Innovative Waste Management and Mine Closure

Deliverable 5.3

“Final report on innovative waste management and mine closure. Guidelines and recommendations for future policy and legislation development”

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1. Executive Summary

This executive summary presents the objectives, methodology and principal findings of the deliverable 5.3.

Objectives and methodology

The aim of WP5 “Innovative Waste Management and Mine Closure” is to elaborate how innovations in waste management and mine closure are generated or taken up in different EU Member States and on EU-level and how this is either facilitated or inhibited by policies and legislation on national or European level. The purpose of the deliverable 5.3 is to complement the preliminary findings of D5.1 and D5.2 by carrying out additional interviews with representatives from different stakeholder groups (academia, industry, NGO’s and policymakers). The topics and questions of survey addressed the respondents’ perception of national and EU-level mineral policies, gaps and needs with respect to innovation in waste management and mine closure. Questions for the survey (interview) focus on previously identified innovations in waste management and mine closure.

In this deliverable, the results of WP5 are summarized.

Initially, a brief introduction and the objectives of MIN-GUIDE project are presented, together with an analysis of the aim of WPS and the scope of Deliverable 5.3

Moreover a summary of Deliverable 5.1 & 5.2 is also presented. Deliverable 5.1 includes a review of the mineral policies and legislation relevant to innovation in waste management and mine closure in the EU Member States.

In Deliverable 5.2, in which a benchmarking analysis was conducted on EU MS policy frameworks of waste management and mine closure. The aim of this analysis was the provision of an in-depth best practice description and the identification of those evaluation criteria that can be used within a scoreboard on innovation processes. The data used for the analysis came from literature and a series of interviews with Experts, especially from NTUA network.

In addition, the results of the Policy Laboratory 4, which was held in Lavrion, Greece are summarised. Key stakeholders related with Mining Value Chain participated in the event. All the participants indicated that they valued the Policy Laboratory and the chance to exchange with, and learn from, each other. The Policy Laboratory 4 contributed to identification of needs and existing gaps associated with the currently existing framework for innovation in Waste Management and Mine Closure.

Furthermore, 7 Case Studies which are going to be uploaded to the online Minerals Policy Guide are presented. The final selection of the cases to be presented is the result of long research and careful collection of information via interviews, literature review and workshops.

Based on the input both from previous deliverables and from the additional interviews and innovation case analyses, analysis of needs and gaps as well as SWOT analysis has been conducted. Recommendations for future development of waste management and mine closure sector were evaluated.
Main Findings

Conclusions and recommendations for future policy development for innovation in waste management and mine closure were developed based on survey, gaps and needs analysis and SWOT analysis.

Most of the mineral policies are addressing the whole mineral value chain. The use of raw materials from secondary sources has been identified as a natural part of the life cycle of materials, and the need for improved collection and recycling of secondary materials have been emphasized. National mineral regulations should stimulate new approaches and solutions that have positive impacts. Qualitative national strategic documents on extractive waste management should be assembled, evaluated and approved by independent experts. The principle of a lifelong cycle should be implemented in mineral policies and legislation of mine closure and waste management. National strategies for remediation of exploration and extraction sites should be developed based on the inventory of both abandoned and active exploration and extraction sites. An inventory of mining sites where the remediation was not published should be also made public.

Deregulation (abolition of administrative restriction) should be considered for the purpose of easier use of recycled/secondary materials. To encourage the use of recycled/secondary materials by creating the demand for such materials (i.e. in government financed construction projects etc.).

A mine closure plan should be developed from the inception of a mine project so that it is an integrated part of the design. A mining design should contain the future purpose of extractive sites after mine closure. The future purpose of extractive sites after mine closure must be accepted in spatial plans.

Administrative authorities involved in the procedure of mine closure should closely work together to deliver a positive outcome. The need for simplification and speeding up the permitting procedure is noted from many experts for raw materials in general, as well as in the part of mining value chain of mine closure and waste management.

An annual national forum should be organised for the purpose of transparency and public acceptance of mining activities, as well as raising awareness on society’s need for raw materials. The forum should foster communication and connection between related stakeholders in the process of waste management & mine closure.

There are many abandoned and devastated open pits that are not rehabilitated. The need for a national strategy for remediation of exploration and extraction sites which include the list of abandoned exploration and extraction sites was noted.

Experts have highlighted the public opinion that mining is not environmentally friendly and the lack of awareness on society’s need for raw materials. Experts recommended the organization of an annual forum where mining companies would propose their future remediation plan and demonstrate good practical examples. The forum should foster communication and connection between the different groups of stakeholders involved in mining.
2. Background and objectives

2.1 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: the MIN-GUIDE Minerals Policy Guide 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 below). 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>
<thead>
<tr>
<th>Common approach</th>
<th>WP1</th>
<th>Minerals policy guide development and conceptual basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP2</td>
<td>Stock-taking of EU and EU MS mineral policy and legislation</td>
<td></td>
</tr>
<tr>
<td>WP3</td>
<td>Innovative exploration and extraction</td>
<td></td>
</tr>
<tr>
<td>WP4</td>
<td>Innovative processing</td>
<td></td>
</tr>
<tr>
<td>WP5</td>
<td>Innovative waste management and mine closure</td>
<td></td>
</tr>
<tr>
<td>WP6</td>
<td>Raw materials knowledge and information base</td>
<td></td>
</tr>
<tr>
<td>Core content</td>
<td>WP7</td>
<td>Stakeholder management, communication and dissemination</td>
</tr>
<tr>
<td>Cross-cutting management and engagement</td>
<td>WP8</td>
<td>Project management</td>
</tr>
</tbody>
</table>
2.2 Work package 5- Scope and objectives

The implementation of novel waste management and mine closure actions in different EU Member States are investigated in WP5. Furthermore, the compliance of these actions with the national and European policy and legislation is examined.

