Author(s):
Ms Martha Bicket, Policy Studies Institute, University of Westminster
Mr Thomas Watson, Policy Studies Institute, University of Westminster

With contributions by:
Gerald Berger and Andreas Endl (Vienna University of Economics and Business), Michael Tost (Montanuniversität Leoben) and Johan Frishammar (Luleå University of Technology).

With thanks to those who participated in the Validation Workshop:

Project coordination and editing provided by
Gerald Berger & Andreas Endl
Institute for Managing Sustainability, Vienna University of Economics and Business
Welthandelsplatz 1, A-1020 Vienna, Austria
Phone: +43-1-31336-0
Email: info@min-guide.eu
www.min-guide.eu/

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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

National Technical University of Athens
Athens, Greece

Instituto Geológico y Minero de España
Madrid, Spain

University of Aveiro
Aveiro, Portugal

GOPA Com.
Brussels, Belgium

University of Zagreb – Faculty of Mining, Geology and Petroleum Engineering
Zagreb, Croatia

Ministry of the Employment and the Economy
Helsinki, Finland
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### List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIP</td>
<td>European Innovation Partnership</td>
</tr>
<tr>
<td>EITI</td>
<td>Extractive Industries Transparency Initiative</td>
</tr>
<tr>
<td>EMEA</td>
<td>Europe, the Middle East and Africa</td>
</tr>
<tr>
<td>EMERI PA</td>
<td>European methodology for regional innovation policy impact assessment and benchmarking (EU-funded project under the Sixth Framework Programme)</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>GCC</td>
<td>The Cooperation Council for the Arab States of the Gulf</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GHK</td>
<td>GHK Consulting (part of ICF International)</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>GMI</td>
<td>Global Mining Initiative</td>
</tr>
<tr>
<td>HPGR</td>
<td>High Pressure Grinding Rolls</td>
</tr>
<tr>
<td>ICMM</td>
<td>International Council on Mining and Metals</td>
</tr>
<tr>
<td>IP</td>
<td>Intellectual Property</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Organisation</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>JRC</td>
<td>Joint Research Centre (European Commission)</td>
</tr>
<tr>
<td>MIN-GUIDE</td>
<td>Minerals Policy Guidance for Europe (EU-funded Horizon 2020 project)</td>
</tr>
<tr>
<td>MS</td>
<td>Member State</td>
</tr>
<tr>
<td>NIMBY</td>
<td>Not In My Back Yard</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OHSAS</td>
<td>Occupational Health and Safety Advisory Services</td>
</tr>
<tr>
<td>PCC</td>
<td>Precipitated Calcium Carbonate</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>R&amp;D&amp;I</td>
<td>Research, Development and Innovation</td>
</tr>
<tr>
<td>RFID</td>
<td>Radio-Frequency Identification</td>
</tr>
<tr>
<td>SITRA</td>
<td>Suomen itsenäisyysjouhlarahasto (Finnish Innovation Fund)</td>
</tr>
<tr>
<td>SLO</td>
<td>Social Licence to Operate</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>SME</td>
<td>Small and Medium Enterprises</td>
</tr>
<tr>
<td>SPIRE</td>
<td>Sustainable Process Industry through Resource and Energy Efficiency Public-Private Partnership</td>
</tr>
<tr>
<td>PPP</td>
<td>Sustainable Process Industry through Resource and Energy Efficiency Public-Private Partnership</td>
</tr>
<tr>
<td>SPSS</td>
<td>IBM SPSS Statistics (statistical analysis software package)</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>WP</td>
<td>Work Package</td>
</tr>
</tbody>
</table>
1. Background and objectives

1.1. MIN-GUIDE: a brief introduction

The Horizon 2020-funded MIN-GUIDE project aims to support the secure and sustainable supply of minerals in Europe through the development of a major new online repository outlining guidance and the latest in good practice for minerals policy decision makers. The project’s key objectives are (1) to provide guidance for EU and EU Member States minerals policy, (2) to facilitate minerals policy decision making through knowledge co-production for transferability of best practice minerals policy, and (3) to foster community and network building for the co-management of an innovation-catalysing minerals policy framework. MIN-GUIDE will profile relevant policy and legislation in Europe, identifying innovation-friendly good practice through quantitative indicators, qualitative analysis of country-specific framework conditions, and the compilation of minerals statistics and reporting systems. These insights will form the basis for the project’s key output, an online Minerals Policy Guide (referred to in this document as ‘the Policy Guide’).

The project is split across 8 work packages (WPs) (see Table 1 unterhalb). The content-rich work packages are WPs 2-6: WP2 will produce a comprehensive and well-structured knowledge repository of EU level and EU Member States’ mineral policies and governance frameworks; WPs 3-5 will identify, benchmark, and elaborate good practice on policy innovation capacity according to the different activities along the whole mining value chain (permitting, exploration, extraction, cross-border exploitation, processing, waste management, recycling, remediation and mine closure); and WP6 will review the mineral data base and recommend standardisation and systematic reporting requirements for EU Member States.

Table 1: The MIN-GUIDE work packages

<table>
<thead>
<tr>
<th>Common approach</th>
<th>WP1</th>
<th>Minerals policy guide development and conceptual basis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WP2</td>
<td>Stock-taking of EU and EU MS mineral policy and legislation</td>
</tr>
<tr>
<td>Core content</td>
<td>WP3</td>
<td>Innovative exploration and extraction</td>
</tr>
<tr>
<td></td>
<td>WP4</td>
<td>Innovative processing</td>
</tr>
<tr>
<td></td>
<td>WP5</td>
<td>Innovative waste management and mine closure</td>
</tr>
<tr>
<td></td>
<td>WP6</td>
<td>Raw materials knowledge and information base</td>
</tr>
<tr>
<td>Cross-cutting management and engagement</td>
<td>WP7</td>
<td>Stakeholder management, communication and dissemination</td>
</tr>
<tr>
<td></td>
<td>WP8</td>
<td>Project management</td>
</tr>
</tbody>
</table>

1.2. This deliverable

This first MIN-GUIDE deliverable (D1.1) sits under WP1. WP1 underpins the project conceptually by establishing a common understanding across the project consortium around three key issues: “what do we mean by innovation?”, “what is ‘good’ practice?”, and “what is the MIN-GUIDE approach to
benchmarking?”. In doing so, WP1 supports a more robust, coordinated and comprehensive approach to the identification of good practice across WPs 2-6. This deliverable outlines our understanding of these key concepts and how they will be applied in MIN-GUIDE. D1.1 is predominantly intended to be an internal working document for use by the MIN-GUIDE project team. However, it may also be of interest to those who want to learn more about MIN-GUIDE, and also more widely as an example of forming a common approach, and of approaches to the application of innovation and benchmarking theories in practice.

The material presented in this report is the product of desk-based literature reviews and consultation with experts through a ‘Validation Workshop’ coordinated by Policy Studies Institute at the University of Westminster in London on 12 May 2016. This full-day workshop brought together 24 experts to discuss, explore and critique these common approach issues as they appeared in an early draft of this report. Participants comprised members of the MIN-GUIDE Advisory Board and the project team, representing perspectives from the European Commission (DG Growth), industry, policy, civil society organisations and academia. However, the perspectives presented in this deliverable are the authors’ own interpretation of the issues and should not be taken to represent the views of individual workshop participants or their respective organisations.

The frameworks set out as a first step in this deliverable will continue to develop and evolve as necessary to reflect any key emerging issues over the course of the project (e.g. from WPs 2-6, the MIN-GUIDE Policy Laboratories and Annual Conferences), in order to maintain their relevance and usefulness as effective tools to guide and support the project.

Together, these frameworks aim to ensure that the Policy Guide is conceptually aligned and in touch with the needs of its users and the real-world challenges in minerals policy.

The remainder of this report is split into two core sections: (1) the MIN-GUIDE innovation framework, and (2) the good practice and benchmarking framework.

1. The innovation framework has two main objectives. The first is to aid the coherent identification across WPs 2-5 of innovation opportunities to catalyse secure and sustainable minerals production. The framework therefore sets out a common understanding of different types of innovation, including but not limited to technological innovations and innovations in organisational management processes, for example. The second, broader objective is to set out and agree a common understanding of innovation and its application in the MIN-GUIDE project. For this purpose, the framework also brings together latest academic and industry understanding about how innovation takes place, barriers and drivers, and relates these back to the minerals and mining context.

