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Mining Regions and Cities
Case of Andalusia, Spain

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Foreword

Mining regions can play an essential role in meeting climate goals and in accelerating the recovery from the COVID-19 crisis. Global environmental agendas have recognised the relevance of the mining sector to accelerate the transition to a low-carbon economy. Particularly, European Union (EU) priorities, driven by the Green Deal and the new Industrial Strategy, have made the environmental sustainability of mining extraction and transformation a priority to achieve the EU's climate neutrality goal by 2050. While mining is a global industry, its geographic concentration is a critical factor in the design of policies for sustainable economic development. Promoting environmentally sustainable regional mining value chains can provide new business opportunities for local firms and high-value-added jobs for local communities, while advancing in meeting the climate goals.

Andalusia is a European region that can leverage the increasing global and EU demand for sustainable raw materials and thus become a frontrunner in leading technologies and circular processes for environmentally sustainable mining. Andalusia is the largest mining producer in Spain, the second-largest copper producer in the EU and a leader in marble and gypsum production. The region hosts companies and activities at almost all stages of the mining value chain, from extraction to services and processing activities. Andalusia benefits from two distinct mining subsectors, each with a rich network of suppliers that are relevant for local development: the metallic mining sector (e.g. copper and zinc), which accounts for most of the regional mining production, and the non-metallic sector (ornamental rocks, aggregates and industrial minerals), which is highly dispersed across the territory.

The region has the potential to further mobilise the assets of its mining ecosystem to attract investment and open new sources of growth while meeting EU climate goals. These assets include attractive geology, a strategic geographic location among EU and non-EU markets, good infrastructure and benefits from the proximity of mines to urban centres (e.g access to services). Furthermore, the region enjoys a mining identity with a young workforce that offers community support for mining ventures.

Yet, the region must overcome existing bottlenecks to fully leverage the potential of its mining ecosystem, while reducing its income gaps with respect to the national average. These include a low innovation intensity with insufficient linkages among firms within the regional mining value chain, a large share of small- and medium-sized enterprises (SMEs) and entrepreneurs in low-value-added activities and a complex and unpredictable regional administrative process for mining operations that relies on an outdated national regulation.

This study identifies how Andalusia can build on its strengths and address current and future challenges to become an EU frontrunner on sustainable mining while accelerating regional growth and productivity. To this end, developing a national mining strategy can be instrumental to unlock synergies across Spanish mining regions and assist the EU's climate goals. Furthermore, Andalusia's updating of the regional mining strategy represents a key tool to create the conditions for innovative projects across the mining value chain and increase its attractiveness for innovative firms and skilled workers.

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Abbreviations and acronyms

AEMA	Andalusian Marble Business Association
AFA	Andalusian Aggregates Manufacturers' Association
AFCA	Andalusian Cement Manufacturers' Association
AMINER	Association of Research, Extraction, Mining-Metallurgical Transforming, Auxiliary and Services Companies
CLC	Cobre las Cruces
EIT	European Institute of Innovation and Technology
FUA	Functional urban area
GDP	Gross domestic product
GVA	Gross value added
GVC	Global value chain
ICT	Information and communication technology
IGME	*Instituto Geológico y Minero de España*, Geological and Mining Institute of Spain
IPB	Iberian Pyrite Belt
KIBS	Knowledge-intensive business services
KIMS	Knowledge-intensive mining services
METS	Mining equipment, technology and services
MITECO	Ministry for the Ecological Transition and the Demographic Challenge
MIREU	Mining and Metallurgy Regions of the EU
MMD	Macael Marble District
MMH	Mining and Minerals Hall
NM	Non-metallic
OFICEMENT	Cement Manufacturers' Association of Spain
PPP	Purchasing power parity
R&D	Research and development
SME	Small- and medium-sized enterprise
TiVA	Trade in Value Added
TL2	Territorial Level 2
TL3	Territorial Level 3
VET	Vocational education and training

Executive summary

Assessment

Andalusia is a growing player in the European mining sector, with the potential to become a frontrunner in environmentally sustainable mining and to reduce its income and employment gap with the rest of Spain. Andalusia is the southernmost region of Spain, with the largest population and second-largest land area in the country. It is the lead mining region in Spain (38.6% of mining production), the second-largest copper producer in Europe and a leader in marble and cement production. The region's location in the Iberian Pyrite Belt (IPB), encompassing Seville and Huelva through to Southern Portugal, represents a global asset when it comes to metallic minerals. Within the region, Huelva is the main mining (TL3) region, carrying out 70% of the region's metallic mining.

Andalusia's mining value chain can assist the EU in meeting its climate goals by 2050 while unlocking new business opportunities to create high-value-added jobs in the region. Andalusia hosts companies and activities at almost every stage of the mining value chain, from extractive to processing activities as well as technology and services providers. It benefits from two distinct mining subsectors, each with an extended supply chain. The metallic mining sector (copper and zinc) accounts for most of the regional mining production and is largely made up of large foreign-based companies. The non-metallic sector (ornamental rocks, aggregates and industrial minerals), by contrast, is highly dispersed across the territory and composed mainly of small-sized businesses.

Andalusia has a number of local assets that can help the region become a frontrunner in environmentally sustainable mining and open up new growth opportunities. These assets include attractive geology, a strategic geographic location among EU and non-EU markets (North Africa and Latin America), good infrastructure (reliable energy and sound transport infrastructure) and proximity of mines to urban centres that facilitate access to services and labour force. Furthermore, the region enjoys a mining identity with a young workforce that offers community support for mining ventures.

However, the region must overcome a number of existing bottlenecks in its mining value chain to fully leverage these assets and, in turn, boost productivity and reduce income and employment gaps with the rest of Spain. These include a low innovation intensity in the mining value chain, with insufficient linkages among types of firms and universities as well as a relatively low educational attainment of the labour force. In addition, a high share of the business in the mining ecosystem and its related industries are small- and medium-sized enterprises (SMEs) and entrepreneurs located in low-value-added activities. Furthermore, the region relies on a complex and unpredictable administrative process for mining based on outdated national regulation.

Addressing these challenges and mobilising assets will be vital to fully capitalise on the increasing global demand for minerals and the greater strategic European support for reliable access to sustainable raw materials. In particular, the EU Green Deal represents opportunities for Andalusia to become a frontrunner in resource circularity and environmentally sustainable mining. The national government can help attain these goals through a national mining (or mineral) strategy that unlocks synergies among regional mining clusters, whilst enabling the benefits to accrue to local communities. Furthermore, the new mining strategy

of Andalusia is a unique opportunity to establish a clear and long-term vision for mining activities in the region and to strengthen the co-ordination with other regional policies and international actors to attract investment and unlock innovative business opportunities.

Key recommendations

Mobilising the strengths of Andalusia's mining ecosystem to increase competitiveness and attractiveness for firms and workers

For this, the regional government should:

- **Update and improve the accessibility of Andalusia's geological information**, in collaboration with the Geological and Mining Institute of Spain.
- **Facilitate and strengthen links with African and Latin American mining jurisdictions** to become a gateway to and from the EU in sustainable mining processes and technologies.
- **Better integrate urban and infrastructure plans with mining development plans** to improve the movement of goods and services for the mining sector as well as to avoid land use conflicts.
- **Make the most of the local mining identity and heritage** to strengthen community acceptance and information on mining activities while enhancing the mining business ecosystem.

Addressing challenges for development in Andalusia's mining ecosystem to unlock growth opportunities and assist the EU's climate goals

For this, the regional government should:

- **Enhance innovation within Andalusia's mining value chain** to generate sustainable mineral transformation processes and technologies, by:
  - *Promoting service innovation activities in the mining value chain*. This involves providing capacity and networking support to upscale knowledge-intensive mining service providers and establishing a testbed for mining firms and service providers to co-create projects.
  - *Boosting the role of the third sector to support mining innovation and entrepreneurship*. This involves strengthening partnerships with universities to promote research and academic programmes on mining and acting as a broker to facilitate the creation of an institutional platform to conduct research and development (R&D) in mining.
  - *Improving skills in Andalusia to prepare its workforce and youth population to meet the future needs of the mining industry*. This involves boosting training programmes on environmentally sustainable mining activities in partnership with universities and industry associations as well as better involving youth in mining activities through a greater communication of employment opportunities in the mining sector.
- **Upscale and guide SMEs towards higher-value-added activities** in order to increase resilience and offer stable sources of income in the local economy, by:
  - *Strengthening regional technical support programmes for SMEs* to improve networks with large mining companies, build capacity and promote the internationalisation of mining providers and small non-metallic mining firms.
  - *Reducing further administrative obstacles for start-ups and SME growth*.
- **Improve the regional mining regulatory framework and permit award process** to enhance competitiveness and ensure environmental protection. This action requires close collaboration with the national government.

Actions for the regional government:

- **Establishing a formal co-ordination mechanism** within the regional government to evaluate and deal with administrative processes for mining (e.g. a one-stop-shop, a single decision-making body or a branch in the Project Accelerator Unit).
- **Creating specific programmes to train government staff and provide digital solutions** to improve mining administrative processes.
- **Setting clear administrative timelines** to deal with applications for new and expanded mining projects, including times for environmental evaluations.

Actions for the national government:

- **Updating the national mining regulatory framework** to make it more efficient and better integrated with other sectoral regulations, including environmental regulations and land use planning.

Improving national co-ordination on mining to help attain EU strategic goals and support national and regional development and well-being

For this, the Spanish national government should:

- **Develop a national strategy on raw materials or mining**. This strategy should build on the ongoing process of developing the *road map for the sustainable management of raw materials*.
- **Improve the financial and institutional capacity of the Geological and Mining Institute** to help co-ordinate the national mining strategy and boost its research and exploration activities.

Strengthening Andalusia's 2021-27 mining strategy to make the regional mining value chain a frontrunner in environmentally sustainable mining and an engine to increase income and well-being

For this, the regional government should:

- **Define a unified vision of the role of mining for regional development** by agreeing on a clear goal for mining development in the updated mining strategy and enhancing the mining brand in the region.
- **Establish concrete objectives with measurable targets and a timeframe of actions** in the mining strategy.
- **Strengthen the monitoring framework of the new mining strategy** by differentiating between outcome and output indicators and developing horizontal indicators.
- **Improve the involvement of municipal governments and local communities** in the mining strategy.
- **Unlock synergies with other regional policy strategies and promote local networks** to support a regional mining cluster based on innovation.
- **Boost collaboration with Spanish and Portuguese mining regions, and with EU mining initiatives**, to promote joint mining projects, enhance knowledge and funding access.

1 Assessment and recommendations

Assessment

Andalusia is the largest mining producer in Spain and a growing mining player in Europe

Andalusia, the southernmost region of Spain, has the largest population and second-largest land area in the country. It is the lead mining region in Spain in terms of production (38.6% of mining production) and employment (28.4%). Andalusia is also a growing player in the European mining sector, distinguishing itself as the second European producer of copper and leader in the production of marble and gypsum. The region's location in the Iberian Pyrite Belt (IPB), encompassing Seville and Huelva through to Southern Portugal, represents a global asset when it comes to metallic minerals. Within the region, Huelva is the main mining (TL3) region, producing 70% of the region's metallic mining[1].

Andalusia hosts companies and activities at almost every stage of the mining value chain, from extractive to processing activities as well as technology and service providers. It benefits from two distinct mining subsectors, each with an extended supply chain. The metallic mining sector (copper, zinc and lead) accounts for most of the regional mining production and is largely made up of branches of large foreign-based companies. In contrast, the non-metallic sector (ornamental rocks, aggregates and industrial minerals) is highly dispersed across the territory and is composed of small local family businesses.

Andalusia's mining ecosystem has the potential to make the region a frontrunner in environmentally sustainable mining while unlocking new business opportunities locally

The EU's priorities, driven by the Green Deal and the new Industrial Strategy, have made sustained access to raw materials and the environmental sustainability of mining value chains a cornerstone of the EU climate neutrality goal for 2050. Raw materials are essential for the development of clean energy technologies (e.g. wind turbines, batteries, fuel cells and autonomous cars). The amount of minerals required for these technologies is greater than for fossil fuel-based counterparts and in some cases exceed the current production levels. The demand for both rare minerals (e.g. cobalt, lithium) and some traditional metallic minerals, such as copper, is expected to increase.

The increasing global demand and strategic EU support for sustained access to raw materials represents an opportunity for Andalusia. The mining ecosystem in Andalusia presents a number of strengths that can be further mobilised to become a frontrunner in resource circularity and environmentally sustainable mining. They include:

- *Attractive geology*. Andalusia's subsoil has diverse geology and, after many years of mining, remains highly prospective. It covers 60% of the IPB and holds the largest European reserve of non-ferrous minerals. Andalusia's mineral deposits contain some quantities of minerals identified as critical to supporting the generation of clean energy technologies (e.g. zinc, lead, silver, nickel,

cobalt, copper, molybdenum, manganese) and a rich mining endowment (more than 400 mines) that provides a fertile ground for technologies to recover traditional and critical minerals.

- *A strategic geographic location as the closest EU region to Africa and with cultural proximity to Latin America*. Africa and Latin America are important sources of minerals for Europe as well as relevant mining markets that also seek greater environmentally friendly mining practices. Responsible sourcing initiatives coupled with EU support for sustainable mining practices provide Andalusia with a competitive advantage to engage with African and Latin American mineral producers and become a gateway to and from the EU in sustainable mining processes and technologies.
- *Good infrastructure and proximity of mines to urban centres*. Andalusia's mining potential sits close to large urban centres, which provides the bonus of not having to operate in isolation, unlike many mining projects in other OECD regions. Logistics, health, safety and personnel matters are all greatly simplified by having urban centres closely at hand. The region also benefits from a reliable transport (roads, railroads and ports) and energy (sound mix of energy sources, with a share of renewables) infrastructure. Yet, work remains to be done to enhance the quality of the infrastructure (e.g. broadband) and the co-ordination among infrastructure plans and the mining strategy.
- *A marked mining identity with a young workforce that offers community support for mining ventures*. According to the 2018 INFACT survey (3 000 citizens), 60% of Spaniards showed an attitude between neutral and positive towards mineral exploration, which is relatively higher than in other European countries (Finland, Germany). Despite the impact on perception after the environmental disaster in the Aznalcóllar Mine at the end of the 1990s, Andalusian communities kept recognising the benefits of mining for the local economy and regional development.

Yet Andalusia needs to address some challenges to unlock the potential of its mining ecosystem and reduce the income and employment gaps with the national average

Andalusia's economy is large but underperforms against the income levels of the national and OECD mining regions average. While the region is the third-largest contributor to national gross domestic product (GDP) (13.3% in 2019), its GDP per capita and productivity level are the third lowest in Spain and far below the OECD TL2 benchmark. The financial crisis hit Andalusia's economy hard and the region has not been able to close the income and productivity gap with the national average to the levels prior to the 2008 crisis. A high share of low value-added and seasonal service activities in the economy (e.g. retail, some tourism-related activities and real estate) has driven such a structural gap.

Mining was one of the drivers of the regional recovery after the 2008 crisis and can be instrumental to support the economic recovery to the COVID-19 crisis and help reduce the income and employment gap at the national levels. Contrary to the trends in construction and tourism, the value of the production and the share of regional employment of metallic mining have grown steadily since 2010. During 2000-18, employment in metallic mining grew above the levels of agriculture and construction. The recovery from the COVID-19 crisis will involve aiming at greater resilience and economic diversification. Leveraging the assets of its mining ecosystem and the relevance of raw materials for the energy transition, Andalusia could create new business for firms and offer value-added jobs for the community.

To attain new development opportunities, Andalusia has to overcome various challenges that affect its mining business environment. These bottlenecks include:

- *Low innovation levels in the regional mining value chain*. Innovation in Andalusia is mostly driven by government spending and higher education institutions. Despite some innovative industrial companies, including mining companies such as Cobre las Cruces or Cosentino, the levels of patenting and research and development (R&D) expenditure from the private sector are below the European average. Low levels of innovation in the region and mining ecosystem reflect a lack of

effective channels for collaboration among different types of firms and with research institutions (e.g. among metallic and non-metallic subsectors).

- *Furthermore, the region's educational attainment* (32% of the workforce with tertiary education) *falls below the average of Spanish regions* (39%) and the OECD benchmark of mining regions (36%), with the mining province of Huelva (25%) scoring some of the lowest levels in Andalusia.
- *A large share of small- and medium-sized enterprises (SMEs) and entrepreneurs in low-value-added activities*. The large majority of nascent entrepreneurs in Andalusia declare that their ventures do not generate innovations of any kind, nor new products, services or innovative features. Despite the growth of Andalusian mining sector over recent years, the share of new regional business within the extractive industries is relatively low, with most of new business creation taking place in tourism and non-tradeable services (shops, restaurants).
- *A complex and unpredictable administrative process for mining at the regional level that relies on an outdated national regulation*. Despite Andalusia's efforts to reduce response times in the permitting process (an objective of the regional mining strategy 2014-20), the average approval time of permits still lacks predictability, with the unclear directive of maximum response times and lack of standardisation on approval times for both concession and research permits. Delays in Andalusia also seem related to the legal vulnerability of public officials in charge of mining-related decisions linked to environmental appeals and legal actions against mining ventures. Finally, mining legislation relies on an outdated national law (1973 – prior to the Spanish Constitution of 1978 and the accession to the EU) with a number of legal guidelines issued at different times and without a legal co-ordinating document.

A national mining strategy could help better mobilise the potential of the Spanish mining sector to support sustainable development and EU climate goals in concerned regions

Spain is one of the few EU countries (e.g. Finland, Portugal, Sweden) with mining resources that does not have a national strategy on mining or minerals. Mining policy in Spain is a combination of regional mining policies, where regions are responsible for mining policy design, mining permit delivery and mining policy implementation. The national government (specifically the Ministry for the Ecological Transition and the Demographic Challenge) has a general monitoring role, mainly in charge of overseeing mining security, waste mining and issues related to mining processes when a mine is located across two regions. Since 2020, the national government has aimed to reinforce policy co-ordination on mining by initiating a process to establish a road map for the sustainable management of raw materials.

Despite current efforts for national co-ordination, the lack of a national strategy on mining development leads to duplication of actions among regions and missed opportunities to spur synergies across regional mining ecosystems and among national policy strategies. The national government has scope to perform a more active co-ordinating role in relation to mining policy, through a clear strategic vision on the role of mining for regional development and a policy approach that fosters regional co-operation on mining investment and promotes policy complementarities among mining and other national sectoral plans to boost innovation, attract investment and increase well-being.

Andalusia's updating process of its mining strategy is a unique opportunity to make the regional mining value chain a frontrunner in assisting the EU climate agenda and an engine of income and well-being

Andalusia's new Mining Strategy 2021-27, which is currently under development, can be an opportunity to overcome some shortcomings of the previous strategy (2013-20). Areas for improvement include establishing a clear and long-term vision for mining activities in the region, aligning it to regional development goals and identifying concrete outcome objectives with a clear timeframe for action. The new

strategy should also enhance the engagement with municipal governments and communities, while developing national and international networks.

Defining a clear vision of the role of mining for regional development, with concrete objectives and a sound monitoring framework

Developing a common vision will help create consensus within the regional government and across different actors at the local level. This process needs to go beyond mining by integrating strategic goals from other economic sectors. To overcome the old strategy's shortcomings, which presented too broad objectives and a lack of timeframe, the new strategy needs to identify simple, well-targeted and concrete outcome objectives, accompanied with a timeframe of priority actions for the short, mid- and long terms . Furthermore, the new strategy should be paired with a dedicated monitoring framework with clear differentiated outcome and output indicators, including indicators to measure horizontal goals.

Involving municipal governments and local communities in the mining strategy

The region's new strategy can benefit from a greater involvement of local governments and communities to gain legitimacy and consolidate a common vision. Municipal governments are complementary to the strategy as they provide a local vision and support with resource management and policy implementation. While the regional government has already regular interaction with local governments, this co-ordination is not formally institutionalised. Ensuring a better and sustained intraregional collaboration needs a greater alignment of the mining strategy with the municipal development plans and the formalisation of a communication channel among levels of government.

Defining mechanisms to involve views of local actors (e.g. citizens, universities and interest groups) on the future of mining development and incorporating their feedback in the strategy can improve the quality of policy outcomes. Host communities tend to be on the front line regarding the negative externalities from mining ventures, while benefits span across national/regional governments and firms. The strategy needs to clearly define the institutional channels for community engagement in policy design and implementation and a clear framework on benefit-sharing agreements (monetary and non-monetary benefits) with local communities.

Unlocking synergies with other policy strategies and sectors to boost innovation

The strategy has a particular scope to improve linkages with other economic activities and, in particular, with the service activities associated with mining value chains. The new strategy needs to establish the institutional mechanisms to create links with other sectoral plans and with Andalusia's smart specialisation strategy (e.g. aerospace, renewable energies, construction and tourism). These linkages can strengthen the internal supply of sustainable minerals and materials and unlock local innovation through technologies and circular practices in the mining process that increase environmental outcomes and international competitiveness of the entire economy.

Developing national and international networks

The new mining strategy should also help Andalusia's mining ecosystem to enhance co-operation with national and international actors. Given the autonomy of Spanish regions to develop their own mining strategy, increased co-ordination with other regions can be instrumental to share good practices for mining development, develop joint projects and access greater funding. The strategy can include specific actions to formalise the co-operation with mining Portuguese regions and reinforce Andalusia's role in the EU and other international initiatives. For example, by highlighting the particularities of its mining value chain, Andalusia can become the bridge between EU mining sustainable practices and Latin American or North African markets. Furthermore, as the only region sharing the Iberian Piryte Belt with Portugal,

Andalusia can set up a partnership with regions in Portugal to structure a cross-border mining project and reach foreign investors and EU funds with a unified voice.

Recommendations

Mobilising the strengths of Andalusia's mining ecosystem to increase competitiveness and attractiveness for firms and workers

For this, the regional government should:

1. **Update and improve the accessibility of Andalusia's geological information**, in collaboration with the Geological and Mining Institute of Spain. This involves improving the geological information on Andalusia's mining website, with special attention to the mapping of critical minerals.
2. **Facilitate and strengthen links with African and Latin American mining jurisdictions** to become a gateway to and from the EU in sustainable mining processes and technologies. In collaboration with mining business associations, this involves promoting networking and partnerships with those jurisdictions and their established companies as they seek to adopt sustainable mining practices and promote responsible sourcing of minerals to Europe.
3. **Better integrate urban and infrastructure plans with mining development plans** to improve the movement of goods and services for the mining sector as well as to avoid land use conflicts. This co-ordination could aim to enhance the transport efficiency of goods (e.g. ports, roads and railways) for metallic and non-metallic mining.
4. **Make the most of the local mining identity and heritage** to strengthen community acceptance and information on mining activities, while enhancing the mining business ecosystem, by:
   - *Enhancing the communication of mining benefits among local communities*. To this end, the regional government together with mining business associations can promote dialogue among citizens and other actors (e.g. non-governmental organisations [NGOs], universities) within Andalusia's Mining and Minerals Hall event and before every mining project to share experiences on how to maximise the benefits of mining ventures for the local community.
   - *Partnering with universities and other local actors* (citizens, municipalities and business representatives) to better engage with interest groups with a negative perception of mining.
   - *Improving the links between corporate social responsibility programmes of mining companies and regional development programmes* through shared projects for local communities and ad hoc communication strategies.

Addressing challenges in Andalusia's mining ecosystem to unlock growth opportunities and assist the EU climate goals

For this, the regional government should:

5. **Enhance innovation within Andalusia's mining value chain** to generate sustainable mineral transformation processes and technologies, by:
   - *Promoting service innovation activities in the mining value chain*. Specific actions include:
     - Providing capacity and networking support to increase and upscale knowledge-intensive mining service providers. This requires establishing knowledge exchange mechanisms with foreign-based mining and manufacturing firms to upscale services offered by local mining service providers while helping them meet high standard procurement requirements. This should also involve developing capacity-building programmes for service providers on

circular processes and technologies for environmentally sustainable metallic and non-metallic mining.

  - Establishing a testbed for mining firms and service providers to co-create projects and experiment. This can be beneficial to build collaboration among metallic and non-metallic mining providers and firms. Andalusia's mines could be the lifelong learning laboratory for the local mining value system, inspired by the experience of Australia or Sweden.

- *Boosting the role of educational institutions and the public research sector* to support innovation and entrepreneurship for environmentally sustainable mining. Specific actions include:
  - Strengthening partnerships with universities in the region to promote research and academic programmes on technologies and circular practices that reduce carbon emissions in the mining value chain. This includes collaborating with universities to align their research programmes with regional mining strategy goals and industry needs. The regional government can learn from the partnership of Karlstad University and Värmland Region in Sweden.
  - Acting as a broker to facilitate the creation of an institutional platform to conduct R&D in mining. The platform could be co-coordinated by a body of private, academic and public representatives and should work through demand-driven projects from the private sector. This R&D platform can co-ordinate the testbed for the co-creation of projects, develop partnerships with existing regional incubators and promote intrapreneurship activities for companies and knowledge transfer between metallic foreign-based and non-metallic firms.
- *Improving skills in Andalusia* to prepare its workforce and youth population for the future needs of the mining industry and attain high-value-added jobs**.** Specific actions include:
  - Boosting training programmes in partnership with universities and industry associations to prepare the regional workforce and young generations for the upcoming demand of knowledge-intensive and environmentally sustainable mining activities. This could also involve vocational formation on traditional non-metallic mining activities. Practices from the Canadian Mining Innovation Council's "ReThink Mining" initiative can guide Andalusia.
  - Involving the young population in mining activities through a greater communication of employment opportunities in mining and promotion of internship programmes within the industry.

6. **Upscale and guide SMEs towards higher-value-added activities** in order to increase resilience and offer stable sources of income in the local economy, by:
   - *Strengthening regional technical support programmes for SMEs to improve networks with large mining companies, build capacity and promote the internationalisation of mining providers and small non-metallic mining firms*. This involves enhancing financial (e.g. grants, co-financing) and training programmes for digital transformation and project collaboration with universities and firms.
   - R*educing further administrative obstacles to SME creation and growth*. This involves strengthening capacity-building programmes to help SMEs navigate the regulatory environment in the region and promoting the digitalisation of administrative and fiscal processes.
7. **Improve the mining regional regulatory framework and permit award process** to enhance competitiveness and local community acceptability, while ensuring environmental protection. This action requires close collaboration with the national government.

   For this, the regional government should:
   - *Establish a formal co-ordination mechanism within the regional government to evaluate and deal with administrative processes for mining*. This institutional tool (e.g. a one-stop-shop, a single decision-making body or a branch in the Project Accelerator Unit of Andalusia[2]) should

gather officers from different regional ministries to accelerate mining administrative processes and improve co-ordination across regional regulations (e.g. environmental and land use) and with national and European legislation. This mechanism can also take stock on expert knowledge (universities or specialised consultants) to issue formal recommendations on the permit award process of mining projects.

- *Create specific programmes to train government staff and provide digital solutions to improve mining administrative processes*. These training programmes would benefit from partnerships with business associations from metallic and non-metallic mining to update the administration on the needs and benefits of a new type of mining operation.
- *Set clear administrative timelines to deal with applications for new and expanded mining projects, including times for environmental evaluations*. Timelines can be set in the regional mining strategy as a clear goal for improvement. Andalusia can find inspiration in the roadmap set by Canada.

For this, the regional government should:

- *Update the national mining regulatory framework* to make it more efficient and better integrated with other sectoral regulations, including environmental regulations and land use planning.

Improving national co-ordination on mining to help attain EU strategic goals and support national and regional development and well-being

For this, the Spanish national government should:

8. **Develop a national strategy on raw materials or mining**. This strategy should build on the ongoing process of developing the *road map for the sustainable management of raw materials.* The national strategy should include a long-term vision for mining development, clear mechanisms for co-ordination with other national development policies, tools to promote environmentally sustainable mining processes and technologies, as well as strategies to attract investors, improve communication and boost the well-being of local communities.
9. **Improve the financial and institutional capacity of the Geological and Mining Institute** to help co-ordinate the national mining strategy and boost its research and exploration activities. This institute can also help promote the Spanish mining value chain internationally. Spain may find of interest the structure and role of the Geological Survey of Finland.

Strengthening Andalusia's 2021-27 mining strategy to make the regional mining value chain a frontrunner in environmentally sustainable mining and an engine to increase income and well-being

For this, the regional government should:

10. **Define a unified vision of the role of mining for regional development** by:
    - Agreeing on a clear vision for mining development in the updated mining strategy. This vision should be built through a consensus with different local actors, have a long-term timeline (e.g. 2050, in line with the EU Green Deal) and aim to mobilise all of the comparative advantages of the region.
    - Enhancing the mining brand of the region and creating a plan to promote it internationally as part of the mining strategy. This brand and its promotion activities need to be developed and co-ordinated with other branding strategies and actors in the region. The brand should aim to attract new firms and skilled workers, based on an image of an innovative business environment that produces essential materials and know-how for the low-carbon transition.

11. **Establish concrete objectives with measurable targets and a timeframe of actions in the mining strategy**. This includes refining existing indicators and creating a timeframe for objectives by indicating which axis and action lines are a priority for the next few years (e.g. 2021-27) and which are inscribed in a longer timeline (2030).
12. **Strengthen the monitoring framework of the new mining strategy** by:
    - Differentiating among outcome and output indicators to measure long-term objectives and operative tasks differently.
    - Developing horizontal indicators that measure transversal objectives in the strategy and avoid duplication across specific tasks, while creating complementarities.
13. **Improve the involvement of municipal governments and local communities in the mining strategy** by:
    - Aligning the new mining strategy with municipal development plans. This can be done through frequent, formal dialogue sessions with municipal governments and their early involvement in the development process of the strategy and its monitoring.
    - Improving co-operation with municipalities through the proposed institutional platform for R&D in mining and the multi-stakeholder co-ordination platform for mining development.
    - Including in the new strategy a guideline/toolkit to structure and implement benefit-sharing mechanisms for mining in Andalusia. This includes identifying the models used in the region and facilitates capacitation programmes for companies and communities to make the most of the benefit-sharing process.
14. **Unlock synergies with other regional policy strategies and promote local networks** to support a regional mining cluster based on innovation by:
    - Establishing a formal mechanism within the regional government to better co-ordinate the different sectoral policies (e.g. aeronautic, industry, construction) with the aim to mobilise the innovative potential of the mining sector. This mechanism should gather representatives from different units of regional and municipal governments.
    - Promoting in the new mining strategy the creation of a multi-stakeholder platform for mining development that gathers all relevant actors in the mining value chain to identify synergies and projects of common interest. This should include representatives from companies of different sizes, universities and the third sector as well as local governments. This group should have a role in the preparation and monitoring of the mining strategy. The platform can help promote network activities and the international visibility of actors. For this, the regional government can get inspiration from the Mining Finland programme.
15. **Boost collaboration with Spanish and Portuguese mining regions as well as with EU mining initiatives** to promote joint mining projects, enhance knowledge and funding access by:
    - Developing partnerships with regional mining initiatives in Spain (e.g. the Iberian Sustainable Mining Cluster). The new mining strategy should map out the existing regional mining initiatives and specify the mechanisms to involve Andalusia in those initiatives to articulate common projects and promote a co-ordinated approach to reach European support programmes.
    - Defining the new mining strategy tools and flagship projects to materialise the co-operation with Portuguese regions located in the geological formation of the IPB. This can involve a common strategy to attract investors and reach EU funding.
    - Taking an active role in the EU mining networks to promote common projects with EU mining regions and consolidate Andalusia's role as the bridge for EU mining innovation and sustainable practices with Latin American and North African markets. This collaboration should also aim at improving the competitiveness and internationalisation of local SMEs in the mining ecosystem.

Notes

[1] The OECD regional database collects and publishes regional data at two different geographical levels, namely large regions (Territorial Level 2, TL2) and small regions (Territorial Level 3, TL3). Both levels encompass entire national territories. With some exceptions, TL2 regions represent the first administrative tier of subnational government (i.e. states in the United States or *régions* in France). TL3 regions are smaller territorial units that make up each TL2 region. Andalusia is composed of eight TL3 regions: Almeria, Cadiz, Cordoba, Granada, Huelva, Jaen, Malaga and Seville

[2] In 2019, the regional government of Andalusia created the Project Accelerator Unit to accelerate the administrative procedures of strategic projects. This unit promotes the streamlining of all the procedures of the Andalusian public administrations to process all projects of regional interest effectively and in less time (See Chapter 3).

2 Strengths and challenges in the regional development of Andalusia

The chapter provides an overview of the main trends of the region, in the economic, social and environmental fields, setting the basis for policy recommendations in the following chapters. The chapter first describes the mining sector in the Spanish and Andalusian context. It then examines the demographic patterns in the region followed by its main economic trends. The final section of the chapter examines the main enabling factors for regional development and the quality of life of its citizens.

Assessment and policy takeaways

Andalusia is the southernmost region of Spain, has the largest population and the second greatest land area in the country (17.8%). It is the lead mining region in Spain (38.6% of mining production) and a growing mining player in Europe, standing out as the second European copper producer. The Iberian Pyrite Belt (IPB), located between Seville, Huelva and Portugal, represents an international mining asset on metallic minerals. Huelva is in fact the main mining region at Territorial Level 3 (TL3) in Andalusia, containing 70% of the regional metallic mining production.

While other economic activities (notably tourism and agriculture) represent much larger shares of Andalusia's gross domestic product (GDP) and employment, mining has been an important driver during the recovery of the 2008 global financial crisis. If well managed, this sector can also play an important role in the recovery from the COVID-19 crisis.