Deliverable 5.1 presents a preliminary report of the policy framework in EU and Member States level that foster or inhibit the innovation in Waste Management and Mine Closure. In addition, specific innovation cases were presented and some industry good practices in Waste Management and Mine Closure are identified. A detailed analysis of relevant policies, innovation cases and good practices, including the input from interviews, questionnaires, and the 4th Policy Laboratory Workshop on Waste Management and Mine Closure, will be cited in the final project report.

2.3 Deliverable 5.3- Scope

As it has been already mentioned, in “2. Background and Objectives” session, WPs 2-5 are the core content of a time-lag to allow for 'multiple loop learning' processes. Insights form WPs 2-5 feed into the content of the Minerals Policy Guide.

Interesting outcomes of two previous Deliverables 5.1 and 5.2 on innovative waste management and mine closure are summarized. The explicit analysis of relevant policies, innovation cases and good practices with the input from questionnaire, and the 4th Policy Laboratory Workshop on Waste Management and Mine Closure (WM-MC) feed into Deliverable 5.3.

The goal of Deliverable 5.3 is the accomplishment of an assessment and gap analysis for supporting future policy and legislation development for innovation in WM-MC. This report aims to provide useful suggestions concerning the future policy developments and directions on (WM-MC) policy and legislation. The main feed information for this task was the output/results of the 4th Policy Lab workshop in which participants across the whole Europe, share and exchange information (more details see in the related session 4 below).
3. Summary of the Deliverables of WP5

3.1 Deliverable 5.1

The Deliverable 5.1 (“Policy and legislation framework for innovation in waste management and mine closure”) was submitted in April 2017. The report provides a preliminary description of the policy framework at EU and Member States level that foster or inhibit the innovation in Waste Management and Mine Closure. In addition, specific innovation cases are presented and some good practices in WM-MC are identified.

The term “policy driven good practices” is referred to innovative actions on waste management and mine closure that are transparent and dispose a clear legal framework.

Deliverable 5.1 consists the basis for the comprehensive and in-depth analysis of industry cases and their relation to EU MS policy frameworks for Deliverable 5.2. Furthermore, a list of relevant innovations concerning WM-MC fragment, and more specifically concerning the the raw materials sector value chain, are reported. Waste Management practices and the Mine Closure innovations are categorized separately and analyzed. Most of them have mainly an impact on environmental and social aspects. [1]

3.2 Deliverable 5.2

The Deliverable 5.2 (“Report on innovation evaluation criteria and best case practices in waste management and mine closure”) was submitted in July 2017. The report makes a preliminary benchmarking analysis and presents good case studies on the Waste Management and Mine Closure fragment of the minerals value chain. A benchmarking analysis on EU MS policy frameworks of waste management and mine closure is conducted providing an in-depth best practice description and identify those evaluation criteria aiming to the creation of a scoreboard for innovation performance.

Among the findings of the survey, it is underlined that initiatives at EU (Directive 2006/21/EC) and National level improved the environmental conditions of Waste Management and Mine Closure and led to some exceptional case studies around the Europe. Sound waste Management, valorization of wastes into added value products and introduction of innovative technologies is apparent to lead to better environmental conditions in mining operations with subsequent benefits to social acceptance. In parallel, Mine closure good practices with alternative to conventional approach lead by clear legislation is the key solution to make mines rehabilitation an added value for the sector and additionally keep alive the economy for the local economy and enhance social acceptance.

In addition the good practices related to Waste Management and Mine Closure are either Policy or Industry driven. Policy driven good practices considered the actions based on a good, transparent and clear legal framework that facilitates the innovation in Waste Management and sets clear rules and innovative approach in Mine Closure practices. The rehabilitation of abandoned mines project in Portugal can be mentioned as a good practice example. In this case DGGG formulated a roadmap to rehabilitate all the Closed Mines with a clear description in legal framework and with the establishment of a subsidy company to perform the
rehabilitation plan. Cornwall Mining Heritage in UK, Geopark and Old Mine Science and Art Center in Poland, Cultural and Technological Park of Lavrion in Greece present good practice results. Industry driven good practices are those coming from the Social Corporate Responsibility of numerous EU Industries with innovative approach, cases which go beyond legislation minimum requirements. [2]

4. Policy Laboratory 4


This Policy Laboratory is the fourth in a series of stakeholder workshops organized within the MIN-GUIDE project. The main objective of this Policy Laboratory will be to provide an overview of and reflect upon innovation examples in Waste Management and Mine Closure, including tailings management, waste water management and mine closure and how they link to Policy in the EU Member States.

The Policy Laboratory process, designed by the MIN-GUIDE partners, engages participants from policy, industry, geological surveys, research, and civil society in an exciting and interactive exchange. It allows participants to learn from good practice cases, explore transferability, and discuss gaps and future needs by considering innovation-fostering examples and potentials. Result will be used to further develop the centerpiece of the MIN-GUIDE project – the online Minerals Policy Guide. More information about the Policy Laboratory can also be found on the MIN-GUIDE homepage.

Figure 1: 4th MIN-GUIDE Policy Laboratory Workshop in Lavrion, Greece on 21-22 September 2017

The case studies presented in the Workshop are summarized in Table 2. The presented cases comply with the following criteria set by MIN-GUIDE:

- Resource security
- Economic sustainability
- Environmental sustainability
- Social responsibility
- Good governance

In any case, it is necessary to be declared that the selection of presented cases reflects the views only of the authors.