2. The framework for good practice and benchmarking establishes a common approach to benchmarking, building on a review of promising examples in benchmarking practice including approaches to the development and refinement of benchmark indicators. The framework aims to produce a clear and informed value statement of what is ‘good’ or ‘best’ with regard to minerals and mining policy and proposes a corresponding preliminary set of possible MIN-GUIDE benchmark indicators for use in WPs 2-6.
2. Innovation framework

2.1. Innovation – a working definition for MIN-GUIDE

For the purposes of the MIN-GUIDE project, we propose an understanding of innovation based on the OECD Oslo Manual definition:

“An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.” OECD and Eurostat (2005, p. 146)

In lay terms, we interpret an innovation to be the novel application of something (e.g., a product, tool, software, process, technique, method or concept).

An innovation has two essential ingredients: novelty and implementation. An innovation is a new thing or way of doing things. However, innovation differs from the concept of invention (Kemp & Pearson, 2007) in that an innovation must have been implemented, and can include the implementation of an existing product, process, etc. in a new, different context.

To avoid the term innovation being used indiscriminately, and in keeping with the scope of its analysis, in the Oslo Manual, the OECD bounds its notion of innovation by setting the minimum level of novelty required as “new (or significantly improved) to the firm” (OECD & Eurostat, 2005, p. 146).

In the context of minerals and mining, innovations may include those supporting: the exploration of new deposits, the creation of new markets for existing products, and the improvement of existing production processes (e.g. through automation) (Kurkkio, Frishammar, Söderholm, & Ejdemo, 2014).

Specific examples of previous innovations in the mining industry include: the safety lamp, dynamite for safer and more effective blasting, the steam engine to pump water out of mines, the locomotive to move extracted ore, electrolytic processes to refine metals, and, more recently: Geographic Information Systems (GIS) and portable spectrometry for exploration, RFID tags in personnel tracking, and finding new uses for mine tailings (Minalliance, 2012). Innovations more broadly may also include stakeholder engagement tools, e.g. for addressing public acceptability issues, and supply chain management to exploit opportunities for industrial symbiosis and the circular economy, as we explore further in the following sections.

2.2. How innovation takes place

The process by which innovations are transferred from one context (firm, sector, country, region, etc.) to another is called diffusion. An innovation may be the result of diffusion from another context (via external interaction or collaboration), or the result of internal research and development (without external interaction or collaboration), or some combination of the two (OECD & Eurostat, 2005).

Innovation in mining is seldom bold and radical; it is often incremental and conducted through a learning-by-doing logic where (mainly) processes are improved continuously over time.
**Innovation activities** are defined to be “all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations” (OECD & Eurostat, 2005, p. 146). Innovation is therefore the product of a potentially vast range of conditions, actors and activities spread across a number of different and overlapping levels, and the interactions between them. Consequently, innovation is typically difficult to predict, measure or manage. However, a wide body of literature seeks to explore ways in which innovation may be measured and how it might be enabled or supported through appropriate management or governance frameworks. There are multiple theories and conceptualisations of how innovation works – how innovations emerge and diffuse, and how this process is best managed or supported.¹

Notably, a key trend in recent thinking over the last decade shows support for innovation policy that is (1) challenge-driven and (2) embraces a broad concept of innovation (European Commission, 2010; OECD & Eurostat, 2005; Steward, 2016). It is broad in the sense of promoting a systems perspective of innovation, focusing on innovation across the value chain rather than on single-point solutions. This widens the scope from more traditional supply side technology-driven innovation policy to acknowledge the role of demand side-focused innovation as well. What is considered to be an innovation has also expanded over time to include non-technological innovations, marketing and organisational innovations, among others (e.g. OECD and Eurostat (2005)).

### 2.3. Different types of innovation

As described above, innovation is not limited to technological developments. There is considered to be a much broader range of different types of innovations. In Table 2 below we list some attempts from the literature to classify and organise these different types of innovations into categories.

<table>
<thead>
<tr>
<th>Source</th>
<th>Types of innovation</th>
</tr>
</thead>
</table>
| Oslo Manual (OECD & Eurostat, 2005) | • Product innovation: introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses  
• Process innovation: implementation of a new or significantly improved production or delivery method, e.g. techniques, equipment, software  
• Marketing (or presentational) innovation: implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing  
• Organisational innovation: implementation of new organisational methods in business practices, workplace organisation or external relations |

¹ A variety of different models of innovation are illustrated in Annex A on page 45.
### Ten types of innovation

(Keeley, Walters, Pikkel, & Quinn, 2013)

**Configuration:**
- Profit model: how you make money
- Network: how you connect with others to create value
- Structure: how you align your talent and assets
- Process: how you use signature or superior methods to do your work

**Offering:**
- Product performance: how you employ distinguishing features and functionality
- Product system: how you create complementary products and services

**Experience:**
- Service: how you support and enhance the value of your offerings
- Channel: how you deliver your offerings to customers and users
- Brand: how you represent your offerings and business
- Customer engagement: how you foster distinctive interactions

### EIP on raw materials

(European Commission, 2012)

- Technology-focussed
- Non technology-focussed
- International cooperation

### Taxonomy of public sector innovation

(Windrum, 2008)

- Services innovation: a new or improved service
- Service delivery innovation: a new or different way of providing a service
- Administrative or organisational innovation: a new process
- Conceptual innovation: a new way of looking at problems; challenging current assumptions
- Policy innovation: a change to policy thinking or behavioural intentions
- Systemic innovation: a new or improved way for public sector to operate and interact with stakeholders

### Typology of eco-innovation

(Kemp & Pearson, 2007)

- Environmental technologies: e.g. waste water treatment technologies, environmental monitoring and instrumentation, green energy technologies
- Organisational innovation: e.g. environmental management and auditing systems, supply chain management
- Product and service innovation: e.g. products: material products such as eco-houses; green financial products; and services: waste management, consulting, car sharing
- Green system innovations: e.g. alternative systems of production and consumption such as a renewables-based energy system

### Five types of innovations

(Schumpeter, 1934)

- Introduction of new products
- Introduction of new methods of production
- Opening of new markets
- Development of new sources of supply for raw materials or other inputs
- Creation of new market structures in an industry
### 2.4. The MIN-GUIDE innovation categories

One of the aims of D1.1 is to aid the coherent identification across WPs 2-5 of innovation opportunities to catalyse secure and sustainable minerals production. Based on the examples of different typologies in Table 2 oben, we propose the following innovation categories\(^2\) to help guide the identification of innovation opportunities and best practice in MIN-GUIDE:

1. **Product** innovation: introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses, e.g. a new material or new use for a material (e.g. tailings).
2. **Process** innovation: implementation of a new or significantly improved production or delivery method, e.g. techniques, equipment, software. Also within this broader category we include and highlight **input** innovation: new sources of inputs (e.g. mining waste).
3. **Marketing** innovation: implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing (e.g. new communication tools for raising awareness and building public acceptability).

\(^2\) This list of MIN-GUIDE categories has been revised based on feedback and discussion at the Validation Workshop. An earlier draft of the common approach originally proposed seven categories: product; process; input; marketing; organisational; system; and governance innovation. **Input** innovation is still highlighted in the new framework, as some workshop participants and project team members found it to be a useful distinction. However, it is now included under the broader process innovation category more in line with the well-accepted Oslo Manual categorisation of innovation. **Governance** innovation has been removed as its own category of innovation and is instead considered in the new framework, where relevant, within either organisational innovation or as a cross-cutting actor perspective (see below) (i.e. when referring to innovation in policy framework design from the perspective of policy-makers as innovators, for example).
4. **Organisational** innovation: implementation of new organisational methods in business or policy practices, workplace organisation or external relations (e.g. environmental management and auditing systems; supply chain management; industrial symbiosis; closer cooperation between different ministries on minerals policy design and delivery).

5. **System** innovation: (e.g. innovations which result in significant improvements in more than one step of the supply chain, or in another sector)

It is important to note that these categories are not mutually exclusive. Innovations can involve aspects of multiple categories, and it is not always easy to draw clear-cut distinctions between the different types. For further reading and guidance on the differences between the product, process, organisational and marketing categories, see OECD & Eurostat (2005, pp47-56). In addition to the Oslo Manual categories we also include system innovation as a category of its own to prompt the consideration and identification in MIN-GUIDE WPs 2-5 of promising broad-reaching innovations across the value chain and/or other sectors, in line with the ‘broad concept of innovation’ advocated in section 2.2 above.

Another key point is that one actor’s product innovation may be another’s process innovation. For example, a technology-supplier’s product innovation is, from a mineral processing firm’s perspective, a process innovation. In other words, the innovation categories depend on the perspective of the innovating actor in question. Within the MIN-GUIDE project one can consider there to be three broad core perspectives:

1. the minerals and mining industry perspective;
2. the policy-maker perspective; and
3. the external perspective.

