)

- **Metallurgical processing and recycling**
  - New innovative pyro-, hydro- or biohydro-metallurgical processes to extract metals.
  - New knowledge on distribution of elements between different process streams and their capacity for different elements.
  - New innovative techniques to utilize carbon containing waste streams.
  - New innovative separation techniques or combinations of techniques to efficiently separate the metals contained in complex material streams.
Catalyzing and inhibiting elements

• External barriers
  – Investors
  – Potential employees
  – Suppliers
  – Customers
  – Competitors
  – Partners
  – State
  – Society

• Individual barriers
  – Managers’ abilities and attitudes
  – Employees’ abilities and attitudes

• Organizational barriers
  – Strategy
  – Structure
  – Size
  – Resources
  – Organizational culture and learning

• Group barriers
  – Team structure
  – Team climate
  – Team processes
  – Members’ characteristics
  – Leadership style
Analysis of good practice examples

- Analyze innovation type
- Link to societal and industry challenges
- Analyze related policies
- Analyze related legislation
- Match policy against barriers/facilitators

→ Establish a causal chain:
Innovation cases - Challenges (or drivers) - Public policies - Effective direction (barriers/facilitators)
Policy and legislation framework

- EU Raw Materials Initiative
- EIP (in particular SIP on raw materials)
- National mineral strategies (for 10 MS)
- National innovation strategies
- Minerals related policy is vertically (regional) and horizontally (along the value chain) dispersed
- Often based on societal challenges (resource efficiency, environmental impact, health and safety etc)
- Strong impact from other policy/legislation, e.g. tax legislation, RDI programmes
Policies/legislation related to Use of resources - examples

- **Energy conservation and efficiency**
  - Law Establishing Centre for Energy Efficiency and Mining Development 11(1981) (Spain)

- **Water management**
  - Water Framework Directive 2000/60/EC (EU)
  - Water Act 264/1961 (Finland)
  - Water Supply Act 130/1999 (Denmark)
  - Water Resources Act 1991 (United Kingdom)

- **Land management and ownership of resources**
  - Policy1A Mines / Mining Code (France)
  - Environmental code 1998:808 chapter 3-4 (Sweden)
  - Act on the Land Information System and Related Information Service (Finland)
  - Land Use and Building Act 132/1999 (Finland)
  - Spatial Planning Act 763/2002 (Denmark)
  - Local Government, Planning and Land Act 1980 (United Kingdom)
  - Law of Property Act 1925 (United Kingdom)
Policies/legislation related to Emissions and wastes - examples

• Reduction and handling of wastes (incl hazardous substances)
  – PolicyA5 Mines / Regulation for the prevention and surveillance of mining risks (France)
  – Regulation on Maximum Limits of Hazardous Substances in Soil and Ground Water 8/1999 (Estonia)

• Management of processing rejects
  – Dam Safety Act 494/2009 (Finland)
  – PolicyA4 / Mines Law on liability for damage resulting mining and the prevention of mining risks after the end of operation (France)

• GHG and other emissions
  – Act on Pollution Prevention and Control 16(2002) Spain
Policies/legislation related to Permitting and social aspects - examples

• Permitting procedures and licensing
  – Environmental Impact Assessment Directives 2011/92/EU and 2014/52/EU
  – Directive on the conservation of wild birds 2009/147/EC (EU)
  – Act on Environmental Impact Assessment Procedure 468/1994 (Finland)
  – Mineral Raw Materials Act BGBl. I 80/2015 (Austria)
  – Environmental code 1998:808 (Sweden)
  – Federal Mining Law Art 4 § 71 of BGBl. I S. 3154 (2013) (Germany)
  – Mining Code Act 950/2009 (Denmark)
  – Law on Industrial Licensing 169/2012, 73/2015, 278/2015 (Portugal)

• Health and Safety
  – Occupational Health and Safety Act 1996 (Estonia)
  – General Regulation of Mining Basic Safety 863(1985) (Spain)
  – Health and Safety at Work Act 1974 (United Kingdom)
Policy impact on processing innovations

• Innovations are mainly driven by business opportunities

• Policy is playing a role particularly in areas where innovation is used to meet legislative requirements:
  – Environment (e.g. energy efficiency, water, waste management)
  – Health and safety (e.g. exposure to heavy metals, dusts, process chemicals)

• The RMI is seen as positive since it puts mineral raw materials on the political agenda

• Horizon 2020 and EIT RM programmes are seen as an important asset for processing innovations
Conclusions

• Mode of thinking amongst policy makers towards the raw materials industry has significantly improved over the last 5-10 years
  – Recognising the importance of a secure and safe supply of raw materials from primary and secondary sources
  – National and regional mineral and raw material strategies

• Legislation imposes various types of restrictions
  – Process improvements versus economy of operations
  – Quantity of policy initiatives and legislation

• Policies and legislation affecting innovation
  – Linked to general societal challenges – energy and resource efficiency, waste management, emissions to air and water, and hazardous substances
  – Indirect drivers

• Innovation in all parts of the value chain is a critical factor for success
Great ideas grow better below zero
Policy Laboratory 1
Mineral processing

Jan Rosenkranz
Mineral and Metallurgical Processing
Policy Lab structure

- Innovation in mineral processing, enabling environments and supporting policies
  - Part 1 – Listening, exchanging, and learning
    - Presentation of innovation cases
    - Table discussions with presenters
  - Part 2 – Exploring transferability
    - Table discussions on transferability aspects
Mineral processing

- Liberation of valuable minerals by crushing and grinding
- Separation into valuable minerals and gangue
  - Gravity separation
  - Magnetic or electrical separation
  - Flotation
- Product handling
  - Dewatering (wet processing)
  - Agglomeration
Guiding questions – Part 1

• What was the innovation case about? Problem formulation and rationale for the case?

• What were the outcomes/results from the innovation case?

• Project team, setting and implementation? What were the major barriers or challenges during design?

• Connection to policy framework? What were the drivers in terms of policy and legislation? Obstacles/promotion with respect to policies and legislation?
Guiding questions – Part 2

• What is the most important thing to consider for successful transfer of the policy/non-policy factors to other countries?

• What could be the major driving institution/body/ministry to implement the policy and/or support non-policy factors after transfer to another country?

• What is the necessary first step to successfully transfer the policy/non-policy factor into another country?

• Which key stakeholders need to be involved?