This chapter identifies trends in the mining sector for Andalusia (TL2 region) and Huelva (TL3 region or province) as well as factors and bottlenecks for development when compared to a benchmark of OECD mining regions and national performance. These include the following:

- Andalusia records a slightly positive population growth (0.79% annual average since 2001) similar to the national average (0.81%) and well above the OECD TL2 benchmark (0.33%). However, this rate has slowed in line with the economy in 2008, mainly due to interregional outmigration of young people.
- The region enjoys a relatively larger share of the working-age population (67% of the total population) than nationally (65.8%) and in the OECD TL2 benchmark (64%). The share of the elderly population (17%) is also below the average of the OECD TL2 benchmark (20%). The relatively large labour force, along with a high unemployment rate, can represent a relevant source of labour supply for mining development. Yet, the declining trend in the fertility rate, as well as the outmigration of young people, threatens this demographic bonus.
- Andalusia's economy is large but underperforms when compared to national and international levels. The region is the third-largest contributor to national GDP (13.3% in 2019), yet its GDP per capita and productivity level are the third-lowest in the country and far below the OECD TL2 benchmark. Likewise, by 2020, nearly 1 out of every 5 unemployed Spaniards were Andalusian (22.7% of national unemployment).
- The financial crisis hit Andalusia's economy hard. The region has not been able to close the income and productivity gap with the national average to the levels prior to the 2008 crisis. By 2018, Andalusia's GDP per capita was 74.2% of the national average, ranking as the third-lowest amongst Spanish regions. Without the right policy response, the COVID-19 crisis could further broaden the gap.
- This structural gap is driven by a higher share of low-value-added and seasonal service activities. The service sector (75% of Andalusia's GDP) is mainly made up of low-value-added activities including retail, public administration and real estate. This leads to an entrepreneurial ecosystem dominated by a high proportion of small businesses (30 inhabitants per establishment, compared to 33.4 in Spain). As a result, 97.7% of companies have fewer than 20 employees, representing 53% of employment.
- Mining has contributed to the regional recovery after the 2008 crisis. Contrary to the trends in construction and tourism, the value of the production and share of regional employment of metallic mining has grown steadily since 2010. During 2000-18, employment in metallic mining grew above the levels of agriculture and construction. Similar to the 2008 financial crisis, the

mining sector (mainly the metallic mining subsector) has shown resilience during the COVID-19 crisis and, thus, has the potential to support the economic recovery of the region.

- While Andalusia stands out internationally in a number of well-being dimensions, notably safety, community support and environmental quality (e.g. air quality, biodiversity), the region has scope to improve critical enabling factors for development. They include education attainment levels, coverage of high-speed broadband and innovation levels.

Policy takeaways

- Co-ordinated regional strategies to promote mining development and align education and training programmes with mining industry needs can help mobilise the working-age and unemployed population. Policies to boost the business ecosystem across the mining value chain can contribute to attract new skilled workers and retain the young population in the region.
- Regional policy strategies could leverage the mining sector to help Andalusia accelerate the recovery from the COVID-19 crisis and rebuild the economy with a higher share of high-value-added activities. Promoting innovation in Andalusia's mining value chain can unlock new business opportunities for local firms and small- and medium-sized enterprises (SMEs) to transition towards higher and stable income sources.
- Better conditions for regional development and increased well-being of citizens requires long-term strategies to raise education levels, access to quality broadband and innovation levels in the region.

Introduction

This chapter offers a comprehensive diagnosis of Andalusia, Spain, and its most active mining provinces, particularly Huelva. The chapter compares Andalusia's development against national trends and a benchmark of other OECD mining regions at Territorial Level 2 (TL2) and Territorial Level 3 (TL3) (see Box 2.1 for an explanation of territorial categorisation). Based on these comparisons, the analysis identifies major strengths and bottlenecks in Andalusia's development and well-being. While mining is not the main contributor to the region's GDP and employment, this diagnosis reveals the relevance of leveraging Andalusia's mining potential to create a prosperous and sustainable future.

The chapter first describes the mining sector in the Spanish and Andalusian context. It then examines the demographic patterns in the region followed by its main economic trends. The final section of the chapter examines the main factors for regional development including the quality of life of its citizens.

To better compare the performance of Andalusia against comparable regions also specialised in mining and extractive activities, the analysis in the chapter makes use of two benchmarks, one based on comparable TL2 regions to Andalusia and a second one based on comparable smaller TL3 regions to Huelva.

The construction of the TL2 benchmark makes use of all OECD TL2 regions (394 regions) and conducts selection criteria based on the following three variables to identify comparable regions with Andalusia:

- **Weight of the mining sector** based on the economic weight of industry (excluding manufacturing) in the region and measured as the share of the total gross value added (GVA) of mining in the TL2 region.
- **Mining sectoral specialisation** measured through a location quotient defined as the share of the mining sector in the region to the total share, against the national share in mining to the overall share. Specialisation is calculated both in terms of employment and of GVA.
- **Degree of rurality** of the region, measured as the share of the population in the region living in functional urban areas (FUAs).

The selected regions in the benchmark are those with less than half of the standard deviation from Andalusia's level in the three indicators and all specialised in mining. Across all OECD TL2 regions, the analysis identifies a benchmark of 29 OECD TL2. A complete list of the mining regions selected in the analysis is provided in Annex Table 2.A.1.

The second analysis is based on a more granular approach at the TL3 level. Its objective is to analyse the performance of Huelva, the most specialised TL3 mining region of Andalusia, to comparable OECD TL3 regions specialised in mining and extractive activities. In order to establish international comparisons, the analysis identifies the benchmark of regions based on the following five characteristics:

- **Population**. Measured as the total number of inhabitants in the TL3 region.
- **Density**. Calculated as the number of inhabitants per kilometre square.
- **Weight of the mining sector**. Measured as the total gross value added (GVA) of mining in the TL3 region.
- **Mining sectoral specialisation**. Calculated as the employment and GVA regional share of the industry over the national share.
- **Degree of rurality** based on the OECD TL3 revised typology (Box 2.1). This typology classifies Huelva as a non-metropolitan region close to a small/medium city. Therefore, only regions classified in the same TL3 group as Huelva are included in the benchmark.

As with the TL2 benchmark, the selected regions are those with a value less than half of the standard deviation from Huelva. The analysis identifies 31 OECD TL3 regions with similar characteristics to those of Huelva, A complete list of the mining regions selected in the analysis is provided in Annex Table 2.A.2. The chapter and the rest of the report will refer to TL3 regions as provinces or TL3 regions, interchangeably.

Box 2.1. OECD TL3 revised typology

The OECD regional database collects and publishes regional data at two different geographical levels, namely large regions (Territorial Level 2, TL2) and small regions (Territorial Level 3, TL3). Both levels encompass entire national territories. With some exceptions, TL2 regions represent the first administrative tier of subnational government (i.e. states in the United States, *estados* in Mexico or *régions* in France). TL3 regions are smaller territorial units that make up each TL2 region.

The OECD has adopted a new typology to classify administrative TL3 regions. This classification allows measuring socio-economic differences between regions, across and within countries. It is based on the presence and access to functional urban areas (FUAs) – a concept defining cities and the urban hinterland, in other words, urban economic agglomerations.

By controlling for these regional characteristics, the typology classifies TL3 regions into two groups, metropolitan and non-metropolitan regions. Within these two groups, five different types of TL3 regions are identified. The metropolitan regions (MRs) adopt 50% of the population of the TL3 (small) region living in an FUA of at least 250 000 people as a threshold; non-metropolitan regions (NMRs) 60-minutes' driving time as a threshold, a measure of access to an FUA.

The methodology follows the criteria below:

- ***Metropolitan TL3 region,*** if more than 50% of its population live in an FUA of at least 250 000 inhabitants. MRs are further classified into:
  - **Large metropolitan TL3 region**, if more than 50% of its population live in an FUA of at least 1.5 million inhabitants.
  - **Metropolitan TL3 region**, if the TL3 region is not a large metropolitan region and 50% of its population live in an FUA of at least 250 000 inhabitants.
- ***Non-metropolitan TL3 region,*** if less than 50% of its population live in an FUA. NMRs are further classified according to their level of access to FUAs of different sizes into:
  - **With access to (near) a metropolitan TL3 region (NMR-M)**, if more than 50% of its population live within a 60-minute drive from a metropolitan area (an FUA with more than 250 000 people); or if the TL3 region contains more than 80% of the area of an FUA of at least 250 000 inhabitants.
  - **With access to (near) a small/medium city TL3 region (NMR-S)**, if the TL3 region does not have access to a metropolitan area. Fifty percent of its population has access to a small or medium city (an FUA of more than 50 000 and less than 250 000 inhabitants) within a 60-minute drive; or if the TL3 region contains more than 80% of the area of a small or medium city.
  - **Remote TL3 region**, if the TL3 region is not classified as NMR-M or NMR-S, i.e. if 50% of its population does not have access to any FUA within a 60-minute drive.

The described procedure leads to more statistical consistency and interpretable categories that emphasise urban-rural linkages and the role of market access.

Megatrends affecting regions specialised in mining and extractive activities

The geographically concentrated nature of mining leads to a highly specialised economy, bringing with it particular challenges and opportunities to mining regions and the well-being of its inhabitants. Global megatrends, including demographic change, climate change and the transition to a low-carbon economy, as well as digitalisation and automation, are transforming industries and societies. These megatrends are also bringing new challenges and opportunities to the development of mining regions (Table 2.1).

Table 2.1. Opportunities and challenges of megatrends for mining industry and regions

	Opportunities	Challenges
Changes in demographic trend (population ageing and migration)	• Successful integration of migrants may enhance labour supply. • Lifelong learning can enable the old workforce to keep adding value.	• Ageing population/local demographic decline leads to a shortage of labour. • Unsuccessful migrants' integration may lead to social problems. • Many migrants tend to reside only temporarily and eventually move south to larger cities.
Climate change and environmental pressures	• High standard of environmental performance and requirements will soon be a competitive advantage for regions that have transitioned to fossil-free, low electrified mining and the development of environmentally friendly technologies to reduce carbon emissions in mineral and metal processes.	• Pressures for the mining industry to improve its performance and reduce its environmental footprint. • Harder policies and regulation to issue permits to operate in the future. • Higher public reticence to accept mining explorations and openings.
Technological innovation (e.g. digitalisation, automation, decentralised energy)	• Digitalisation/automation may compensate for shortages of labour in some sectors. • Can make mining regions more attractive to live by providing quality public services, including remote healthcare solutions. • Creation of new jobs by involving regional actors to develop new digital- and automated solutions. • Offer greater labour opportunities for women and various segments of the population.	• Displace certain workers in the mining sector, mainly the ones that perform more repetitive tasks. • If technological innovation is produced outside the region, it can affect the competitiveness of the region. • Can reduce the need for certain minerals by replacing them with laboratory products or by extracting them from the recycling process.

As will be explored in the next section, Andalusia is well-positioned to address the demographic challenges. Mining environments are typically vulnerable to demographic challenges that affect their workforce structure. Against this backdrop, Andalusia's relatively young workforce is an important asset. In addition, Andalusia's municipalities specialised in mining also have a relative gender balance, which contrasts with the trend in many mining regions (Abrahamsson, 2006[1]). Workforce availability in the mining regions as well as gender balance and high retention capacity are an important asset for Andalusia's mining sector and its development potential.

In terms of the transition to a low-carbon economy, mining regions can and should be relevant actors to attain environmental goals. These regions supply the minerals and materials needed to develop green technologies. As Chapter 3 will explore, increasing the supply of energy from renewable sources and developing materials and technologies that reduce carbon emissions is an untapped opportunity in mining regions including in Andalusia. At the same time, the extractive nature of mining activities is a matter of social and political concern, which has led to increasing pressure to reduce the environmental impact from these activities. Increasing sustainability across such extractive processes will place mining regions as key patterns to attain climate goals and reduce societal pressure over their activities.

Finally, technological change and digitalisation can further reduce the cost of moving people and goods and providing services as well as increase productivity. Technology is already changing the way minerals are extracted and transformed. IT also allows attaining a more sustainable extractive process by lowering consumption of natural resources and fossil fuels and performing more controlled extractions that produce a minimum impact on the earth. This megatrend is particularly relevant in Andalusia as the region hosts extractive but also transformative firms in its mining business environment (Chapter 3).

Andalusia is likely to be affected by these megatrends. As this study will show, some of the megatrends brought by demographic changes, pressures to transition to a low-carbon economy and effects from technological progress are already bringing a number of challenges and opportunities in the mining ecosystems of Granada, Huelva and Seville. Indeed, as Chapters 3 and 4 will stress, the impact of megatrends on mining municipalities will very much depend on policy responses to address the changes and prepare firms and communities for future changes.

Spain, a relevant mining country

Spain has a varied and important mining production thanks to its geological diversity. This mining richness places Spain as the third country in Europe (after Sweden and Finland) with the most mineral raw material resources, becoming a leading reference among European mining countries (La Razón, 2020[2]). The significance of Spain's mining output is highlighted in the 2018 Spanish mining statistics report (Ministerio para la Transición Ecológica y el Reto Demográfico, 2018[3]):

- Europe's second-largest producer of copper (used for electricity conductors, pipes and structures).
- Europe's only producer of sepiolite and glauberite, used in pharmaceutical products and detergents among others.
- Europe's only producer of magnesite and potassium salts widely used in agriculture.
- A leading producer of fluorspar and gypsum used for the formulation of insecticides, fluxes and a variety of ornamental purposes and construction respectively.

Mining activities in Spain have a great historical tradition dating back centuries and the sector has been fundamental during the industrialisation of the country from the 19th century onwards. With the arrival of the Romans, a significant advancement was experienced thanks to the incorporation of new mining-related technologies. The Arabs and the subsequent discovery of America continued the mining activity, reactivating silver, copper and lead mines. In the second half of the 19th century, the incorporation of legal regulations (Mining Law of 1868) facilitated the entry of foreign capital along with new techniques that intensified the production and benefits of minerals such as copper, pyrite, iron or coal (IGN, 2018[4]; Montagut, 2015[5]).

From coal to mining of leading minerals

The mining tradition in Spain was initially focused on energy minerals but has rapidly transitioned towards one of metallic products. Historically, energy mineral products (coal) were the primary mineral resource in the country but its current production has declined sharply in both quantity and value. In fact, a decree in 2018 ordered the repeal of all subsidies associated with coal mining. Instead, metallic and ornamental mining resources have remained active and nowadays generate the biggest mining value production throughout the territory. Most of the mining production (60%) comes from metallic and non-metallic minerals, with the rest being quarry, ornamental rock and energy minerals.

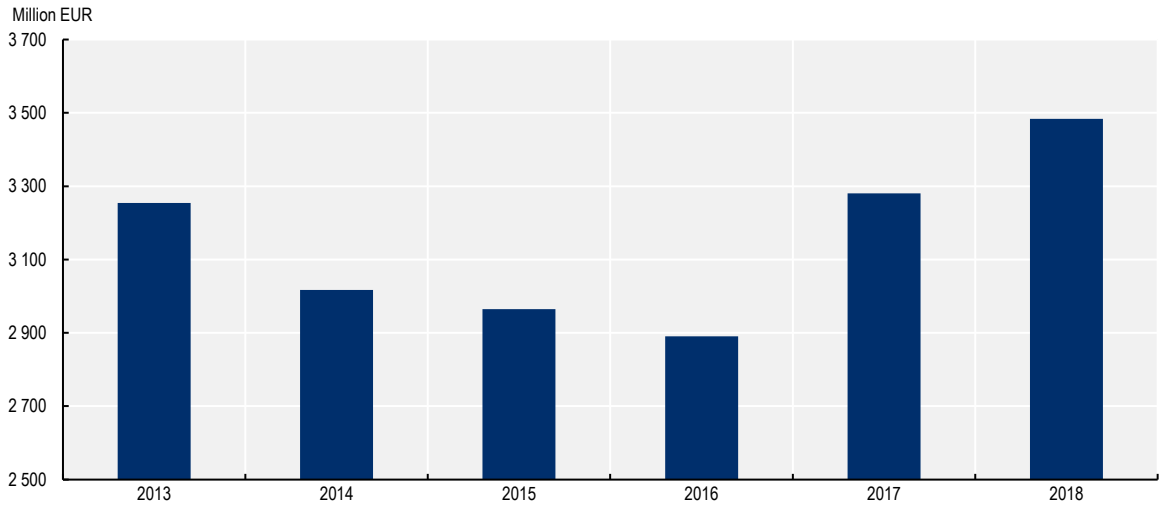
- **Metallic mining** is the current driving force of the Spanish mining industry, with the IPB (FPI), located between Seville, Huelva and Portugal, containing one of the largest amounts of non-ferrous metal reserves in the world. About 2 000 million tonnes of ore have been exploited already and

there are still more than 400 million tonnes to be exploited (Junta de Andalucía, 2016[6]). In addition, the largest gold mine in Europe is located in Asturias, and other regions such as Castilla y Leon and Extremadura have deposits of wolfram, tin, lithium and vanadium.

- In **non-metallic mining**, Spain is an important global player standing as the leading world producer of marble and gypsum. The marble of the Macael area or the gypsum from Almeria are global players in non-metallic mining. Yet, this type of mineral is highly reliant on construction cycles. Relevant deposits of potash for fertilisers and vacuum salt are also available in Catalonia.

Overall, the mining activity in Spain has experienced fluctuations during the last decade. While activity resumed in the immediate aftermath of the crisis, a downward trend continued until 2016, mainly due to the fall in the price of energy products (Ministerio de Energía, Turismo y Agenda Digital, 2016[7]). However, since 2018, the contribution of the mining sector grew in Spain and reached 29 890 direct jobs and 2 731 mines (Figure 2.1). This upward trend was associated with the recovery of international prices and the consequent reopening of mines in Spain.

Figure 2.1. Evolution of the mining production value of Spain, 2013-18



Source: Ministerio para la Transición Ecológica y el Reto Demográfico (2018[3]), *Estadística Minera de España*, https://energia.gob.es/mineria/Estadistica/DatosBibliotecaConsumer/2018/Estadistica_Minera_anual_2018.pdf (accessed on 3 October 2020).

The mining activity in Spain does not occur equally throughout the territory. At a regional level, Andalusia concentrates the highest share of employment and production in the Spanish mining sector, tripling the production and doubling the employment of the second most relevant mining region in the country (Catalonia). The ranking of the five regions with the largest number of employees is completed by Asturias, Castilla y Leon and Galicia. These 5 autonomous communities represent almost 68% of national mining employment. The next sections outline the chief characteristics of Andalusia, its demographic and economic trends as well as the status of its enabling factors for development.

Andalusia, the leading mining region in Spain

A dispersed settlement structure and the largest Spanish region by land area

Andalusia is the southernmost region of Spain, and the second-largest region by land area. It borders Portugal to the west, as well as the Mediterranean Sea and the Atlantic Ocean along its coasts. Andalusia

is made up of 106 municipalities and is one of the 17 autonomous communities[1] that constitute Spain. Andalusia is composed of eight TL3 regions: Almeria, Cadiz, Cordoba, Granada, Huelva, Jaen, Malaga and Seville. With 1.95 million inhabitants, the TL3 region of Seville is the largest province in Andalusia and the city of Seville (688 592 inhabitants) is the fourth largest city in Spain.

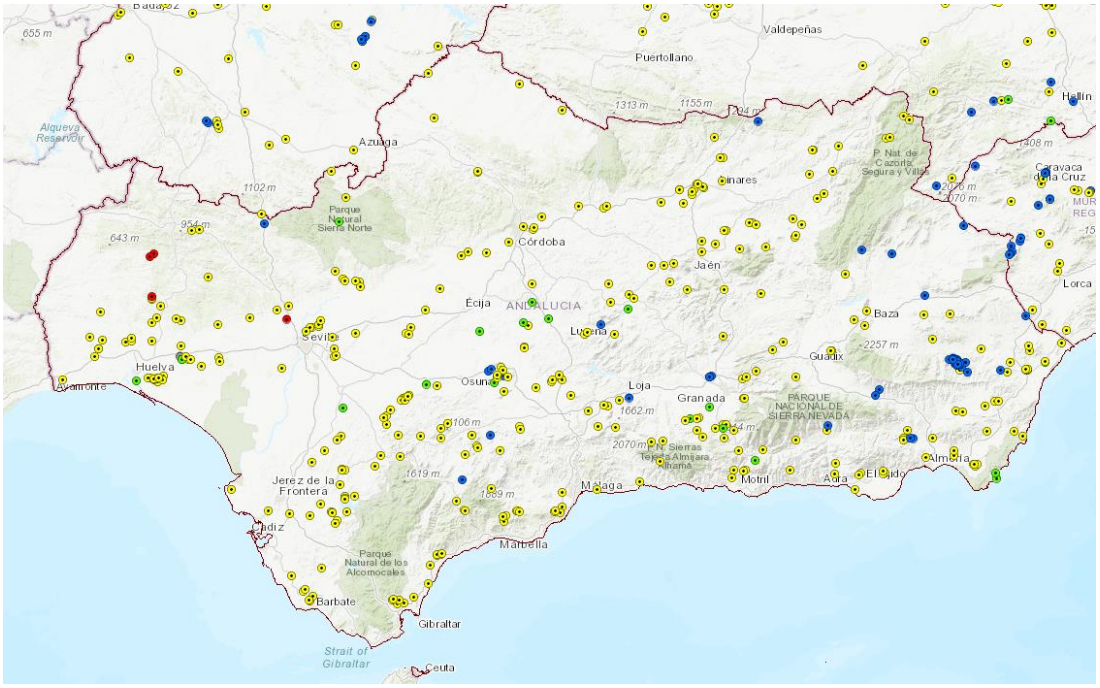
Table 2.2. TL3 Andalusian provinces by OECD typology

TL3 region Andalusia	Population, 2019	Surface (km^2)	Density (inhabitants/km^2)	OECD typology
Seville	1 957 197	14 042	139.38	Regions with a city >1M
Malaga	1 683 271	7 308	230.33	Regions with a city >250K
Cádiz	1 251 149	7 435	168.26	Regions near a city >250K
Granada	914 678	12 635	72.39	Regions with a city >250K
Cordoba	785 240	165 321	22.52	Regions near a city >250K
Almeria	706 871	8 774	80.56	Regions with/near a city <250K
Jaen	632 027	13 496	46.83	Regions with/near a city <250K
Huelva	524 576	10 128	51.79	Regions with/near a city <250K

Note: The classification criteria for the OECD typology can be found in Box 2.1.
Source: INE (2020[8]), *Estadística sobre actividades de I+D. Año 2019*, https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176754&menu=ultiDatos&idp=1254735576669 (accessed on 12 November 2020).

Figure 2.2 shows the areas with the current highest population density, where Almeria, Huelva and Seville correspond to places with mining deposits. Huelva and Seville host most of the metallic mining production in the region, while Almeria most of the non-metallic production (marble and other aggregates) (Chapter 3). The mineral transformation facilities are mostly located in Seville, as well as the company's central offices.

Figure 2.2. Map of Andalusia with all active exploitations, 2017



Note: The colour of the dots indicates: red - metallic mining; green - industrial minerals; blue - ornamental rocks; yellow - quarry products.
Source: IGME (2021[9]), *Visor InfoIGME*, http://info.igme.es/visorweb/default.aspx?configuracion=ESTMINERA (accessed on 8 February 2021).

Past and present of the mining region of Andalusia

Andalusia has been a mining force throughout history because of its great geodiversity. The extraction activity in Andalusia dates back to no less than 5 000 years ago (Portal Andaluz de la Minería, 2021[10]), when first sediments are located in the province of Huelva. With the arrival of the Romans in the region, there was a notable advance in mining techniques and tools, as was the case for the rest of the peninsula. Andalusia's increase in mining power was amplified by the implementation of the railroad as a means of transport, which now has one of the oldest and densest networks of Spain.

By the second half of the 19th century, Andalusian mining supplied one-eighth of the world's lead production, one-tenth of the world's copper and one-third of the production of iron and copper pyrites for sulphur, which gives us an idea of the importance of this economic activity in Andalusia. As a result, minerals such as copper were, at that time, pillars of the economic and industrial growth of Andalusia.

The early 2000s put an end to the prosperity of the mining sector, with a slowdown that lasted 10 years in which no work was done in the metallic mining sector. Spanish metallic mines closed down due to the downward fluctuations of metal prices. In the period 2007-12, the extractive mining sector experienced a decrease of 60.43% in its volume of production. After the financial crisis, the trend changed in Andalusia. The region experienced a growth in mining production, whose share over the national production rose from 18.4% in 2010 to 25.8% in 2013 (Ministerio para la Transición Ecológica y el Reto Demográfico, 2018[3]). Andalusian mining continues to grow as the global market has entered a new period with increasing international demand for minerals.

Mining, a great opportunity for regional development in Andalusia

The present offers a scenario of strategic opportunity for mining in Andalusia. Andalusia has the largest European reserve of non-ferrous minerals with nearly 470 active companies and mining operations that produce 41 million tonnes per year. Mining industry directly employs more than 7 400 people, especially relevant in a region of Spain facing high levels of unemployment.

The value of total production ranks Andalusia the overall mining leader in Spain (Table 2.3) with a share of 38.6% over the total national production value, followed by Catalonia (13%) and Castile and León (9.9%). In 2018, Andalusia accounted for the vast majority of the total national production value of metal ores, as the spearhead of the country. While in quarrying products the distribution by region is more equitable, Andalusia still leads with 22.3% of the total production value, followed by Catalonia (13.5%). As a whole, while Andalusia hosts 17% of all national open mines, it produces 38.6% of the national production value, illustrating the size of Andalusian mining operations and productivity.

Table 2.3. Share of the TL2 regional mining production value and employment over national, 2018

Autonomous community	Share of production value (%)	Share of employment (%)	Main extractions
Andalusia	38.6	24.8	Copper, lead, zinc, silver, plaster, marble
Catalonia	12.9	12.0	Hydrocarbons, potash, industrial rocks
Castile and León	9.9	11.6	Coal, anthracite, slate, glauberite, tungsten
Galicia	7.3	11.3	Kaolin, quartz, slate, granite
Asturias	4.9	8.1	Coal, anthracite, fluorite, gold

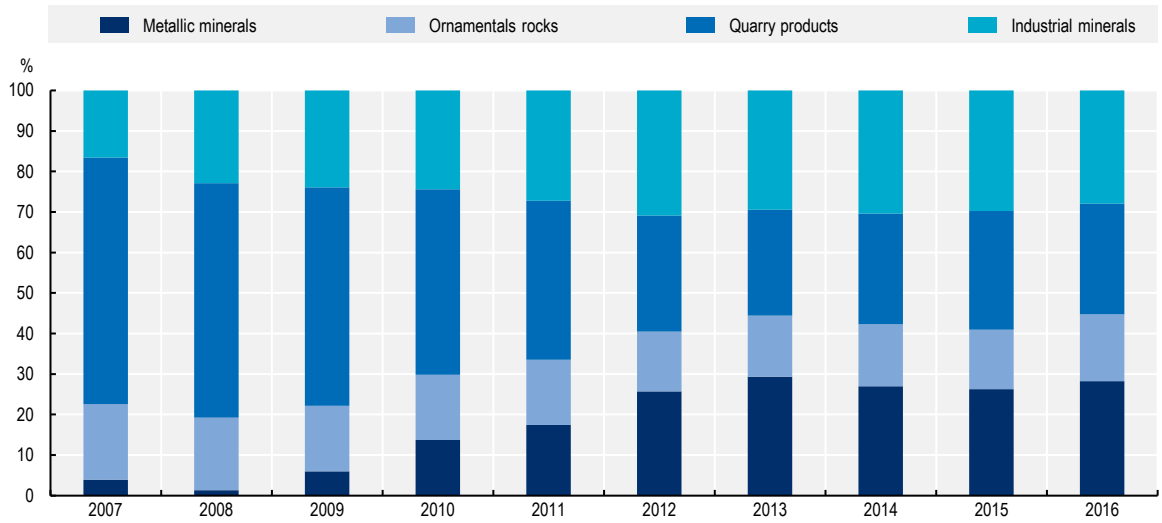
Note: Share over the total value.
Source: Spanish Government (n.d.[11]), *Minería y Explosivos*, https://energia.gob.es/mineria/Paginas/Index.aspx; Spanish Government (2018[12]), *Estrategia Minera Nacional 2018*.

Andalusia has gained relevance in the national mining sector and is currently the first national producer and employer for the sector:

- The significant mining expansion in the region has enabled Andalusia to employ 30% more workers in the mining sector over the last 2 decades. While the number of employees in Spain in mining fell from 44 605 in 2000 to 29 890 in 2018, Andalusia increased the number of employees in the mining sector from 5 252 to 7 424 during the same period.
- Andalusia has multiplied by 14 the value of its mining production since 2000. In Andalusia, the reopening of mines – especially of the region of Huelva – has led the current mining value production to expand from EUR 90.8 million in 2000 to generate EUR 1 346 million in 2018.

Over the years, the mining subsectors have evolved differently, with metallic mining being the best performing in the last decade (Figure 2.3). While in the years prior to the crisis, Andalusian mining was mainly based on non-metallic mining (quarry products 61%, ornamental rocks 19% and Industrial products 17%), with the economic downturn brought on by the financial crisis and the halt in construction, metallic mining benefitted from high international commodity prices to gain its greater mining relevance in the region. It is worth remarking that, despite the general economic fall during the financial crisis, industrial and ornamental mining endured the turbulence of external financial shocks relatively well, maintaining stable values between 2009 and 2016 at less than 8% change in the value of production. This indicates an effective resilience of both metallic and non-metallic mining subsectors leading to a sustained production value over time.

Figure 2.3. Value of mining production in Andalusia by metallic and non-metallic subsectors



Source: INE (2020[8]), *Estadística sobre actividades de I+D. Año 2019*, https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176754&menu=ultiDatos&idp=1254735576669 (accessed on 12 November 2020); Spanish Government (2018[12]), *Estrategia Minera Nacional* from 2000 to 2018.

As mentioned in the previous section, of special relevance is the IPB. The Andalusian provinces of Huelva and Sevilla take up almost 60% of the IPB, while the remaining 40% is located in the Portuguese region of Alentejo. This mining resource has more than 82 active mines for resources that are estimated at more than 1 600 Million tonnes of massive sulphides and 2 500 Mt of mineralisation in stock, constituting one of the most important metallogenic provinces in the world and considered one of the deposits with the highest concentration of sulphides in the planet. Overall, Huelva accounts for most of the region's metal production (70%), followed by Seville (30%) which contains the remaining part.

The rising value of some metals, together with the presence of ores in Andalusia, form a scenario of strategic opportunity for the increasing recovery of mining. In Andalusia, copper in particular is increasingly sought after due to the high demand in building clean energy technologies and from industrial processes in Asian countries. In this context, exploration in the entire IPB has expanded and led to the reopening of old mines such as Aguas Teñidas, Riotinto or Sotiel and new ones such as Cobre Las Cruces, while La Zarza, Lomero, San Telmo or Tharsis, among others, are in viability studies (Table 2.4).

Table 2.4. Selected municipalities according to main operating mines in Andalusia, 2020

Municipality	Province	Mine	Company
Calañas	Huelva	Sotiel	MATSA – Minas de Aguas Teñidas
Almonaster la Real		Aguas teñidas, Magdalena	
Minas de Riotinto		Riotinto	Atalaya Mining
Huelva		Copper production and refining	Atlantic Cooper
Alosno		Mina de Tharsis[1]	Maprise
Macael	Almeria	Canteras de Macael	Multiple companies (>300)
Sorbas		Mina de Yeso	Yesos Almería
Gerena	Seville	Las Cruces	Cobre las Cruces
Guillena			
Salteras			
Alnazcollar		Mina de Alnazcollar	Minera los Frailes

Note: Non-operational mines that are being projected or in study and development phases such as Minas del Marquesado and San Telmo have not been retained for the selection.
1. Extraction of iron and copper from the *Tharsis mine* residues.
Source: AYMA Mining (2020[13]), "¿Dónde se encuentran las principales explotaciones mineras de Andalucía?", https://aymamining.com/donde-se-encuentran-las-principales-explotaciones-mineras-andalucia/ (accessed on 4 October 2020).

As the following chapters will outline, the European Union (EU) is increasingly urging countries to make the most of its mineral resources and transformation process to enhance industrial resilience and support the transition to a low-carbon economy. Along that path, Spain and particularly Andalusia are well placed, as several key materials for the transition can be found and exploited in its territories, such as aluminium, cobalt, tin, graphite, lithium, manganese, nickel, gold, silver, rare earths and tungsten. Therefore, Andalusia has the possibility to be a frontrunner and position itself as a key player in the European mining scenario.