Table 2: Presented case studies on Waste Management and Mine Closure in the 4th MIN-GUIDE Policy Lab

<table>
<thead>
<tr>
<th>Case</th>
<th>Title</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>101 things to do with a hole in the ground, Eden project</td>
<td>Mine Closure</td>
</tr>
<tr>
<td>2</td>
<td>Rehabilitation of abandoned mines in Portugal</td>
<td>Mine Closure</td>
</tr>
<tr>
<td>3</td>
<td>Rehabilitation of old mine waste sites. The case of LTCP</td>
<td>Mine Closure</td>
</tr>
<tr>
<td>4</td>
<td>Vineyards in the service of waste management and mine closure</td>
<td>Mine Closure</td>
</tr>
<tr>
<td>5</td>
<td>Closure and Ongoing maintenance of Lignite Mine in Austria</td>
<td>Mine Closure</td>
</tr>
<tr>
<td>6</td>
<td>Treatment and Recovery of Waste Water Originating from Magnesite Ore Washing Facilities</td>
<td>Waste Management (Waste water)</td>
</tr>
<tr>
<td>7</td>
<td>Passive Treatment in an old sulphide mine in northern Greece</td>
<td>Waste Management (Waste water)</td>
</tr>
<tr>
<td>8</td>
<td>Rehabilitation of Thoricos Bay in Lavrion</td>
<td>Waste Management</td>
</tr>
<tr>
<td>9</td>
<td>Sea tailings disposal</td>
<td>Waste Management</td>
</tr>
</tbody>
</table>

The role of the Participants, in the different interactive sessions, was useful, especially in case of parallel Policy Labs and the open discussions.

The most important conclusions are presented below.

One of the main goals of Policy Lab was to investigate the policy and non-policy factors that contribute to the waste management and mine closure good cases. In the Table 3 the most crucial policy and non-policy factors are summarized.

Table 3 Policy and non-policy factors which drive to good waste management and mine closure cases
Policy factors | Non-Policy factors
--- | ---
Dir.2006/21/EC (Extractive Industry Wastes) | Physicochemical characteristics of Waste
Dir.2000/60/EC (EU Water Framework) | The will of the municipality authorities to develop actions and solutions
Dir.2014/52/EU (Envir. Impact Assessment) | Water shortage & Sustainable groundwater management
Dir.2006/118/EC (Groundwater) | Public concerns
EU and National funding (e.g. H2020) | Self-sustaining land use

The most important findings of the exploring transferability session, focusing on how to transfer the most interesting non-policy factors and supporting policies to other countries and/or circumstances, are summarized in Table 4.

**Table 4: The transferability of factors to the other MS.**

<table>
<thead>
<tr>
<th>Transferability aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep knowledge of EU regulations</td>
</tr>
<tr>
<td>Good knowledge of local context</td>
</tr>
<tr>
<td>More structure funds</td>
</tr>
<tr>
<td>Knowledge on how to access to funds</td>
</tr>
<tr>
<td>High level of transparency</td>
</tr>
<tr>
<td>Invitation &amp; Participation of locals to the meetings</td>
</tr>
</tbody>
</table>

The existing needs & gaps and the necessary future steps that should be implemented aiming to supporting the optimum waste management practices were specified in the “Needs and gaps session” and are presented in Table 5.

**Table 5: Outcome from Needs and Gaps session**

<table>
<thead>
<tr>
<th>Needs and Gaps</th>
<th>Future steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of database on the type of waste</td>
<td>An adequate and comprehensive database (Inventory)</td>
</tr>
<tr>
<td>Governments to provide monitoring tools for the applied practices aiming to the development of confidence between the authorities and the local communities</td>
<td>More funds are needed</td>
</tr>
<tr>
<td>Communication with local community and public involvement</td>
<td>The good practice principles to include the resolution of conflicts</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>The standardized mine closure procedures should be upgraded to a different level with road mapping (economic impact, social impact, biodiversity)</td>
<td>Strict inspections and fee application when closure provisions do not fit into land use development plans</td>
</tr>
<tr>
<td>Lack of dissemination of successful cases</td>
<td>Dissemination activities (projects, workshops, Newsletters, etc.)</td>
</tr>
<tr>
<td>Enforcement of regulations</td>
<td>Need of experts/skilled professionals</td>
</tr>
</tbody>
</table>
| Compilation and Codification of EU environmental regulation related to water and waste management | • Relevant DG to assign the project  
• Consistent education of public servants & environmental auditors and other relevant professional bodies |
| Active participation of stakeholders in the selection of the final land use after mine closure | This procedure to be included in the relevant legislation and environmental terms and financial guarantee |
| How to secure funding | Prioritisation of structural funds |
| Review MWD to include offshore waste disposal sites | Data Harmonization on Mining Waste sites |
| Research for more effective methods and applications of new technologies | Focus on Waste Facilities because there are new potential of raw material |
| Post closure monitoring of liquid and solid waste is not sufficiently established | Elaborating post-closure monitoring guide |
5. Current situation in European & MS policies and governance with respect to innovative waste management and mine closure

5.1 Case Studies

The case studies that will be uploaded to the online Minerals Policy Guide /MIN-GUIDE were selected taking into account various factors such as environmental hazard, and restoration significance for the local communities. The data concerning the mine localities were gathered via interviews, literature review, and workshops. The assessment of the total information leads to the selection of some interesting case studies as these have been presented in the 4th MIN-GUIDE Policy Laboratory workshop.

Innovative projects concerning sustainable waste management and mine closure should be focused on the following pathways:

1. Development of new materials and new applications produced by the valorisation of mining wastes,
2. Recycling of mining wastes within the production chain
3. New communication tools for raising awareness and building public acceptability,
4. Transparent online monitoring systems accessible by local society

Some successfully implemented projects in abandoned mining districts which incorporate the previously mentioned pathways, are mentioned below.