The industry perspective can be further broken down (e.g. by value chain element) and considers the possible innovations from the perspective of those at the firm-level within a given element of the value chain, for example. The innovation categories may also be filled in from the alternative perspective of a policy-maker, whose product is policy and whose organisational structures, processes and marketing may themselves be subject to innovation, e.g. to better support a given policy objective or outcome. These two perspectives are both broadly within the scope of MIN-GUIDE. The third perspective, the external perspective, denotes all actors and innovation activity which lie beyond the reasonable influence of minerals and mining policy, i.e. everything which does not fall under the first two perspectives.
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
</table>
| **Product**   | Introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses | - a new material or new use for a material (e.g. tailings)  
- “Pilbara Blend” iron ore, allowed for the usage of lower quality ores and increased average sales price  
- New light-weight alloys and manufacturing techniques  
- Use of various waste materials in cement production (alternative fuels and feedstock materials)  
- The reuse of waste from the mining industry (e.g. in Spain: coal waste in the manufacture of cement)  
- Use of mining waste as secondary raw materials  
- Use of mining waste for mine closure  
- Industrial mineral PCC for coating of paper  
- Mining waste valorisation (product/process innovation)  
- Nanotechnology  
- Mining equipment (remote control...)

| **Process**   | Implementation of a new or significantly improved production or delivery method | - New techniques, equipment, software  
- Talc that was milled to smaller size (through a new milling process), which allowed new applications  
- Governance: public consultation processes for new mining policies, inter-ministerial working groups, policy-making advisory bodies (e.g. AT: Raw Material Alliance)  
- Ore sorting to separate out coarse waste at early stage of processing  
- HPGR – High Pressure Grinding Rolls used in cement clinker grinding now in ore comminution  
- GIS use for valuing resources in ore mining and adapt to end products  
- Solution mining  
- Innovative approaches to how policy is developed bottom-up and influenced from the project outcomes and deliverables  

Also including: **Input** innovations (new sources of inputs):  
- Urban mining
<table>
<thead>
<tr>
<th>Marketing innovation</th>
<th>Implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Communication or facilitation models or tools for raising awareness and building public acceptability</td>
</tr>
<tr>
<td></td>
<td>• Responsible Jewellery Council: Implementation of certain environmental and social standards in participants’ companies should give customers more certainty and allows differentiation; Fair Gold</td>
</tr>
<tr>
<td></td>
<td>• Raw Material University Days / Raw Material Days (general awareness-raising instruments)</td>
</tr>
<tr>
<td></td>
<td>• New approaches to how minerals policy is communicated to individuals or groups of stakeholders</td>
</tr>
<tr>
<td></td>
<td>• New tools and channels for communication</td>
</tr>
<tr>
<td></td>
<td>• Design thinking</td>
</tr>
<tr>
<td></td>
<td>• User-first approach</td>
</tr>
<tr>
<td></td>
<td>• Communicating Life Cycle Assessment results</td>
</tr>
<tr>
<td></td>
<td>• Shift in business model from profit to long-term value for shareholders</td>
</tr>
<tr>
<td></td>
<td>• Network of stakeholders</td>
</tr>
<tr>
<td></td>
<td>• Inclusion of local communities in order to secure acceptance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organisational innovation</th>
<th>Implementation of new organisational methods in business practices, workplace organisation or external relations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Environmental management and auditing systems, supply chain management; industrial symbiosis</td>
</tr>
<tr>
<td></td>
<td>• ISO 9001 and 14001, OHSAS 18001; EITI leading to more tax transparency in participating countries (could also be listed in 7); Shared Value concept and other stakeholder engagement tools</td>
</tr>
<tr>
<td></td>
<td>• New business models to facilitate the SLO (Social License to Operate) in new mining projects</td>
</tr>
<tr>
<td></td>
<td>• Business parks – use of surplus heat at another plant, waste stream as input to another plant</td>
</tr>
<tr>
<td></td>
<td>• Health and Safety procedures or guidelines at site/company level</td>
</tr>
<tr>
<td></td>
<td>• Coordination between different sectoral ministries</td>
</tr>
<tr>
<td></td>
<td>• Streamlining the permitting procedure, harmonisation of policy objectives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System innovation</th>
<th>Innovations which result in significant improvements in more than one step of the process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Talc as described in 2 above was used in plastics in the automobile industry to make them stronger and lighter, improving safety and fuel efficiency there</td>
</tr>
<tr>
<td></td>
<td>• Symbiosis between mining (mineral, processing) metallurgical industries and recycling</td>
</tr>
<tr>
<td>supply chain, or in another sector</td>
<td>companies to minimise process losses (supply chain/business model innovation)</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>• Geometallurgy – a holistic approach to characterisation and modelling along the production chain.</td>
</tr>
<tr>
<td></td>
<td>• Sectoral symbiosis – SPIRE PPP</td>
</tr>
<tr>
<td></td>
<td>• Strategic policy framework covering different value-chains, different topics (education, research, public awareness, streamlined permitting etc.)</td>
</tr>
<tr>
<td></td>
<td>• The development of Mineral Strategies and Action Plans (integrating the mining sector into different / larger contexts: e.g. Austrian Mineral Resource Plan and Austrian Resource Strategy)</td>
</tr>
</tbody>
</table>

Source: MIN-GUIDE WP1 Validation Workshop (12 May 2016) group exercise
2.5. Driving innovation

“Necessity is the mother of invention” – English proverb

As we note above, the factors contributing to innovation are complex. It can therefore be problematic to isolate, identify or trigger the causal relationships resulting in innovation. Instead we can try to create the supportive conditions for innovation, using an understanding of the common drivers and barriers to innovation as a starting point.

Actors’ motives for innovating are a key driving force for innovation, supported by the availability and transferability of innovations and developments in other fields, while barriers may include economic (e.g. prohibitive cost), endogenous (i.e. lack of internal capacity, such as skills) and legal factors (e.g. unsupportive regulations) (OECD & Eurostat, 2005).

Table 4 unterhalb illustrates the results of a Eurobarometer survey on the attitudes of European entrepreneurs towards eco-innovation (Gallup, 2011). The items at the top of the list are those most commonly voted as ‘important’ drivers or ‘serious’ barriers by SME managers. While these results focus specifically on the issue of eco-innovation – innovation for environmental progress towards sustainable development3 – they help to generate some generic insights into potential drivers and barriers relevant to innovation for a range of purposes.

Table 4: Perceived drivers and barriers of eco-innovation according to entrepreneurs

<table>
<thead>
<tr>
<th>Drivers of innovation development, diffusion and uptake (in decreasing order of importance)</th>
<th>Barriers to the development, diffusion and uptake of innovations (in decreasing order of importance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Expected future increases in energy prices</td>
<td>• Uncertain demand from the market</td>
</tr>
<tr>
<td>• Current high energy prices (as an incentive to innovative, to use less energy and decrease the cost)</td>
<td>• Uncertain return on investment or too long a payback period for eco-innovation</td>
</tr>
<tr>
<td>• Current high material prices (as an incentive to innovate to use less material and decrease the cost)</td>
<td>• Lack of funds within the enterprise</td>
</tr>
<tr>
<td>• Good business partners</td>
<td>• Insufficient access to existing subsidies and fiscal incentives</td>
</tr>
<tr>
<td>• Secure or increase existing market share</td>
<td>• Existing regulations and structures not providing incentives to eco-innovate</td>
</tr>
<tr>
<td>• Access to existing subsidies and fiscal incentives</td>
<td>• Lack of external financing</td>
</tr>
<tr>
<td>• Technological and management capabilities within the enterprise</td>
<td>• Reducing energy use is not an innovation priority</td>
</tr>
<tr>
<td>• Increased market demand for green products</td>
<td>• Technical and technological lock-ins (e.g. old technical infrastructures)</td>
</tr>
<tr>
<td>• Expected future material scarcity (as an incentive to develop innovative, less material-intensive substitutes)</td>
<td>• Lack of qualified personnel and technological capabilities within the enterprise</td>
</tr>
<tr>
<td></td>
<td>• Market dominated by established enterprises</td>
</tr>
<tr>
<td></td>
<td>• Reducing material use is not an innovation</td>
</tr>
</tbody>
</table>