Andalusia in a snapshot

The following sections will offer a diagnosis of the demographic and economic trends and enablers for development in the region. Its most outstanding characteristics have been summarised in the following table:

Table 2.5. Highlights of Andalusia by topic

Demographic	Andalusia has the highest population share and is the second-largest region in Spain.
	The population growth that followed the economic expansion in the region stagnated with the arrival of the crisis, as did the rest of the country.
	The region enjoys a demographic bonus, with a young, working-age population and relatively low elderly population ratios.
	The contribution of inflow migration stopped with the economy in 2008, leading to a current trend of outmigration – especially with the young population – to larger cities in Spain such as Barcelona and Madrid due to better labour and educational offer.
Economic	In economic terms, Andalusia is the third-largest contributor to the national GDP although, on a per capita level, it is the third-largest in Spain with the lowest GDP per capita.
	The region experiences a structural gap in economic terms with the rest of the country. The GDP per capita as well as productivity have improved in the last two decades but remain far below the national average values.
	At a sectoral level, the region has experienced a progressive deindustrialisation process towards low-value-added activities such as agriculture, tourism and services. This has led to the seasonality of employment and informality of the labour market. As a result, one in every five unemployed Spaniards are Andalusian (2020).
	However, mining has been an economic engine during the recovery years following the 2008 crisis and the value of its exports has led to represent a quarter of the region's total exports.
Enabling factors for the development	Andalusia still faces low education levels in primary and tertiary education compared to the national levels. Although the region is progressing, there is still room for improvement, particularly at the tertiary level.
	The structure of companies in Andalusia is atomised, with high levels of entrepreneurship led by necessity and mostly oriented toward the low-value services sector.
	In terms of citizen well-being, the region outperforms the OECD benchmark regions in terms of safety, air quality and community support.
	Andalusia's coverage of network connectivity is similar to national levels and OECD regions. However, the speed of the connectivity and the usability of the Internet is slightly below the national values.
	Andalusia invests less in research and development (R&D) than the national and European average. As a result, it ranks as a moderate innovative region in the European context.

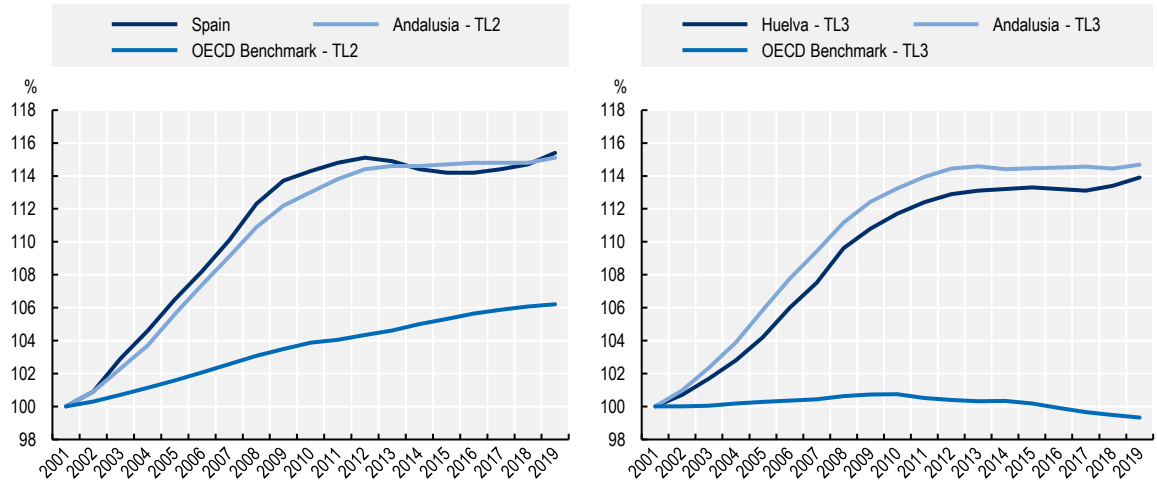
Demographic trends

The soaring population growth in Andalusia has stabilised in the last decade

The growth of the population of Andalusia has mirrored the rapid pace of the rest of the country. Between 2001 and 2019, the population of Andalusia grew by 15.1%, similar to the national average (15.4%) and far greater than the OECD TL2 benchmark (6.2%) (Figure 2.4). The most economically prosperous years of the last decades (2000-07) coincided with the years of maximum demographic growth. The financial crisis affected most OECD countries, in different ways and degrees. Particularly in Spain, a slowdown in the attractiveness of the Spanish economic model meant a drop in the positive balance of migration to the country. Without a sufficiently positive natural replacement, this inevitably meant a change in the trend of demographic growth throughout the years that the crisis lasted. However, the COVID-19 crisis is generating uncertainty over the economy, with direct effects on demographic drifts, as Spain is one of the countries most economically affected, as shown in the *OECD Economic Outlook* report (OECD, 2020[14]).

At the TL3 level, the population growth of Huelva has grown strongly in the last two decades. The mining province of Huelva has experienced double-digit accumulated growth, reaching 13.9% over the last 2 decades. This is significant compared to the accumulated growth of the OECD TL2 benchmark (-0.6%). However, this positive behaviour is being threatened by migration, mainly of young people, to other regions. Thus, Huelva was the second Spanish province to lose the most inhabitants in 2017, while large cities such as Madrid experienced a population growth in the same year.

Figure 2.4. Population growth rate 2001-19

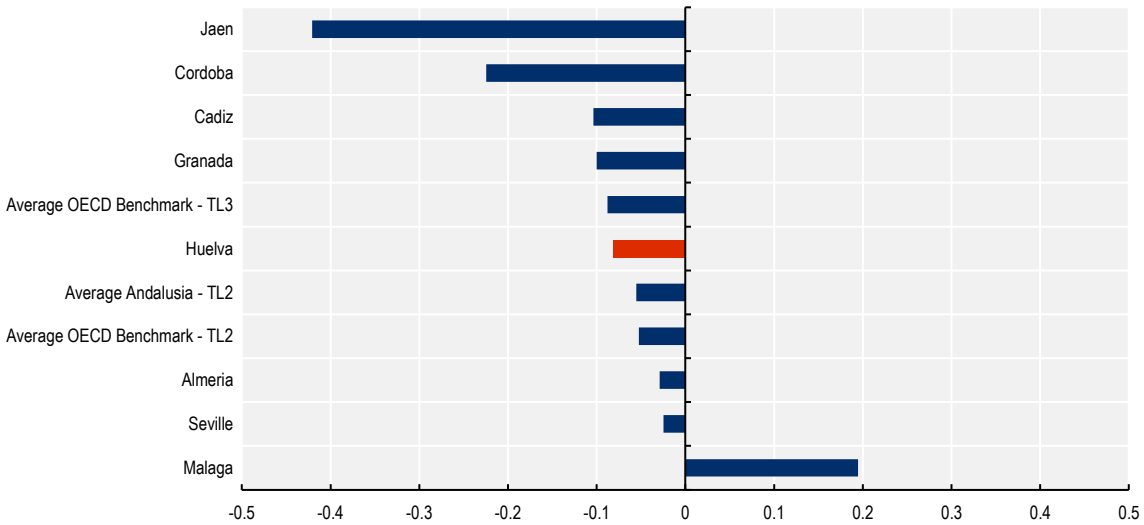


Note: 2001 = 100.
Source: OECD (2021[15]), "Regional demography", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

Young Andalusians from rural areas are migrating…

All of the provinces of Andalusia except for Malaga have experienced a negative regional migratory balance in the last decade (Figure 2.5). Since 2008, a regional movement out of the Andalusian regions, especially severe in rural municipalities, accompanied the population stagnation in absolute terms (Figure 2.4). A recent study analysed the Andalusian municipalities, of which 54% have lost population from 2000 to 2016; in the case of those with less than 5 000 inhabitants, depopulation has affected 71% of them.[2] An exception to this trend is Malaga, where most of the newcomers were foreigners (70% of total 23 629 in 2019), highlighting its high international attractiveness (Diario Sur, 2020[16]).

Figure 2.5. Ratio of net migration rate to the total population, during the post-crisis period 2008-18



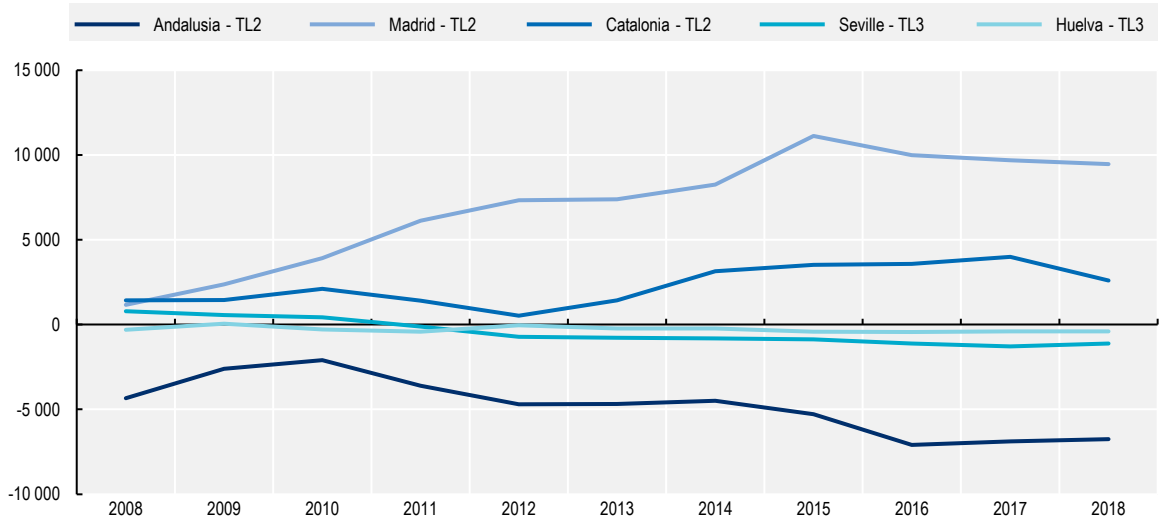
Note: Average 2008-18.
Source: OECD (2021[15]), "Regional demography", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

…to the large cities of the country

The population leaving Andalusia is particularly composed of young people migrating to larger cities of Spain. In the years following the financial crisis, the negative migration balance in Andalusia was slightly accentuated, with a greater trend of youth outmigration from 2011 onwards (Figure 2.6). Furthermore, while the provincial capital, Seville, was in positive net migration between 2008 and 2011, from that year forth the trend has only slowly declined, reaching relative stability in the years 2017 and 2018. Huelva, similarly to its provincial capital, touched positive migration values in 2009, which were then corrected, and has maintained a negative balance since then.

The largest cities in Spain, Barcelona and Madrid, attract a large part of the youth population of Spain (Figure 2.6). Motivations may range from the educational offer to employment possibilities. Both cities have experienced a constant positive migration balance since the crisis, with a particular peak in Madrid since 2014. In fact, by 2018, the number of young people coming from other Spanish regions into Madrid more than doubled the figure in Catalonia. Andalusia, and Seville in particular (the fourth largest city in Spain), has the potential to attract and retain youth. Its mild climate and geographic location can be good levers if supported by greater job opportunities and educational offer (Chapter 3). At the educational level, such is Andalusia's potential for attraction that Granada ranked the third most chosen Spanish city by European students of the Erasmus + programme in 2018 (Libertad Digital, 2018[17]). As the next section outlines, mining municipalities as well as cities can provide stable, quality work that could help retain and attract youth.

Figure 2.6. Net interregional mobility, persons aged 15 to 29



Note: Inflows minus outflows.
Source: OECD (2021[15]), "Regional demography", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

In summary

The demographic drifts of the Andalusian regions are an integral part of their economic performance. Its population grew strongly until the financial crisis of 2007, after which it stabilised for a decade, revealing that the attractiveness of its incoming migration depended partially on the region's economic performance. Nowadays, the uncertainty of the COVID-19 crisis may have a negative effect on population growth, as was the case with the previous crisis. The province of Huelva closely reflects regional and national trends as its sustainability in the medium term is threatened by the rural exodus of younger generations,

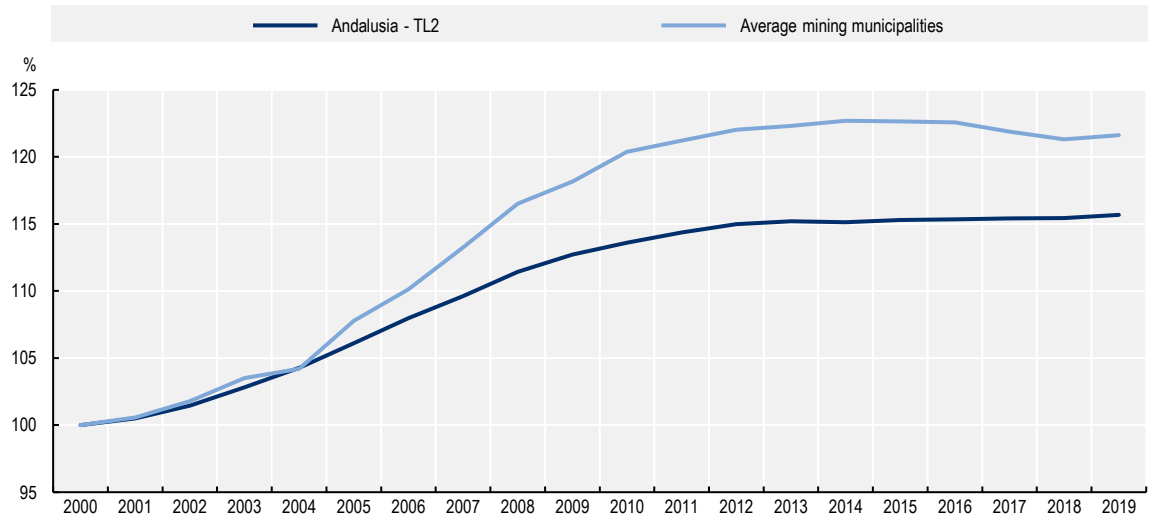
particularly to the large cities of Spain. In this context, the mining municipalities, due to their good economic performance, have seen their populations emerge and maintain high values compared to the rest of the region.

Mining has the potential to reduce demographic challenges in rural municipalities

The mining municipalities of Andalusia (see Table 2.4) have the capacity to retain the population (Figure 2.7). Data on demographic growth in mining municipalities of Andalusia are on average positive, reaching an accumulated population increase of 21.6% from 2000. A remarkable average value when compared to the regional average of Andalusia (14.7%), the province of Huelva (13.9%) and the national average (15.4%). Population in municipalities such as Salteras, Guillena and Gerena have grown by 80%, 52% and 38% respectively between 2000 and 2019. Other municipalities of Huelva with no mining activity and no known tourism destinations such as Niebla, San Bartolome de la Torre or Trigueros have registered growths of between 7% and 12%, significantly lower than the mining municipalities.

Overall, mining municipalities perform better than the provinces where they are located, with a prominent role in the fixation of the population in rural areas. The economic activity around mining and the employment generated from it is fundamental for the attraction of the working-age population to rural regions.

Figure 2.7. Population growth in cities and mining municipalities in Andalusia, 2000-19

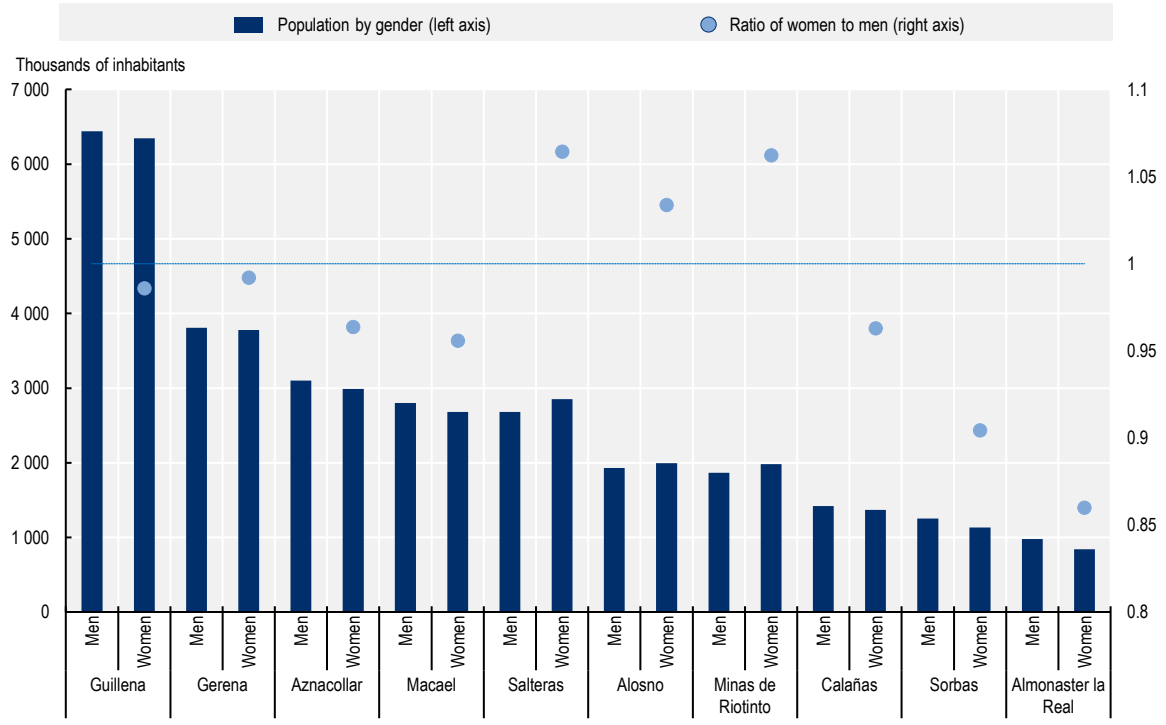


Note: 2000=100. Selected ten mining municipalities according to operating mines.
Source: Junta de Andalucía (2019[18]), *Indicadores sociales de Andalucía*, https://www.juntadeandalucia.es/institutodeestadisticaycartografia/indsoc/indicadores/61.htm (accessed on 10 November 2020).

Mining municipalities have a relatively sustainable gender balance

In terms of gender, there is one constant in almost all mining municipalities: overrepresentation in favour of men over women. The outstanding exceptions are Alosno, Minas de Riotinto and Salteras, which on average have more than 5% overrepresentation in favour of women. Elsewhere, the mining municipalities are on average 4% above men than women (2019), the cases of Almonaster la Real (85% women over men) and Sorbas (90.4%) being the most prominent (Figure 2.8). Adopting a specific approach to this aspect is of significant relevance when addressing demographic phenomena such as gender imbalance in order to establish sustainable communities over time.

Figure 2.8. Population of the ten selected mining municipalities of Andalusia by gender, 2019



Note: Ratio calculated as total male inhabitants over female inhabitants.
Source: Junta de Andalucía (2019[18]), *Indicadores sociales de Andalucía*, https://www.juntadeandalucia.es/institutodeestadisticaycartografia/indsoc/indicadores/61.htm (accessed on 10 November 2020).

In summary

Mining municipalities have a leading role in population fixing in rural areas as Andalusia's attractiveness as a region for other regions' population is declining. Solid economic growth, along with sufficient service provision – regardless of the region's rurality – is vital to establishing prosperous communities in the medium term. In addition, offering quality jobs and competitive educational programmes are fundamental for the younger population, which, while rooted in their region, may sacrifice opportunities if they choose not to migrate.

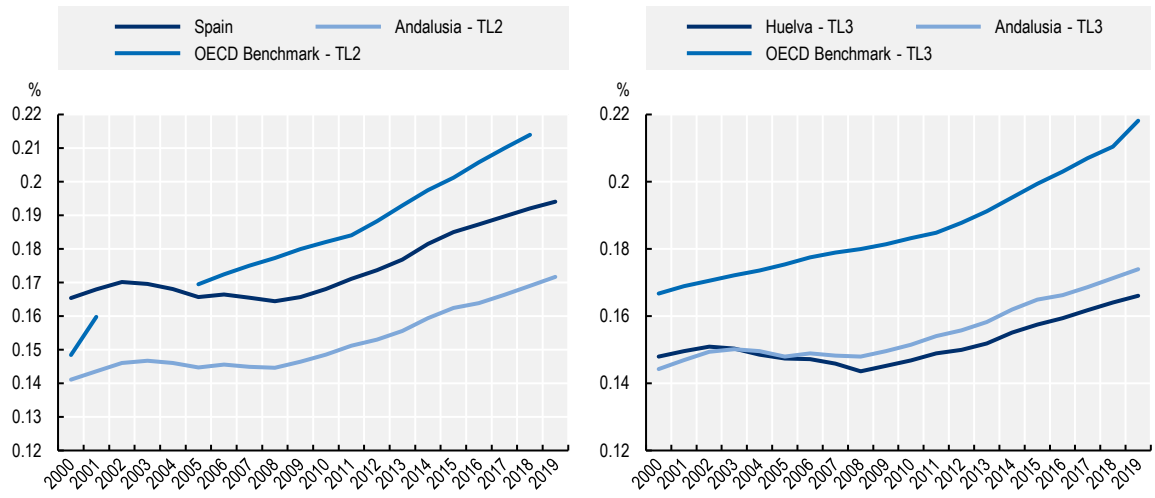
Andalusia has a demographic bonus but ageing is an increasing trend

Andalusia benefits from a demographic bonus with a relative low elderly dependency ratio compared to national and OECD benchmark levels. The regional elderly dependency ratio is below the levels of Spain and the OECD TL2 benchmark of mining regions (Figure 2.9). Likewise, in 2019, Huelva experiences a significantly lower elderly dependency (16.6%) than the national average (19.4%) and TL3 OECD benchmark (21.8%) with implications for the region's large working-age population as will be explained in the next section. The youth dependency ratio has also been relatively positive for Andalusia and Huelva in the last two decades, particularly with respect to the national average.

However, the slowdown of the population growth experienced between 2008 and 2015 had an impact on the youth and elderly dependency ratios of Andalusia, gradually mitigating the demographic bonus that the region still enjoys (Figure 2.9 and Figure 2.10). The youth dependency ratio is relatively positive for Andalusia but in the last decade, the gap has narrowed and equalled the OECD TL2 benchmark. Whilst in 2000 Andalusia had 26.15% and Huelva 25.84% of youth dependency ratio compared to a national

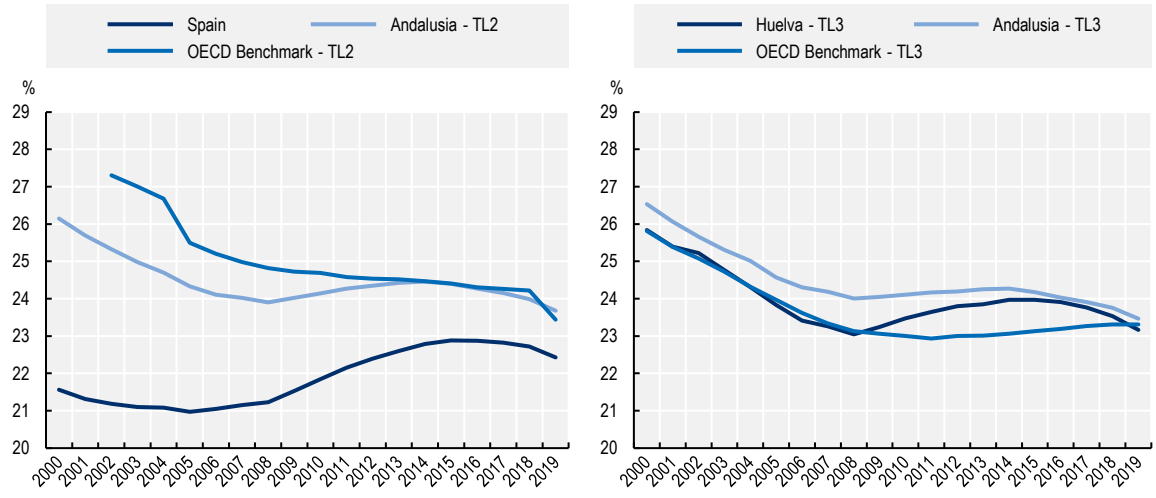
average of 21.6%, the gap has narrowed substantially in 2019 to 1.3% and 0.7% respectively. Regarding the elderly dependency ratio, all regions covered in the case study experienced increases over the last decade, yet at different rates. In 2019, Andalusia enjoys a substantial difference with respect to the national average of 2.2%, increasing to 2.8% in the case of Huelva. When comparing with the OECD TL2 and TL3 benchmarks, both Spanish regions stand out with gaps of 3.1% for Andalusia and 5.2% for Huelva. Overall, Andalusia benefits from a large working-age population as the next section will explore, resulting in a demographic composition sustainable over time.

Figure 2.9. Elderly dependency ratio in Spain, Andalusia, Huelva, TL2, and TL3 comparable regions, 2001-19



Note: Calculated as a share of individuals over 65 years old over the working-age population (15-65 years old). There is a jump of years for the OECD benchmark TL2 due to lack of data from some regions.
Source: OECD (2021[15]), "Regional demography", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

Figure 2.10. Youth dependency ratio in Spanish TL2 and TL3 regions, 2001-19



Note: Calculated as a share of individuals 0-15 years old over the working-age population (15-65 years old).
Source: OECD (2021[15]), "Regional demography", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

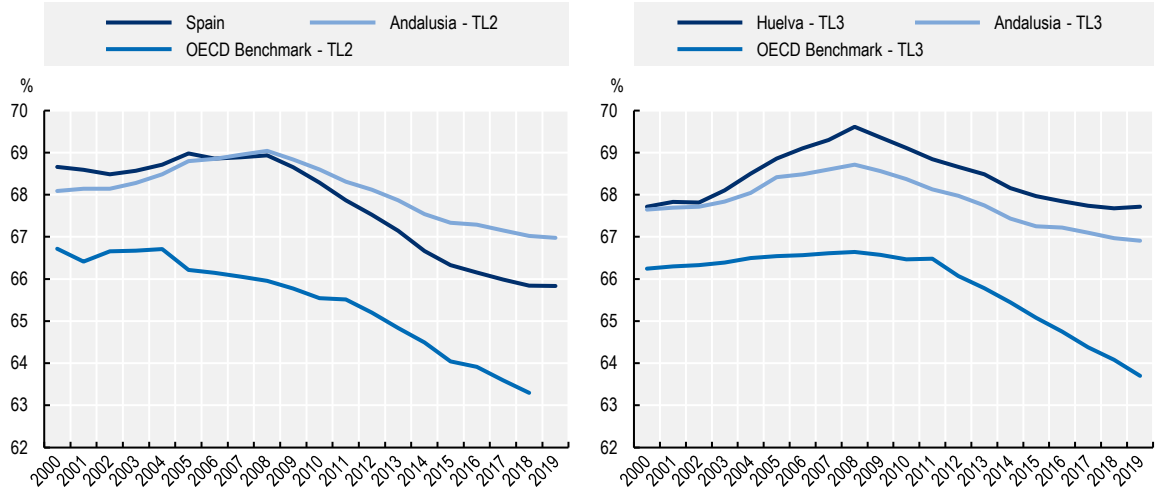
Andalusia has a large working-age population, although it is in decline

Andalusia has a large share of the working-age population compared to the national average and the OECD comparison (Figure 2.11). Both at the OECD TL2 and TL3 benchmark levels, there are substantial differences with the regions of study, which highlights the strength of Andalusia as a provider of labour force as long as the current trend is not negatively accentuated and sustainable levels are recovered.

The relatively positive comparison of Andalusia and Huelva with the OECD TL2 and TL3 benchmark is blurred by the fact that the ageing population (Figure 2.9) is increasingly reducing the workforce in the region. The financial crisis directly affected the working-age population share of the region. While in 2008, the regional share of Andalusia was very similar to the figure of Spain, 69.0% and 68.9% respectively. Andalusia's share since then suffered a change in trend and began to fall, more sharply than the national average. The difference in the working-age population between Andalusia and the OECD TL2 benchmark widened, reaching a maximum gap of 3.7% in 2019, the latest data available. At the TL3 level, Huelva has a share of the working-age population above the level of Andalusia and far above the level of the OECD TL2 benchmark of mining. In 2019, the share of the working-age population of Huelva (67.7%) was 0.8 perceptual points above the level of Andalusia (66.9%). Such supply of labour force is one of Huelva's strengths that can be mobilised to attain provincial prosperity. This is partially explained by the strong impact that the crisis had on unemployment and its repercussion on the emigration of the youngest part of the labour market to other regions in Spain and countries of the EU.

The region faces a trend towards a small and declining workforce, which is not only a challenge to the sustainability of the region's current economic activity but also hinders the growth of new businesses and the financial income of local municipalities (see Chapter 3).

Figure 2.11. Working-age population in Spanish TL2 and TL3 regions, 2000-19



Note: Share of the working-age population (15-64 years old) over the total population.
Source: OECD (2021[15]), "Regional demography", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

In summary

Andalusia has a strong workforce as its population is young, standing out from comparable OECD regions. In particular, the province of Huelva is significantly above the TL3 benchmark for mining regions and this characteristic is one of Huelva's strengths for future prosperity. However, an ageing and shrinking workforce has accompanied recent years of stagnant population growth. As a result, the scenario is

prosperous for the region of Andalusia, whereas it is important to capitalise on the demographic bonus by mobilising the labour force – particularly youth – to contribute to the labour market.

Table 2.6. Summary of demographic trends of Andalusia and its mining regions

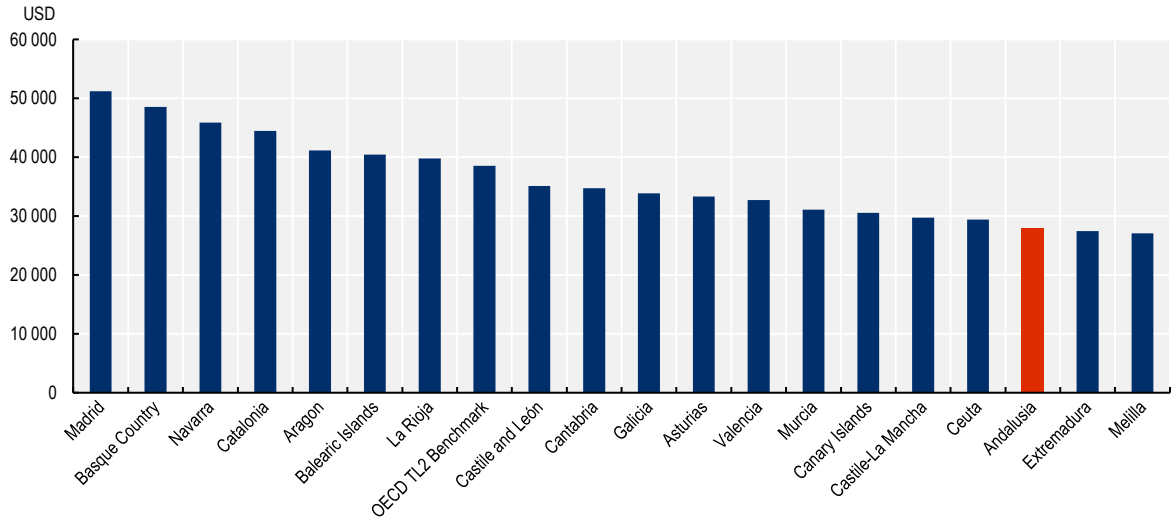
	Spain, Andalusia and OECD TL2 benchmark	Huelva, Andalusia and OECD TL3 benchmark	Mining municipalities of Andalusia
Population distribution	The region of Andalusia concentrates the largest share of the population (17.8%) of Spain along with its 106 municipalities.	Huelva has 524 576 inhabitants, the lowest share of the population (6.2%) among the provinces of Andalusia. A quarter of its population is concentrated in the provincial capital (city of Huelva).	Mining municipalities have a relatively small size of between 2 and 12 000 inhabitants. These mining municipalities have a relatively sustainable gender balance (2.2% overrepresentation in favour of men).
Population growth	The population growth experienced since 2000 slowed down at the same time as the economy due to the 2008 crisis. By 2019, Andalusia had accumulated 15.1% growth since 2001, significantly higher than the OECD TL2 benchmark (6.2%) Although the inflow population sustained demographic growth in the period leading up to the crisis, the trend has changed. In the last decade, outmigration became one of the main population outflows in the region.	Huelva's growth in the last three years has managed to accelerate again, mainly due to the attractiveness of the mining municipalities. Overall, during the period 2000-19, Huelva maintained a growing pace, unlike the OECD TL3 benchmark. Huelva, like the rest of the region, is suffering from outmigration of the youngest population (15-29 year-olds) to the largest cities of the region and the country (Barcelona and Madrid) due to educational and labour opportunities.	The mining municipalities have grown in population significantly above the rest of the region (22% vs. 16% since 2000). The constant increase in work in the mining sector has brought people of working age to the mining municipalities. While in 2008 there were 359 people dedicated to mining activities, in 2018 it grew to 3 770.
Ageing population	Andalusia enjoys a demographic bonus for a large young population of working age. Although the elderly and youth population experiences positive values in the region (17.1% and 23.7% in 2019), the recent trend shows that this advantage diminishes.	Huelva has a high working-age population. The province has a relatively lower ratio of elderly and similar youth to the OECD TL3 benchmark, although the trend tends to reduce this advantage.	

Regional economic trends

Andalusia, a low-income region whose convergence with national levels is on the horizon

Andalusia is the Spanish region that provides the third greatest contribution to the national GDP. With 18% of the Spanish population, Andalusia's economy contributes to 13.3% of the national GDP. This gap translates into a low level of income per capita in the region, the third-lowest in Spain (USD 27 922), just after Melilla (USD 27 092) and Extremadura (USD 27 446) (Figure 2.12). Likewise, Andalusia's GDP per capita (USD 29 922 in 2018) is far below the level of the OECD TL2 benchmark of mining regions (USD 38 774).