**Eden project** [5]

<table>
<thead>
<tr>
<th>Case 1</th>
<th>Description</th>
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<tbody>
<tr>
<td>From a China Clay Pit to world-famous visitor attraction and educational centre, UK</td>
<td>The Eden Project is at the top of the list of good cases. It is one of the most innovative and sustainable solutions in mine closure design. A china clay open-pit mine was transformed into one of the largest indoor rainforests in the world; this was achieved with an integrated, multidisciplinary approach with an awareness of the need to plan for the social, cultural, environmental and economic impacts. Eden project (Cornwall), since its opening to the public in 2001, has attracted more than 18 million visitors and inspired an economic renaissance by contributing more than 1.7 billion euro to the local economy.</td>
</tr>
</tbody>
</table>
Environmental Monitoring Program \cite{6}

<table>
<thead>
<tr>
<th>Case 2</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>An new integrated Environmental Monitoring Program (EMP) in Kassandra Mines, Greece</td>
<td>The second case is related to the Environmental Monitoring Program applied by the Hellas Gold SA in Kassandra Mines and which is considered one of the biggest environmental investments in mining industries in Greece for protecting the environment, alongside the well-being of society. The new Environmental Monitoring Program (EMP) in Kassandra Mines consists of 320 stations and sampling points for the continuous monitoring and recording of all environmental media in the wider area of the mine sites. Continuous monitoring parameters such as air dust, vibrations, soil, noise, meteorological, solid waste, surface water, sea, ground water, drinking water, mine water, are measured continuously throughout the 24 hours, with a minute step. The access to the database is open to the public. The equipment cost exceeds 4.000.000 EUR, and the annual running cost of the monitoring stations is estimated to over 2.000.000 EUR.</td>
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</table>
Figure 3: The Environmental Monitoring Program in Kassandra Mines

El Soplao project [7]

<table>
<thead>
<tr>
<th>Case 3</th>
<th>Description</th>
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<tbody>
<tr>
<td>From an orphan mine site to a touristic asset, La Florida mines, Cueva del Soplao, Cantabria, Spain</td>
<td>Spain is one of the most important mining countries in EU. The region where La Florida lead-zinc mines are located, Cantabria, was the most significant zinc district in the world during the end of the 19th and the beginning of the 20th century. The El Soplao project is one of the most ambitious underground works for tourism undertaken in Spain. The mine is a reference to the conversion of an orphan mining site into a pole of tourist and scientific attraction. It is also protected as Geosite. The bad examples of waste disposal and mine closure (or better mine abandon) of the past times were turn into modern projects that give to the area and its population another source of income: eco-friendly tourism. In addition, international symposiums and congresses are regularly organized in the restored mine.</td>
</tr>
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Figure 4a: The El Soplao cave before its restoration  
Figure 4b: The El Soplao cave after its restoration
Environmental Remediation of Old Mining Areas [8],[9]

<table>
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<tr>
<th>Case 4</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Rehabilitation of abandoned mines:</strong> Covas, Fonte Santa, Terramonte, Espinho, Lousal, Old dam Urgeiriça, São Domingos mine, Portugal</td>
<td>One of the most successful rehabilitation practices exists in Portugal, where DGEG- Direção Geral de Energia e Geologia (Portuguese Mining Authority) formulated a roadmap to rehabilitate various abandoned mines such as Covas, Fonte Santa, Terramonte, Espinho, Lousal, Old dam Urgeiriça, São Domingos mine, with a clear description within the national legislation framework and with the establishment of a subsidy company to perform the rehabilitation plan. Portugal is committed to correct environmental liabilities and impacts of centuries of mining activity (passive until 1990). Since 1990 every mining company is responsible to ensure the environmental rehabilitation of its sites. The Government defined a policy and created the conditions for the implementation of an Environmental Remediation of Old Mining Areas Plan. 95 mining areas were funded with 89 M€ between 2001-2015, 9 mining areas with ongoing remediation works with 26,6 M€ for the period between 2016-2019, and 51 planned interventions in remaining mining areas are funded with 87 M€ between 2016-2022.</td>
</tr>
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**Figure 5a:** The Lousal Mine before its rehabilitation  
**Figure 5b:** The Lousal Mine after its rehabilitation

Lavrion Technological & Cultural Park [10]

<table>
<thead>
<tr>
<th>Case 5</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Rehabilitation of old mine waste</strong></td>
<td>One of the most successful restoration cases in Greece is the creation of the Technological &amp; Cultural Park, in Lavrion city. In spite of its small population (about 10,000 habitants), the city was one of</td>
</tr>
</tbody>
</table>
the most important industrial centres in Greece during the 19th and 20th century. An old zinc-lead plant in Lavrion mining district was transformed to a Technological & Cultural Park. The implementation of the project was monitored by the National Technical University of Athens (NTUA) and supported by the local municipality. A highly polluted area (soil contaminated by mining and metallurgical wastes) was converted to a new enterprise, scientific and cultural center. The rehabilitation of the Lavrion abandoned metallurgical plant consists a novel challenge reinforcing the "knowledge economy" in Attica prefecture. The restoration cost of the plant complex was about 15,23 million Euros and was covered from EU and national sources.

Figure 6a: The underground repository under construction

Figure 6b: The underground repository on operational phase

Copernicus: a new intelligent tool

<table>
<thead>
<tr>
<th>Case 6</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>On line monitoring of possible waste dam displacement and on line mapping of soil pH variation, EU</td>
<td>Copernicus is the European system for monitoring the Earth and is coordinated and managed by the European Commission. The development of the observation infrastructure is performed by the European Environment Agency and EU countries. Copernicus supports applications in a wide variety of domains. One of them is the emergency management and security, which is very important for the sustainability of mining activities. Earth observation satellites and in situ sensors such as ground stations, airborne sensors, and sea-borne sensors, are used for data collection. Two representative examples of the application of Copernicus are the: a. on line monitoring of possible waste dam displacement and b. on line mapping of soil pH variation; in both cases the data provided could prevent future failures.</td>
</tr>
</tbody>
</table>
Figure 7: Accumulated displacement of a waste dam in Portugal

Figure 8: Soil ph map in Portugal

Milos restoration practice [12]

<table>
<thead>
<tr>
<th>Case 7</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vineyards in the service of mine closure, Milos island, Greece</td>
<td>An innovative reclamation approach was followed in the perlite mine in Milos island by IMERYS Industrial Minerals Greece S.A. A mining area was converted after the end of its life to Vineyards with the goal to create a dynamic ecosystem and minimize the visual disturbance of a mining activity, having a positive result in the local community welfare. The success transformation of a closed perlite mine in Milos Island to a new financial activity via viticulture took place in 2014. Through Vineyard project, the environment is protected and preserved with the application of an organic cultivation method. Moreover, irrigation water is recycled, which is an aspect of invaluable importance as water in the Cyclades Islands is in shortage.</td>
</tr>
</tbody>
</table>
Four free training seminars, with approximately 300 participants, have been already organised for the local community, encouraging Milos’ residents to revive small family vineyards using organic agricultural methods. Education on the use of industrial minerals is also encouraged, as a number of minerals from Milos are used in viticulture and wine production. More specifically, bentonite is used for wine stabilization, while perlite is used in wine clarification. Finally, the activity will also contribute to “alternative” tourism on the island, attracting visitors interested in wine-making and wine-tasting.