3 “Eco-Innovation is any form of innovation resulting in or aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources.” (European Commission, 2011)
<table>
<thead>
<tr>
<th>Drivers and Barriers</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Good access to external information and knowledge, including technology support services</td>
<td>• Limited access to external information and knowledge, including a lack of well-developed technology support services</td>
</tr>
<tr>
<td>• Expected future regulations imposing new standards</td>
<td>• Lack of suitable business partners</td>
</tr>
<tr>
<td>• Limited access to materials</td>
<td>• Lack of collaboration with research institutes and universities</td>
</tr>
<tr>
<td>• Existing regulations, including standards</td>
<td></td>
</tr>
<tr>
<td>• Collaboration with research institutes, agencies and universities</td>
<td></td>
</tr>
</tbody>
</table>

Source: Eurobarometer (2011)

Together with the criteria in Table 6 and the challenges in Table 7 in the following section 3, the above listed drivers and barriers will act as common starting point and scoping exercise for each of the individual WP3-5 mining value chain elements. Scoping and contextualising the individual WPs 3-5 in this way will support the development and adaptation of a conceptual framework on supportive conditions for innovation from a mining value chain specific perspective.
3. Benchmarking and good practice framework

This section aims to set out a common understanding of and approach to benchmarking in the MIN-GUIDE project. First we provide an introduction to benchmarking as a concept and summarise key approaches and examples from the literature (sections 3.1 and 3.2) (a full summary of the studies reviewed is presented in Annex B on page 43). We explore what ‘good’ might mean in the context of MIN-GUIDE and minerals policy in the EU (section 3.3), and examine the issue of selecting indicators (section 3.4).

We end with a set of steps to contextualise and guide a common approach to benchmarking across MIN-GUIDE WPs 2-5 (section 3.5).

3.1. An introduction to benchmarking

Benchmarking is the practice of comparing performance (e.g. of different companies, Member States) against a ‘best in class’ ‘benchmark’ performance. It is commonly applied in a variety of contexts including competitive benchmarking (conducted by an individual company which compares itself against a leading competitor to reveal and target critical areas for success and improvement), policy, and collaborative benchmarking (conducted collectively by a group of players each aspiring to improve through the sharing of information and good practices). Existing well-established examples of collaborative benchmarking in industry include benchmarking in the UK construction industry and the EU water and wastewater utilities industry.

Benchmarking can be thought of as ‘the continuous measurement and improvement of an organisation’s performance against the best in order to obtain information about new working methods or practices in other organisations’ (Kozak and Niels, 2001). Benchmarking is most often applied in a business context, and many definitions of the methods reflect this. Similarly, the practice has been defined as ‘a continuous and systematic process of comparing products, services, processes and outcomes with other organisations or exemplars, for the purpose of improving outcomes by identifying, adapting and implementing best practice approaches’ (Scott, 2011).

Benchmarking is nevertheless a flexible concept that, in practice, can be (and has been) adapted to suit the needs of diverse organisations, something reflected in its migration from the business world to the policy world.

The fundamental aim of measuring and comparing performance in this way is therefore to identify areas for improvement. Whilst business benchmarking bears some similarities to other assessment tools, such as performance gap analysis, comparison research, competitor analysis and quality assurance models, it can go further than comparing outputs by scrutinising the operational and management skills and processes that shape them. With a business focus, Kozak and Niels (2001) identify some of the principal purposes of benchmarking. These include:

---

5 http://constructingexcellence.org.uk/
6 http://www.waterbenchmark.org/
• To help business understand where they have strengths and weaknesses depending upon changes in supply, demand and market conditions.
• To help better satisfy the customer’s needs for quality, cost, product and service by establishing new standards and goals.
• To motivate employees to reach new standards and to welcome new developments within the related area and to improve the motivation of employees.
• To allow businesses to realise what level(s) of performance is achievable by considering other methods and to show how such improvement may be made.
• To document reasons as to why differences exist.
• To enable businesses to improve their competitive advantage by stimulating continuous improvement in order to maintain world-class performance and increase competitive standards.
• Establish a pool of innovative ideas that are cost-effective and time-efficient from which the most applicable examples may be utilised.

While many of these steps apply specifically to the business applications of benchmarking, the approach has been applied in a wide variety of policy contexts.

Potential pitfalls when benchmarking can be minimised from the outset through the selection of appropriate partners and ensuring outcomes, scope and parameters are agreed upon from the start (Wilson et al., 2000). Challenges may include time constraints, competitive barriers, cost, lack of ongoing commitment and human resources, resistance to change, poor planning and short-term expectations (Bendell, Boulter and Kelly, 1993).

Table 5 below lists the factors for benchmarking success identified by UK construction industry collaborative benchmarking organisation ‘Constructing Excellence’ and how they will be taken into account and addressed in MIN-GUIDE WPs 2-5.

Table 5: Factors for benchmarking success

<table>
<thead>
<tr>
<th>Factor</th>
<th>Relation to MIN-GUIDE approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) A clear understanding of what needs to be improved, and why. [...] Benchmarking must align with the organisation’s objectives if it is to be successful</td>
<td>See section 3.3 for an initial discussion of the role and shape good practice takes. WPs 2-5 will further elaborate on this, e.g. by refining the drivers, barriers and challenges they are to address.</td>
</tr>
<tr>
<td>(b) Establishment of goals and targets that are both challenging and achievable with effort</td>
<td>WPs 2-5 will address this as part of the ‘scope definition’ (see section 3.5, step 1).</td>
</tr>
<tr>
<td>(c) Careful selection of who to benchmark against</td>
<td>The Policy Labs, which take part in WP3, will bring together stakeholder to examine what good practice looks like, why it takes this form, and whether and how it can be transferred.</td>
</tr>
<tr>
<td>(d) Clear understanding of the reasons for any difference in performance</td>
<td>WP7 will undertake stakeholder engagement activities with policymakers, businesses and other parties to encourage adoption of MIN-</td>
</tr>
</tbody>
</table>
3.2. Benchmarking approaches and examples

There is no single benchmarking approach or tool that can be applied universally; neither is there a universally-agreed categorisation or typology of different benchmarking methods, leading to claims of the need to develop more widely accepted methods (Worrell, 2011). Having clear and achievable aims and appropriate partners is arguably more important than the type of benchmarking being carried out (Scott, 2011). Nevertheless, certain ways of describing different approaches to benchmarking do exist.

‘Internal benchmarking’ refers primarily to comparisons drawn between different divisions within a single organisation, or between organisations operating as part of a chain in different countries. Higher performing business units can be identified and practices shared in order to achieve similar outcomes across the organisation (Kozak and Nield, 2001).

‘External benchmarking’ seeks to compare an organisation’s performance with some element external to its own business (or otherwise) operations. ‘Competitive benchmarking’ is when a comparison is drawn between two direct competitors, which may require the exchange of sensitive information and so be difficult to achieve. It has been suggested that this may be more appropriate for larger businesses (Cook, 1995). ‘Functional benchmarking’ refers to comparisons between organisations in different industries where they perform similar functions or activities and similar conditions (and for this reason is also known as ‘non-competitive benchmarking’). An example could be a comparison between the cleaning services used an airliner and a train operator (Cook, 1995).

‘Generic benchmarking’ (also ‘strategic benchmarking’) aims to draw useful comparisons between an organisation and the best businesses operating the same processes and functions but in different industries. It is believed that best performers will be more likely to share their experiences.

While benchmarking in the world of business is therefore relatively commonplace, the use of ‘policy benchmarking’ as a way of comparing and improving activity in the public sphere is more novel. For example, this review has revealed no ‘how to’ document on the various methods for carrying out policy benchmarking studies, although it has uncovered a number of studies that relate to benchmarking in varying ways. While such studies do not always follow a formal process, many of them have structures that echo benchmarking guidance from management studies (e.g. iSixSigma.com, n.d.):

1. Agreement of research/exercise objectives and definition of scope
2. Choice of benchmark partner(s)
3. Determine measurement methods, units, indicators and data collection method
4. Data collection
5. Analysis of the discrepancies
6. Present results and discuss implications/improvement areas and goals
7. Make improvement plans or new procedures
8. Monitor progress and plan ongoing benchmark
The majority of policy benchmarking efforts reviewed in WP1 relate to innovation policies, especially in Europe. Here we discuss some instances of activity that has taken place to date in this area.