Figure 2.12. GDP per capita of TL2 regions of Spain compared to OECD TL2 benchmark, 2018



Note: GDP per capita measured in USD per capita, constant prices, constant purchasing power parity (PPP) and base year 2015.
Source: OECD (2021[15]), "Regional demography", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

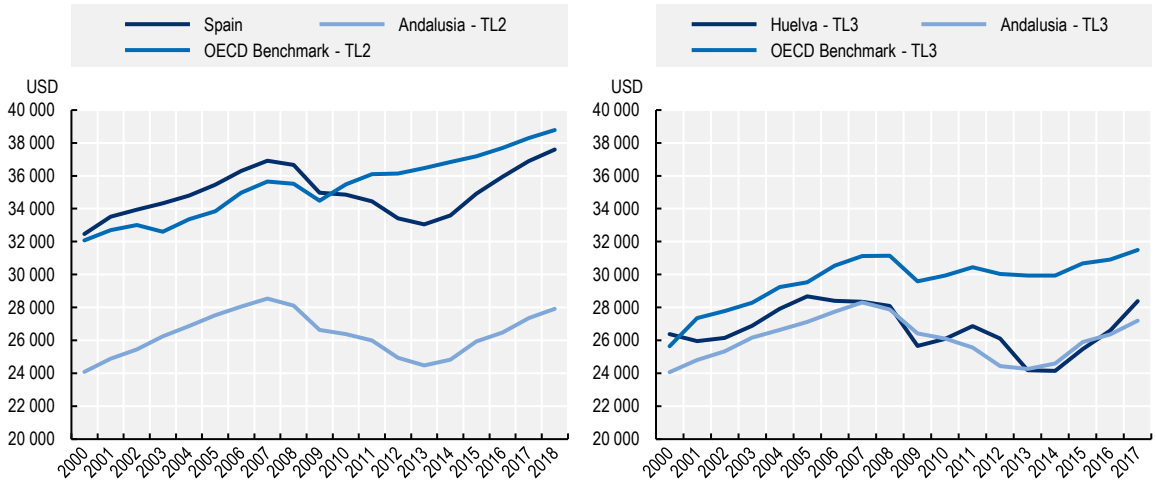
Andalusia's GDP recorded higher growth rates at the beginning of the 2000s but was hardly hit during the crisis. In the period prior to the financial crisis, the economy of Andalusia experienced a constant acceleration (2.4% annual average), slightly higher than the rest of the country (1.9%) and the OECD TL2 benchmark of regions (1.5%), driven mainly by the peak of sectors such as construction and services. However, the region was hit hard by the 2008 crisis, experiencing a sharp fall, which places it among the TL2 regions of Spain with the largest 2007-09 drop (-1.7% annual average).

In the post-financial crisis era, the economy recovered and as of 2017 was at higher levels than before the financial crisis (Figure 2.13). Mining expansion has been one of the factors supporting such recovery, with a value of mining production that doubled in the last 2 decades (from 0.28% to 0.57% of total GDP).

At the TL3 level, Huelva has shown positive economic performance in the context of Andalusia, while below the OECD TL2 benchmark. At the beginning of the 2000s, Huelva suffered a drop in GDP partly due to the slowdown in mining activity, which led to decoupling from the OECD TL3 benchmark's GDP per capita levels. After a short period of recovery, the arrival of the financial 2008 crisis coupled with the fall in the price of minerals led Huelva to experience a sharp drop in its GDP. Since the years after the crisis, the following rise in mineral prices supported the relaunch of the mining activity in Huelva. From 2016, Huelva stood out in GDP per capita values at slightly higher levels than the Andalusian region and its growth rate is closing the gap with the OECD TL2 benchmark.

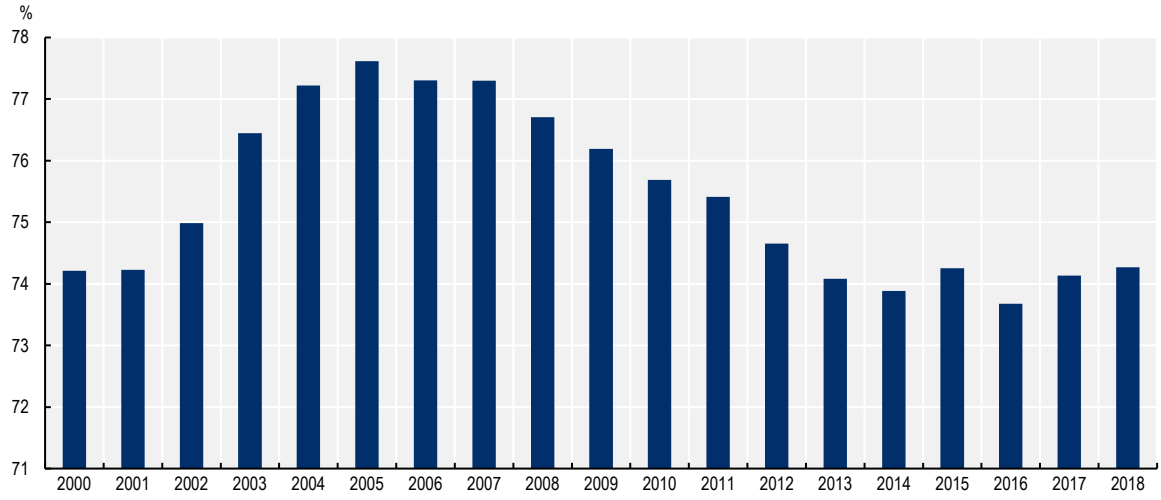
The region has not been able to maintain a sufficient economic performance to close the structural gap with the national average (Figure 2.14). The gap between the GDP per capita of Andalusia and Spain has increased over the years (from USD 8 372 per capita in 2000 to USD 9 673 in 2018). While Andalusia was able to close the gap in the period previous to the 2008 financial crisis, the crisis had a greater impact on Andalusia's economy, which has not been able to recover since. By 2018, Andalusia's GDP per capita was 74.3% of the national average and 54.5% of the capital region Madrid. A deindustrialisation process along with an economy highly reliant on construction and seasonal activities (as will be explored in the following sections) has been a burden for the recovery of Andalusia relative to the national trend. In the context of the COVID-19 crisis, it is relevant to conduct strategies to avoid this crisis further expanding the income gap at the national level.

Figure 2.13. GDP per capita trend in Spanish TL2 and TL3 regions, 2000-18



Note: GDP per capita measured in USD per capita, constant prices, constant PPP and base year 2015.
Source: OECD (2021[15]), "Regional demography", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

Figure 2.14. Gap of GDP per capita between Andalusia and Spain, 2000-18



Note: The gap has been calculated as the share of GDP per capita of Andalusia in comparison to Spain.
Source: OECD (2021[15]), "Regional demography", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

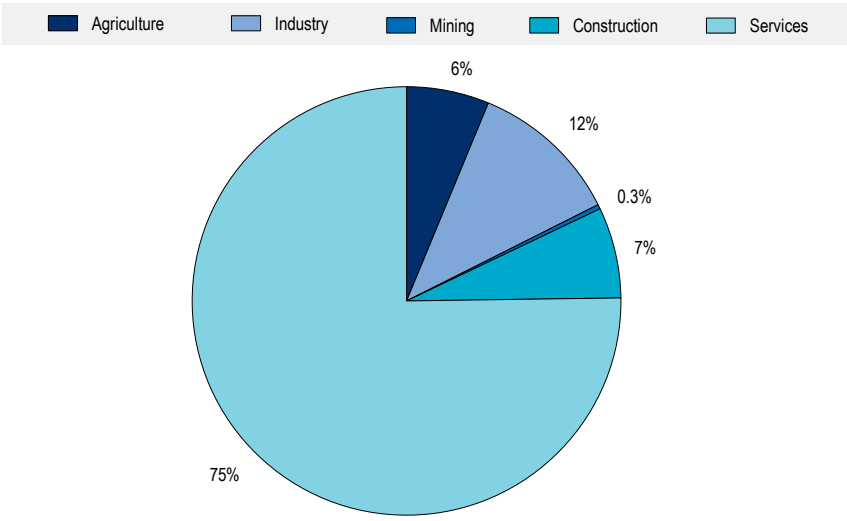
In summary

Andalusia has grown but has not converged with the rest of the country. Despite the progress made in the social and economic fields, the imbalance with the rest of Spain remains and this region has not managed to climb up the various regional competitiveness levels. Beyond their contribution to the generation of wealth and employment, productive activities linked to rural areas are an essential element for territorial cohesion and balance in Andalusia, which has slowed down the inertia of depopulation.

Strengthening the industry to bridge the structural gap with Spain

Andalusia has an economy highly dependent on low value-added service activities. The service sector is the leading economic activity in the region (75% of regional GDP in 2019), followed by industry (11.6%), agriculture (6.2%) and construction (6.8%) (Figure 2.15). The service subsectors with the greatest weight in the economy are wholesale trade and retail trade[3] (31.5% of total services). Many of the activities of the service are linked to tourism, a sector that has maintained a growing pace thanks to the region's international attractiveness and whose contribution to the GDP (measured through its associated revenues across all related activities) accounts for a slightly higher share (12.8%) than the level of industry (Junta de Andalucía, 2017[19]). In fact, the contribution of construction has also been partially linked to the demand for tourism facilities (hotels, secondary houses). While the mining sector represents a relatively lower share of the GDP, its associated activities, linked to industry, construction and services should be better measured to account for the entire contribution of mining to the GDP.

Figure 2.15. Sectoral GDP contribution to the total regional GDP of Andalusia, 2019

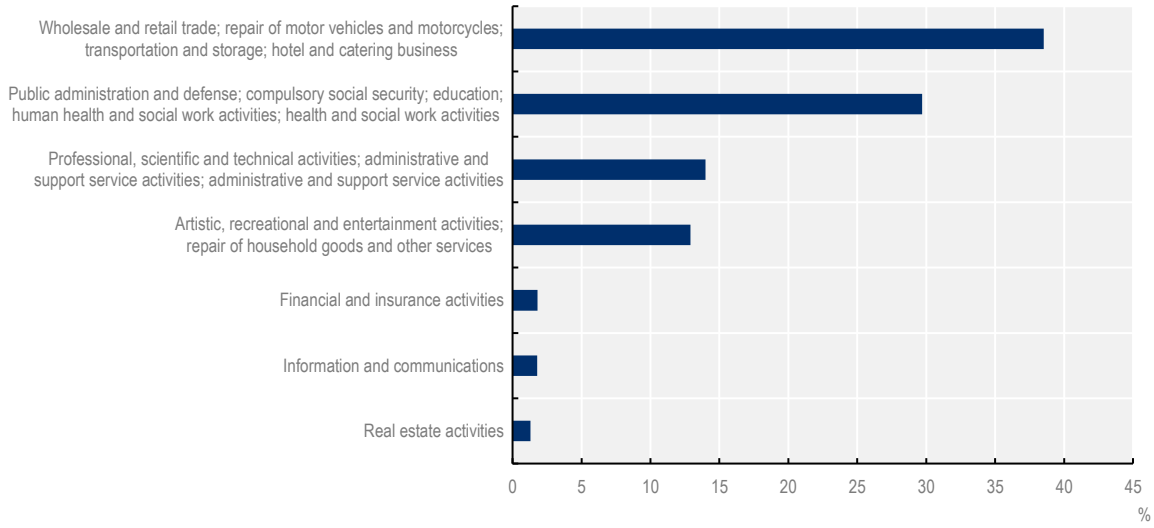


Note: Industry data includes manufacturing and mining data is from 2018, denominated under the category of extractive industries.
Source: IECA (2019[20]), *El Mercado de Trabajo en Andalucía. Datos estructurales*, https://www.juntadeandalucia.es/institutodeestadisticaycartografia/merctrab/mtInd03.htm (accessed on 5 October 2020); Annual Regional Accounting of Andalusia (Instituto de Estadística y Cartografia de Andalucía, 2020[21]).

Tourism has thus contributed to the skewed development of associated low-value-added service activities. The breakdown of the service sector reveals the importance of trade, hotels and restaurants, which are essential to the tourism sector (Figure 2.16). The second and third most representative services are public administration – including education, health and social services – (28.4%) and real state (17.6%). In contrast, services with a higher added value such as financial services or information and communications have only a 4.3% and 2.5% weight over the total service of the region.

This strong dependence on the services sector, which is also highly – seasonal, particularly in the case of those associated with tourism, has led to economic fluctuations in periods of uncertainty, with direct impacts on regional unemployment rates. This seasonality of the Andalusian economy has contributed in part to the structural gap against national levels, holding back the region's economic growth at higher rates.

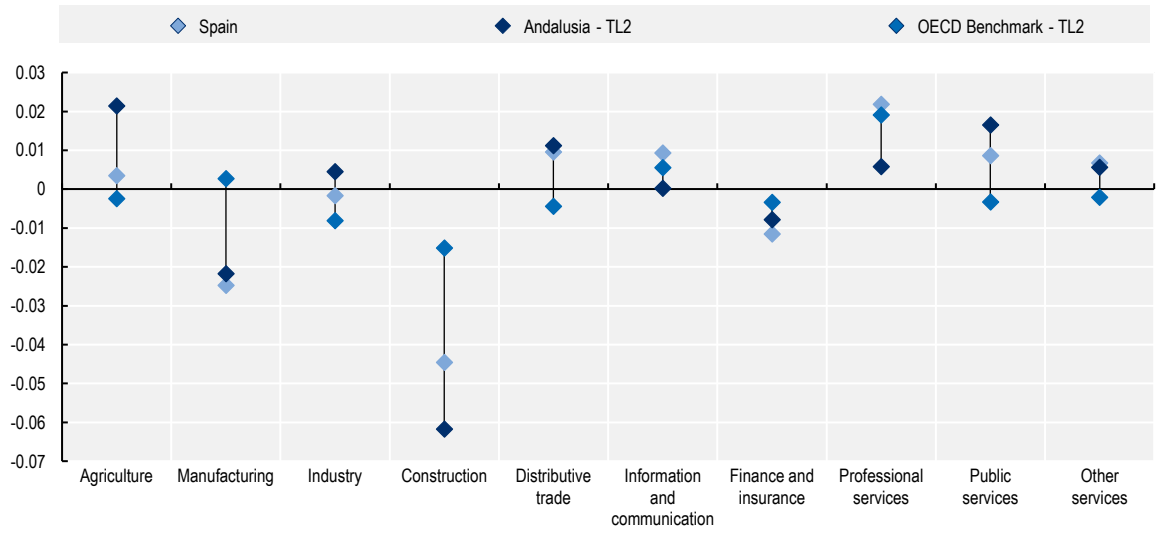
Figure 2.16. Share by type of service over total services in Andalusia, 2019



Source: IECA (2019[20]), *El Mercado de Trabajo en Andalucía. Datos estructurales*, https://www.juntadeandalucia.es/institutodeestadisticaycartografia/merctrab/mtInd03.htm (accessed on 5 October 2020); Annual Regional Accounting of Andalusia (Instituto de Estadística y Cartografia de Andalucía, 2020[21]).

During the financial crisis, Andalusia underwent slow industrialisation in favour of other sectors such as the tertiary and agricultural sectors (Figure 2.17). Therefore, the agricultural sector and the agri-food industry (which includes mining) are the backbone of regional economic activity, especially in rural areas, thus representing a total of a quarter of Spanish agri-food exports. Together with tourism (not broken down as an individual activity in Figure 2.17 due to its multi-sectoral nature), both are the pillar of the region's production system.

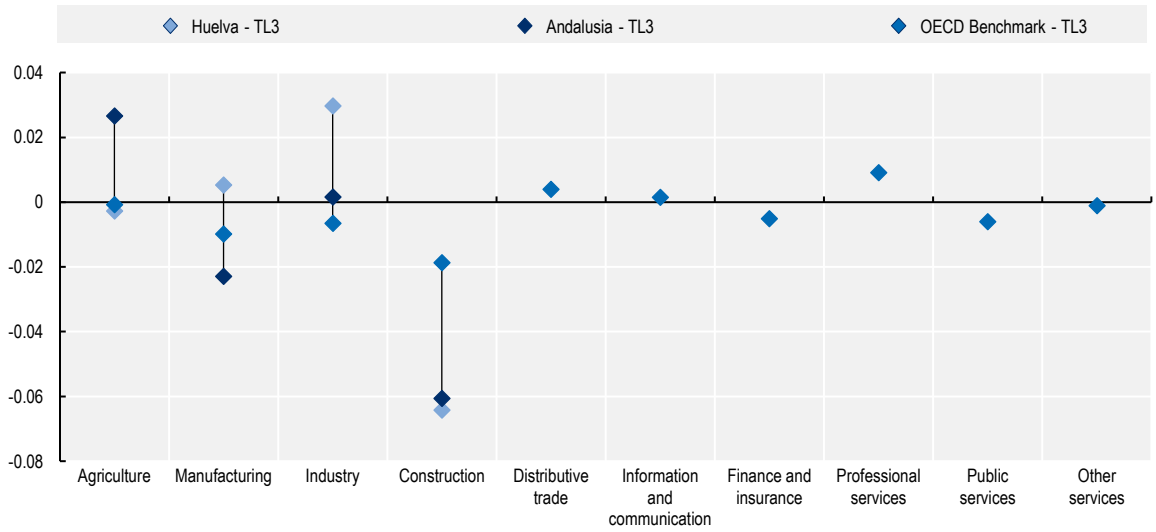
Figure 2.17. Change in GVA share, by sector in Spain, Andalusia and OECD TL2 benchmark, 2005-17



Note: The category Industry contains mining sectoral activities.
Source: OECD (2021[15]), "Regional economy", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

At the TL3 level, as observed in Figure 2.18, the trends are even. While the construction sector suffered the largest drop of all economic sectors (6% for Andalusia and OECD TL3 benchmark and 3% for Huelva), the industry sector took off with a significant increase partly due to mining (3% in the period from 2005 to 2017).

Figure 2.18. Change in GVA share, by sector, Andalusia, Huelva and OECD TL3 benchmark, 2005-17



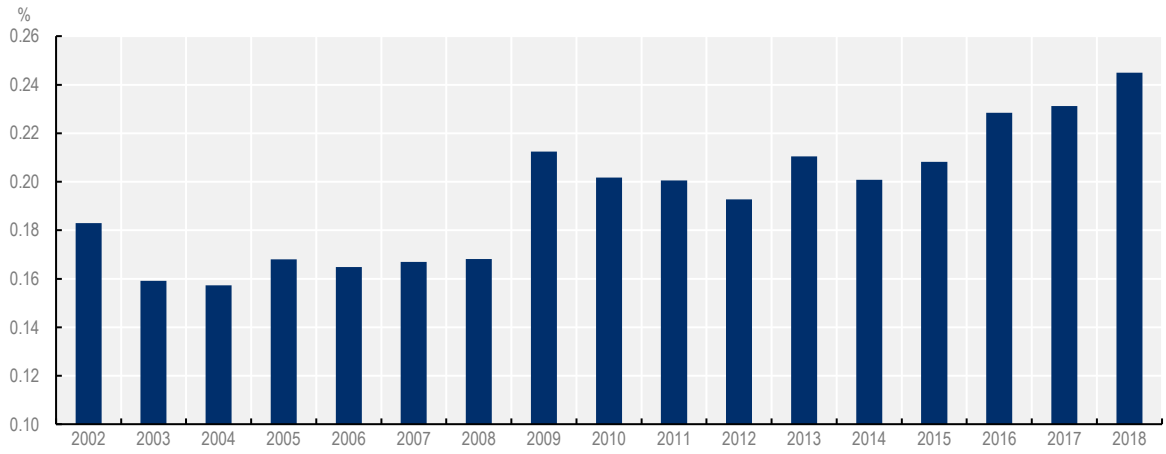
Note: No data availability for Huelva and Andalusia for six sectors. The category Industry contains mining sectoral activities.
Source: OECD (2021[15]), "Regional economy", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

Mining an engine for Andalusia's economic recovery

Mining has supported the positive growth of the industry in the region. During the period 2005-17, industry's GVA grew (0.4%), unlike the country (-0.2%) and the OECD TL2 benchmark (-0.8%). This performance coincides with the reactivation of mining activity in Andalusia, being decisive due to its relative weight on exports during the region's recovery process after the financial crisis. Indeed, starting in 2009, international copper prices grew substantially reaching a peak in 2011 (4.48 USD per pound) and tripling the value of 2000 at present. In parallel, the volume of Andalusian mining exports has grown by 187% since 2008, almost 3 times the value of its exports, to reach EUR 5 697 million in 2018. Over the years, Andalusia has progressed from being the fourth largest exporter in 2009, with 13.8% of the total, to consolidate its position as the leading exporter in 2018 with 20.5%, overtaking the Basque Country, Valencia and Catalonia, leading national exports in 2018 and becoming the top 10 exporters in this period. As a whole, Andalusia is consolidated as the second-largest exporting region in Spain. Huelva, in particular, remained the leading province in terms of exports' value, representing 22.4% of Andalusia's total exports.

Overall, the mining dynamic has boosted the contribution of the sector not only to the economy but also to the total employment of the region (see Figure 2.19). Therefore, the share of employment in the mining sector over the total regional employment almost doubled during 2002-18, reaching values of 0.25% in 2018. This sector increased its levels of employment, particularly after the 2008 crisis. Moreover, metallic mining is concentrating the highest growth within the subsectors of Andalusian mining. In fact, this subsector represents the only increase of employment in mining during 2009-16, by doubling its number of employees. Within non-metallic mining, trends are different. While employment in industrial mining decreased at regional employment levels (-2.3% compared to a -3.8% decrease of the total regional employment), the other two subsectors experienced more significant drops: quarry products (-37.2%) and ornamental rocks (-25.9%).

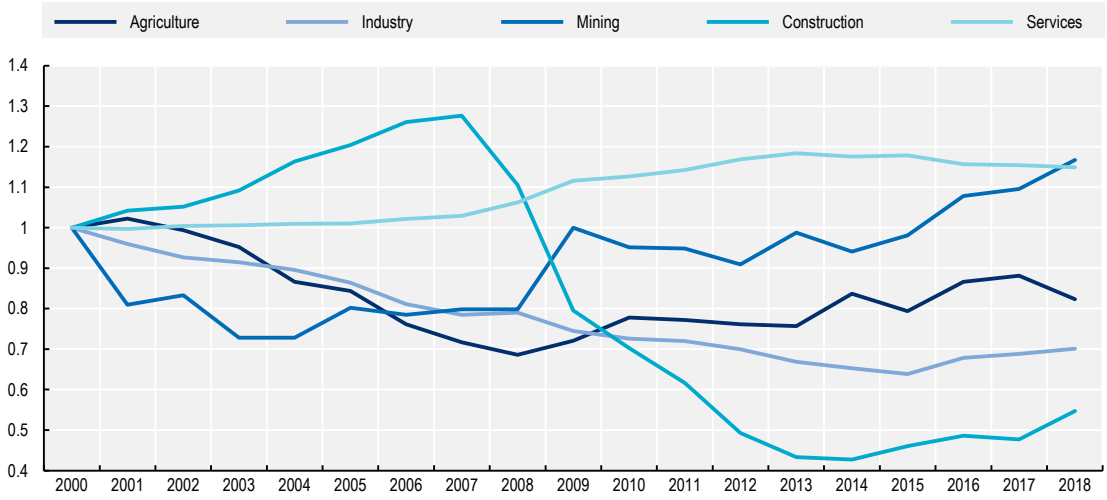
Figure 2.19. Share of employment in the mining sector over total employment of Andalusia, 2000-18



Source: INE (2020[8]), *Estadística sobre actividades de I+D. Año 2019*, https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176754&menu=ultiDatos&idp=1254735576669 (accessed on 12 November 2020); Spanish Government (2018[12]), *Estrategia Minera Nacional* from 2000 to 2018.

Such trend of job creation in mining has overpassed the dynamic in other sectors, including industry, construction and agriculture. In fact, these sectors experienced a gradual decrease in job creation, in favour of sectors such as mining and services (see Figure 2.20). This dynamic reveals that the mining sector can become a tool to attain sustainable job opportunities in the region and create more sustainable incomes. This phenomenon is increasingly relevant in the current scenario due to the economic crisis that is looming because of the COVID-19 health crisis. Moreover, copper prices have increased considerably in 2020 compared to 2019 (25.8%), showing a substantial opportunity for the Andalusian mining sector unlike the majority drop in other economic sectors. The countercyclical nature of the mining activities, particularly metallic mining, may lead the region to a faster recovery.

Figure 2.20. Growth of employment by economic sector, 2000-18



Note: 2000=1.
Source: IECA (2019[20]), *El Mercado de Trabajo en Andalucía. Datos estructurales*, https://www.juntadeandalucia.es/institutodeestadisticaycartografia/merctrab/mtInd03.htm (accessed on 5 October 2020); Annual Regional Accounting of Andalusia (Instituto de Estadística y Cartografia de Andalucía, 2020[21]).

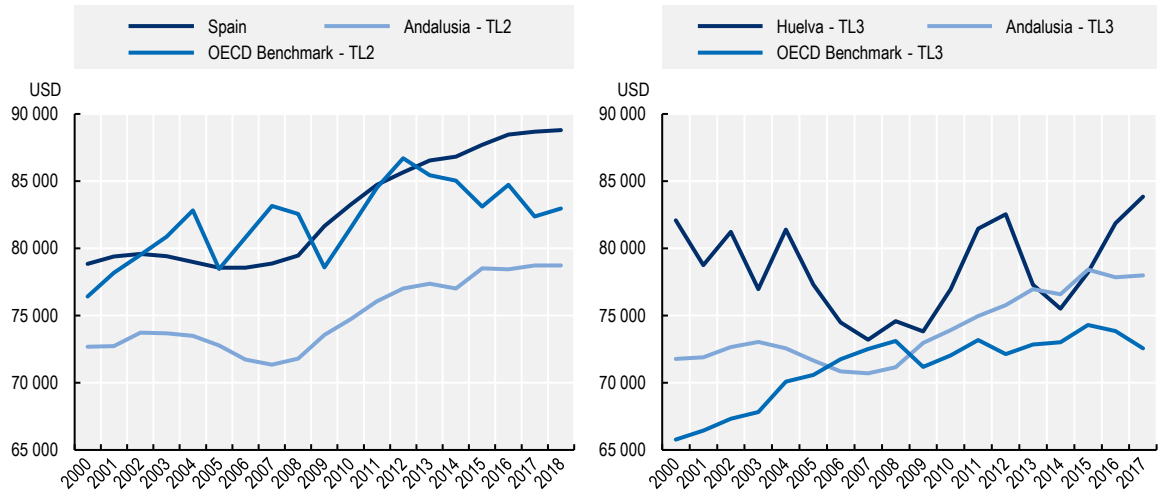
Productivity as an enabler of growth

A fundamental factor that has a positive impact on wages, employment, equality and ultimately well-being is productivity. Andalusia has raised its productivity levels over the last two decades (Figure 2.21). However, it remains below the national average and the OECD TL2 benchmark. This is due to several factors, including low labour force education, innovation (see Chapter 3), productivity and company size, all of which are hampering Andalusian growth.

Overall, the increase in productivity is not so much due to advances in innovation, or the economic structure of the region but rather to a correction of the market by adjusting the values. As one of the limiting causes of rising productivity, the atomisation of companies does not allow for an agglomeration of economies that would generate synergies to increase regional productivity. Ornamental mining is experiencing an agglomeration bottleneck, as will be explored in Chapter 3. To reach levels of education similar to the rest of the country, there must be an increase in public-private partnerships in innovation investment, as well as support for the creation of companies and their growth, indispensable pillars to sustain a growth of productivity in the medium term.

In 2018, productivity in Andalusia was USD 78 720, an increase of 8.3% over 2000 levels. Although growth has been relatively constant – aside from the initial period of the financial crisis –, the reality is that the structural gap with the rest of the country has not allowed the difference to be reduced. In the last available data (2018), Andalusia's productivity was 11.4% below the national average and 5% below the OECD TL2 benchmark. As a result, the autonomous community of Andalusia ranks 14th among the 17 autonomous communities. As will be explored in Chapter 3, the mining sector brings extensive innovation and can foster the technological development of the region. Working to unite the productivity of these highly technological sectors with other drylands is one of the main challenges to promote regional development.

Figure 2.21. Labour productivity trend, 2000-17



Note: Productivity measured as the GDP over the total workforce.
Source: OECD (2021[15]), "Regional economy", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

In summary

Andalusia's productivity is increasing but has not yet converged with the rest of the country. The high dependence of its economy on the service sector may aggravate the effects of COVID-19 over time since the high seasonality of the sector has made it one of the first to be the most affected by the global slowdown. The spearhead has been tourism, where the reduction of visitors and derived income has implied a significant impact on regional economy. Its fast recovery in productivity, to the detriment of employment, emphasised a market correction of the phenomenon. That rapid rise was the preamble to a recovery that continues to this day, with current ongoing uncertainty about the final impact of the COVID-19 crisis on country economies. Taking advantage of the region's strengths to equitably increase employment and economic performance while boosting structural productivity will be key to meeting the challenges of the present and future.

Unlocking the labour force potential through a strong labour market

The Andalusian labour market is relatively weak in the OECD and country context, with high rates of informal labour. While this informality offers the benefits of avoiding the burden of regulation and taxation, its participants suffer the cost of not having access to the protection services of the law that the state offers (Loayza, 2016[22]). Misallocation of resources and loss of the advantages offered by a robust legal framework or others such as access to international markets and slow migration to more productive areas, are characteristics of the informal labour market. The result is a weak labour market, with poor quality contracts that ultimately result in low economic growth (Loayza, 2016[22]).

As explored in previous sections, the Andalusian economy is based on agriculture and the service sector. Seasonal economic activities such as agriculture and particularly tourism – as part of the service sector – have led to a temporary labour culture, characterised in general by short "contracts", low wages and little legal protection. Among other indicators, informality can be measured by the elasticity between employment and GDP. In 2019, Andalusia was the Spanish region with the largest submerged economy, while Huelva was leading the region, partly because of its high specialisation in agriculture. The total number of employed people in the province of Huelva in 2017 was estimated at 226 048, of which 183 475 were in declared jobs and the rest were the result of the underground economy (CESpH, 2018[23]). Chapter 4 will explore mining branding and the positive effects of mining in the region where it is located, with low rates of informality in the mining sector, particularly in the metallic mining sector. This is a positive aspect in a context where informality is present partly due to temporary economic activities such as agriculture which, as explained in this section, can lead to higher rates of informality.

Seasonal employment harms the quality of work in the region of Andalusia

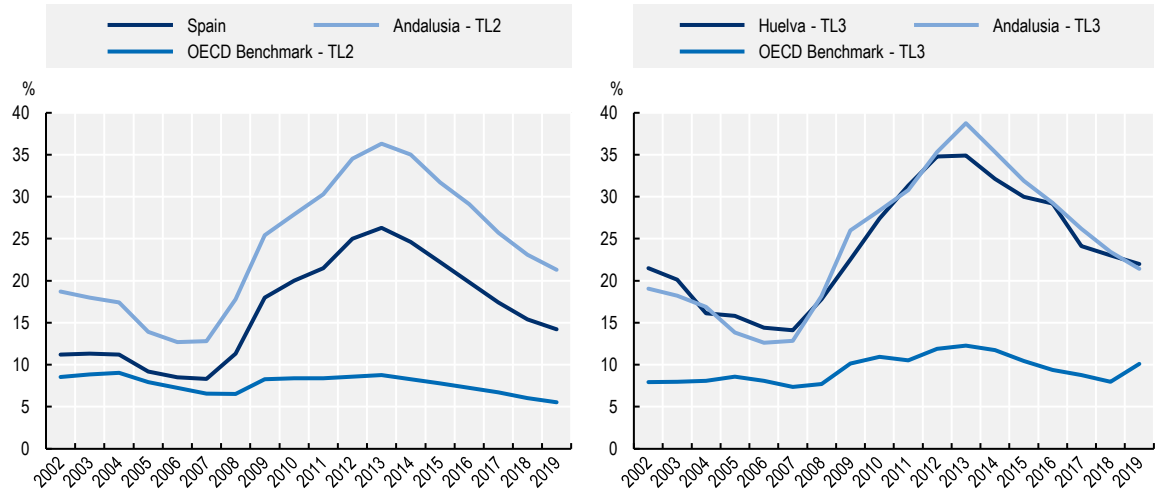
The seasonality of the Andalusian economy has led to consistently high unemployment rates over time, resulting in a structural gap with the rest of the country. In 2018, practically 1 out of every 5 Spanish unemployed was Andalusian (21.3%) (see Figure 2.22). During the economic expansion phase linked to the real estate boom, the gap with the rest of Spain in a period of economic expansion did not fall from double digits (12.8% in Andalusia vs. 8.3% in Spain), resulting in implications for the quality of the Andalusian labour market.

As explored in previous sections on the economic performance of Andalusia, the seasonality of its economic activity has a direct implication on the quality of the labour market. Weak labour market as well as an atomised business demography, mainly made up of SMEs as will be seen in the following section, impairs the structure of Andalusian employment. A further reason that is slowing down Andalusia's progress in terms of unemployment is the reduced mobility of the labour market. There is no such direct correlation between geographic locations where work is present and the displacement of the unemployed

working-age population towards those areas. As a result, this potential labour demand is limited to other regions.