5.2 Overview of current situation in EU MS

The Extractive Waste Directive (Directive 2006/21/EC) on the management of wastes sets up the framework for the extractive industry wastes management with the aim of ensuring long-term stability of disposal facilities and preventing or minimising water and soil pollution.

The assessment of Member States performance regarding the implementation of the Extractive Waste Directive (2006/21/EC) Report, which was published on July 2017, provides the current situation in the MS on (a) the Member State enforcement and control; (b) accident prevention, (c) waste management plans, (d) application and permitting procedures, (e) financial guarantees, closure and post closure phase; transboundary effects, inventory of closed extractive waste facilities, cyanide-based processes in gold production.

The directive 2006/21/EC provides measures, procedures and guidance to prevent or minimize the adverse effects on the environment and risks to health resulting from the management of from extractive industries wastes. The implementation of the Directive is of high importance for the Raw Material Sector in Europe. As a consequence, the identification of the difficulties in the implementation is essential. European Commission requires from Member States to submit a report on the implementation every three years in order to assess the situation and have a better understanding of the issues.
The identification of the causes of the difficulty of implementation of EWD is the main goal of this Report, as only if the exact causes of the problem are known, a successful solution can be found. First of all, the number of inspections reported by Member States varies considerably. Probably the reason is that the provisions relating to inspections may not be understood and implemented in the same way. Within this frame, the Commission could develop draft technical guidelines. The Waste facility classification raises also concerns and argument between MS. Some MS report that there are no extractive waste facilities on their territory, however these states host extractive industries that generate wastes. Furthermore, there are discrepancies between the numbers of facilities reported and the volumes of hazardous extractive wastes. Another important issue is the Permitting procedure. It is not very clear whether the facilities that meet the criteria for Category A should be permitted based on the Extractive waste Directive, Industrial Emission Directive or the Seveso Directive. As part of the permit applications, operators have submitted extractive waste management plans (EWMPs). The competent authorities in the different Member States should approve these EWMPs and monitoring their implementation. Since the entry of the EWD into force, on 1 May 2008, important data have been collected across the EU, which should foster a wider dissemination of existing good practices. Financial guarantees provoke also contradictory situations since the Decision allows MS to determine a more detailed methodology for assessing the value of guarantees. [13]

This is an overview of the current situation in some EU member states.

**Croatia**

Extractive waste is excluded from the national Act on Sustainable Waste Management (OG 94/13, 73/17) in the part that is regulated by mining law. At the same time Mining Act (OG 56/13, 14/14) does not transpose the Extractive Waste Directive (EWD 2006/21/EC). This may be one of the main reasons why mining or environmental authorities do not stimulate the introduction of innovations in waste management.

Mine closure is a part of the Mining management plan (Mining design) which has to be submitted before the permit/concession is issued. Therefore, mine closure should be planned from the beginning of the extraction, has to be in line with regulations, environmental impact assessment requirements and best practise, the extraction sites should maintain their mechanical stability after the end of extraction and be biologically remediated. Mining Act (OG 75/09) introduced the obligation to obtain the confirmation, through mining and environmental inspection, that remediation and environmental measures have been fulfilled after the site closure; the confirmation is a prerequisite for the issue of a certificate of deletion from the Register of extractive sites. According to provisions of the Mining law all exploration and extraction sites need to be remediated before deletion. There is no public data available showing whether all mining sites fulfil this obligation or not. Policies do not stimulate innovations in the mine closure, because inter-institutional intervention is required. Moreover, the wider public believes that mining is not environmentally acceptable and there is lack of awareness of society’s need for raw material.

Therefore, national policies do not have a positive effect on innovation in waste management and mine closure. Lack of cooperation and coordination is evident, thus mineral and waste policies are not addressing this issue properly.
The national mineral policy generally proclaims stimulate mining activity but practically there are difficulties in implementing this policy. Mining and production of minerals is generally over regulated. Procedures are rigid, complicated and long-lasting. Innovations are not stimulated. Operators are not encouraged to protect rights at court because of long cases.

Gaps and Needs:

- There is a lack of quality national policies developed by independent experts.
- For the purpose of sustainable waste management it is a prerequisite to determine areas suitable for exploration and extraction and incorporate them in state and counties' spatial plans because mining activities are also dependant on legislation other than the Mining Act (Physical Planning and Building Act).
- A new strategy for mineral resources in Croatia should be developed and include solutions for waste management and mine closure.
- For the purpose of sustainable waste management and mine closure, better coordination among the state authorities involved in permitting procedures of (mining governance body, physical planning governance body, environmental and nature protection governance body) should exist.

**Finland**

Compared to other EU countries, the Finish national mining related policies are supportive to innovative actions concerning waste management and mine closure. Finland established the Green mining program in 2011. The main objective of the Green Mining Programme was to make Finland a global leader of a sustainable mineral industry by 2020. However, a number of experts believe that the national mining policy presents weaknesses that impede the further development of this industrial sector. Part of the public opinion considers that government authorities are responsible for initiatives delay in waste management and mine closure. Changes and improvements in national mineral policy must be focused on the transparency in the decision-making process and the simplification of the licensing.

**France**

The mining legislation does not consider innovative tools for waste management and mine closure, and innovations are introduced only by mining companies.