Throughout the 1980s and 1990s, national benchmarking initially adapted corporate benchmarking techniques to assess the efficiency of public services against comparators in the private sector – which were subsequently adapted to compare like with like (d’Acosta, Melgarejo, Mercer-Blackman, 2013). Groenendijk (2004) notes the distinction between three types of public sector benchmarking: (i) that of public sector organisations, (ii) of public policies and policy outcomes, and (iii) of policy systems. Policy benchmarking, a relatively novel addition to the benchmarking tradition, has been described as “searching experience and lessons across space”, with a view to ‘finding’ policies and strategies abroad that may support the development of policies at home, and can therefore be seen as the starting point for a learning process (Rose, 1993 in Huggins, 2010). Exercises in international policy benchmarking have been carried out in a remarkably wide range of policy fields in recent years, including trade, productivity and growth, innovation, gender equality in science, safer internet policies, social policy, energy policy and health policy. Annex B on page 43 lists a number of previous policy benchmarking exercises; although many are outside the mining and minerals field, they provide a variety of transferrable lessons. See section 3.5 for a contextualisation of the findings and implications for MIN-GUIDE.

A number of descriptive benchmarking studies come from countries that have significantly different developmental and policy contexts (and priorities) from the EU. Given the paucity of methodologically detailed studies from developed countries, these are nevertheless included below; they often outline the approach in ways that could provide lessons for MIN-GUIDE.

On a national level, benchmarking is used to compare a country’s performance on a given issue against a given standard, and may therefore be most effective when similar countries are grouped together, although Zabala-Iturriagagoitia et al. (2007) argue that innovation is path dependent and location-specific and policy responses need to recognise this. The process is very similar to that employed by businesses and emphasises the identification of central indicators, the factors that influence them, the performance and policy gaps between countries, and the recommendation and monitoring of policies designed to narrow them. Benchmarking has often been undertaken within the context of macroeconomic performance (McAulife, Saxena and Yabara, 2012; Johnson, Ostry, and Subramanian, 2007; d’Acosta, Melgarejo, Mercer-Blackman, 2013).

There is a high degree of variation in the methods used to carry out benchmarking studies, with some following a ‘looser’ methodological approach (or perhaps not fully discuss it) (e.g. Ezell and Atkinson, 2011). It may be that the subject of a benchmarking exercise is intrinsically harder to measure or without readily available and accessible datasets with which to do it. Moreover, measuring like with like may prove problematic where there is a lack of accepted policy frameworks, and this is only compounded where multi-level policy interventions overlap and interact, as in the EU. Attempts to benchmark innovation policies across the EU face the challenge of involving numerous policy actors and objectives, whilst to be executed in their simplest form they require a single set of coherent policy objectives and a defined set of actors (Berger, 2005 in Manjón, 2010).

Sustained interest regional level benchmarking (principally in Europe) has emerged relatively recently (e.g. Zabala-Iturriagagoitia et al., 2007; Kutvonen, 2007; Huggins, 2010; Uyarra, 2010;
Kuusisto and Lahtinen, 2015; see typology in Huggins (2010)), as attempts have been made to benchmark regional innovation policies. It has been noted in assessing regional innovation systems’ performance that these systems must be taken as a whole, including both qualitative and quantitative indicators (Leydesdorff, 2001), which may influence the choice of MIN-GUIDE indicators in later work packages. Likewise, Zabala-Iturriagagoitia et al. (2007) observe that literature on policy evaluation is agreed that there is a need to combine different approaches, methods and indicators, and that quantitative information appears to offer only partial insight into the condition of innovation systems.
3.3. ‘Good’ practice and good practice criteria

A key first step in the benchmarking process is to have an understanding of what success looks like – what constitutes ‘good’ performance or ‘good’ when we talk about good practice. This step of defining ‘good’ is also important for the MIN-GUIDE concept of innovation: innovation for what purpose? What is the nature and desired impact of the innovations which we seek to stimulate and support through policy?

At the private firm level, a firm may benchmark to identify, and/or engage in innovation activities to realise, improvements to its productivity, profit, and cost-effectiveness, for example.

Our characterisation of ‘good’ practice for MIN-GUIDE is informed by the project’s overarching aim: to support the secure and sustainable supply of minerals in the EU.

Taking sustainability to encompass each of the economic, social and environmental dimensions, we elaborate on this aim to arrive at the good practice goal criteria for MIN-GUIDE proposed in Table 6

Table 6: MIN-GUIDE good practice criteria

<table>
<thead>
<tr>
<th>Overarching aim</th>
<th>Sub-criteria</th>
<th>Corresponding sustainability dimension(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The secure and sustainable supply of minerals in the EU</td>
<td>• Resource security, balancing short and long-term resource needs (e.g. through strategic use of critical minerals and harmonisation of goals across different policy areas and removal of barriers)</td>
<td>Economic Social Environmental</td>
</tr>
<tr>
<td></td>
<td>• Economic sustainability: To support the economic sustainability of the minerals and mining industry in the EU, including jobs and profitability (e.g. through maintaining competitiveness).</td>
<td>Economic</td>
</tr>
<tr>
<td></td>
<td>• Environmental sustainability: To minimise the environmental impacts of waste and other activity in the minerals and mining sector (e.g. minimising waste and maximising material recovery through improved resource efficiency and resource management).</td>
<td>Environmental</td>
</tr>
<tr>
<td></td>
<td>• Social responsibility (at all stages of the value chain); health and safety; CSR; jobs; welfare; wellbeing.</td>
<td>Social</td>
</tr>
<tr>
<td></td>
<td>• Good governance; shared and differentiated responsibility; co-management and cooperation; transparency; public acceptance; accountability.</td>
<td>Social (Institutional procedural)</td>
</tr>
</tbody>
</table>


It should be noted that there are overlaps and synergies between these sub-criteria categories, as well as potential conflicts. It is also important to consider the temporal dimension of activities; successful performance or progress against one criterion may conflict with progress on another in
the short term but be mutually reinforcing in the long run, and *vice versa*. The order of the sub-criteria in table above is not a priority ordering, although it may be useful to agree on a priority ordering, especially where activities to support different goals conflict.

Challenges associated with the identification of good practice include varying national contexts and requirements. Different pre-existing institutional conditions (either institutions or the policies they implement) in different countries may present an obstacle, and the structural and/or functional weaknesses they were believed to offset or mitigate will need to be properly understood in subsequent MIN-GUIDE work packages. This means that these differences may frustrate attempts to identify what is ‘good’, since both policies and processes will have evolved in response and therefore may be sensitive and specific to local conditions. Transfer of a good practice in one (country) context to another therefore does not necessarily guarantee success in the new context. Dolowitz et al. (2000) ask what motivates policymakers to engage in the policy transfer process, how and at what stage do different actors become involved, when in the policy cycle does policy transfer take place, and what form does this transfer take: is it ‘copying’, or something more sophisticated? Understanding what constitutes good practice is fundamental to enabling policy transfer.

A corresponding goal-based approach of identifying ‘good’ practice, further building on the approach outlined in Table 6 oben, is to elaborate and work backwards from the challenges facing minerals and mining. Table 7 unterhalb brings together examples of some of the challenges facing minerals and mining under each of the respective stages of the minerals value chain and the policy framework (corresponding to MIN-GUIDE WPS 2-6 respectively).

**Table 7: Challenges for minerals and mining**

<table>
<thead>
<tr>
<th>WP element</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| Mineral policy governance framework (WP2) | • Designing the right policy instruments or policy mixes to meet the objectives envisaged in the first place.  
• Cross-sectoral integration and coherence of policies that are in the competence of different ministries and policy units within one ministry.  
• Collaboration and exchange between different tiers of government (i.e. EU, national, regional and local) in designing and delivering minerals policies.  
• Implementation of comprehensive monitoring and policy evaluation tools (e.g. minerals policy scoreboard).  
• Involving the right mix of stakeholders (e.g. industry, research, CSOs) who are crucial in the design and delivery of policies, and designing the right process for effective dialogue and exchange. |
| Exploration, extraction, cross-border exploitation (WP3) | • Future mining projects towards greater depth increase exploration and extraction costs &raise safety issues.  
• Reduced grade mining deposits are characterised by higher waste production, energy and water usage.  
• Reliable & faster remote exploration methods to increase knowledge about deep and low grade deposits.  
• Potential policy and legislation conflicts concerning exploitation and associated environmental impacts in cross-border areas.  
• Higher waste production, energy and water usage due to low grade deposits |
3.4. Indicators

A next step is to identify benchmark indicators based on the clear and informed shared value statement of what is ‘good’ with regard to minerals and mining policy, explored in section 3.3 oben. These will be decided in each of the mining value chain elements throughout WPs 2-6 and will encapsulate the broad sense of innovation described earlier, for example, by being sensitive to a range of different possible types of innovation. The European Commission (2006) discusses the selection of indicators in the context of evaluation, arguing that it is desirable the objectives are set during the formulation process, and outlines a set of suggested properties for valid indicators (see Table 8 unterhalb). Work packages 2-5 should measure their selection of proposed indicators against this list as a minimum in order they satisfy the key criteria.