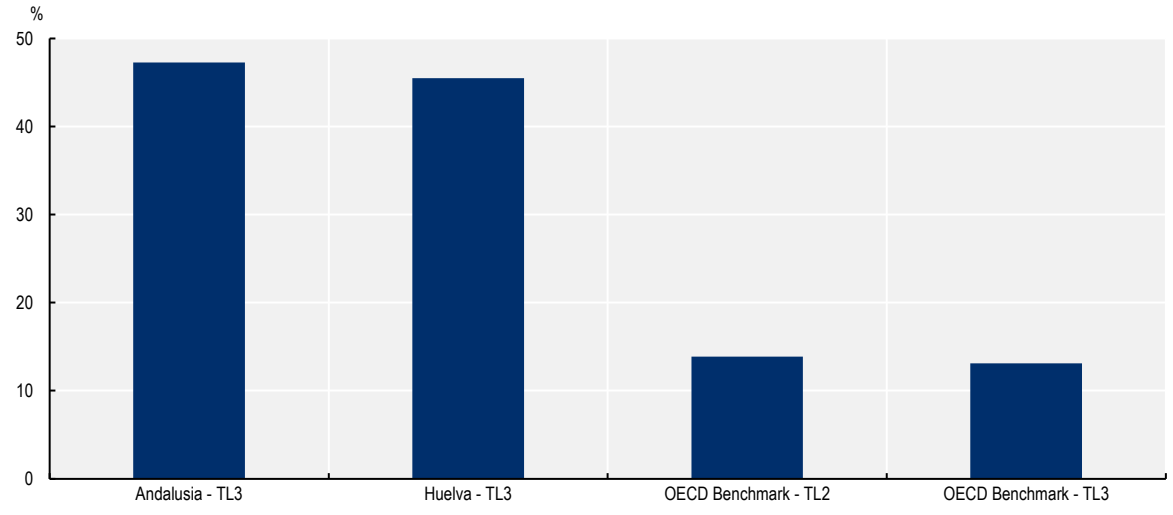
Mobilising all of the young people who currently neither study nor work, estimated at 253 200 in Andalusia in 2019 (INE, 2019[24]), is vital to revitalising the economy and the labour market (Figure 2.23Figure 2.22). Absorbing this young workforce and generating value from it are fundamental to maintain the demographic bonus characteristic of the region and to cut the structural gap with the rest of the country.

Figure 2.22. Unemployment rate over labour force in Spain, Andalusia, Huelva and comparable TL2 and TL3 regions



Note: Percentage of unemployed population over labour force 15-64 years old.
Source: OECD (2021[15]), "Regional labour", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

Figure 2.23. Youth unemployment rate, 2005-19



Note: Percentage of young unemployed population (15-24 years old) over labour force (15-64 years old).
Source: OECD (2021[15]), "Regional labour", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

Table 2.7. Summary of economic trends of Andalusia and its mining municipalities

	Spain, Andalusia and OECD TL2 benchmark	Huelva, Andalusia and OECD TL3 benchmark	Mining municipalities of Andalusia
Overall economic performance	• Andalusia has grown economically, but the structural gap with Spain has not been reduced. It ranks as the 3rd TL2 region in Spain with the lowest GDP per capita in 2018. • During the period 2000-18, Andalusia increased its GDP per capita by 15.9% (27 922 in 2018), which represents an accumulated increase equal to that of Spain and slightly less than the reference (20.8%). • In the same period, Andalusia's productivity grew in line with GDP, reaching USD 78 720 in 2018, an increase of 8.3% over the levels of 2000.	• Huelva has shown positive economic performance in the context of Andalusia, although with irregular growth rates and seasonal drops in GDP. • Between 2014 and 2017, Huelva stood out in terms of per capita GDP values, starting at levels slightly lower than those of the Andalusian region and rising to a level 4.3% higher, partly due to increased mining activity.	• The mining communities have experienced a period of prosperity since mining activities recovered after the crisis. • The growing mining sector, which already represents more than half of the Andalusian mining sector, has grown steadily in economic and employment terms over the last decades.
Economic sectoral distribution	• The agricultural sector and the agri-food industry are the backbone of regional economic activity. However, the growth of the Andalusian economy over the last decade has relied strongly on mining products exports. • Overall, Andalusia is gradually becoming less industrial and more dependent on stationary sectors has meant fluctuations for the whole economy. • In 2019, the sectoral composition of Andalusia's GDP was highly dependent on the service sector (74.1%), followed far behind by industry (11.6%), agriculture (7.7%) and construction (6.7%).	• Huelva in 2015 had a great dedication to seasonal sectors, such as agricultural products (4.4% participation of Andalusia) followed by industry (1.7%). • Between 2005 and 2017, the construction sector suffered the biggest fall of all economic sectors (6% for Andalusia and the OECD TL3 benchmark and 3% in Huelva). In the same period, the industry sector took off with a significant increase due to mining (3% in the period of 2005 to 2017).	
Labour market	• The seasonality and low skill levels of the jobs largely explain the structural unemployment in the region. The seasonal labour market is dependent on services, tourism and agriculture, leading to higher rates of labour informality. • In 2018, practically 1 out of every 5 unemployed Spaniards was Andalusian (21.3%) and 2 532 000 young people were neither studying nor working. • The reduced size of the companies (97.7% of companies had fewer than 20 employees) is limiting the capacity to absorb labour.	• In 2019, Huelva was the province of Spain with the largest submerged economy, partly because of its high specialisation in agriculture. • Mining has grown and along with it the associated employment in Huelva. From representing 27% of mining employment in Andalusia in 2000 to 51% in 2018.	• Employment in mining municipalities has continued to grow over the last two decades. If in 2000 there were 5 152 employees in the mining industry in Andalusia, in 2018 the figure rose to 7 424.

Well-being of the region of Andalusia

Snapshot of quality of life in Andalusia

Progress in the region and development of its business environment are relevant to ensure well-being in Andalusia. Retaining and attracting people and businesses are some of the aspects which depend directly on policies aimed at the well-being of the citizen. This is partly achieved by offering sufficient high living standards to make the region attractive to both foreigners and locals. The OECD's regional well-being analysis provides a tool for policymakers to assess the region's strengths and weaknesses, monitor trends and compare their results with those of other regions, nationally and internationally (Box 2.2). To better understand the relationship between well-being and mining regions, the analysis presented in this section adopts the OECD regional welfare framework to compare quality of life outcomes in Andalusia with the average for OECD TL2 mining regions and the average for Spain.

Box 2.2. OECD Regional Well-being Indicators

Building comparable well-being indicators at a regional scale

The OECD framework on measuring regional well-being builds on the OECD Better Life Initiative at the national level. It goes further to measure well-being in regions with the idea that well-being data are more meaningful if measured where people experience it. Besides place-based outcomes, the framework also focuses on individuals since both dimensions influence people's well-being and future opportunities.

In line with national well-being indicators, regional well-being indicators concentrate on informing about people's lives rather than on means (inputs) or ends (outputs). In this way, policies are directed to well-being features that can be improved by policies. Regional well-being indicators also serve as a tool to evaluate how well-being differs across regions and groups of people.

Regional well-being indicators are multi-dimensional and include both material dimensions and quality of life aspects. They also recognise the role of citizenship, institutions and governance in shaping policies and outcomes.

Although well-being dimensions are measured separately, the regional well-being framework aims to allow for comparisons and interactions across multiple dimensions to account for complementarities and trade-offs faced by policymakers. At the same time, the comparison of regional well-being indicators over time allows comparing dynamics of well-being over time, as well as the sustainability and the resilience of regional development.

Regional well-being in Spain is measured along 11 well-being dimensions: income, jobs, housing, health, access to services, education, civic engagement, environment and safety – for which there are comparable statistics at the regional level – and the 3 additional dimensions of work-life balance, community (social connections) and life satisfaction. The OECD database has available comparable data at the subnational level only for the first two. The figure below shows the details of the indicator used for each dimension.

Figure 2.24. Indicators by well-being dimension, Andalusia

Source: OECD (n.d.[25]), *OECD Regional Well-Being (database)*, www.oecdregionalwellbeing.org (accessed on 27 May 2019).

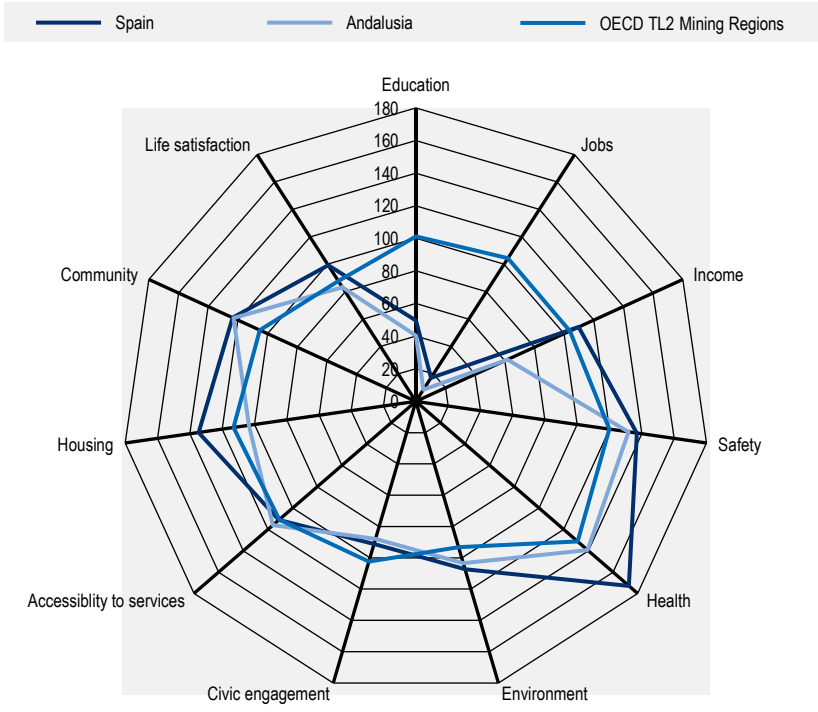
The region of Andalusia has uneven well-being results compared to the average of the OECD TL2 mining regions (Figure 2.25). Andalusia shows an above-average performance of the OECD regions in 5 dimensions of well-being out of the 11 in total. The region, therefore, ranks particularly high in Safety, Health, Environment, Civic Engagement, Housing and Community. The lowest well-being scores compared to the OECD TL2 regions refer to Education, Jobs and Income. As for Accessibility to Services, the region is slightly above the average. The downside of Andalusia and Spain lies in the low-performance dimensions that are far from the results of the OECD TL2 mining region average, which poses a great challenge for the development of policies capable of reducing this gap. In particular, dimensions such as Jobs or Education require great efforts to reach levels comparable to the other OECD regions.

The picture deteriorates when Andalusian well-being is compared to the Spanish average. Andalusia performs above the regional average in Spain only in one dimension of well-being: Accessibility to Services. In contrast, the region ranks below in all other dimensions, where Income, Health and Housing experience the lowest performance with respect to the average of regions in Spain.

Overall, Andalusia stands out among all comparison groups in the following areas:

- **Safety**: Despite low-income levels and high unemployment, the region enjoys a high level of safety. The absence of harm, whether due to crime, conflict, violence, terrorism, accidents or natural disasters, is significantly lower (9.5) compared to OECD TL2 regions (7.2). Spain (9.9), compared to the rest of the OECD countries (7.5), ranks 5th in terms of safety, equal to Portugal, showing the high level of security in the country, indispensable for the well-being of citizens.

Figure 2.25. The region's performance in the 11 OECD dimensions of well-being, 2018



Note: Simple average of OECD TL2 regions = 100.
Source: OECD (n.d.[25]), *OECD Regional Well-Being (database)*, www.oecdregionalwellbeing.org (accessed on 10 November 2020).

- **Environmental quality**: The region's location, a large geographical area bound by the Mediterranean Sea and the Atlantic Ocean, offers a great variety of natural ecosystems, mountains and forests. This is important for the tourism industry and attracting people who value outdoor activities. Furthermore, Andalusia is the 3rd region in Spain with the largest protected area making up 18.9% of the total territorial surface.
- **Community**: The frequency of contacts with others and quality of personal relationships are crucial determinants of well-being. People get pleasure from spending time with others, be it their family, friends or colleagues. Activities are more satisfying when shared with others. Furthermore, social networks can provide material and emotional support in times of need, as well as providing access to jobs and other opportunities. The nature of social interactions also has wider implications beyond the immediate social circle, impacting levels of trust within their community, which is an important driver of other outcomes including democratic participation, crime and health (OECD, 2011[26]).

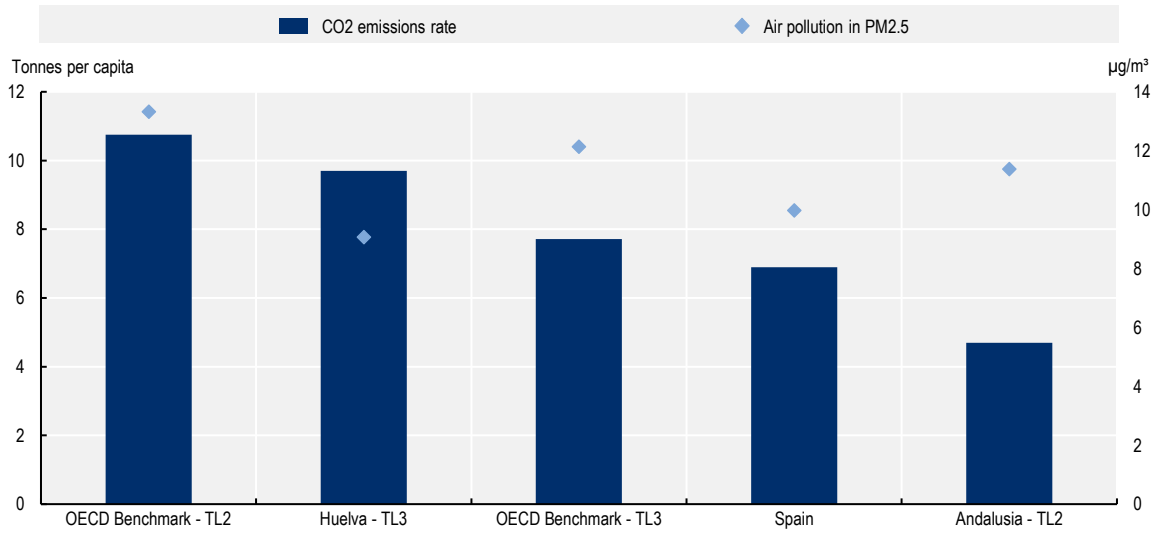
Andalusia benefits from good air quality, relevant for citizens' health

Andalusia enjoys good air quality emitting relatively low levels of CO_2 into the atmosphere and moderate levels of suspended particles 2.5 micrometres in diameter (PM2.5) (Figure 2.26). Although CO_2 exists naturally in the earth's atmosphere, the growing industrialisation and production rate is raising this figure to values much higher than normal. CO_2 has an impact on the health of citizens as well as on local and global natural ecosystems. Andalusia has a relative advantage over the other OECD TL2 benchmark of mining regions as in 2008 (last available data), CO_2 values (4.7 tonnes CO_2 per capita) were significantly below the OECD TL2 benchmark average (10.75) and slightly below the national average (6.9).

PM2.5 particles consist of a mixture that can include organic chemicals, dust, soot and metals. These particles can be generated by all kinds of combustion, including cars, trucks and factories, among other activities. Fine particle pollution has been shown to cause many serious health effects, including heart and lung disease. In this air quality indicator, Andalusia experiences moderate values, around 11.37 µg/m³ for 2019, relatively similar in value to the 13.32, 12.13 and 9.97 for OECD TL2 and TL3 benchmarks and Spain respectively.

Mining activity has a direct impact on CO_2 emissions due to its high energy consumption. Huelva, the largest mining province of Andalusia, therefore shows relatively high values with respect to the national average although, in terms of PM2.5, it has the lowest value in comparison (Figure 2.26). In the regional development of the province, strategies with low environmental impact must be sought after. By means of innovation and the use of renewable energies as an energy source for activities such as mining, as will be explored in Chapter 3, the region can offer citizens levels of air quality that guarantee their well-being.

Figure 2.26. Air quality in Spain, Andalusia, Huelva and the TL2 and TL3 OECD benchmark



Note: The TL2 level values for air pollution in PM2.5 correspond to 2019 while, at the TL3 level, they correspond to 2012. For CO_2, the values are for 2008.
Source: OECD (2021[15]), "Regional environment", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

In contrast, Andalusia has a relatively lower performance in housing availability and health outcomes:

- In **jobs**, the region faces the challenges of unemployment. Andalusia is among the four regions with the lowest values in the employment dimension within the well-being indicators. The fact that it is the region with the largest population implies an effect that can spill over to the rest of the country, as Spain also ranks last among OECD countries in terms of unemployment. High unemployment rates and an insecure labour market first affect workers with shorter educational development, highlighting the interrelationship with Andalusia's two other weak points; education and income. The periods of long-term unemployment have a significant impact, as they weigh heavily on the welfare of individuals and their families.
- In **income,** earnings are an important component of job quality. Andalusia's GDP per capita was 74.3% of the national average (USD 37 595) and 54.5% for Madrid, underlining a difference in income for the economic capital compared to the rest of the TL2 regions.
- In **education**, investment has fallen in recent years, reaching 21.7% in 2019 with respect to total public expenditure, equalling 2005 levels (Junta de Andalucía, 2019[18]). Furthermore, in the OECD

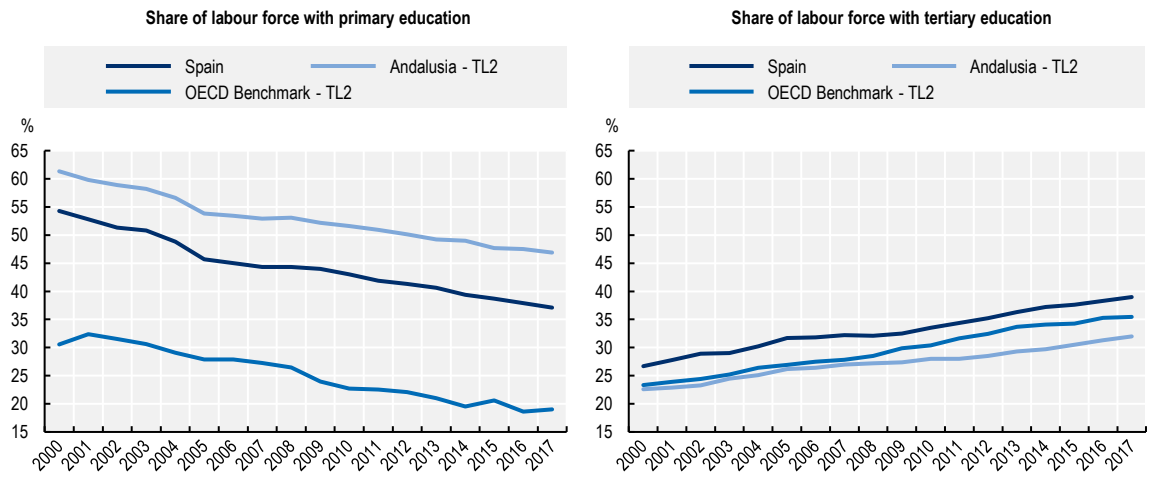
Programme for International Student Assessment (PISA), Andalusia follows the national trend that places Spain below the OECD average (OECD, 2020[27]). Andalusia is the fourth region with the lowest scores in Spain, ahead of Ceuta, Melilla and the Canary Islands. However, when comparing Andalusia with other TL2 mining regions, the region experiences a relatively higher performance than the OECD benchmark.

Enabling factors for development

Andalusia's human capital records low levels of education, especially in Huelva

The level of education in Andalusia is relatively low when compared with the average levels of Spain and the OECD mining regions. On the one hand, the share of the population with primary education in the region dropped in the last 2 decades from 61.3% to 46.9%, experiencing a significant increase to levels comparable to those of Madrid (47.3%). Yet this value remains remarkably higher than the OECD benchmark (19%) (Figure 2.27). On the other hand, the share of the labour force with tertiary educational attainment in Andalusia has risen in the past few years, from 22.6% in 2000 to 32% in 2017. While the improvement is noticeable, the figure is still slightly below the level of TL2 OECD mining regions (35.5%) and the national level (39%) (Figure 2.27).

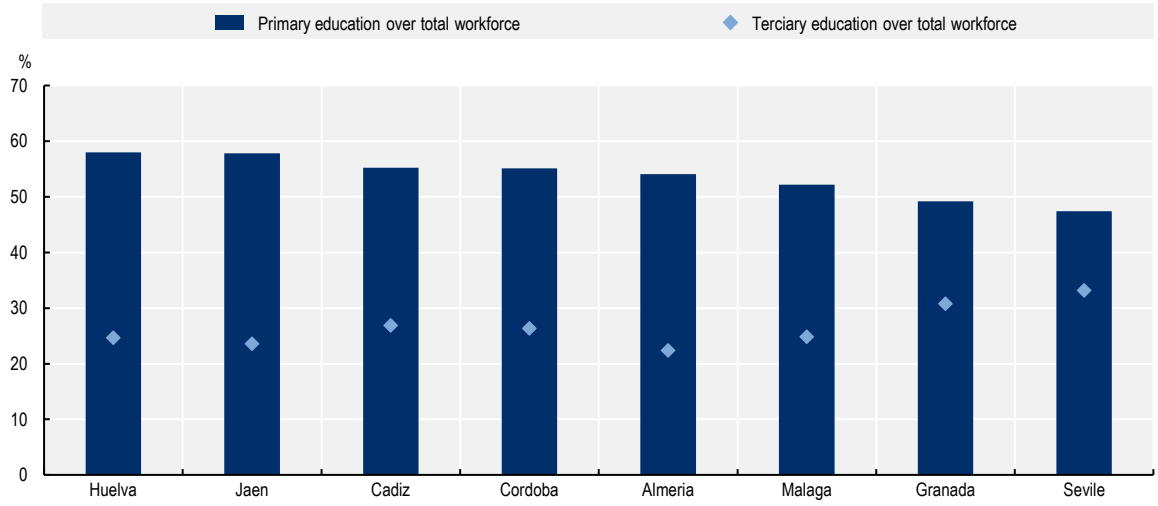
Figure 2.27. Share of level of education over labour force, Spain, Andalusia and OECD TL2 benchmark, 2000-17



Source: OECD (2021[15]), "Regional innovation", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

In Huelva, the education of young people is a cause of concern (Figure 2.28). The proportion of the population with only primary education (58%) is the highest among the provinces of Andalusia, followed by Jaén (57.8%) and Cádiz (55.2%). Although tertiary education in Huelva has managed to emerge from the low levels, there is still a gap. The share of the labour force in Huelva with at least tertiary education (24.7%) is behind the provincial capital, Seville (33.2%), yet above provinces such as Jaén and Almería. The divergence in the level of higher education with the national level reflect the structure of the labour market in the region and the movement of the most qualified young people to the cities. The main reasons for this regional migration are due to the high level of education of large universities, mainly in larger cities such as Granada or Seville.

Figure 2.28. Share of the level of education over labour force, provinces of Andalusia, 2014



Source: Labour Force Survey. Results for Andalusia. (IECA, 2019[20]) ; Statistics on training, labour market and educational-formative abandonment (MEFP, 2020[28]).

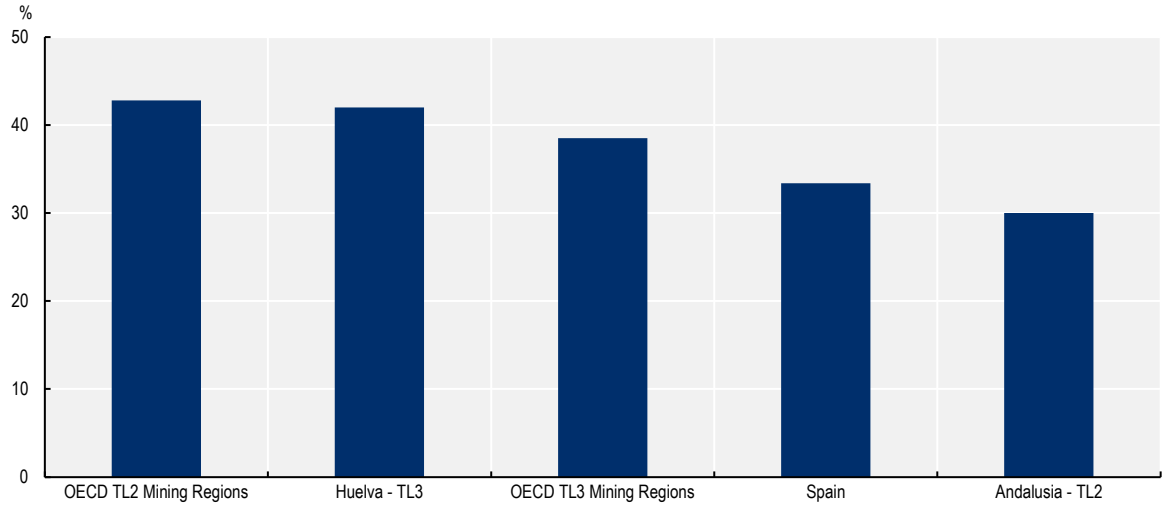
Promoting the establishment and growth of Andalusian companies as a catalyst for development

Andalusia's establishments are small in size and increasingly larger in number, constituting a shortcoming for the regional development of Andalusia. Andalusia has 30 inhabitants per establishment, slightly above the national average of 33.4, yet significantly higher than the OECD TL2 benchmark (Figure 2.29) highlighting the business atomisation of the region. While, by 2019, Andalusia recorded the sixth consecutive year of growth in the absolute number of companies, the size of these businesses remains small. In that same year, 97.7% of companies had fewer than 20 employees or no employees and provided 53.2% of employment. The remaining share of businesses with more than 20 employees accounted for 46.8% of employment, highlighting the fundamental role of large companies in job creation. Within the mining sector, non-metallic mining is a subsector mainly made up of small companies. As an example, in 2014, quarry and ornamental mining accounted for 29% of mining companies with less than 9 employees.

Overall, encouraging entrepreneurship for the creation of new companies as well as the development of existing ones is a fundamental opportunity for Andalusia, as will be explored in Chapter 3.

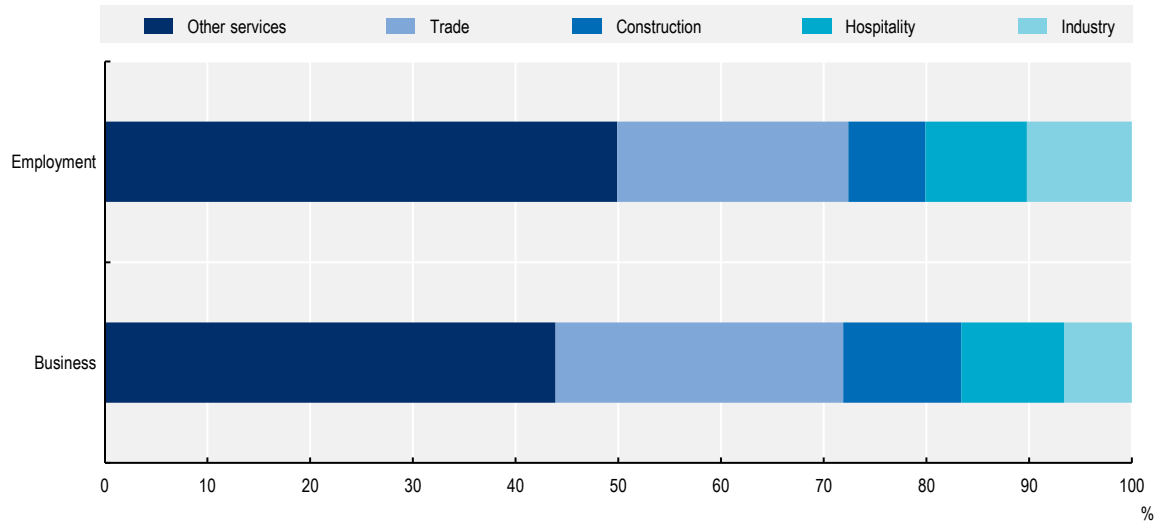
At the provincial level, Huelva amplifies the traits that the region experiences, yet with the singular opportunity of mining activities as the axis of business generation. In 2016, Huelva only contributed 18 of the 300 largest companies in Andalusia (Huelva Información, 2016[29]). While the first 4 are companies related to agricultural products, the companies positioned next, Atlantic Copper and Mina de Aguas tenidas Matsa, with 636 and 623 workers respectively, demonstrate the importance of companies from different sectors with sufficient volume to create a prosperous business fabric. Chapter 3 will explore the promotion of higher-value-added chains around mining activities, which can serve as a lever for companies from other sectors to gain weight and support each other to generate a solid business structure, less dependent on seasonality.

Figure 2.29. Ratio of total inhabitants over establishments in Spain, Andalusia, Huelva and TL2 and TL3 OECD benchmark



Source: OECD (2021[15]), "Regional labour", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

Figure 2.30. Business and employment by economic sector in Andalusia, 2019



Source: Junta de Andalucía (2019[30]), *Directorio de Empresas y Establecimientos con Actividad Económica en Andalucía*, https://www.juntadeandalucia.es/datosabiertos/portal/dataset/directorio-de-empresas-y-establecimientos-con-actividad-economica-en-andalucia (accessed on 3 October 2020).

In summary

The business scenario in Andalusia is composed of a large number of companies but of a small size, representing a disadvantage for the regional development of Andalusia. On the other hand, larger enterprises have the potential to generate economies of scale and create a business ecosystem with greater potential to absorb the labour force in a region suffering from high unemployment. In the rural areas, the limited possibility of agglomeration economies places mining companies in a pivotal position to

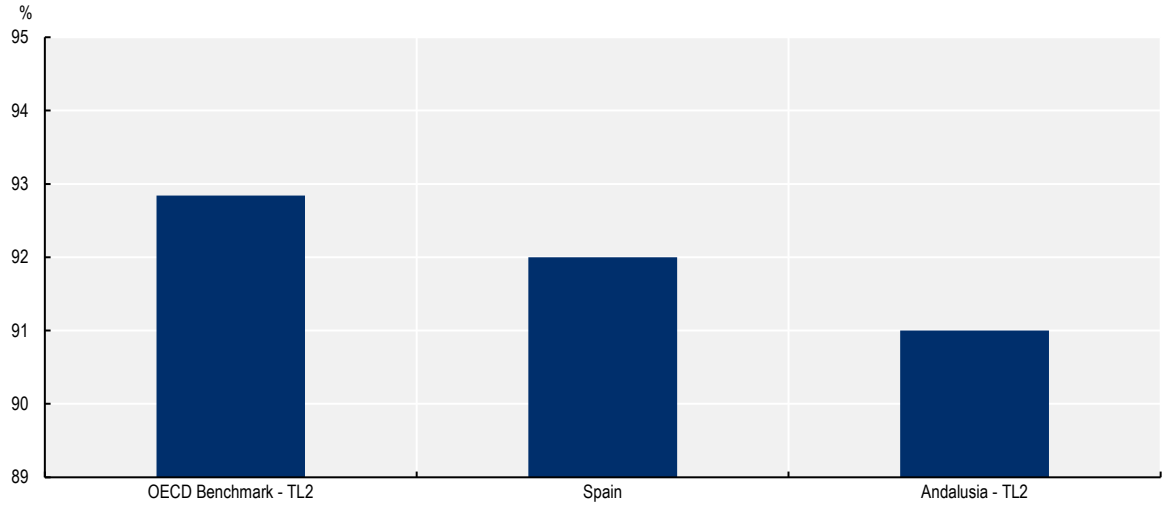
encourage the creation and growth of companies in places where they operate. Overall, a long-term co-ordinated policy strategy is needed to unlock the region's maximum potential.

Andalusia has converged on Internet access levels with the rest of the country

Andalusia has made steps forward in terms of access and use of Internet connectivity in the last years (Figure 2.31). According to OECD (OECD Regional Statistics, 2021[15]) and the Survey on Equipment and Use of Information and Communication Technologies in Households (INE, 2019[31]), there has been a significant increase in Andalusian households with Internet access, rising to 91% in 2019, which places Andalusia slightly below the national levels (92%) and the OECD TL2 benchmark of mining regions (92.84%). Similarly, the broadband speed has managed to converge, reaching national values. While Andalusia in network coverage greater than or equal to 30Mbps is slightly below the national average (93.0% and 94.2% respectively), it is similar to the national average in fixed network coverage greater than or equal to 100Mbps (82% for both).

In terms of use, 92.4% of Andalusians have used the Internet in the last 3 months, which is very close to the national average (93.2%) (INE, 2020[32]). Furthermore, with mobile phones being increasingly used as an Internet access point, in Andalusia, almost all households have one (98.1%). Access to and use of telecommunications services is especially relevant given the context caused by the COVID-19 which has led many workers to telework, making use more than ever of these services deployed in the regions.

Figure 2.31. Percentage of population using the Internet, 2019

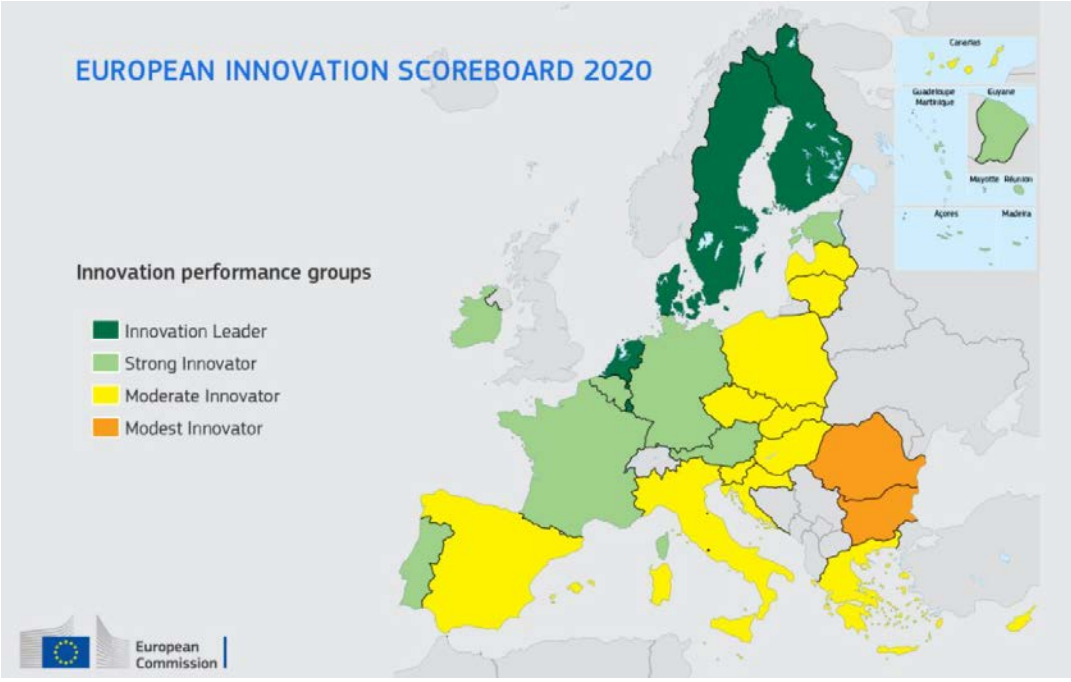


Source: OECD (2021[15]), "Regional innovation", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

Andalusia is a moderate innovative region in a moderate innovative country

Spain is one of the countries with the lowest levels of innovation in the EU, placing its investment in R&D significantly below the European average (Figure 2.32). Spain requires significant changes to keep pace with countries such as Spain, which leads innovation in Europe based on the training of its human resources and its digital infrastructure, or Portugal, which has improved to become a strong innovator and leader in innovation in SMEs. The average annual public spending on R&D in Spain was 1.24% of total GDP, behind Europe (1.96%) and behind the average of OECD countries (2.37%). In 2018, Andalusia allocated 0.92% of its GDP to this purpose, placing it behind other regions such as the Basque Country (1.96%), Madrid (1.71%) and Navarre (1.68%) (INE, 2020[8]).