Many mining legislations are characterized by a technical approach, focusing on technical safety, but do not describe the necessary actions concerning the long-term management of mine sites. Therefore, a number of necessary changes in the national mining regulations should be realized.

**Greece**

The standard waste management practice in Greece is the disposal of solid wastes in underground facilities of abandoned mines, or in abandoned open pits.

In Greece, mine closure planning is an integral part of the authorization procedure as it is included in the stage of approval of the environmental impact assessment and the relevant environmental terms approval. Special environmental evaluation is usually also required for mining or quarrying projects within Natura 2000 sites, which are plenty in Greece. The interests of the affected communities and ecosystems are taken into account at an early stage.
in the planning phase before extraction begins. In general, regional planning and information procedures must be carried out in advance of the development of mining activities. The current form of the national mineral policy do not encourage the introduction of innovations in waste management and mine closure. Government authorities are efficient, however what needs to be improved is the timetable for environmental assessment, licensing and inspection, which often exceeds the institutional times due to lack of specialized staff. So there is a need for better staffing or a flexible reorganization of structures so that they can better meet the above policy targets.

Greek Mining code does not provide for alternative uses of the mine site after the end of the life of the mine. This has to be changed and these aspects need to be incorporated into the national legal framework and also to be included in the National Mineral Policy and relevant development plans.

One of the key challenges for the mining policy in Greece is to show that places with mining history have a wide range of applications and are not a negative factor in the development of the area. With appropriate central legal regulation and an effective regional management, a place previously described with negative connotations can be transformed into interesting sites beneficial for the region as a touristic centre.

Ireland

National mining legislation provides for a closure plan from the inception of a mine project; this consists an integrated part of the design. Financial provisions are in place and the closure plan is a dynamic document which can be changed as new technologies are advancing or new ideas are developed. This facilitates innovations in the management of the extractive industries waste and mine closure.

The approach related with extractive industries waste management and mine closure, is well structured. It involves three authorities who work closely together to deliver a positive outcome.

Poland

The public’s impression is that there is no clear policy concerning the introduction of innovations in waste management and mine closure but there are several projects supported by Ministries or other governmental institutions undertaken by the environmental science sector, as well as, projects connected with methane reusing from coal mines.

The government authorities responsible for mining activities in Poland are not well structured and efficient enough because responsibility is diffused between too many institutions. The most significant problem related with the extraction and processing activities is the waste management. There are too many conflicting legal documents with equal power. Decision-makers do not know the details, so they postpone actions. National raw materials policy should be more strictly and appropriately connected with geological survey and with earth sciences institutes. Moreover, geological research is not adapted to the requirements of local needs and global trends.

Slovenia
The national mining strategy stimulates the rational use of mineral sources and consequently closure of exhausted mineral and ore deposits (in the framework of existing spatial plans). In Slovenia, the mining right holders have the responsibility for the mining site closure and remediation. The national mineral policy is rendered inefficient because of its rigidity, while the mining activities have very small synergies with national mineral policy.

It is suggested that proper changes in national mining regulations and also a multilateral spatial planning policy could guarantee the necessary environmental protection actions.

**Sweden**

The national mineral policy is supportive to the mining industry and innovations, but does not provide very realistic and directly applied incentives for the mining companies. Government actions with real impact are mostly under the form of penalties and restrictions. The waste management problems are not correlated with policies, but with the interpretation of various authorities with specific policies. There have been changes at municipality and provincial level, and the initial response is positive, as they are more knowledgeable on these matters.

A specific attention should be given to the recycling of secondary materials. The valorisation of iron sand in the building industry and the mine tailings can be mentioned as examples.

**Gaps and Needs**

- The human factor and the creation of Natura 2000 areas in old mining areas both generates problems for the mining industry.

**United Kingdom**

National Mineral Policy does not either help or disable mine opening in the UK as policy is based on commercial decision. The greatest influence is correlated with obtaining of the required planning permissions. The Environment Agency is a very well-structured organization despite its funding limitations during the last years.
6. Analysis of Needs and Gaps

6.1 Summary from questionnaire

Within the task, the outcomes of Deliverables 5.1 and 5.2 were discussed with key stakeholders through questionnaires; the received answers were used as an input for a gaps and needs analysis.

Within the scope of this task is the following are investigated:

- the existing national raw materials policies of EU MS are stimulating or not hindering the introduction of innovations in waste management and mine closure
- whether the responsible government authorities for the waste management and mine closure are well-structured and efficient
- How the national mineral policy can be improved in a way to facilitate the implementation of innovation in waste management and mine closure,
- the identification of possible changes in national mining regulations/governance (and other regulations affecting mining) which could promote mining activities in general
- the identification of the needs and gaps of existing raw materials policies for waste management and mine closure

In order to response to these questions a questionnaire has been developed and sent via e-mail to experts in all MS in the fields of geology and mining and particularly to the specialists of waste management and mine closure. The questionnaire was sent to 140 contacts. The list of questions is attached in the Annex. The structure of the responses by sector and country is shown in Figure 10.

![Response by group stakeholders and Response by country graphs]

Figure 10: Structure of response by sector and by country

The structure of the answers to three of the questions is shown in Figure 11.
Figure 11: Structure of answers to the questions related to policy impacts

The summary of the questionnaire answers is below presented.

**National mineral legislation for mine closure and waste management**

National mineral legislations are not supporting enough for the introduction of innovations in concerning the mine closure and waste management stages of the mining value chain. National mineral legislations should encourage new approaches and solutions that have
positive impacts (mainly environmental, but also socio-economic etc.). To improve the implementation of innovations in mine closure and waste management, the responsible mining authorities should state regulations in national documents and legislation.

Generally, many mining legislations present a rather technical approach, focusing mainly on technological and safety issues, and less on an appropriate description of a long-term evolution of mine sites.

National mineral policy should be also focused on economic issues and not be limited to political issues. National mineral policy needs expert decision makers in environmental protection. National raw materials policy is not strictly connected with geological survey and with earth sciences institutes. There are too many conflicting legal documents with equal power. Decision-makers are not sufficiently trained and specialized, so they postpone actions. Geological research is generally far away from needs and global trends (Poland).