Table 8: Key properties of good indicators

<table>
<thead>
<tr>
<th>Property</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant</td>
<td>There should be a clear intuitive link between the indicator and the [policy] objective that is to be achieved. To provide a better picture of performance, indicators should be output-orientated, or if measuring relative efficiency,</td>
</tr>
</tbody>
</table>
both input and output indicators may be combined.

<table>
<thead>
<tr>
<th>Bounded and comprehensive</th>
<th>Information should be provided with a small number of most significant indicators that cover all the main aspects of the target of evaluation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accepted</td>
<td>Indicators should be discussed with the interested parties to reach an agreement on their interpretation and acceptance.</td>
</tr>
<tr>
<td>Credible</td>
<td>Indicators should be unambiguous, easy to interpret and credible for reporting purposes.</td>
</tr>
<tr>
<td>Easy</td>
<td>The indicator data being accessible and readily obtainable means that the evaluation can be carried out without disproportionate costs for acquiring information. In addition, indicators should also be capable of independent verification.</td>
</tr>
<tr>
<td>Reliable and robust</td>
<td>Indicators should be impervious to manipulation and unwanted distortion, exhibiting an appropriate level of accuracy and dependability.</td>
</tr>
<tr>
<td>Consistent and comparable</td>
<td>Ideally indicators remain consistent from year to year and display comparability even across different contexts.</td>
</tr>
</tbody>
</table>


A leading benchmarking study is the European Innovation Scoreboard, which records and compares measures of innovation across EU Member States. The Scoreboard measures innovation by combining a total of 25 different indicators, divided across three categories, into a ‘Summary Innovation Index’. Likewise, the forthcoming Raw Materials Scoreboard will cover a range of indicators on environmental and economic sustainability, innovation and governance, and will most likely provide critical input and guidance for the selection of indicators and data sources. Table 10 on page 47 details exemplar indicators and their sources, of which Eurostat is the most prominent.

### 3.5. Benchmarking in MIN-GUIDE

Against this background, we propose the following steps as an overarching guide to the benchmarking approach in WPs2-5 of MIN-GUIDE:

1. **Define the scope.** Describe where the work package-relevant boundaries lie (e.g. geographical, temporal, sectoral, etc.). Share and collaborate with other WPs and MIN-GUIDE partners to ensure a coherent approach to scope definition. Questions for work packages to consider include:
   a. Who to benchmark against?
   b. Which parts of the value chain should be included in the scope? This requires specific definition with examples
   c. Which sectors of actors should be included? Where are the boundaries (e.g. equipment manufacturers)?

2. (**What does success look like?** Define the criteria which determine success. See section 3.3 on ‘Good’ practice and good practice criteria
   a. Are there any additional criteria specific to the focus or scope of the work package?
   b. Are certain criteria more important than others? If relevant, establish a priority order and weighting.

---

3. (‘How do you measure success?’) Identify benchmark or ‘key performance’ indicators for each of the criteria in step 2. See section 3.4 on Indicators, and Table 8: Key properties of good indicators. Identify appropriate data sources and refine the list of indicators based on data availability.

4. Collect and analyse data.

5. Present results and discuss: Highlight good practice and its key components, potential for learning and transferability, performance gaps, improvement areas and goals.
   a. This will take place in the Policy Labs. The presentation of results will be in a format informed by D1.2 on Policy Guide format and features.

6. Develop corresponding guidance, e.g. improvement plans and targets. Important questions include:
   a. What is transferred?
   b. Who is involved in policy transfer?
   c. Where is it transferred from and to, and what are the key differences?
   d. How is it transferred?

---

8 Work Packages should also refer to the Raw Material Scoreboard indicators (forthcoming).
4. Next steps

4.1. Implementing the common approach

In this deliverable we have outlined our understanding of key concepts and how they will be applied in MIN-GUIDE: ‘what do we mean by innovation?’, ‘what is ‘good’ practice?’, and ‘how to approach benchmarking?’, in order to support a more robust, coordinated and comprehensive approach to the identification of good practice across WPs 2-6.

As a cross-cutting work package running through the majority of the MIN-GUIDE project, WP1 will continue to support the project on these common approach issues and advise on the implementation of the common approach – as set out in this deliverable – in WPs 2-6 as necessary.

The frameworks set out in this deliverable will continue to develop and evolve as necessary to reflect any key emerging issues over the course of the project (including in WPs 2-7, the MIN-GUIDE Policy Laboratories and the Annual Conferences), in order to maintain their relevance and usefulness as effective tools to guide and support the project.

4.2. Next in MIN-GUIDE

The focus of WP1 now turns to the development of the MIN-GUIDE Policy Guide, in particular the framework of the Guide and its features. Deliverable 1.2, outlining the proposed structure and format of the Policy Guide is due in Summer 2016.

WP2 (Stock-taking of EU and EU MS mineral policy and legislation) is underway, with work on WP3 (Innovative exploration and extraction) due to begin in June 2016.

The next MIN-GUIDE event will be the first Policy Laboratory on innovative minerals policy governance (WP2) in September 2016.

A beta version of the MIN-GUIDE project website, the main repository of relevant information and events (including the MIN-GUIDE Annual Conferences and Policy Laboratories) as well as the Policy Guide itself is available at: www.min-guide.eu.

For more information about the project, and to sign up to receive the MIN-GUIDE Newsletter (distributed every three months) with project updates, latest news, and opportunities for collaboration, contact Andreas Endl: Andreas.Endl@wu.ac.at.
REFERENCES

(Innovation Framework) References


Steward, F. (2016). Building an EU Industrial Policy focused on Innovation


(Innovation Framework) Additional bibliography

. MIN-GUIDE grant agreement.


European Commission. (2014). *Evaluation and Exchange of Good Practice for the Sustainable Supply of Raw Materials within the EU.*


Steward, F. (2016). Building an EU Industrial Policy focused on Innovation


(Benchmarking and Best Practice Framework)

References


Groenendijk, N.S. (2004), The use of benchmarking in EU economic and social policies, European Communities Studies Association (ECSA) annual meeting, University of Southern Denmark, 24th-25th September 2004.


Jerman-Blazic, B. (2008), The development of research and innovation policies based on a benchmarking assessment: the case of mobile communications technology R&D in the new member states of the EU, Technology Analysis & Strategic Management, 20(2):201-216.


ANNEX A: Models of Innovation

Figures 1-10 in this Annex depict a range of ‘models’ of innovation from the literature identified as of potential interest to MIN-GUIDE and the MIN-GUIDE project team.

**Figure 1**

[Diagram showing the innovation cycle with stages: idea generation, idea selection, idea implementation, idea diffusion, sustaining ideas.]


**Figure 2**

[Diagram showing the innovation cycle with key elements: leadership, culture, corporate strategy, human capital, incentives and rewards, organisational capability and agility, focusing on the important things.]


**Figure 3**

[Table showing factors and performance of eco-innovation with knowledge implemented and demand pull.]

*Source: Measuring Eco-Innovation* (Huppes et al., 2008)

**Figure 4**

[Diagram showing the stages of the innovation chain from Government to Consumers.]

*Source: in Governance for Industrial Transformation* (Foxon, Makuch, Mata, & Pearson, 2004)
Figure 5: “The Multi-Level Perspective”

Source: Technological transitions as evolutionary reconfiguration processes (Geels, 2002)

Figure 6: “The Innovation Measurement Framework”


Figure 7: “A systemic view of innovation”

Source: Trends in OECD Countries’ International Competitiveness (Durand, Madaschi, & Terribile, 1998)
Figure 8: “Generic model of national innovation systems”

Source: *RCN in the Norwegian Research and Innovation System* (Kuhlmann & Arnold, 2001)

Figure 9: “Closed innovation”

Source: *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Chesbrough, 2003)

Figure 10: “Open innovation”

Source: *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Chesbrough, 2003)
ANNEX B: Recent policy benchmarking studies