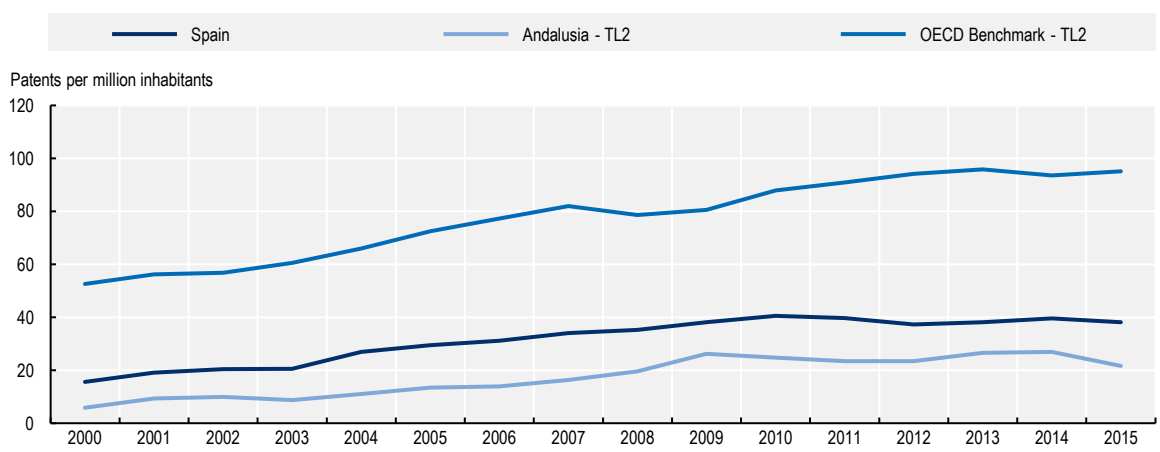
Figure 2.32. European Innovation Scoreboard, 2020



Source: EC (2020[33]), *EC RIS 2019 (database)*, https://ec.europa.eu/docsroom/documents/36081 (accessed on 23 February 2020); EC (n.d.[34]), *European Innovation Scoreboard*, https://ec.europa.eu/growth/industry/policy/innovation/scoreboards_en.

The European criterion for measuring innovation through a wide range of indicators classifies the region of Andalusia as a "moderate innovative region" within the Regional Innovation Scoreboard (European Commission, 2020[33])**.** However, patent applications (Figure 2.33) and investments in R&D are below the European average levels in 2018 (22 patent applications per million inhabitants), still below the national (38) and European (106.84) averages (European Commission, 2020[33]). The bottlenecks generated by a relatively low performance in innovation will be explored in Chapter 3 as well as unlocking the region's potential to cope with the challenges of the future. Particularly low are the levels of innovation related to SMEs, an opportunity to be explored and which will be further discussed in the following chapters.

Figure 2.33. Patents in Spain, Andalusia and comparable TL2 regions, 2000-15



Source: OECD (2021[15]), "Regional labour", https://doi.org/10.1787/region-data-en (accessed on 27 January 2020).

In summary

Andalusia has a social perception that outstands the average levels of the OECD. Community engagement is fundamental to face the rest of the challenges that Andalusia faces, mainly those related to education, jobs and income. Strengthening public investment in research as well as strengthening links between universities and companies are important to raise the level of innovation in the region. Currently, the levels of innovation in Andalusia are moderate in comparison with the rest of Europe, with room for improvement to increase investment and strategies to promote innovation.

Table 2.8. Well-being and enabling factors summary

	Spain, Andalusia and OECD TL2 benchmark	Huelva, Andalusia and OECD TL3 benchmark
Well-being	• Andalusia outperforms in safety, community and environment over the other mining OECD TL2 benchmark. On an environmental level, the leading mining region in Spain has positive air quality values compared to the OECD TL2 benchmark.	• Although Huelva, the leading mining province in Andalusia, has similar per capita CO_2 levels to the OECD TL3 benchmark, it is the province with the lowest PM2.5 levels of all regions compared.
Education	• The level of education in Andalusia is relatively low in Spain and the context of the OECD. However, between 2000 and 2017, the proportion of the labour force with lower education decreased from 61.3% to 46.9%, reaching the levels of Madrid (47.3%). • Higher education in Andalusia has increased in recent years, from 22.6% to 32% (2000-17). This figure is slightly lower than the level of the OECD TL2 mining regions (35.5%) and the national level (39%).	• In Huelva, the proportion of the population with primary education (58%) is the highest in the provinces of Andalusia, followed by Jaén (57.8%) and Cádiz (55.2%). • Although tertiary education in Huelva has managed to emerge from the low levels, there is still a significant gap. Huelva, at 24.7%, is above provinces such as Almería and Jaén but still lags behind the provincial capital Seville (33.2%).
Business environment	• Andalusia has 30 inhabitants per establishment, slightly higher than the national average of 33.4, although significantly higher than the OECD mining regions, highlighting the business atomisation of the region. • In 2019, 97.7% of enterprises had fewer than 20 employees or no employees at all, while enterprises with more than 20 employees accounted for 46.8% of employment.	• In 2016, Huelva only contributed to 18 of the 300 largest companies in Andalusia. • The largest 4 of these 18 are related to agricultural products. Atlantic Copper, MATSA and Mina de Aguas Teñidas then demonstrate the importance of companies from different sectors with sufficient volume to create a prosperous business environment.
Broadband	• Andalusia's broadband access rose to 91% in 2019, which places the region slightly below the national average (92%). In terms of use, 92.4% of Andalusians have used the Internet in the last 3 months, which is very close to the national average (93.2%). • Andalusia´s network coverage greater than or equal to 30Mbps is slightly below the national average (93.0% and 94.2% respectively) and similar to the national average (82% both) in fixed network coverage greater than or equal to 100Mbps.	
Innovation	• The region is moderately innovative in the European context, held back by relatively low investment in R&D compared to the national and European average. • The average annual public spending on R&D of Andalusia was 0.92% of total GDP, significantly behind Europe (1.96%) and Spain (1.24%).	• Given the location of the mining industry and economic activity with a high added value, Huelva has the possibility of transferring innovation to boost its business environment across the province.

Annex 2.A. Selected OECD TL2 and TL3 mining regions

Annex Table 2.A.1. Benchmark of OECD TL2 regions used for comparison with the TL2 region of Andalusia

Region	Code	Country
Wallonia	BE3	Belgium
Grand Est	FRF	France
Nouvelle-Aquitaine	FRI	France
Occitanie	FRJ	France
Auvergne-Rhône-Alpes	FRK	France
Provence-Alpes-Côte d'Azur	FRL	France
Brandenburg	DE4	Germany
Lower Saxony	DE9	Germany
Saxony-Anhalt	DEE	Germany
Lazio	ITI4	Italy
Hokkaido	JPA	Japan
Tohoku	JPB	Japan
Northern-Kanto, Koshin	JPC	Japan
Chugoku	JPH	Japan
Shikoku	JPI	Japan
Gyeongbuk Region	KR03	Korea
Jeolla Region	KR04	Korea
Chungcheong Region	KR05	Korea
Veracruz	ME30	Mexico
Groningen	NL11	Netherlands
Western Norway	NO05	Norway
Lower Silesia	PL51	Poland
Galicia	ES11	Spain
Catalonia	ES51	Spain
Valencia	ES52	Spain
East Midlands	UKF	United Kingdom
South West England	UKK	United Kingdom
Kentucky	US21	United States
Utah	US49	United States

Note: Selection of regions based on the region's specialisation in the mining sector as well as its location quotient and desk research to select the suitability.

Annex Table 2.A.2. Benchmark of OECD TL3 regions used for comparison with the TL3 region of Andalusia

Region	Code	Country
Klagenfurt-Villach	AT211	Austria
Cher	FRB01	France
Ardennes	FRF21	France
Aube	FRF22	France
Drôme	FRK23	France
Düren	DEA26	Germany
Heraklion	EL431	Greece
Komárom-Esztergom	HU212	Hungary
Zala	HU223	Hungary
Somogy	HU232	Hungary
Jász-Nagykun-Szolnok	HU322	Hungary
Csongrád	HU333	Hungary
L'Aquila	ITF11	Italy
Potenza	ITF51	Italy
Cosenza	ITF61	Italy
Grosseto	ITI1A	Italy
Pieriga	LV007	Latvia
Noord-Overijssel	NL211	Netherlands
Trencín Region	SK022	Slovak Republic
León	ES413	Spain
Salamanca	ES415	Spain
Almería	ES611	Spain
Cádiz	ES612	Spain
Cordoba	ES613	Spain
Granada	ES614	Spain
Jaén	ES616	Spain
Málaga	ES617	Spain
Seville	ES618	Spain
Västerbottens County	SE331	Sweden
Champaign-Urbana, IL	US028	United States
Topeka, KS	US167	United States

Note: Selection of regions based on the region's specialisation in the mining sector as well as its location quotient and desk research to select the suitability.

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Notes

[1] Autonomous means that each of these autonomous communities has its own executive, legislative and judicial powers.

[2] The criteria to determine the areas affected by depopulation will be the demographic density, the ratios of ageing and birth rate, the geographical isolation and the difficulties of territorial structuring.

[3] Wholesale and retail trade also includes repair of motor vehicles and motorbikes, transport and storage, hotels and restaurants.

3 Mobilising the potential of Andalusia's mining value chain

This chapter examines the strengths and bottlenecks of the mining sector and identifies strategies and policy responses to help unlock new growth opportunities in mining activities and the development of the region. The chapter begins with an overview of Andalusia's mining business environment. It then analyses the strengths that the region can mobilise to meet higher levels of income and well-being through mining development. Finally, it examines strategies to overcome a number of challenges to boost competitiveness and create higher-value-added jobs.

Assessment and recommendations

Assessment

- Andalusia's mining value chain includes elements from almost all stages of the industry: extractive and processing activities as well as equipment, technology and services providers. Andalusia benefits from two distinct mining subsectors, each with different dynamics, characteristics and needs. The metallic mining sector (copper, zinc and lead) accounts for most of the regional mining production and is largely made up of large foreign-based companies. In contrast, the non-metallic sector (ornamental rocks, aggregates and industrial minerals) is highly dispersed across the territory and is composed of small local family businesses.
- The mining ecosystem in Andalusia presents a number of strengths that can be further mobilised. These include attractive geology, a strategic geographic location, good infrastructure and proximity of mines to urban centres as well as a mining identity that fosters community support for mining ventures. By activating these assets, Andalusia can strengthen its mining business environment and increase its attractiveness for innovative firms and skilled workers.
- At the same time, the regional mining business ecosystem needs to address some challenges to unlock its development potential, attain higher productivity levels and help reduce the income gap at the national level. These bottlenecks include low innovation levels in the regional mining value chain, a large share of small- and medium-sized enterprises (SMEs) and entrepreneurs in low-value-added activities, and a complex and unpredictable regional administrative process for mining that relies on an outdated national regulation. Addressing these challenges can bring new growth opportunities and help Andalusia become a national and European frontrunner to contribute to EU climate goals by developing sustainable mining practices and technologies.

Recommendations

Mobilising the strengths of Andalusia's mining ecosystem to increase competitiveness and attractiveness for firms and workers

For this, the regional government of Andalusia should:

1. Update and make Andalusia's geological information more accessible in collaboration with the Geological and Mining Institute of Spain (IGME in Spanish). This involves improving geological information on Andalusia's mining website, with special attention to the mapping of critical minerals and waste mining.
2. Facilitate the links with African and Latin American mining jurisdictions to become a gateway to and from the European Union (EU) in sustainable mining processes and technologies. In collaboration with mining business associations, this includes promoting networking and partnerships with those jurisdictions and their established companies as they seek to adopt sustainable mining practices and promote responsible sourcing of minerals to Europe.
3. Better integrate urban and (national and regional) infrastructure plans with mining development plans to improve the movement of goods and services for the mining sector as well as to avoid land use conflicts. This co-ordination could aim to enhance the transport efficiency of goods (e.g. in ports, roads and railways) for metallic and non-metallic mining.
4. Make the most of the local mining identity and heritage to strengthen community acceptance and information on mining activities, while enhancing the mining business ecosystem by:
    - Enhancing the communication of mining benefits among local communities. To this end, the regional government together with mining business associations can promote dialogue sessions among citizens and other actors (e.g. non-governmental organisations [NGOs],

universities) within Andalusia's Mining and Minerals Hall event and before every mining project, to share experiences on how to maximise benefits to the local community from mining ventures.

- Partnering with universities and other local actors (citizens, municipalities and business representatives) to better engage with interest groups with a negative perception of mining.
- Improving the links between corporate social responsibility programmes of mining companies and regional development programmes through shared projects for local communities and ad hoc communication strategies.

Addressing development challenges in Andalusia's mining ecosystem to unlock new growth opportunities and support the EU climate goals

For this, the regional government should:

5. Enhance innovation within Andalusia's mining value chain to generate sustainable mineral transformation processes and technologies by:
   - *Promoting service innovation activities in the mining value chain*. Specific actions include:
     - Providing capacity and networking support to increase and upscale knowledge-intensive mining service providers. This requires establishing knowledge exchange mechanisms with foreign-based mining and manufacturing firms to upscale services offered by local mining service providers while helping them meet high-standard procurement requirements. This should also involve developing capacity-building programmes for service providers on circular processes and technologies for environmentally sustainable metallic and non-metallic (NM) mining.
     - Establishing a testbed for mining firms and service providers to co-create projects and experiments. This can be beneficial to build collaboration among metallic and non-metallic mining providers and firms. Andalusia's mines could be the laboratory of continuous learning for the local mining value system, following experiences from Sweden or Australia.
   - *Boosting the role of educational institutions and the public research sector* to support innovation and entrepreneurship for environmentally sustainable mining. Specific actions include:
     - Strengthening partnerships with universities in the region to promote research and academic programmes on technologies and circular practices that reduce carbon emissions in the mining value chain. This includes collaborating with universities to align their research programmes with the regional mining strategy goals and industry needs. The regional government can learn from the partnership of Karlstad University and Värmland Region in Sweden.
     - Acting as a broker to facilitate the creation of an institutional platform to conduct research and development (R&D) in mining. The platform could be jointly co-ordinated by a body of private, academic and public representatives and should work through demand-driven projects from the private sector. This R&D platform can co-ordinate the testbed for co-creation of projects, develop partnerships with existing regional incubators and promote intrapreneurship activities for companies and knowledge transfer between metallic foreign-based and non-metallic firms.
   - *Improving skills in Andalusia to prepare its workforce and youth population* to meet the future needs of the mining industry and unlock high-value-added activities within the mining value chain. Specific actions include:

- Boosting training programmes in partnership with universities and industry associations to prepare the regional workforce and young generations for the upcoming demand of knowledge-intensive and environmentally sustainable mining activities. This could also involve vocational training on traditional non-metallic mining activities. Practices from the Canadian Mining Innovation Council's "ReThink Mining" initiative can guide Andalusia.
- Involving the young population in mining activities through a greater communication of employment opportunities in mining and promotion of internship programmes within the industry.

6. Upscale and guide SMEs towards activities of higher value-added in order to increase resilience and offer stable sources of income in the local economy by:
   - Strengthening regional technical support programmes for SMEs to improve networks with large mining companies, build capacity and promote the internationalisation of mining providers and small non-metallic mining firms. This involves enhancing financial (e.g. grants, co-financing) and training programmes for digital transformation and project collaboration with universities and firms for greater insertion of SMEs in global mining value chains.
   - Reducing further administrative obstacles for start-ups and SME growth. This involves strengthening capacity-building programmes to help SMEs navigate the regulatory environment in the region and promoting the digitalisation of administrative and fiscal processes.
7. Improve the mining regulatory framework and permit award process to enhance competitiveness and local community acceptability, while ensuring environmental protection. This action necessitates close collaboration with the national government.

   For this, the regional government should:
   - Establish a formal co-ordination mechanism within the regional government to evaluate and deal with administrative processes for mining projects, including for awarding permits. This institutional tool (e.g. a one-stop-shop, a single decision-making body or a branch in the Project Accelerator Unit) should gather officers from different regional ministries to accelerate mining administrative processes and improve co-ordination across regional regulations (e.g. environmental and land use) and with national and European legislations. This mechanism can also take stock of expert knowledge (universities or specialised consultants) to issue formal recommendations on the permit award process of mining projects.
   - Create specific programmes to train staff and provide digital support in relation to mining administrative processes and a new type of mining operations. These training programmes would benefit from partnerships with business associations from metallic and non-metallic mining.
   - Set clear administrative timelines to deal with demand and development of mining projects, including the environmental evaluations. Expected timelines can be set in the mining strategy as a clear goal for improvement. Andalusia can find inspiration in the roadmap set by Canada.

   For this, the national government should:
   - Update the national mining regulatory framework to make it more efficient and integrated with other sectoral regulations, including environmental regulations and land use planning.

Introduction

Andalusia is the leading mining region in Spain contributing to most of the mining value production in the country. This sector has played a key role in the regional economic recovery after the 2008 crisis and has systematically contributed to the largest share of regional exports in value-added. The sector is now well-positioned to also play a central role in the process of Andalusia's recovery from the COVID-19 pandemic and help to transition to a low-carbon economy. To this end, Andalusia will need to fully mobilise the assets of its mining value chain. These include, amongst others, a strategic geographic location close to Africa and cultural proximity to Latin America, good infrastructure and accessibility of mining to urban centres, a business environment with innovative foreign-based mining and manufacturing firms, and a community with mining identity.

Besides its numerous assets, Andalusia faces various challenges to harness the potential of its mining business environment and enhance growth opportunities for local firms and people's well-being. These challenges include low innovation levels around the mining value chain, SMEs and entrepreneurs trapped in low-value-added activities and an outdated and complex administrative process for doing business in mining. Promoting growth in mining and associated industries and services can help the region transitioning to higher-value-added activities and close the structural gap with the national economy in terms of income and productivity.

The purpose of this chapter is to identify policy recommendations to help realise the potential of Andalusia's mining ecosystem and unlock new growth opportunities. The chapter finds that Andalusia is well equipped to become a frontrunner in mining sustainable practices and technologies to contribute to the energy transition agenda and reach markets in Africa and Latin America, all while opening up renewed possibilities of work and well-being for the population. This chapter begins with an overview of Andalusia's mining business environment. It then analyses the strengths that the region can mobilise to meet higher levels of income and well-being through mining development. Finally, it examines the strategies to overcome a number of challenges in order to boost productivity and create higher-value-added jobs.

The mining business ecosystem in Andalusia

Mining has long been an important sector for the world economy and is likely to become more relevant in the future (National Research Council, 2008[1]). A growing population, larger urbanisation rates, increasing worldwide prosperity and the transition to a low-carbon economy are all factors that will likely increase the demand of a wide number of minerals and metals. A steady availability and adequate supply of mineral raw materials is also an important element to ensure future economic growth and enable technological developments, as well as the sustainability of many downstream and related activities.

Mining is also an important factor in the development of subnational economies. A healthy mining sector can translate into higher investment rates, infrastructure development, high income and generally stable jobs and the possibility of joining global value chains (McMahon and Moreira, 2014[2]). Yet, mining can also bring challenges, including vulnerability to external shocks, and environmental and social impacts. As per the geographical concentration of the activity, these positive and negative impacts are amplified at regional and local scales when well-managed, and the mining sector can be the source of national and regional sustainable development and greater societal well-being.

While the region of Andalusia is not considered a global player in terms of mining and other economic activities (e.g. agriculture and tourism) contribute to a much larger share of regional gross domestic product (GDP) and employment, the mineral and metals production in the region is the largest in the country (39% in 2018). Andalusia is in fact the top mining region within Spain in a variety of domains (Spanish National Government, 2020[3]):

- Production of mineral products by value (amounting to 38.6% of the national total in 2018).
- Production of metallic products (amounting to over 90.1% of the national total in 2018).
- Production of aggregates (amounting to 22.3% of the national total in 2018).
- Number of mining exploitations (464).
- Employment, by number of employees (7 412 in the extractive subsector, not including transformation, amounting to 24.8% of the national total).

Mining value chains in metallic and non-metallic minerals

As described in further detail in Chapter 2, Andalusia is a region with a long history of mining. This historical legacy still continues nowadays with active production in extracting metals, aggregates, industrial minerals and ornamental rocks. These activities, if properly harnessed, can further support Andalusia's development objectives and also open new opportunities within the EU Raw Materials Strategy, improving the region's national and international standing (Chapter 4).

Andalusia enjoys the benefit of having a two-pronged mining industry: the metallic and non-metallic sectors. Collectively, the metalliferous and non-metalliferous extractive sectors position Andalusia as the Spanish top mining region. These two types of mining present important differences and both can offer a wide range of opportunities across the territory for different sizes of companies and types of workers (Table 3.1).

As mentioned in Chapter 2, metallic mining has supported most of the high production level of the regional mining sector. This type of mining has grown steadily since the early years of this century from no metallic mines in 2013 to 6 in 2016, with a pipeline of 8 more projects in different stages of development. But aside from metals, Andalusia is also a strong non-metallic producer. Its industrial minerals, aggregates and ornamental rock industries are generally well represented throughout the region and have an important footprint in term of volume and employment. In the case of the marble industry in the TL3 region of Almería – the Macael Marble District (MMD) – mining even plays a regional identity component.

Table 3.1. Metallic vs. non-metallic mining

	Metallic mining	Non-metallic
General description	• Complex, capital-intensive operations including mine opening, processing plant and ancillary infrastructure and equipment (powerplant, hauling and transportation equipment)	• Generally simpler operations consisting of site and basic handling and processing (except in the ornamental rocks and cement subgroups which include processing plants)
Main products (in Andalusia, including current and past production – the latter are shown in italics)	• Metals (concentrates or refined) including copper, *iron ore*, lead, *gold*, *silver* and zinc	• Aggregates (siliceous sand) • Ornamental rocks (marble) • Industrial rocks and minerals (gypsum, talc, construction rocks, clays and cement) • Energy minerals (*coal*)
Company description	• Large, multinational companies • Generally headquartered abroad	• SMEs and micro companies, generally family-owned and operated • Strong local connection
Type of operation	• Open-pit or underground (depending on geological and economic considerations)	• Generally open-pit (quarries)
Economic considerations	• Small volumes of products sold at great unitary value • Transportation and logistics a relevant but non-essential component of cost	• Large volumes, small unitary value • Transportation and logistics a key cost component
Technological profile	• Advanced technological requirements in exploration, extraction, processing and mitigation/remediation	• Limited application of technology; often not essential to the process

	Metallic mining	Non-metallic
Markets	• International commodities markets • Cyclical behaviour • Export-oriented	• Local or regional markets (varies by product: in the case of marble, may be international) • Very dependent on local demand (generally related to infrastructure public projects and construction) • Local consumption
Footprint and location	• Medium-sized to large operations • Concentrated in very specific areas with high metallic content	• Small operations • Concentrate near centres of consumption (on account of the relevance of transportation costs) • Generally, well dispersed throughout the region
Employment	• Hundreds to thousands of employees per operation • Large indirect employment generation	• Less than a dozen employees per operation (often in the single digits) • Small indirect employment generation

The next sections describe the main characteristics of metallic and non-metallic mining sectors in Andalusia by outlining chief assets, companies and transformative facilities.

Metallic mining and transformation

Andalusia's metallic mining goes back hundreds of years and in its long past has seen many cycles of booms and busts.[1] In its current shape, starting in the early years of the century, Andalusia has seen a slow but steady rebirth of its metallic mining, with a geographical focus on the Iberian Pyrite Belt (IPB), in the provinces of Huelva and Seville. More recently, there has also been renewed activity in non-IPB deposits, such as the iron ores from the Sierra Nevada region, in the province of Granada. The region benefits from a rich stock of metallic mines and projects (Table 3.2).

Table 3.2. Metallic mines and projects in Andalusia, 2020

Mine	Region TL3	Municipality(ies)	Owner	Mineral	Status
Las Cruces	Seville	Gerena, Guillena, Salteras	Cobre Las Cruces, SA (CLC) – Wholly-owned subsidiary of First Quantum Minerals Ltd.	Copper (cathodes)	Operational since 2009
Las Cruces (Polymetallic)	Seville	Gerena, Guillena, Salteras	CLC	Copper, zinc, lead, silver	Project
Aguas Teñidas	Huelva	Almonaster la Real	Mina de Aguas Teñidas, SA (MATSA) – Jointly owned by Mubadala Investment Co. and Trafigura Group Pte Ltd.	Copper, zinc, lead (concentrates)	Operational since 2009
Magdalena	Huelva	Almonaster la Real	MATSA	Copper, zinc, lead (concentrates)	Operational since 2015
Sotiel	Huelva	Calañas	MATSA	Copper, zinc, lead (concentrates)	Operational since 2015
Riotinto	Huelva	Minas de Río Tinto	Atalaya Mining Plc – Publicly traded. Significant shareholders include Trafigura Group Pte Ltd., XGC, Orion and Liberty	Copper (concentrate)	Operational since 2016
Aznalcóllar and Los Frailes	Seville	Aznalcóllar	Minera Los Frailes, SA – Owned by Grupo Mexico (majority shareholder) and Minorbis, a Magtel Group[1] subsidiary	Copper, lead, zinc	Project

Mine	Region TL3	Municipality(ies)	Owner	Mineral	Status
Tharsis	Huelva	Alosno, Tharsis, Villanueva de las Cruces	Tharsis Mining & Metallurgy, SL (Tharsis) – Wholly-owned Magtel Group affiliate	Copper, cobalt	Project
La Zarza	Huelva	Calañas	Tharsis	Gold	Project
San Telmo	Huelva	San Telmo, El Cerro de Andévalo	Tharsis	Copper, zinc	Project
Minas del Marquesado	Granada	Alquife, Lanteira, Aldeire, La Calahorra	Minas de Alquife, SLU – Family-owned	Iron oxides (hematites)	Operational since 2020
Masa Valverde	Huelva	Valverde del Camino, Beas	Atalaya Mining Plc – Publicly traded. Significant shareholders include Trafigura Group Pte Ltd., XGC, Orion and Liberty	Copper, zinc	Project
Patrás (Mina Concepción)	Huelva	Almonaster la Real	MATSA	Copper, zinc	Project
Los Toscanos	Huelva	El Cerro del Andévalo	MATSA	Copper, zinc	Project
Oropesa	Córdoba	Fuente Ovejuna	Minas de Estaño SLU	Tin	Project

Note: Magtel is an Andalusian conglomerate based in Cordoba, operating in a range of areas including civil works and engineering, telecommunications and information technology (IT), renewable energies, railroads and mining services.

The Andalusian metallic extractive sector produces a small but growing array of valuable mineral products. The main products, by volume, are copper concentrates and cathodes, followed by zinc concentrates and metallic lead. As to future production, together with an increase in the volumes of current mineral commodities – several of the projects in the pipeline are in advanced stages of development – there is an expectation that Andalusia may extract a wider mix of metals from its deposits. For example:

- The Cobre Las Cruces polymetallic refinery project is being designed to produce lead, silver and zinc, in addition to copper.
- Tharsis Mining and Metallurgy's Tharsis and La Zarza mines are expected to produce cobalt and gold respectively.
- Minas del Alquife's project in Granada (Minas del Marquesado mine) is reported to be on the verge of obtaining its first iron ore export permits.

A sector with a wide range of international players

The companies involved in the extraction of metallic products are primarily multinational firms (generally acting through wholly-owned subsidiaries or affiliates), with simultaneous operations in several jurisdictions. They include most notably First Quantum Minerals Ltd. and Grupo México.

A notable exception to this foreign-based industrial environment is represented by the Magtel Group involvement in Tharsis Mining & Metallurgy, and minority ownership of Minera Los Frailes, in partnership with Grupo México. Magtel, which was set up in Córdoba in 1990, has activities throughout the region and has recently moved into the mining business as an investor. The direct participation of a large Andalusian industrial player is a positive development for the sector's long-term viability and community standing.[2]

This rebirth of the metallic sector in the last 20 years, involved both old, well-known assets being put into production as well as new discoveries of relevance (e.g. the discovery of Mina Magdalena dates from 2013) (Box 3.1). This is an encouraging sign and suggests further exploration can yield discoveries of importance, even in terrain that has seen mining since pre-historic times. Andalusia should in this regard put in place active policies that include incentives to boost private exploration, as well as to conduct basic

geologic and ground-laying work. The regional government's 2018 partnership agreement with the Spanish Geologic and Mining Institute of Spain for the updating of the region's 1:200 000 geological cartography as well as for the development of 1:50 000 detailed geological surveys, is a step in this direction.

Box 3.1. Some (very) old assets coming back to life

After many centuries of almost permanent mining and metallurgical activities, the discovery of rich and undeveloped mineral resources in the Americas put a (temporary) stop to Andalusia's pre-eminence as a top European mining centre. The 16th and 18th centuries, therefore, saw many of Andalusia's mining sites go unused and abandoned, as the industry declined to a halt.

The second half of the 19th and early 20th centuries – dubbed Andalusia's "Mining Century" – put the region in the top rankings of global and European production of several mining commodities including lead (of which it became the world's top producer): iron ore, coal, copper, graphite, sulphur, mercury, gold and silver. This process would successively touch upon different areas of Andalusia (from Almería in the southeast to Huelva in the northwest). It leads to the opening of hundreds of mines, the laying of several hundred kilometres of new railroad and the establishment of dozens of smelters, ports and processing facilities in industrial hubs such as Linares-La Carolina, Peñarroya-Pueblonuevo, Riotinto or Villanueva del Río y Minas.

Mining booms, however, do not spring eternal. The profound disruptions caused by the First and Second World Wars and the Spanish Civil War would put an end to the 100-year-long cycles and leave Andalusian mining, once again, in a state of abandonment and decay. The footprint left by the ebbing industry was, this time, much larger than before. So much so that some of these areas are now being recast as industrial tourism destinations. The province of Huelva, for instance, offers visits of its Riotinto Park and the Tharsis, Cueva de la Mora, Herrerías, La Zarza, Concepción, Peña del Hierro and San Telmo mines, among many other vestiges from the mining heyday (see Regional Government of Andalucia (2017[4]).

But, as is the case with booms, downward cycles do not last forever either. Starting in the early years of the 2000s and encouraged by the "commodities supercycle" linked to China's rapid growth as well as by technological changes in the processing of complex polymetallic deposits, metallic mining in Andalusia began a comeback.

One by one, (some very) old mining assets and locations were put back to work and are today the backbone of the resurgence of Andalusia's mining industry. Others are being primed to be opened in the future. In the long-fertile IPB, Riotinto, Sotiel or Tharsis are all operational projects or in preliminary stages of development (Table 3.2). This rebirth of mining resources has yet to focus on the remains of past activity. As is often the case in mining, ever-diminishing cut-off grades and new technologies transform yesterday's wastes into today's assets. The reprocessing of the many waste rock and tailings of former mines is a natural next step for the region.

The regional government of Andalusia has already taken steps in this direction: the Andalusian Mining Strategy (AMS) 2020 already focuses on reprocessing of mining as a key opportunity for growth (AMS, Action 4.1.3 "Utilisation of mining residues"). Recently, the regional government has actively begun mapping the extent of these old sites, with a view of incentivising the reopening of former mining operations.

Source: Regional Government of Andalusia (1986[5]), *Andalusian Mining: White Paper*; Regional Government of Andalusia (2013[6]), *Estrategia Minera de Andalusia 2020.*

Transformation activities with innovative practices

Together with the extraction of ores and minerals, Andalusia is also involved in their primary transformation of metallic minerals. Cobre Las Cruces (CLC) produces at-the-mine high purity copper cathodes and, since 1970, Atlantic Copper (AC, a Freeport-McMoRan subsidiary) operates a copper smelting and refinery facility and sulphuric acid plants in the city of Huelva, where it processes Andalusian ores as well as mineral concentrates from around the world.