National mineral policies impede mining activities mainly because they are over-regulative. Administrative procedures are rigid, complicated and long-lasting. Mining companies are not encouraged to protect mining rights at court because of long-lasting court cases (Croatia). Extractive waste is excluded from the Act on Sustainable Waste Management (OG 94/13, 73/17) in the part that is regulated by Mining law.

There is a lack of qualitative national waste management policies developed by independent experts. Studies on extractive waste management should be developed involving all relevant stakeholders in industry, market, universities, research institutions and professional associations. Such studies should be the base for the development of strategic documents on extractive waste management.

**National governing and responsible authorities for mine closure and waste management**

The coordination and communication between authorities responsible for mine closure and waste management is not appropriate. One of the experts mentioned that the problem is not mineral regulations itself, but different interpretation of the same mineral regulations by various responsible authorities (Sweden).

The need for simplification and speeding up of the permitting procedure is noted by many experts on raw materials, especially in case of mining value chain of mine closure and waste management.

The lack of well-trained employees in mining and other governing supervising public institutions is observed.

**Abandoned, orphan and non-rehabilitated exploration and extraction sites**

There are many abandoned and orphan open pits that are not rehabilitated. There is no public data available in the case of several mining sites where the obligation of remediation was not carried out. The need for a national strategy for remediation of abandoned exploration and extraction sites was noted. Most remediation attempts in mining areas have the same problems: such as spatial planning and requiring of flexible permitting procedure. Before changing the national regulations on mine closure, strategic documents should be developed based on the inventory of abandoned or active extractive industry sites which need be remediated.
**Transparency and dissemination of good practice cases on mine closure and waste management**

Experts have highlighted that the public opinion about mining is controversial. From one side it is thought that mining is not environmentally friendly and from the other side there is the awareness of society’s need for raw materials. Experts have also recommended the organization of an annual forum in which mining companies would propose their future remediation plan and demonstrate good practical examples. This forum should foster the communication and connection between the different groups of stakeholders which are involved in mining: a) mining inspectorate, b) ministry responsible for mining, c) academia and d) mining companies.

**Incentives for the mining companies**

At the moment, mainly the universities and research institutes have benefits by the governmental research programmes. There is no real incentive for the mining companies. The Government actions are mostly in the form of penalties and restrictions (Sweden).

Governmental incentives (authorities responsible for science and/or environment) for mining projects are primarily directed to the energy resources. This situation is a result of mining electorates’ political decisions, and thereby the projects concerning raw materials are less important (Poland).
6.2 SWOT Analysis

This SWOT analysis is conducted on the basis of interviews results in combination with the outcome/results of policy laboratory 4, as they were presented above in the context of the Strategic Plan. The aim of this SWOT analysis is to analyse the possibilities for future strategic development on waste management and mine closure activities.

Table 6: SWOT Analysis

<table>
<thead>
<tr>
<th>Internal Origin</th>
<th>Helpful</th>
<th>Harmful</th>
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<tbody>
<tr>
<td><strong>STRENGTHS</strong></td>
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<tr>
<td>• public sensitivity in the EU for environmental protection</td>
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<tr>
<td>• good examples of countries with Existence of National Mineral Strategy harmonized with the highest sustainability goals</td>
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<tr>
<td>• there are good examples of realization of &quot;one man vision&quot; in waste management and changing the use of the area where mining activity was performed</td>
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<tr>
<td>• most common form of mining in the EU is the quarrying and extraction of sand and gravel which does not produce hazardous waste</td>
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<tr>
<td>• a high level of technological development in the exploitation of mineral resources in the EU, which includes care for the environment</td>
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<tr>
<td>• existence of funds for environmental protection at national and EU level</td>
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<td></td>
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<tr>
<td><strong>WEAKNESSES</strong></td>
<td></td>
<td></td>
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<tr>
<td>• lack of national mineral strategy in most EU member states, which includes waste management and mine closure,</td>
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<tr>
<td>• national mining legislation that does not encourage innovation in waste management and mine closure</td>
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<tr>
<td>• governing bodies which are responsible for mining activities are often not well structured and harmonized with government bodies that deal with environmental</td>
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<tr>
<td>• there is a tendency in the EU environmental legislation to be imposed upon the respective national level legislation without the recognition of the particularities of each member country</td>
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<tr>
<td>OPPORTUNITIES</td>
<td>THREATS</td>
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<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td></td>
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<tr>
<td>• development of national mineral strategy for all EU MS, which includes</td>
<td>• constant restrictions and demands concerning the environmental</td>
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<tr>
<td>waste management and mine closure in a sustainable way</td>
<td>protection actions by the responsible authorities</td>
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<tr>
<td>• standardization and harmonization of national mineral legislation with</td>
<td>• negative public perception about mining activities in Europe due to</td>
<td></td>
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<tr>
<td>the environmental legislation</td>
<td>environmental incidents in Europe and worldwide</td>
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<tr>
<td>• the facilitation of environmental rules for mineral resources that do</td>
<td>• mine closure is a political priority, however it is not designed on</td>
<td></td>
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<tr>
<td>not produce hazardous waste</td>
<td>an economical and environmentally sustainable way</td>
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<tr>
<td>• there is a general need to establish an educational and promotional</td>
<td>•</td>
<td></td>
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<tr>
<td>program to raise public awareness of raw materials in an economically</td>
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<tr>
<td>viable way</td>
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<td></td>
</tr>
<tr>
<td>• improvement of national mineral policies and governance to stimulate</td>
<td></td>
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<tr>
<td>innovation in waste management and mine closure</td>
<td></td>
<td></td>
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<tr>
<td>• improving transparency and communication with the local public</td>
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</table>
6.3 Suggestions – recommendations for future policy developments

Recommendations for the future mineral policy development for introducing innovation in mine closure and waste management were performed based on both needs and gaps analysis and SWOT analysis.