Table 9: Recent policy benchmarking studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy benchmarking for productivity and growth: Review and proposed framework for the Caribbean</td>
<td>Performance and indicators were selected based on a) those which were most closely related to the drivers of real income and b) those for which data was readily available. Policy indicators consisted of those that most accurately reflected the policy stance towards different sectors in the economy and which have the highest impact on economic performance. Examples are: tax rates, cost to import and export, procedures to start a business. Others were based on perceptions and included: quality of electricity supply, quality of educational system, quality of roads. Although perception data was not seen as ideal for this study, in many cases it was the only data available. Policy indicators were then grouped together under each performance indicator where there was deemed to be a positive correlation (e.g. Performance Indicator 5: Total Investment (% GDP) 1993-2012 contained the following policy indicators: interest rate spread, quality of port infrastructure, procedures to start a business (number), time to start a business (days), time to register a property (days)). The final step was to identify the performance indicators that are lagging behind the benchmark and then single out the corresponding worst performing policy indicator. A graph with four quadrants is created where, for each country, each performance indicator is compared against the benchmark and the corresponding policy indicator is also compared. This can be described in a 2-dimensional graph with performance on the y axis and policy on the x axis.</td>
</tr>
<tr>
<td>International benchmarking of countries’ policies and programs supporting SME manufacturers</td>
<td>Comparative study examining the different programmes and policies developed countries have in place to support manufacturing by SMEs. The study was carried out by a USA trade association and aimed to draw lessons about how the USA could improve the support it offers to SME manufacturers. Very little methodological detail; largely qualitative/comparative in tone.</td>
</tr>
<tr>
<td>Benchmarking SME policies in the GCC: A survey of challenges and opportunities</td>
<td>No text available</td>
</tr>
<tr>
<td>A proposal of indicators and policy framework for innovation benchmark in Europe</td>
<td>The paper aims to conduct an analysis of existing innovation policies in Europe and also to propose a set of indicators for measuring their performance (note it does not actually carry out a benchmarking study). To this end, it develops an innovation framework consisting of seven innovation policy areas (governance, environment, co-operation, growth, intellectual property, infrastructure, human resources), each consisting of four innovation policies (e.g. R&amp;D targets, tax incentives, promoting centres of excellence, support for IP rights at public and private level, raising young people’s interest in science, research and innovation). The second step is to identify suitable indicators for the measurement of each policy field. Each one is therefore analysed taking into account a general overview of the</td>
</tr>
</tbody>
</table>

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policy and previous literature considerations in order to suggest possible suitable indicators for the measurement of the policy area.

The paper thus briefly details each policy area, and proposes indicators. Examples include: implementation of an innovation plan (plus number of years in place), share of enterprises receiving any public funding, European Patent Office applications per million of the population, IT expenditure as a percentage of GDP, R&D personnel employed in all sectors (also disaggregated by sector).

**Benchmarking innovation policy and innovation framework conditions**

Uses a mix of quantitative and qualitative data to assess innovation performance and policy across 27 OECD countries. Develops case studies to provide policy guidance at national level.

The paper takes 2 innovation areas that have been identified ‘in sizing innovation framework conditions’ and selects various indicators within each, noting whether there is good, partial or no data coverage (5, 6 and 1 respectively). Policy areas include: public investment in R&D, commercialization of research, highly educated workers, customers and suppliers, access to technology etc.

These policy areas are then collected together under four sub-indices – public research, co-operation between knowledge institutions and the private sector, innovation finance, market conditions – from which one composite indicator is produced.

Data for each of the 11 indicators comes from a variety of sources: the OECD, the EU, the World Economic Forum and the International Institute for Management Development.

Despite the paper’s claim, qualitative data is notably under-represented, and appears to play the role of filling the gaps where existing data is insufficient. In this case survey data has been used ‘as an indicator of the validity of ‘hard’ data and may also be used for deriving missing values in quantitative data’.

**Collective benchmarking of policies: an instrument for policy learning in adaptive research and innovation policy**

Argues in favour of collective (international) benchmarking of policies; no actual benchmarking.

**Transnational policy learning in Europe: Attempts to transfer innovation policy practices**

Not a benchmarking study. Reviews attempts at trans-national policy learning, concluding that empirical findings suggest there is little evidence of this taking place. Also highlights a number of attempts to transfer innovation policies and presents a range of factors that can potentially inhibit trans-national policy learning.

**Benchmarking policy measures for gender equality in science**

Aims to benchmark existing policies for women in science in EU Member States, associated countries and the Western Balkans, and highlight best practice in these countries. It offers recommendations on the need for future data collection disaggregated by sex.

Data came primarily from Eurostat and from national databases, although
insufficient data was a significant obstacle. This is reflected in the report’s central conclusion, which is that more detailed data ought to be collected. Statistical analysis using SPSS was used to identify correlation between indicators (e.g. policy measures and participation outcomes).

Indicators included: legislation (equal pay, wage gaps), equality mainstreaming, female representation in scientific institutions, presence of targets and quotas, networks and mentoring, special funding for universities and research, maternity and paternity leave. The authors note difficulty in ascribing any given outcome to the implementation of a given policy.

**Benchmarking of public biotechnology policy**

This study benchmarks national biotechnology policies of EU Member States. Data was collected in the form of a questionnaire to be completed by policy makers as well as performance indicators that captured whether or not policy goals had been achieved. Furthermore, a historical policy analysis was carried out to show that it is feasible to elaborate the proposed policy input factors on a country level via the policy questionnaire and that the suggested output indicators provide meaningful information on the achievement of certain policy goals set in the past. This process confirmed that the output indicators can provide meaningful information on the achievement of certain policy goals.

Indicators designed to capture the achievement of policy goals were selected based on two main criteria: the availability of data and comparability across countries. 13 indicators were used, such as PhD graduates in life sciences per capita, publication numbers, biotechnology patent applications, numbers of drugs approvals, venture capital investment etc.. The source most used was Eurostat; other sources include the OECD, EPAT, PCTPAT, Ernst and Young biotech reports, Eurobarometer, the EMEA, the JRC, ECVA and the Science Citation Index.

The authors note that there will be a time lag between policy and outcome, and also that indicators record the outcomes for a whole set of policies relevant for the innovation system rather than individual interventions.

**Benchmarking government provision of social safety nets**

Benchmarks the spending on social security across 63 countries. Several rankings are developed: firstly on the level of social security spending, secondly based on (as a function of) observable features in the economy, having controlled for various structural characteristics (e.g. ability to finance expenditure, institutional robustness). This allows a comparison moving from an unconditional ranking to one controlled for features of the economy, and therefore similar countries can be more accurately compared.

**A benchmarking of 9 European Member States policies towards distributed generation**

The aim of this study is to perform a comparative review of regulatory regimes for distributed electricity generation across nine countries. The process divides into three steps: the identification of actual regulatory practices, their evaluation and a synthesis of results.

Around 40 topics were chosen, with questions (qualitative and quantitative) devised for each, which were then posed to the nine partner countries. The responses were standardised in order to allow for evaluation against a common best practice, and then effectively quantified through their categorisation as ‘repulsive’ (their word!) (−1), neutral (0) or support (1) towards distributed generation. Some characteristics
are neither good nor bad and therefore escape the ‘valuation grid’ into which the results are entered.

The topics are then brought together into broadly similar groups (e.g. market access, regulation), and therefore the synthesis for each country consists of four numbers each summing the valuation of all items inside the group. An admitted limitation is the equal weighting given to each topic and its impact on distributed generation outcomes.

| International industrial sector energy efficiency policies | Provides a classification of policies designed to boost industrial energy efficiency, one of which is benchmarking. Paper does not, however, conduct any benchmarking itself. |
| G7 coal scorecard benchmarking coal phase out actions | More a scoreboard than an academic study, this short document provides an overview of how G7 countries have started meeting the challenge of phasing out coal use for electricity generation. National policies are ranked against three questions: is there a risk of new coal power plants being constructed?, are existing coal power plants being retired?, do country actions have a positive international impact? These are subdivided into market drivers and government policy and each is assigned one of the following: poor performer, needs improvement, clear progress. In this way qualitative analysis is converted to a quantitative score (with a qualitative performance summary) and the countries ranked in order of the progress they are making towards a coal phase-out. |
| Policy Benchmarking in the European Union: Indicators and Ambiguities | This paper considers the benchmarking indicators used in relation to the knowledge-based economy on the one hand and social inclusion on the other. Notes that in the absence of indicators of policy inputs and outputs, outcome indicators cannot represent the results of public policy alone. Whilst they may be useful for encouraging ‘laggards’ to catch up with frontrunners, they will not provide ‘comparative policy-relevant information’. The paper is not a study – rather it critiques the choice of indicators for benchmarking for political choice, ‘dynamic change’ and ‘national action’. |
ANNEX C: Innovation Union Scoreboard indicators