- The CLC plant established a hydrometallurgical process that is considered innovative and one of its kind in Europe. This plant is strategically located in the vicinity of the mine in the municipality of Gerena, thus avoiding transportation cost and offering employment and income to the local community in which the extraction occurs. During 2018, the plant produced 71 000 tonnes of copper cathodes with a 99.999% purity (this is one step further than the usual cathode quality which stands at 99.99%). According to the company, the current mine's life is set to end some months after 2020 but the plant will remain active both for the processing of other of the mines' ores as well as minerals from an expansion project. CLC is seeking to leverage its innovative approach to mining and metallurgy and get a second lease in life for the mine (Box 3.2).
- AC operates a smelter and refinery facility and three sulphuric acid plants (together, the *Complejo Metalúrgico de Huelva*) in the city of Huelva. This installed capacity processes copper from Andalusia as well as from other mining operations around the world. The AC copper processing plant produces an average of 300 000 tonnes of cathodes per year, with a 99.99% copper content. In its three sulphuric acid plants, AC processes sulphuric dioxide resulting from copper smelting to produce 1 million tonnes of acid per year. Other subproducts of the AC industrial complex are anodic/electrolytic muds (sold for their content of precious metals), commercial gypsum, iron silicates and nickel carbonate. The AC plant has been in operation since 1970 and, through its logistics facilities within the Port of Huelva, has become Andalusia's largest exporter (45% of its copper and 70% of its sulphuric acid are exported annually) and an important provider of employment (more than 600 direct jobs).

Given its significant exporting profile, the regional government considered the transformation of metallic products as one of Andalusia's "more dynamic and competitive productive activities" (Regional Government of Andalusia, 2013[7]). The sector is also a driver of foreign direct investment, attracting increasing investments over time (e.g. CLC). Adding to the export and investment capacity of this sector, the business ecosystems around the metallic sector can dynamise the regional economy and provide wealth and opportunities for the sustainable development of Andalusia. In addition to the CLC and AC plants, Andalusia's metallic transformation sector includes smaller companies, which included around 268 employers/companies in the metallic transformation subsector.

Box 3.2. Innovation in the transformation sector: CLC's Poly Metallurgical Refinery (PMR) project

The Cobre Las Cruces (CLC) mine and copper deposit – discovered in 1994 – is nearing its end-of-life mark. The mine belongs to First Quantum's Cobre Las Cruces, SA. (CLC), started production in 2009 and is set to close some months after the end of 2020, having reached a total extraction of 15 million tonnes of ore.

However, successful brownfield exploration demonstrated the existence of continued mineralisation below the maximum design depth of the pit, although of a different nature. Whereas the primary find was a secondary sulphide deposit with mainly high grade copper, the new resource is a primary

sulphide polymetallic combination of copper, zinc, lead and silver, mineralisation that is fairly typical of the IPB region.

CLC is seeking to leverage its innovative approach to mining and metallurgy and get a second lease in life for the mine and the plant. Indeed, CLC's current hydrometallurgical process boasts an impressive 99.999% purity copper cathode production and an at-the-site process that takes place in little more than a week between extraction and final product.

The PMR project would:

- Add 10/15 years to the life of the mining operation, continuing as an underground mine below the current pit to a depth of 450 metres.
- Produce an estimated 45 000 tonnes of zinc, 21 000 tonnes of copper, 21 000 tonnes of lead and 33 tonnes of silver per annum.
- Entail an investment of EUR 500 million.
- More importantly, create a one-of-its-kind regional facility with the technical ability to process ores from other IPB deposits.

The PMR would apply proprietary technology developed by CLC and, after two years of highly promising pilot-plant results, is currently seeking regulatory permits to move forward.

Source: Cobre las Cruces SA (2018[8]), *Press Dossier*; Frias, C. et al. (2020[9]), *Advanced Concept "Poly Metallurgical Refinery" Developed by Cobre Las Cruces*.

Non-metallic mining and transformation

The non-metallic (NM) extractive sector in Andalusia is composed of the following subsectors (Spanish National Government, 2020[3]):

- *Aggregates and construction rocks*. The products with greater value of production are limestone, dolomites, and gravel and sands. Other products include siliceous sands and non-ornamental sandstone and marble.
- *Industrial minerals*. Gypsum, siliceous sands and salt are the main products in this subsector. The regional production of gypsum is the largest in Spain (67% in 2018) and a referent for Europe. Other products with a lower value of production include clays for structural ceramics, carbonates (for cement), fluorite (used in metallurgy as a flux), strontium and industrial iron oxides.
- *Ornamental rocks*. Marble is the main product in terms of the value of productions. Other products include sandstone and slate.

The NM extractive sector is relevant in multiple ways for the economic fabric of Andalusia (Table 3.3). The combination of geographical dispersion and a relatively large number of companies and employees places the NM sector as an important engine for rural development in the region. Mines of NM are highly dispersed across the territory and the ecosystem is composed of a large number of companies (98% of all extractive establishments are NM) that represent an important source of income and jobs for rural communities (44% of all extractive industry jobs in Andalusia fall within the NM sector). These companies are in general small local family businesses (with an average of 6.8 employees per establishment).

The geographical distribution of NM mines and transformation sites varies according to the type of mineral. Production sites of aggregate minerals are relatively dispersed across the territory, while the extraction and transformation of industrial minerals and ornamental rocks are rather concentrated in Almería. The greater concentration of the last two types of minerals represents relevant sources of growth for specific municipalities. In industrial mineral, gypsum, for example, is mainly located in the area of Sorbas-Tabernas

in Almería and to a lesser extent in Cádiz, Granada and Seville. In terms of marble, its production is mainly located in Sierra de Macael, Almería.

The geographical concentration of some of these minerals, make this sector highly important in cultural and social terms. Many of those communities identify themselves with this type of mining and have built know-how and history around it. One of the sectors with the most identity and history is the ornamental marble industry of Almería (Box 3.3). Andalusia host around 44% of the total number of jobs in the Spanish marble extraction sector (2018), of which 90% are located in Almería (Spanish National Government, 2020[3]). More than 80 families exploit and transform marble in Sierra de Macael in Almería, making this sector the main economic activity of the area.

Table 3.3. Non-metallic activity in Andalusia, 2018

	Industrial minerals	Ornamental rocks	Aggregates and construction rocks	Energy minerals*	Total (including metallic mining)
Number of establishments (a)	37	69	350	3	464
Employees (b)	324	355	2 355	53	7 424
Average number of employees per establishment (b)/(a)	8.7	5.1	6.7	17.6	16
Production value (EUR million)	24.3	25.2	196	2.2	1 346
Prospectivity (%)**	59.6 (includes gypsum and structural clays)	14	98.3	n.a.	n.a.

Note: n.a stands for not available.
* Energy mineral extraction (especially coal) was an important subsector but has been steadily declining in the past decades. It is no longer significant in terms of companies, employees or value and will thus not be analysed here.
** As a percentage of prospective geological formations within the whole Andalusian territory. Please note there is potential overlap between geological formations prospective for more than one substance.
Source: Adapted from Spanish National Government (2020[3]), *Estadística Minera de España 2018 [Spain's Mining Statistics 2018]*, https://energia.gob.es/mineria/Estadistica/Paginas/Consulta.aspx.

Box 3.3. The Macael Marble District: A matter of identity

NM minerals include different subsectors with, in certain cases, well-defined and disparate elements that would argue for separate analysis. It is not necessarily intuitive to lump together peat and cement, for example, and subject them both to the same examination. But among these, there is perhaps no single sector in the Andalusian setting that has as many defining traits as the ornamental marble industry of Almería.

Indeed, the south-eastern province of Almería, and in particular the production and transformation hub near its geographical centre – the MMD –, concentrates almost 74% of the ornamental rocks' extractive industry of Andalusia. The MMD is comprised of the municipalities of Cantoria, Fines, Líjar, Macael, Olula del Río and Purchena which, taken together, accounted in 2012 for 95% of all Andalusian marble production (Regional Government of Andalusia, 2013[7]).

In terms of transformation – which, in the case of ornamental rocks, is an essential component of value – Andalusia boasted a total of 805 companies in 2012, which at that time represented 23% of the Spanish total (Regional Government of Andalusia, 2013[7]). In 2012, the MMD had 175 "cutting, carving

and finishing" companies, which allowed its products to compare favourably against other Spanish marbles, precisely on account of its transformation.

But regionally critical as it is and barring the notable exception of the company Cosentino SA, the MMD is highly atomised and made up of micro-, small- or at most medium-sized companies. In 2012, almost 89% of MMD companies had no employees (other than their owners) or less than 10 employees. This in turn correlates with a high degree of outsourcing: administrative work, human resources and payroll, legal advice, machinery repair and maintenance, among many other tasks are all covered in great proportion by external help.

As is the case with most NM products, uses and sales of ornamental marble are also highly dependent on strong construction demand. Whenever markets dry up (as was the case during the Spanish construction crisis of the past decade), the whole MMD feels the pinch. Finally, from a social viewpoint, the MMD is made up of small communities, with decreasing and ageing populations (both trends above Andalusian averages) and a high dependency on the marble industry's well-being.

These demographic and socio-economic factors, taken together with the high concentration of the industry in a few municipalities, the small average size of the companies and the consequent lack of financial or management wherewithal to better navigate the cyclical crisis of the sector, all pointed to the advisability of a co-ordinated action between the different MMD actors. That was the goal of a regional government sectoral study (Regional Government of Andalusia, 2013[7]), which suggested greater co-operation and internationalisation of the sector, and was in turn partially captured by the AMS 2020.

One of the actions envisioned under Axis 1 of the AMS is regional government support to the mining industry's different sectors. In this regard, during 2017 and with the assistance of the regional government, two main actions took place to improve co-operation in the sector:

- A *Marca Macael* (Macael Trademark) event took place in New York, as part of a trade delegation involving Andalusia's EXTENDA foreign trade entity and the Andalusian Marble Industry Association (AEMA).
- The 31st Award Ceremony of the *Premios Macael* (Macael Awards) was organised by the AEMA. During this event, the 8th International Meeting on Natural Stone took place and gathered important companies specialised in natural stones.

Source: Regional Government of Andalusia (2013[7]),*Diagnóstico del Sector del Mármol de Macael (Diagnostic of the Macael Marble Sector: Strategic Initiative for Co-operation and Internationalization]*, https://ws050.juntadeandalucia.es/portalandaluzdelamineria/EMA2020.action; Regional Government of Andalusia (2013[6]), *Estrategia Minera de Andalusia 2020 [Andalusian Mining Strategy 2020]*; Regional Government of Andalusia (2018[10]), *Estrategia Minera de Andalusia 2020 – Seguimiento 2017 [Andalusian Mining Strategy 2020 – 2017 Update]*.

A sector with transformative activities located in the same place of extraction

As for the transformation of non-metallic (NM) minerals, Andalusia has a strong cement industry, internationally regarded with structural ceramic products and both traditional and world-leading technologies applied to the transformation of ornamental rocks. In general, apart from the case of ornamental rocks and contrary to the metallic sector, the NM industry does not require complex processes before the product is put to market. Yet, in Andalusia, there exist a few notable exceptions of the more complex transformation process of NM minerals: ornamental rocks, clays for structural ceramics and cement:

- Ornamental rocks require cutting and finishing, and there is a whole slate of transformation companies throughout the region. These are mostly concentrated in the MDD (Box 3.3) where the experience of a particular company, Cosentino, stands out as a good model (Box 3.4).
- In the case of clays for structural ceramics, Spain in general and Andalusia in particular are world-famous for their decorative ceramics and pottery. This is a traditional and well-established subsector with a strong export profile. The transformation is highly artisanal and made in small and generally family-owned workshops, following time-honoured processes. As such, its relevance is cultural and historical, as well as economic.
- In more industrial terms, cement is an important subsector within the non-metallic transformation setting in Andalusia. The region boasts a total of seven cement plants, distributed around the coastal areas and near the main cities, which makes it the largest cement exporter in Spain. Cement plants are owned and operated by large, multinational companies which, aside from supplying local demand, can export their products to other markets whenever there is a need for it. In recent years (following the construction and real estate crisis of the last decade), the Andalusian cement production was strongly export-oriented.

Box 3.4. Innovation in the Non Metallic transformation sector: The case of Cosentino, SA

The Cosentino, SA story is one of success, showing that innovation and drive can turn a regular natural marble producer into a world leader in the "technical surfaces" market. Starting in 1979 from humble origins –Cosentino was one of a myriad of small marble extractors and processors in the Macael Marble District (MMD)–, the company has grown to become one of Andalusia's leading multinationals, as well as one of Spain's Most Renowned Trademarks (see www.marcasrenombradas.com). This family-owned company employs today 4 800 people in Andalusia and around the world.

In spite of owning several marble quarries (starting from just one) and producing natural rock products, the company's extraordinary relevance and success are due to its transformation activities and innovative approach.

Indeed, the product that would position Cosentino in the global markets is Silestone®, a "technologically advanced surface" that came about in 1990 and is mainly used as countertops in kitchens and as surfaces for bathrooms around the world. It is an artificially created surface, made up of a combination of minerals (mostly quartz) and resins, through a process that includes high pressures and temperatures, as well as strict quality control protocols. The result is both aesthetically pleasing and technically advanced (e.g. scratch-, stain-, shock- and acid-resistant, durable, low maintenance, easy to clean, etc.), and rapidly found an eager global demand.

Following this success, Cosentino continued searching for innovative and highly specialised products, developing Sensa by Cosentino® (a specially treated granite), as well as Dekton®, an ultra-compact surface that is its current flagship development. Cosentino is today physically present in 30 countries and sells its products in 110 countries (90% of its revenue come from export markets) but has strong Andalusian roots with large investments in the region. In fact, seven of its eight factories are located in the Cantoria area in the province of Almería.

Source: Regional Government of Andalusia/Asociación de Empresarios del Mármol (2013[7]),*Diagnóstico del Sector del Mármol de Macael (Diagnostic of the Macael Marble Sector: Strategic Initiative for Co-operation and Internationalization]*, https://ws050.juntadeandalucia.es/portalandaluzdelamineria/EMA2020.action; Cosentino SA (https://www.cosentino.com/cosentino/).

Other minerals have scope for greater transformation processes in the region. This is the case of gypsum, whose production is the largest in Spain, which in turn places Andalusia as a leading exporter in the EU.

The gypsum mines in Almería are relatively large in international comparison, benefitting from high purity levels and close proximity to ports. While the region has two large production facilities, Knauff and Saint Gobain, complemented with other ones of lower capacity, most of the gypsum extracted is set aside raw for export. As the next section will explore, finding a mechanism to add higher value to minerals before export should be an important target for the region.

In sum, the Andalusian NM mining subsector is multifaceted and certainly relevant. Its importance stems from its high prospectivity (large endowments in many NM materials), its geographic dispersion and social penetration and its role as a provider of jobs and economic activity in rural municipalities.

Andalusia's mining equipment, technology and services sector

A complementary element in the mining business environment of Andalusia is the range of providers of mining equipment, technology and services (METS) to the extractive sector. This group of companies plays an important role in the development of a resilient and sustainable mining sector providing competitively sourced services and equipment to local miners, as well as becoming a conduit for the benefits stemming from the extraction of mineral resources (METS Ignited, 2016[11]). These are captured and transformed into long-term business propositions that transcend the eventual depletion of mineral reserves.

As such, a healthy and vibrant METS sector is both an enabler of and a multiplier of the positive effects from the mineral extractive industry (Table 3.4). Leading mining jurisdictions around the world have identified the positive impact and effect of the METS sector and are busy designing and implementing public policies to support and improve their respective METS ecosystems.

Table 3.4. METS sector footprint and public policy initiatives: The issue in Australia and Canada

	Economic impact	Employment	Main policy objectives/axis of work
Canada	CAD 18.9 billion (GDP contribution, 2014)	151 000 jobs • 93 000 direct jobs • 58 000 indirect jobs	• Create a hub for innovation in mining • Continue to build on trade relations • Increase sector-specific public programmes and funding • Strengthen Canada's brand • Build skills for the future • Develop policy to encourage innovation
Australia	AUD 92 billion (GVA, 2012)	503 000 jobs • 300 000 direct jobs • 203 000 indirect jobs	• Aligned strategy (METS + mining sector) • Global brand • Internationally competitive sector • Collaborative and innovative • Skilled for the future (2026)

Source: PWC (2019[12]), *Canada's Mining Supply and Services Ecosystem and Exports*; METS Ignited (2016[11]), *Mining Equipment Technology and Services: 10 year Sector Competitiveness Plan, Brisbane*, http://www.metsignited.org/Category?Action=View&Category_id=74.

Andalusia's mining sector has already attracted a number of companies providing specialised equipment (pumps, communications, personal protective equipment [PPE]), services (maintenance, engineering) and technology (geological surveying, software design). The Mining and Minerals Hall biennial event included in its last edition (October 2019) a roster of more than 100 METS companies participating from Andalusia, other regions of Spain, Portugal and Europe.

Aside from the obvious economic impacts and sustainable development effects of a strong Andalusian METS sector, there are other benefits that, even if harder to quantify, should not be overlooked. A well-developed METS sector provides support and community engagement that is key from a social license point of view. Andalusia should focus its public policy on further developing its METS sector. A revised Andalusian Mining Strategy should include a specific chapter on this strategic complement to the extractive

and transformative mineral sectors, including a valuation of this sector in terms of employment and value-added (Chapter 4).

In summary

The Andalusian mining business ecosystem includes elements from almost all stages of the industry: i) extractive activities; ii) processing and transformation; and iii) equipment, technology and services providers. Andalusia enjoys the benefit of having a two-pronged mining industry: the metallic and non-metallic (NM) sectors. Collectively, the metallic and NM extractive sectors position Andalusia as the Spanish top mining region.

Metallic mining provides most of the mining value production of the region, mainly related to copper, zinc and lead. The companies involved in the extraction and transformation of metallic products are primarily multinational firms (generally acting through wholly-owned subsidiaries or affiliates), with simultaneous operations in several jurisdictions.

The NM sector is composed of a variety of subsectors, internationally renowned for its cement industry, gypsum, structural ceramic products and ornamental rocks. This sector is relevant for social and economic reasons in Andalusia as it is highly dispersed across the territory and is composed of a large number of generally family and small-sized companies. In the case of the marble industry in the province of Almería – the MDD –, mining even plays a regional identity component.

While most relevant players in terms of production and innovation are multinational entities, there are a number of significant home-grown companies. That is the case with Cosentino in the non-metallic segment, and of Magtel in the metallic mining front. Finally, the Andalusian mining environment also boasts a relevant number of METS providers, from multinationals with varying degrees of regional presence (Epiroc, Metso, Outotec) to Spanish or even local companies (Insersa, Iturri, Roysa).

This diverse mining ecosystem unveils the attractiveness of the region for mining activities. Its geology, geographic location, the good access of mines to cities, ports and airports along with a mining identity that creates community support for mining ventures are all competitive advantages of the region. Mobilising these assets can strengthen the business environment across the mining value chain and help release new job opportunities in the region.

Nevertheless, as explored later in this chapter, this mining business ecosystem is in urgent need of greater integration of operations and commercial relations of its foreign-based companies and METS with the local economy. An active and fluid linkage between mining companies and METS providers can help enhance the regional innovation system, upscale local SMEs and attain sustainable growth. Furthermore, large multinational companies are of special interest to facilitate new business and knowledge exchange in light of their capacity to traction and generate demand, know-how, job opportunities and open markets otherwise non-readily accessible.

Mobilising strengths of Andalusia's mining value chain

As already described, Andalusia is a region with a long history of mining, stretching thousands of years to pre-Roman times. This continues to this day with metals, industrial minerals and ornamental rocks extracted and oftentimes processed locally, a situation which – if properly harnessed – can ensure mining plays an increasingly important role in Andalusia's development. For these, the region needs to mobilise all of the potential of its mining value chain. It includes a strategic location with remarkable geology, good infrastructure and proximity to cities as well as a relevant mining identity with community support for mining.

Attractive geology with the potential of new highly demanded minerals

Mining, as an extractive industry, requires adequate geology as a threshold element. Mineral deposits are geological anomalies on the world's crust consisting of higher-than-average contents of valuable metals or minerals that can be potentially extracted at a profit. Without proper geology, no mining can ever take place.

Fortunately for Andalusia, its subsoil is among the world's most diverse and, after many years of mining, remains highly prospective. Andalusia is home to one of the most productive geologic formations in Europe and around the world containing the IPB (Box 3.5). The Andalusian geological makeup can be divided into 3 main groups, each from different geological times: i) the Hesperic or Hercinic Massif (HM, 380/320 million years old); ii) the Baetic Range (BR, 15 million years of age); and iii) the Neogene Depressions (erosion of rocks from the HM and the BR). A final notable subgroup is the Cabo de Gata volcanic region, in the province of Almería. This age disparity generally translates into great geodiversity and types of minerals, which is indeed the case in Andalusia (Table 3.5).

Box 3.5. The Iberian Pyrite Belt (IBP): A unique resource

The IBP is one of the world's largest and most important metallogenic provinces. It is located in the southwest of the Iberian Peninsula and covers an area of 9 200 km^2 – roughly the size of the island of Cyprus – from the south of Lisbon in Portugal to the city of Seville in Andalusia. The Andalusian provinces of Huelva and Sevilla take up almost 60% of the IPB, while the remainder 40% is in the Portuguese region of Alentejo.

The IPB is one of the most important volcanogenic massive sulphide (VMS) districts in the world (Almodóvar et al., 2019[13]) and has been mined in different stages during more than 5 000 years (Tornos, López Pamo and Sánchez España, 2009[14]). VMS deposits are typically "small to medium-sized, moderate to high grade" copper-lead-zinc-gold-silver mineral deposits (Stevens, 2010[15]) and are formed by hydrothermal (i.e. hot liquid) fluids that circulate through a sequence of volcanic rocks, exiting on the bottom of the sea as a plume or "black smoker" of metal-rich fluids.

Several VMS occurrences are found in different parts of the world (Alaska, Australia, Canada) but the IPB's extension and the abundance of deposit make it one of the most significant. The Riotinto deposit is considered to be probably "the biggest sulphur anomaly on the Earth's crust, with original tonnages around the 2 500 million tonnes of mineralised rock in different degrees" (Tornos, López Pamo and Sánchez España, 2009[14]).

Even after many centuries of mining activities, the IPB remains an exceptionally large and relevant metal geological asset. Aside from the aforementioned copper-lead-zinc-gold-silver complexes, the IPB "retains a large potential for non-traditional (or accessory ores) products […] Metals like indium, selenium, germanium, rhenium and the precious metals are targets to seek in future exploration scenarios within the IPB" (de Oliveira et al., 2020[16]).

The oxidation and erosion, both natural and human-induced over millennia of mining activities, has created in the IPB a one-of-its-kind environment that is even being studied as a proxy for Martian conditions (Amils, Fernández-Remolar and The IPBSL Team, n.d.[17]).

Some of the main deposits found and exploited over the years in the IPB have been:

- In Portugal: Canal-Caveira, Lousal, Sao Domingos, Aljustrel and Neves-Corvo (the last two are today in the production of copper and zinc).

- In Andalusia: Aguas Teñidas, Concepción, Herrerías, La Zarza, Las Cruces, Poderosa, Riotinto, Sotiel and Tharsis.

Source: Tornos, F., E. López Pamo and J. Sánchez España (2009[14]),"The Iberian Pyrite Belt", in *Contextos geológicos españoles: una aproximación al patrimonio geológico de relevancia internacional*; Stevens, R. (2010[15]), *Mineral Exploration and Mining Essentials*; Almodóvar et al (2019[13]), Massive Sulfide Ores in the Iberian Pyrite Belt: Mineralogic and Textural Evolution, https://doi.org/10.3390/min9110653; Oliveira, D. et al. (2020[16]),"Mineral sustainability of the Portuguese sector of the Iberian Pyrite Belt", *Comunicações Geológicas*, Vol. 107/3, pp. 11-20; Amils, R., D. Fernández-Remolar and The IPBSL Team (n.d.[17]),"Río tinto: A geochemical and mineralogical terrestrial analogue of Mars", *Life*, Vol. 4/3, pp. 511-34.

Table 3.5. Andalusia's diverse geological makeup

	Location	Main features	Mineral prospectivity
Hesperic Massif	North of Andalusia Northernmost parts of the provinces of Córdoba, Huelva, Jaén and Sevilla	About one-third of the Andalusian territory Home to the Andalusian part of the IPB Sierra Morena range	High metallic prospectivity Main metals present: copper, lead, zinc, gold, silver Other metals (traces or small deposits): cobalt, nickel, uranium, tin Presence of industrial minerals: feldspar, fluorite Presence of ornamental rocks: granite Andalusia's sole coal deposits (Guadiato valley, Córdoba)
Baetic Range	South of Andalusia South of the provinces of Almería, Cádiz, Granada, Jaén and Málaga	Largest geological zone: about half of the Andalusian territory Sierra Almagrera, Sierra de los Filabres and Sierra Nevada ranges	Medium to low metallic prospectivity Main metal present: iron ore Other metals (traces or small deposits): copper, silver, lead, nickel, molybdenum High ornamental rocks prospectivity: marble, limestones Presence of industrial minerals: talc, gypsum, fluorite
Neogene depressions	Central Andalusia South of the provinces of Córdoba and Huelva, centre of the provinces of Jaén and Sevilla Pockets in other provinces (Baetic Range)	About one-quarter of the Andalusian territory Guadalquivir depression (valley) Intra-mountainous depressions (Almería, Granada, Ronda)	Low metallic prospectivity Main metal present: gold (placer deposits, heavily exploited in the past) High industrial minerals prospectivity: gypsum, strontium, talc, siliceous sands, clays, peat Medium ornamental rocks prospectivity: limestones
Cabo de Gata	East of the province of Almería	Volcanic region, high hydrothermal activity	High metallic prospectivity Main metals present: lead, zinc, copper, gold, silver, manganese Other metals (traces or small deposits): tin, tellurium, High industrial minerals prospectivity: bentonite Low ornamental rocks prospectivity

Source: Adapted from Regional Government of Andalusia (2013[18]), *Diagnóstico sobre la Situación del Sector Minero Andaluz [Diagnosis of Andalucia's Mining Sector and its Trends as Support for the Regional Mining Strategy].*

This unique formation together with Andalusian mineral endowment is key in terms of the metallic composition of the future. Andalusia's mineral deposits contain at least some quantities of minerals identified as critical to supporting the generation of clean energy technologies, including zinc, lead, silver, nickel, cobalt, copper, molybdenum, manganese and iron ore. Some of those critical minerals are expected to be in very high demands and others will be in short supply for at least some time. The EU has considered some of these minerals in a list of critical raw materials (Chapter 4) and other organisations such as the World Bank have also produced lists of critical minerals from the climate-change-mitigation viewpoint (17 minerals) (World Bank Group, 2020[19]). Furthermore, new technologies could allow extracting some of those critical materials out of the region's old and new mines or waste mining.

To seize this opportunity and attract firms interested in traditional and critical minerals, the region's geological information needs to be up to date, by providing a mapping of new minerals and waste mining that can be reused. Current geological information in Andalusia has scope to be updated and its accessibility through the website of Andalusia Mining (*Portal Andaluz de la Mineria*) improved. Better accessibility on Andalusia's geology could also involve administrative procedures and the other advantages offered by the regional mining value chain. Displaying clear information on Andalusia's mining website can enhance the attraction of investors and researchers.

This opens up a great opportunity for Andalusia's mining sector to become a supplier of certain elements that will be in high demand in future, while at the same time becoming a key partner in a sustainable future and the mitigation of climate change. To mobilise this asset, Andalusia should:

- Take steps to ensure that adequate exploration of its geology is carried out, in order to identify deposits that can be brought into production. It involves updating and making more accessible Andalusia's geological information in collaboration with the Geological and Mining Institute of Spain as well as improving the accessibility to geological information on Andalusia's mining website, with special attention to the mapping of critical minerals

Geographic location: A natural gateway to and from the EU

Andalusia also enjoys the bonus of an advantageous geographical location and characteristics. It is the southernmost region in Spain, its second-largest, as well as its most populous (Chapter 2). Andalusia shares borders with: the Autonomous Communities of Extremadura and Castilla-La Mancha to the north, and Murcia to the east; with Portugal to the west; and is bound by the Atlantic Ocean and the Mediterranean Sea to the south (with ports opening to both seaways).

Andalusia also sits at two important meeting points: physically, it is the closest EU region to Africa (barely a few kilometres across the Strait of Gibraltar) and is culturally close to Latin America (many of the administrative centres of Colonial Latin America were in Cadiz and Seville).

Africa sources many of the minerals to Europe, which has positioned the continent as a key partner to ensure sustainable supply, while supporting the "responsible sourcing" of raw materials. In many European jurisdictions, the trend over the past decade has been towards ensuring "responsible sourcing" of raw materials (Van den Brinka et al., 2019[20]). This means that minerals should be found, extracted, processed and traded in ways that are socially, environmentally and economically sustainable and that do not contribute to the generation or continuity of conflict or human rights abuses (OECD, 2016[21]).

Responsible sourcing initiatives provide Andalusia with the opportunity to engage with African mineral producers and assist them in gaining certification regarding their products and processes. Andalusia should look into ways to do so, as it would be a win-win proposition for all stakeholders involved: the producer, the buyer and Andalusia itself. Andalusia should become a natural partner in these efforts. However, aside from participating in European initiatives, Andalusia should strive to become a key partner for African mining jurisdictions and companies seeking to supply mineral products to the European markets.

These “responsible sourcing” certification services could of course be applied to minerals obtained from other regions of the world, chiefly Latin America. Cultural linkages between Andalusia and Latin American producers of mineral products should also be leveraged, with Andalusia eventually becoming a gateway into European markets. Being able to provide assistance and evidence that a given project is carried out under similar requirements to those applicable in the EU, should be of common benefit to the project, the host community and jurisdiction and Andalusia itself. The “sustainable mining” brand of Europe should be explored as a competitive advantage.

To seize this geographical and cultural proximity, the regional government of Andalusia should facilitate the links with African and Latin American mining jurisdictions to become a gateway to and from the EU in sustainable mining processes and technologies. This involves developing an action plan to promote networking and partnerships with those jurisdictions and their established companies as they seek to adopt sustainable mining practices and promote responsible sourcing of minerals to Europe.

Aside from the African and Latin American proximities, Andalusia is also close to another relevant jurisdiction: Portugal. As seen previously, Portugal and Andalusia share the prolific IPB and they are both intent on developing their resources. Further collaboration with its western neighbour would allow Andalusia to leverage European funds aimed at cross-border integration and development (Chapter 4). Also, Portugal’s support for IPB-related initiatives would allow Andalusia to benefit from the resources and fora that the European institutional system reserves for countries. Areas of common interest and work should include joint promotion of the IPB as a mining investment destination, research and basic geological information gathering, a common development strategy and prioritisation of the sector before relevant European authorities and initiatives (Chapter 4).

Good accessibility of mines to urban centres and a competitive infrastructure

In addition to the advantages provided by its rich subsoil, geographic location and cultural proximity to important mineral producers, Andalusia benefits from mining activity in close proximity to urban centres and a well-established infrastructure that make it a favourable mining destination.

Benefitting from the mining proximity to cities

The fact that Andalusia’s mining potential sits close to large urban centres is another feature that should be considered among its strengths. In many mining jurisdictions in the world, mining occurs in remote and isolated areas (the Pilbara region in Australia, the Arctic Circle in Canada, Finland or Sweden, or the high Andes in Chile and Peru). In contrast, mining in Andalusia takes place in generally mild climates, at low altitudes and within easy reach of many urban centres. The CLC mine is barely 30 minutes (30 km) away from Seville (1.9 million inhabitants), while the Aguas Teñidas and Riotinto mines are a little more than an hour’s drive (75 km) from Huelva (524 576 inhabitants).

This practically unique situation brings to Andalusian mining the bonus of not having to operate in isolation, which is so common to many mining projects. Logistics, stocks, health, safety and personnel matters are all greatly simplified by having large urban centres closely at hand. This also facilitates the exchanges with universities, technological centres and public bodies as well as with suppliers from various economic sectors. The historical proximity to urban centres should also be showcased internationally to attract investors and high skilled workers that want to benefit from the amenities offered by cities. Furthermore, such closer interaction with cities is an opportunity to help improve the community perception towards mining and prove that mining can be done harmoniously with other economic activities and people’s lives.

Yet, this proximity may affect cities and their functionality as well as create land use conflicts. Without proper management, some of the negative environmental externalities created by mining can be accentuated when operations are close to cities. Dust from exploitation, mineral transportation, visual pollution, water management and conflicts on the use of land are just some of the issues that can create

conflicts among mining activities and people and businesses in neighbouring cities. These challenges could ultimately reduce the attractiveness of the region and affect social perception for mining ventures.

Improving the linkages among cities and mining can boost the competitiveness of the mining value chain and make the region more attractive for people and firms to enjoy the advantages of a city while working in the mining sector. To make the most of this proximity, Andalusia should ensure urban planning and infrastructure plans are co-ordinated with mining development plans. This involves encouraging co-ordination with municipal land use plans and alignment with the local vision/needs of urban development (parks, recreational spaces, etc.) by including citizens' opinion in the co-ordinating plans.

Making the most of infrastructure for mining development

Mining requires certain essential infrastructure if it is to develop its full potential, including roads, railroads, airports and ports for the inward flow of raw materials and personnel, as well as for the industry's outward flow of products. A reliable energy supply, both in the form of generation and transmission capabilities, is also a key element to power mining operations and processing plants. Likewise, communication and IT networks, particularly high-speed broadband, is increasingly a need for mining, allowing remote operations and automation transition. Missing items in essential infrastructure can penalise the mining attractiveness of a region, as a certain number of projects cannot be brought to production in economic terms.