**National mineral policies**

National mineral regulations should stimulate new approaches and solutions that have positive impacts. Related regulations should be flexible to support new approaches while possible amendment of the relevant legislation should be made relatively fast. The national strategy documentation should aim to improve implementation of innovations in waste management and mine closure.

Qualitative national strategic documents on extractive waste management should be assembled, evaluated and approved by independent experts. Mineral policies and legislation of mine closure and waste management should aim to the sustainability of the mining sector.

National strategies on remediation processes in abandoned mining districts should be developed and based on the inventory of both abandoned and active exploration and extraction sites. An inventory of mining sites where the remediation was not implemented should be made published.

The use of financial tools, e.g. tax on disposed hazardous mining waste. The quarrying and extraction of sand and gravel that does not produce hazardous waste should excluded from taxation.

Strict regulations in legislations related to waste management & mine closure, as well as, penalties in case of infringement, should be set.

**Introduction of incentives measures for utilization of recycled/secondary materials**

The abolition of administrative restriction should be promoted aiming to the easier use of recycled/secondary materials. The use of iron sand and tailings in the construction industry is a good example.

To encourage the use of recycled/secondary materials by creating the demand for such materials (i.e. in government financed construction projects etc.).

**Mine closure plan**

A mine closure plan should be developed at the initial stages of a mining project and become an integrated part of the design. Mine closure plan is a dynamic procedure which can change as new technologies advance or new ideas are being developed. The appropriate planning facilitates the innovations in the management of the extractive industry waste and mine closure. A mining design should contain the future targets after the mine closure.

**Financial guarantees/provisions**

It is important to ensure that financial guarantees/provisions are in place to facilitate the management and development of the extractive waste and mine closure policies.
Administrative authorities

Administrative authorities that are involved in the procedure of mine closure should closely work together to deliver a positive outcome. The licensing procedure for raw materials extraction should be simplified and accelerated and also incorporating a mine closure and waste management plan.

The employees of mining and other supervising (responsible) authorities should be well trained and qualified concerning mining and administrative procedures.

Transparency and dissemination of good practical cases on mine closure and waste management

An annual national forum should be organised supporting the transparency and the public acceptance of mining activities, as well as raising awareness on society’s need for raw materials. Mining companies should propose their future remediation plans or demonstrate good practical examples. The forum should foster communication and connection between related stakeholders in the process of waste management and mine closure.

R&D programmes

Studies and research programmes regarding waste management & mine closure should have government support (financial and/or leadership).
7. Conclusions

The scope of WP5 is to investigate how innovation processes in the waste management and mine closure are functioning in the different EU Member States and at EU level and how they are supported or impeded by national and European policy and legislation. WP5 encompasses a multi-stage methodology for the compilation of mineral policies and legislation with the adaptation of good practices and innovative actions on waste management and mine closure.

The goal of Deliverable 5.3 is to identify important gaps in the current legislation and stress out the necessary modifications that should be performed for the implementation of good practices on waste management and mine closure.

The Suggestions for future policy improvements are summarized below:

According to the research conducted through interviews, the national mineral regulations do not sufficiently support innovative approaches and solutions. On mine closure and waste management. National mineral policies are hindering mining activities primarily as they are over-regulated. Generally, many mining legislations present mostly a technical approach, focusing on technological and safety issues without setting the framework for mining sustainability.

The need for simplification and speeding up of licensing procedures is noted from many experts involved in raw materials sector.

There is a lack of efficient cooperation between the supervising authorities concerning the waste management and mine closure, and also a differentiation in the interpretation of the regulations by the supervising authorities. Different governing authorities involved in mine closure policies should closely cooperate to achieve efficacious results.

There is a lack of qualitative national waste management policies developed by independent experts. Studies on extractive waste management should be developed with the contribution of all relevant stakeholders creating the necessary documentation on waste management. The principle of the sustainability should be incorporated in mineral policies and legislation concerning the mine closure and waste management.

A mine closure plan should be developed at the initial stages of a mine project as an integrated part of the design. A mining design should contain the future targets for the restoration of abandoned mine localities and should be adjusted with spatial plans.

There are many abandoned open pits that are not rehabilitated.

The national strategy of abandoned mining localities remediation should be based on the identification and classification of the most problematic cases.

The abolishment of administrative restriction should be focused on the supporting of recycled/secondary materials use. This will be realized by creating the demand for such materials (i.e. in government financed construction projects, etc.).

Transparency and dissemination of good practical cases on mine closure and waste management experts can be promoted with the organization of an annual forum where...
mining companies propose their future remediation plans and demonstrate good practical examples. The forum should foster communication and connection between the different groups of stakeholders involved in mining.
8. References


9. Annex

9.1 Questionnaire

MIN-GUIDE’s activities are targeted to foster a minerals policy framework that enables public as well as private sector decision-makers to implement innovative and sustainable approaches to tackle challenges throughout the mining value chain. In that frame, University of Zagreb and NTUA distributed in the end of 2017 a questionnaire to key stakeholders in order to investigate the way in which the national mining related policies affect innovation in waste management and mine closure.

<table>
<thead>
<tr>
<th>ID</th>
<th>Question</th>
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<tbody>
<tr>
<td>1</td>
<td>Is the national mineral policy stimulating or not stimulating/hindering the introduction of innovations in waste management &amp; mine closure?</td>
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<tr>
<td>2</td>
<td>Is the governance authority responsible for waste management &amp; mine closure in your country well-structured and efficient?</td>
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<tr>
<td>3</td>
<td>Could you suggest some possible changes and improvements in national mineral policy (and other regulations affecting mining) to improve implementation of innovations in waste management &amp; mine closure?</td>
</tr>
<tr>
<td>4</td>
<td>Could you specify some possible changes in national mining regulations/governance (and other regulations affecting mining) stimulative for waste management and mine closure activities in general?</td>
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<tr>
<td>5</td>
<td>Are there any gaps or needs in national policies that could improve the situation?</td>
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