Table 10: Innovation Union Scoreboard indicators

<table>
<thead>
<tr>
<th>Main type / innovation dimension / indicator</th>
<th>Data source: Numerator</th>
<th>Data source: Denominator</th>
<th>Years covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENABLERS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Human resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.1 New doctorate graduates (5CED) per 1000 population aged 25-34</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2005 – 2012</td>
</tr>
<tr>
<td>1.1.2 Percentage population aged 30-54 having completed tertiary education</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2006 – 2013</td>
</tr>
<tr>
<td>1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2006 – 2013</td>
</tr>
<tr>
<td>Open and excellent research systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.1 International scientific co-publications per million population</td>
<td>Science-Metrik using Scopus data</td>
<td>Eurostat</td>
<td>2005 – 2012</td>
</tr>
<tr>
<td>1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country</td>
<td>Science-Metrik using Scopus data</td>
<td>Science-Metrik using Scopus data</td>
<td>2002 – 2009</td>
</tr>
<tr>
<td>1.2.3 Non-EU doctorate students as percentage of all doctorate students*</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2005 – 2012</td>
</tr>
<tr>
<td>Finance and support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.1 R&amp;D expenditure in the public sector as percentage of GDP</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2006 – 2013</td>
</tr>
<tr>
<td>1.3.2 Venture capital investment as percentage of GDP</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2006 – 2013</td>
</tr>
<tr>
<td>FIRM ACTIVITIES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 R&amp;D expenditure in the business sector as percentage of GDP</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2006 – 2013</td>
</tr>
<tr>
<td>Linkages &amp; entrepreneurship</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2.2 Innovative SMEs collaborating with others as percentage of SMEs</td>
<td>Eurostat (IS)</td>
<td>Eurostat (IS)</td>
<td>2005, 2008, 2010, 2012</td>
</tr>
<tr>
<td>2.2.3 Public-private co-publications per million population</td>
<td>Centre for Science and Technology Studies (CWS) using Thomson Reuters data</td>
<td>Eurostat</td>
<td>2008 – 2012</td>
</tr>
<tr>
<td>Intellectual assets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3.1 PAT patents applications per billion GDP (in Purchasing Power Standard)</td>
<td>OECD</td>
<td>Eurostat</td>
<td>2004 – 2011</td>
</tr>
<tr>
<td>2.3.2 PAT applications in societal challenges (environment-related technologies) per billion GDP (in Purchasing Power Standard)</td>
<td>OECD</td>
<td>Eurostat</td>
<td>2004 – 2011</td>
</tr>
<tr>
<td>2.3.3 Community trademarks per billion GDP (in Purchasing Power Standard)</td>
<td>Office for Harmonisation in the Internal Market</td>
<td>Eurostat</td>
<td>2006 – 2013</td>
</tr>
<tr>
<td>2.3.4 Community designs per billion GDP (in Purchasing Power Standard)</td>
<td>Office for Harmonisation in the Internal Market</td>
<td>Eurostat</td>
<td>2006 – 2013</td>
</tr>
<tr>
<td>OUTPUTS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.1 SMEs introducing product or process innovations as percentage of SMEs</td>
<td>Eurostat (IS)</td>
<td>Eurostat (IS)</td>
<td>2006, 2008, 2010, 2012</td>
</tr>
<tr>
<td>3.1.2 SMEs introducing marketing or organisational innovations as percentage of SMEs</td>
<td>Eurostat (IS)</td>
<td>Eurostat (IS)</td>
<td>2006, 2008, 2010, 2012</td>
</tr>
<tr>
<td>Economic effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2.1 Employment in knowledge-intensive activities (manufacturing and services) as percentage of total employment</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2008 – 2013</td>
</tr>
<tr>
<td>5.2.2 Medium and high-tech product exports as percentage of total product exports</td>
<td>Eurostat / United Nations</td>
<td>Eurostat / United Nations</td>
<td>2005 – 2013</td>
</tr>
<tr>
<td>5.2.3 Knowledge-intensive services exports as percentage of total service exports</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2009 – 2013</td>
</tr>
<tr>
<td>5.2.4 Sales of new to market and new to firm innovations as percentage of turnover*</td>
<td>Eurostat (IS)</td>
<td>Eurostat (IS)</td>
<td>2006, 2008, 2010, 2012</td>
</tr>
<tr>
<td>5.2.5 License and patent revenues from abroad as percentage of GDP</td>
<td>Eurostat</td>
<td>Eurostat</td>
<td>2006 – 2013</td>
</tr>
</tbody>
</table>

Source: Innovation Union Scoreboard 2015
ANNEX D: Potential MIN-GUIDE indicators

Table 11 unterhalb presents a set of possible indicators discussed at the May 2016 validation workshop. The set is not intended to be complete, exhaustive or mutually-exclusive, but rather a collection of possibilities to stimulate ideas and reactions in WPs 3-5.

**Table 11: List of potential MIN-GUIDE benchmarking indicators**

<table>
<thead>
<tr>
<th>CORE POLICY INDICATOR</th>
<th>PERFORMANCE INDICATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economic implication for EU industry, taking into account:</strong></td>
<td></td>
</tr>
<tr>
<td>Production subsidies</td>
<td>Value of subsidies available</td>
</tr>
<tr>
<td>Tax (dis)incentives</td>
<td>Values of tax breaks available</td>
</tr>
<tr>
<td>Market creation</td>
<td>Grants/loans available for new markets/access to venture capital</td>
</tr>
<tr>
<td>Targets</td>
<td>Productivity/efficiency goals</td>
</tr>
<tr>
<td>Employment (e.g. contracting)</td>
<td>Employments rights vs. labour flexibility</td>
</tr>
<tr>
<td>Regulation/Directives</td>
<td></td>
</tr>
<tr>
<td>Minimum standards</td>
<td>Standards for safety, quality assurance etc.</td>
</tr>
<tr>
<td>Presence of state aid</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Trade</td>
<td>Trade barriers/tariffs/taxes, import/export taxes, trade agreements</td>
</tr>
<tr>
<td>Administrative and procurement simplification</td>
<td>e.g. length of time to carry out business functions; bureaucratic hurdles etc.</td>
</tr>
<tr>
<td>Taxes and royalty regimes</td>
<td>Effective %</td>
</tr>
<tr>
<td><strong>Level of innovation and implementation readiness taking into account:</strong></td>
<td></td>
</tr>
<tr>
<td>Information disclosure (and standardisation thereof)</td>
<td>Requirements around openness of data publication</td>
</tr>
<tr>
<td>Long-term vision/strategy (at regional, national or corporate level)</td>
<td>Presence of coherent government approach</td>
</tr>
<tr>
<td>Supportive governance/ administrative structures</td>
<td>Capacity, presence and supportiveness of governance structures (e.g. regulatory bodies)</td>
</tr>
<tr>
<td>University funding</td>
<td>Funding rate (per capita) for key subjects</td>
</tr>
<tr>
<td>Grants to support R&amp;D/knowledge centres</td>
<td>Presence of funding to support sector; research impact and uptake by industry, states etc.</td>
</tr>
<tr>
<td>Supportive intellectual property regime</td>
<td>Robust legal protection of intellectual property</td>
</tr>
<tr>
<td>Education</td>
<td>Graduation rates: geologists; mining engineering; mineral engineering; metallurgists; material scientists; chemical engineers; computer scientists etc.</td>
</tr>
</tbody>
</table>
### Sustainability, taking into account:

<table>
<thead>
<tr>
<th>Environmental legislation</th>
<th>Implementation and enforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity/geodiversity</td>
<td>Protection of natural environment; % endangered species</td>
</tr>
<tr>
<td>Energy use</td>
<td>Operational energy efficiency; embodied energy use</td>
</tr>
<tr>
<td>Emissions, effluents, waste</td>
<td>Appropriate handling regulation</td>
</tr>
<tr>
<td>Recycling</td>
<td>Publication of data and methods</td>
</tr>
<tr>
<td>Water use and stewardship</td>
<td>Water use efficiency; embodied water use</td>
</tr>
<tr>
<td>Planning processes</td>
<td>Length of planning/permitting process</td>
</tr>
<tr>
<td>Land access and land rights</td>
<td>Legal barriers to land acquisition</td>
</tr>
</tbody>
</table>

### Governance framework:

| Horizontal policy integration | Number of cooperation units between national ministries/agencies  
|                              | Level of involvement in policy design and implementation  
|                              | Quality of instruments for cooperation |
| Vertical policy integration   | Number of cooperation units between ministries/agencies on different political levels  
|                              | Level of involvement in policy design and implementation  
|                              | Quality of instruments for cooperation |
| Stakeholder involvement      | Number of stakeholders (and their institutional affiliation) involved  
|                              | Level and rationale for involving stakeholders  
|                              | Quality of stakeholder involvement instruments |
| Evaluation                   | Number of quantitative and qualitative reviews applied |