Fortunately for Andalusia, its starting point in many of the infrastructure requirements is a strong one:

- **Roads and the railroad network**. Good density of roads (311 km of roads per million inhabitants, which would rank it 4th compared to EU countries. For firms and people, high-speed railroads connect Andalusia's main cities (Cadiz, Cardoba, Granada, Malaga and Seville) to Madrid in approximately 2.5 hours.
- **Ports and airports**. Good density of commercial ports (10 ports in the region) with Algeciras as the largest Mediterranean port in terms of container traffic. Five airports with international flights and airborne cargo volumes increasing in Almeria and Seville airports.
- **Logistics hubs**. Andalusian logistics infrastructure is part of two Trans-European Transport Network (T-ETN): Atlantic (Lisbon-Strasbourg) and Mediterranea.
- **IT communications**. As documented in Chapter 2, the region has a good penetration of broadband services (92% of households with at least 2-10 Mbps services).
- **Power generation, transport and distribution**. A diverse and potent mix of energy sources, with a high proportion of renewables (39% of total Andalusian power generation). Power lines that include connections with Portugal and Morocco.

The diverse and export-oriented mining industry in Andalusia makes infrastructure a key area to improve sectoral productivity. Metallic and NM mining companies use railroads and trucks to move their products to production sites and ports. For many products, especially NM, transport costs account for an important share of final value. Improvement in transport efficiency, including quality of roads and railroads, as well as waiting times at the port, can thus boost the international competitiveness of the sector.

Nevertheless, work remains to be done to enhance infrastructure and take full advantage of opportunities associated with mining development. There has been little to no significant new investment in railroads and the interconnectivity between main ports and railroad network has scope for improvement. Likewise, there is a slow execution of key public investment plans for the development of the T-ETN (especially the Algeciras-Bobadilla-Madrid railroad connection).

Furthermore, broadband coverage in the region is of relatively lower speed when comparing with other mining regions (Chapter 2). Deployment of high-speed broadband should be a strategic target for the government if the region aims to seize the benefits of digitalisation to remain competitive and help reduce carbon emission in its mining process (automation of mines).

Despite the chief relevance of transport for this sector, there seems to be a lack of co-ordination among infrastructure plans and mining strategies within the region. The regional government's Transport Infrastructure Plan and the Energy Plan do not consider the Andalusian Mining Strategy 2020. Greater co-ordination with infrastructure strategies is not only needed for the competitiveness of the mining sector but also to avoid disruptions with other economic activities that rely on regional infrastructure (tourism and agriculture). This overall co-ordination should also help ensure the effective access of raw materials (e.g. aggregates and construction rocks) to infrastructure developments in the region.

Greater regional and national government co-ordination around infrastructure is also needed, as the main railroad network, port and airports are under the national government jurisdiction. For example, when it comes to airports, Andalusia is responsible solely for smaller airstrips and heliports facilities and, in ports, the region is in charge solely for recreational and small/artisanal fishing ports.

Strategic infrastructure projects with high potential for mining development need important support from all levels of government. For example, the reopening of strategic railroad segments, including the Andalusian-Portuguese link through Huelva-Ayamonte-Faro, in the Atlantic Corridor can create the conditions for collaboration with Portuguese mining regions. Improving government co-ordination among infrastructure and mining projects and with national government plans should be a relevant strategy for Andalusia as it could benefit growth and environmental outcomes in the region. Chapter 4 will further outline policy recommendations to improve multi-level governance co-ordination.

In summary, relevant actions that the regional government should undertake to improve its infrastructure include:

- Seeking to understand the NM and metallic mining sector's current and future infrastructure requirements, to facilitate co-ordination with regional and national infrastructure, urban, land use and business plans. This co-ordination should aim to increase the efficiency of transport (e.g. times) of raw materials and align mining projects with improvements and new developments of infrastructure.
- Explore opportunities to associate more closely with Portugal for the joint development of the IPB and leverage this linkage to secure European funding or prioritisation of infrastructure works in the IPB (Chapter 4).

Making the most of the community perception towards mining

The prosperity of mining depends largely on community support. Community members who feel heard and sense that their concerns are reflected in action show greater acceptance of mining operations. As mining activity generates positive and some negative externalities, a low level of community support can lead to a series of bottlenecks. These include a lack of confidence in the regulatory framework and blockade actions to mining activities. On the contrary, the stability of public opinion is highly valued in sectors such as mining where investments reach relatively big magnitudes (Maoping and Xu, 2012[22]).

Andalusia's long mining history has created a strong mining identity across the region. The supply of sustainable employment and local development in a regional context with high unemployment and seasonal economic activities has entrenched the positive attitude towards mining. This identity is a positive asset for the region as help the development of mining ventures. However, automation of tasks in mines and increased local awareness of environmental protection is escalating concerns from public interest groups around mining ventures. Mobilising its strong mining identity and enhancing community engagement to prevent negative perception for mining could put Andalusia in a favourable position in internationally competitive markets.

A region with a strong mining identity

Spain stands out thanks to a better community perception of the employment benefits from mining relative to other European mining countries, including Finland and Germany (INFACT, 2018[23]). According to the INFACT survey, which gathered more than 3 000 citizen responses, 60% of Spaniards showed an attitude between neutral and positive towards mineral exploration, Moreover, 95% of the inhabitants from mining municipalities would accept mineral exploration initiatives if they lead to an effective revitalisation of the economic activity of the region.

At the regional level, Andalusia benefits from greater community perception among Spanish regions. This is particularly the case of traditional mining communities in the IPB (Requejo Liberal, Blázquez Gómez and Del Río Orduña, 2018[24]). Despite the impact on perception after the environmental disaster in the Aznalcóllar mine at the end of the 1990s, Andalusian communities kept recognising the benefits mining has brought to the local economy. Moreover, since mining investments worldwide tend to concentrate in geologically promising regions that are also viewed as mining-friendly, the outside world's consideration of the mining attractiveness of a given jurisdiction is likewise crucial.

Concrete actions from local governments have helped support a positive citizens' perception of mining. For example, in 2019, the mayors of the seven municipalities that make up the Rio Tinto Mining Basin, together with the members of Atalaya Mining's enterprise committee, agreed to ask the Junta de Andalusia to expedite the resolution of the Unified Environmental Authorisation (AAU) in 2019 as part of joint action in favour of mining in the region. The political representatives of the municipalities highlighted the generation of employment and economic prosperity in the surrounding municipalities where mining takes place (Huelva Información, 2019[25]).

Private companies have also conducted a number of programmes to increase the well-being and income of local communities. For example, CLC has conducted corporate social activities to support the diversification of the local economy, which has contributed to maintaining the mining identity. Other practices have aimed to enhance local training and education, including the Holcim Chair for Sustainable Construction project launched by Holcim and the School of Architecture (ETSA) of the University of Seville (US) to promote interdisciplinary teaching and research activities that study the reality, problems and prospects of sustainable construction. These practices can be enhanced and better co-ordinated by linking them with regional development programmes, to ensure a sustained impact at the local level and help strengthen the perception of mining effects on local development.

Nevertheless, automation and climate change undermine the positive perception

Despite the positive perception of mining in Spain and Andalusia relative to other jurisdictions, there is a need to better inform social perception (INFACT, 2018[23]). Economies with a high degree of specialisation in manufacturing and mining could face important risks of job displacement, as this sector contains a high proportion of repetitive tasks. This can undermine the benefits mining has on local employment. In parallel, the increased flow of information on the environmental effects of mining along with greater societal awareness and political will for environmental protection is boosting concerns with regards to mining ventures. These aspects can threaten the community support for mining in Andalusia.

The above-mentioned survey on perception concluded that social perception is not based on sufficient information to form a solid opinion. Andalusians are not fully aware of the role of mining in the economy and the relevance of raw materials for economic sustainability. Further, not all civil actors share the positive vision of mining, since certain civil organisations (Amigos de la TIerra, Ecologistas en Acción, Greenpeace, SEO/BirdLife and WWF) emphasised in 2018 the environmental dangers associated with mining, with the Aznalcóllar spill catastrophe as a stark reminder, even after more than two decades.

In fact, in spite of a generally welcoming approach, the community lacks information on some basic aspects of the industry including, among others: the relevance of raw materials to attain climate neutrality (Chapter

4), the economic relevance of mining for regional and national development and the environmental, social and technical standards currently applied to and by the industry.

Without a consistent citizen information strategy involving all actors and aiming to boost perception, a misinformation campaign on mining impacts could have a major influence on public opinion. One of the strategies to help modernise the image and perception of mining is with sound mining branding (Chapter 4). This branding should not only focus on the extraction but rather stress the benefits that mining brings to the economy as well as the technological advances that help make progress towards a low-carbon economy among other things. Chapter 4 explores in more detail the branding of the mining industry in Andalusia.

In order to mobilise the community and materialise the region's long-time support of mining development towards regional development, the regional government of Andalusia should:

- Involve all stakeholders in the design of the mining strategy, including citizens, universities and environmental groups (Chapter 4 elaborates more on this).
- Integrate public interest groups in mining venture proposals from the beginning. Legitimacy and trust are gained through transparency, fundamentally by giving all parties involved a voice and an inclusive role throughout the mining venture process (see the last section in this chapter).
- Encourage discussion between the community that supports mining and those that are reluctant. A sustainable mining community resides in the capacity of dialogue between all stakeholders. Dialogue sessions among citizens can be hosted in the Mining Hall every two years and before every project. Anti-mining interest groups could be engaged through citizen-to-citizen invitation and by partnering with universities for those fora. The experience of "Mining with other eyes" in Chile can be a guide for Andalusia (Box 3.6).
- Link regional development programmes with mining companies' social responsibility programmes in local communities. This involves complementing existing private programmes with communication strategies and co-ordination with regional programmes to scale up the projects in the community.

Box 3.6. "Mining with other eyes" – The Chilean information campaign on mining industry engagement initiatives for sustainable development

The National Mining Society (SONAMI) together with the Chilean Mining Council organised the Month of Mining with a series of initiatives among which the campaign "Mining with other eyes" (*Mineria con otros ojos* in Spanish). As part of this brand campaign, a wide audience was invited to participate through a contest engaging citizens, whether or not related to the mining sector. As a result, the mining sector was able to deliver a message of commitment to sustainable development while improving the perception of the mining sector as a whole.

The prize for participating and being selected by the competition's evaluation committee was an all-inclusive visit (tickets, food and accommodation) to see the different projects being developed by the industry in the field of renewable energy, sustainable innovation and care for biodiversity. Visits to some of the most impactful initiatives driven by the mining sector in Chile included: the BHP Foundation Ayllu Solar Project; the first Photovoltaic Plant built on a mining deposit, by Anglo American; the Codelco Pampa Elvira Thermal Solar Plant and solar project in the town of Toconce; the Teck Rungo Safe Haven project; the Antofagasta Minerals Monte Aranda Cave Park, Laguna Conchalí and Santa Inés Forest; and the CAP Minería Magnetite Mining Recycling Plant.

Source: SONAMI/Chilean Mining Council (2018[26]), *Mineria con otros ojos*, https://mineriaconotrosojos.cl/ (accessed on 4 November 2020).

Unlocking new opportunities within the Andalusia mining value chain

Besides its numerous assets, Andalusia faces various challenges that affect its mining business environment and its interaction with the local economy and well-being. As mentioned in Chapter 2, the region ranks below the Spanish average and the benchmark of OECD mining regions in productivity, income and employment performance. Overcoming this structural gap needs mobilising the assets mentioned previously but in particular addressing some of the persistent bottlenecks in the mining business environment.

This section outlines the main policy recommendations to solve some of the existing challenges in the regional mining value chain in order to transition towards an innovative mining value chain. These bottlenecks include: i) a low level of innovation with lack of linkages among types of firms and low collaboration with universities to prepare the workforce for future industry needs; ii) a large share of low value-added SMEs and entrepreneurs; and iii) a complex regulatory framework for mining ventures.

Boosting innovation within the mining value chain

Digitalisation and climate change are triggering changes in the extraction and transformation of minerals. The industrial paradigm that dominated most of the 20th century, based on an efficiency-driven strategic focus, has given way to one where digitalisation and innovativeness represent the main source of competitive advantage for businesses. This new phase brings fundamental opportunities to increase productivity in the mining industry through technological progress, including automation and digitalisation of the extraction and transformation process.

Beyond increasing productivity, innovation is also a cornerstone of reducing the environmental impact of the mining process and thus accelerating the transition to a low-carbon economy. Most actions to reduce carbon emissions in production value chains either rely on new technologies or new processes (Moazzem, Rasul and Kh, 2012[27]). Many mining companies are making progress towards decarbonisation, including leveraging new technologies and innovations to add renewables to the electricity supply, improving mining processes, reducing waste and optimising transportation (Kirk and Lund, 2018[28]). Those innovations can provide greater competitive advantages to companies while reducing social and political concerns associated with mining activities.

Innovation can also allow mining regions to be less dependent on price fluctuations and external shocks. Whereas in the past, a fall in price may have meant the closure of certain operations or slowdown of activity, innovation is now giving mines greater flexibility, reducing price dependence, and helping to extract new minerals that before were unknown or unworkable. New technologies are enabling simultaneous pluri-mineral extraction from ore, including from mining waste deposits, which can bring greater technical feasibility and economic viability to the mining industry in Andalusia.

Innovation is ultimately shaping the interaction of the mining sector and local economies. Mining and associated companies increasingly require new types of goods, services and skills to support their innovation process. This new demand is a fertile seedbed where new opportunities can sprout for local SMEs and entrepreneurs. This would help to enlarge the ranks of local businesses in the region's mining value chain. In doing so, Andalusia can transform its mining industry from one of mining extraction to a greater value-added industry of advanced mining expertise. If well planned, Andalusian mining communities can fully benefit from these new economic opportunities to offer job prospects to their young population, reduce inequality as well as raise income and well-being.

A weak innovation system around Andalusia's mining value chain

For many historical industrial and mining regions, such as Andalusia's mining provinces, the knowledge and skillset required to produce and compete in the context of the data-driven economy would necessitate

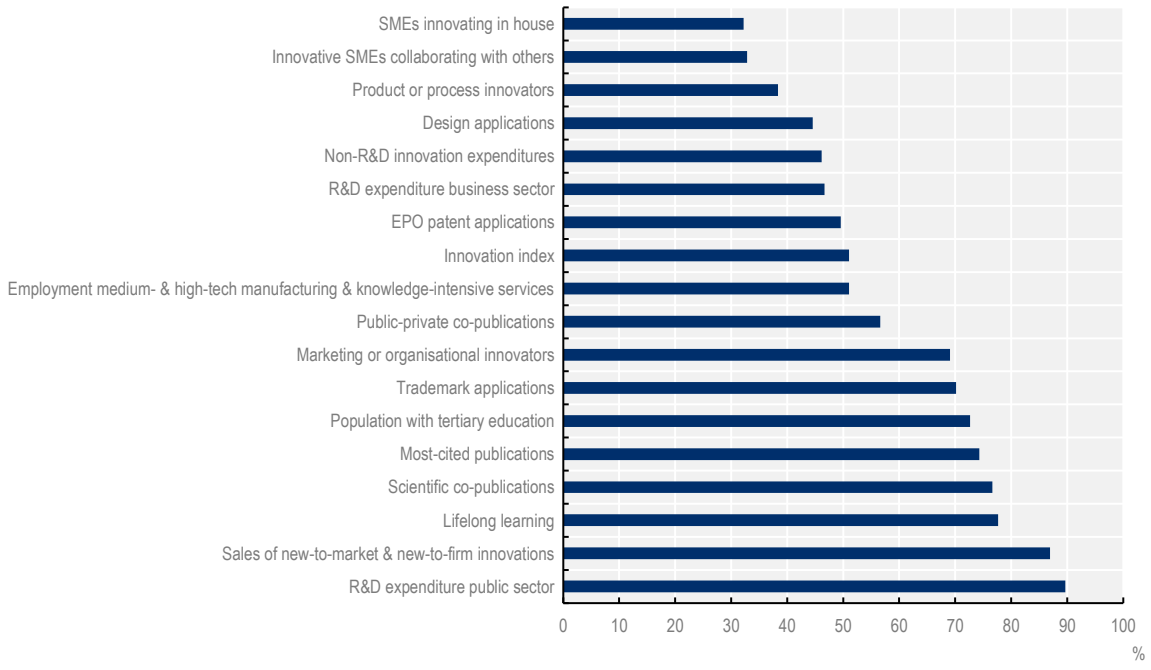
a radical change from existing capabilities. Supporting innovation in mining is a matter of stimulating strong innovation-based development in Andalusia. It has been repeatedly found that innovative regions tend to come up with new value-adding ideas and create new businesses based atop of their existent knowledge space and industrial configuration (Boschma and Frenken, 2010[29]). Mining regions, therefore, tend to advance their innovative capacity in ways related to an existing set of knowledge and skill.

Andalusia does not fare very well in terms of innovation performance compared to similar European regions. In terms of patents, Andalusia ranks unfavourably compared to Spain and other benchmark mining regions (Chapter 2). While it must be noted that patents may be a poor proxy for business innovation when it comes to service-based economies such as Andalusia's, other multifactor measures also reflect a low innovativeness performance in the region.

The EU multifactor innovation index shows how Andalusia's composite index is only half of the European average (Figure 3.1). The indicators that best represent business innovativeness – for instance, product and process innovators, in-company innovating and inter-firm collaborative innovation – all represent Andalusia's poorest scores. According to this innovation index, Andalusia barely reaches a third of the European average for these innovation categories.

Innovation in Andalusia is mostly driven by government spending, public organisations and higher education institutions. In fact, the factors most indicative of the region's innovation are linked to public sector R&D expenditures, scientific publications and higher education (see Figure 3.1). Despite some of the innovative industrial companies, including mining companies such as CLC or Cosentino (Box 3.2 and Box 3.3), the levels of patenting and R&D expenditure from the private sector are below the average regional innovation index.

Figure 3.1. Andalusia regional innovation performance, RES Scoreboard by indicator, 2019



Note: 100 = European country average.
Source: EC (2020[30]), *RIS 2019 (database)*, https://ec.europa.eu/docsroom/documents/36081 (accessed on 23 February 2020).

Despite opportunities in the mining sector, little entrepreneurial activity is oriented towards extractive industries

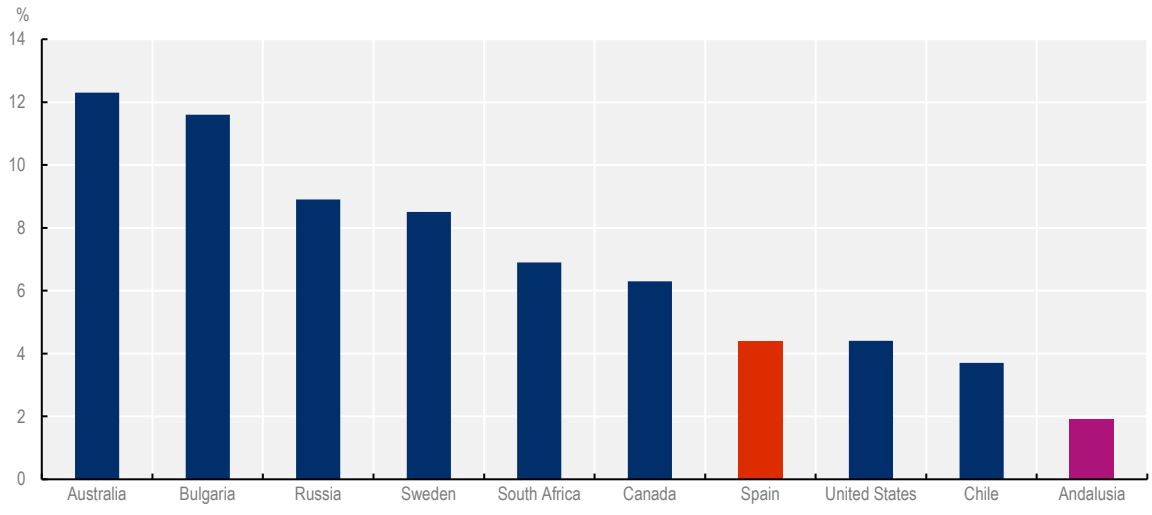
Furthermore, the large majority of nascent entrepreneurs in Andalusia declare that their ventures do not generate innovations of any kind: no new products or services or innovative features thereof, no use of any novel technologies, no process innovation, nor market development (Spanish Entrepreneurship Observatory Association, 2020[31]).

In the specific case of entrepreneurial activity centred towards the Andalusian mining industry, new venture creation is relatively under-represented. Despite the growth of the mining sector over recent years, the proportion of the regional business creation within the extractive industries is relatively low, with most business creation happening in tourism and non-tradeable (stores, restaurants) services.

The growth of business creation around mining is in fact pretty low for the weight of Andalusia's mining in the country (Figure 3.2). The regional's mining entrepreneurial activity in 2019 was less than half of the Spanish average, despite the fact that this national average is pulled down by those regions in Spain with relatively marginal mining sectors. If compared with the sectoral distribution of entrepreneurial activity in other comparatively strong mining nations, the importance of Andalusia's extractive sector-based entrepreneurship is only a fraction of that commonly seen in these countries.

Figure 3.2. Entrepreneurial activity rate in the extractive sector

Measured as the share of total entrepreneurial activity rate in the extractive sector



Note: 2018 data, except for Australia and South Africa, which is from 2017. Entrepreneurial activity is defined as the percentage of working people between 18 and 64 years old, with initiatives in the take-off phase between 0 and 3 months of activity, or in the consolidation phase between 3 months and 3.5 years.
Source: Spanish Entrepreneurship Observatory (2020[31]), "Situation of entrepreneurship in Andalusia in the face of the COVID-19 crisis", https://www.gem-spain.com/wp-content/uploads/2020/10/Informe-GEM-covid19-andalucia.pdf.

Low levels of innovation reflect a lack of effective channels for collaboration within Andalusia's mining system. On the one hand, greater competency exchanges must be channelled from multinational firms through to METS providers and across local companies of all sizes. The region's knowledge space relies on external sources or its few dominant leading firms for innovation, with very little innovativeness percolating out of the region's wider value chain. On the other hand, local universities and research centres need to improve their collaboration with the local business ecosystem to spur ideas and make them sustainable (Government of Andalucia, 2020[32]).

Furthermore, as depicted in Chapter 2, the region's human capital in term of educational attainment, which is essential for innovation, falls below Spain's national average, with the mining province of Huelva scoring some of the lowest levels in the region. For local innovativeness to take hold, the region needs to strengthen its innovation ecosystem by:

- Promoting service innovation through the mining value chain to unlock new business opportunities and innovation capabilities.
- Boosting the role of the third sector to support innovation and entrepreneurship around mining.
- Improving human capital to unlock high-value-added activities around the mining value chain.

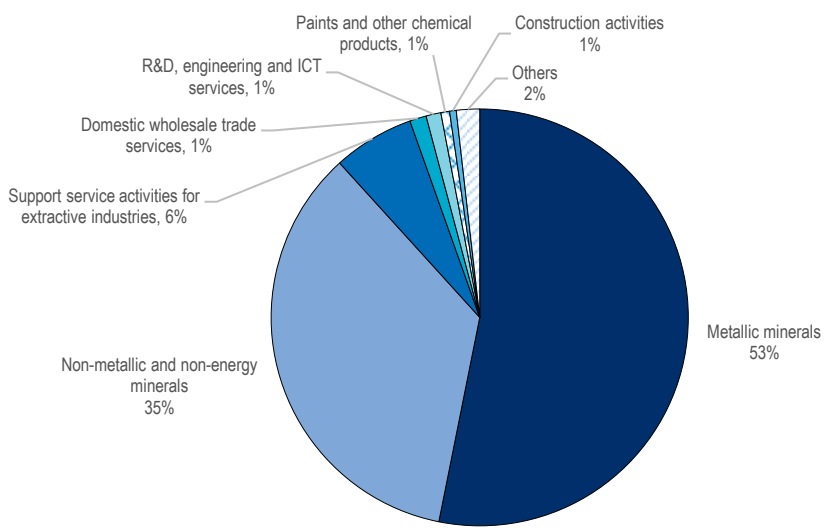
Promoting service innovation in mining for a strong innovative regional system

The mining value chain demands a number of goods and services from the local economy that can be properly channelled to trigger innovation spill-overs for regional businesses. According to an OECD study (2020[33]), out of a sample of 66 countries, 28% of the value-added of mining exports came from different domestic sectors, including services, energy, manufacturing and the agricultural industry. Out of all sectors, services represent most of the backward linkages with mining (18%) (Box 3.7).

The value-added of mining in Andalusia, as in many mining jurisdictions, comes mainly from the sector itself, while the other economic activities adding value to this sector are locally sourced (Figure 3.3). According to the input-output table for Andalusia, the extracted minerals are themselves the main inputs of the final value-added of the mining sector (87% from metallic and non-metallic minerals in 2016). This share is slightly higher than the average across the 65 countries analysed in the OECD (2020[33]) study (Box 3.7), which underlines an opportunity for the region to add greater value to its raw materials. Positively, most of the other inputs that add value to the sector's output are mainly obtained from local activities. *Support services for extractive industries* is the third activity that provides more value-added to the sector (6%), and it is mainly sourced from companies in the region (95% domestically sourced). Other relevant activities for the value added of the sector are domestic wholesale trade services (food process, rubber and plastic products) and R&D services.

Figure 3.3. Inputs to the Andalusian mining extractive industry, 2016

Inputs to mining value-added on basic prices



Note: Others include: glass and stone products, cement, energy minerals and fossil fuels, among others.
Source: Based on Institute of Statistics and Cartography of Andalusia (2017[34]), *Andalusia Input-Output Framework*, http://www.juntadeandalucia.es/institutodeestadisticaycartografia/mioan/ (accessed on 15 December 2020).

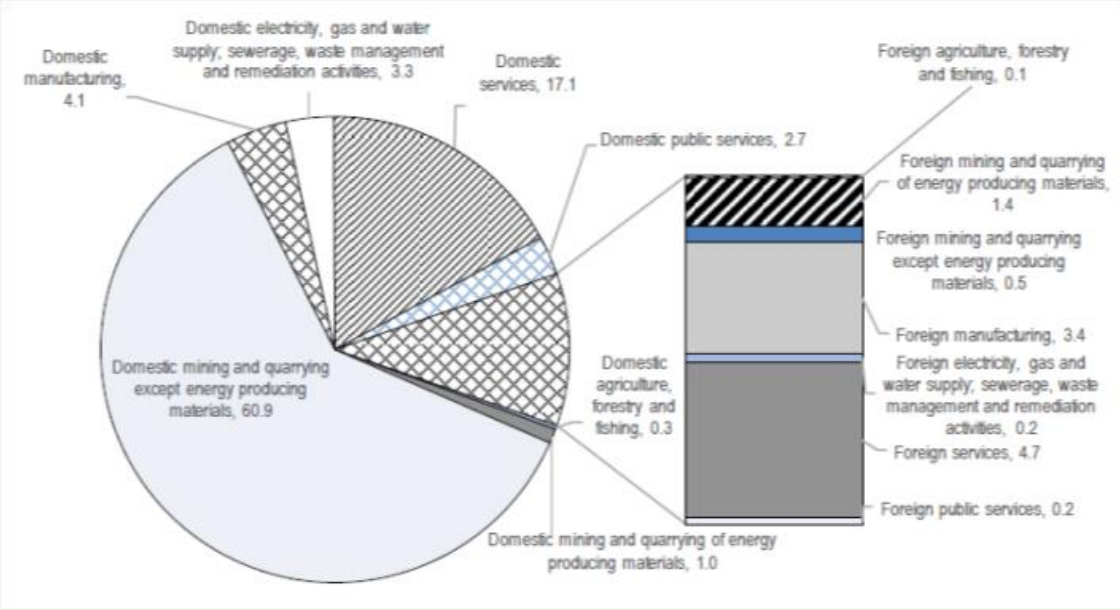
Box 3.7. The relevance of services in the mining value chain

Based on the 2018 Trade in Value Added (TiVA) dataset that comprised 65 countries, the OECD traced value addition into and out of the mining sector throughout the entire value chain. In analyses, backward linkages refer to upstream sectors that provide inputs to the mining sector. Forward linkages refer to downstream sectors that integrate outputs from the mining sector into their production processes.

The analysis found that much of the value-added of mining exports came from the sector itself (59% in 2015). This is due to the inherent value of the minerals extracted, plus the value addition of labour and capital expenditures in the sector. The sector in which mining displays the strongest backward linkages is services, representing 23% of the value-added of exports from the mining sector on average. In Central Asian and European countries, services account for 26% of the value-added of minerals exports. In almost all regions, a large majority of services to the mining sector are produced domestically, accounting for 18% of the value-added of mining exports.

Figure 3.4. Backward linkages, mining sector, 2015

Inputs by sector into mining



Source: Korinek, J. (2020[33]), "The mining global value chain", https://doi.org/10.1787/2827283e-en.

In this context, promoting innovation through services can stimulate industrial firms to introduce value-adding services into their operations. This process, sometimes called territorial servitisation (Lafuente, Vaillant and Vendrell, 2019[35]) is a mechanism used by an increasing number of producers to develop and upgrade their innovation capabilities by realising a shift from products to product-service systems. Servitisation can contribute to delivering greater value-added and tailored solutions to better fit customer needs as well as increase the number of revenue streams (Vendrell-Herrero and Bustinza, 2020[36]).

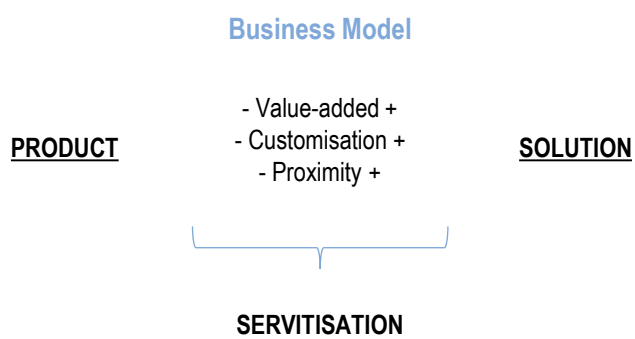
In the case of mining, services demanded by the industry vary according to the lifecycle of mines (from exploration to closure) and need to be in line with the specific legal, technical and economic needs of the mining process. Some of these services demanded in each mining stage include:

- Prospection and exploration, which comprise geological services such as surveying and sample analysis, engineering services that contribute to feasibility studies, mining design and oversight of mining operations.
- Feasibility and exploitation, such as construction services for roads, mine sites and mining camps, drilling services at both exploratory and construction phases. Furthermore, mining is increasingly carried out remotely, which includes services related to data collection and management, specialised software, sensoring, machine learning and innovative business processes.
- Closure and remediation require legal, architectural, urbanistic and environmental services.

Apart from those services linked to the mine itself, there are other services used across the mining value chain. Financial, transportation and research services are also relevant inputs for the refining and transformation process. Furthermore, the current digital and data-driven transition of the industry together with its transformation to carbon neutrality sets up a multitude of new support service needs for the industry. In Andalucía's refining industry, professional and scientific services and domestic wholesale trade services are the third and fourth most relevant factors of final value-added Andalusia (Institute of Statistics and Cartography of Andalusia, 2017[34]). Likewise, in the transformation of ornamental rocks – for example, to manufacture ceramic products, tiles and other inputs for construction – domestic wholesale trade services are the second most relevant input category in terms of value.

In addition to increased revenue streams, the integration of a servitisation strategy can help the competitiveness of Andalusia's industrial firms, including those outside the mining industry. Servitisation, sometimes also called product-service innovation, can potentially serve as a means to transition from a transactional-based product business model to a higher-value-added solution delivery business system (Figure 3.5). Servitisation helps producers add value by increasing the customisation of their service-augmented products, also increasing the relational proximity of industry with their clients, which helps establish switching costs that lower competitive pressures for producers.

Figure 3.5. Servitisation as a means of business model transition



Source: Based on Vaillant, Y. et al. (2021[37]), *Regions on course for the Fourth Industrial Revolution: the role of a strong indigenous T-KIBS sector*, Regional Studies,, http://dx.doi.org/10.1080/00343404.2021.1899157

Developing knowledge-intensive mining providers to attain higher-value-added activities

However, many industries in rural regions face difficulties in transitioning towards a business model that integrates high-value-added services (OECD, 2020[38]). The high complexity and need for diverse resource endowments required for the successful internal development of complimentary services lead servitisation to fall outside the capacity frontiers of many smaller firms (Grönroos and Voima, 2013[39]). Some of the main challenges local companies find in "upping their game" and qualifying to provide goods or services to foreign-based companies in the mining value chain include access to financing, navigating the (often

stringent and complex) technical requirements of mining companies' procurement policies and developing the right skillset.

This is the case of Andalusia's mining value system, which is in dire need of greater knowledge-intensive services to help it surmount the numerous constraints that come with mining in the European context. Challenges currently faced by the mining industry in Andalusia – such as, the need for more efficient use of basic resources (water and energy), better waste treatment, deeper drilling to reach deposits, increasing digital transformation pressures, as well as a very strict EU regulatory framework, among others – require innovative solutions that are not expected to be internally provided by the lead mining firms.

Andalusia's service providers tend to supply only the local market and remain in lock-in situations with big firms in the region. At the moment, some knowledge service providers do exist in Andalusia and a number of them do compete in international markets, as in the case of AYESA (provider of water management services) that also has a presence in Latin America. Yet, most of the service providers are overly dependent on the demand from the mining companies in the region, with low levels of internationalisation (Government of Andalucia, 2020[32]). Some of the issues can be ascribed to lack of human capital, innovative capabilities and independence. For example, Huelva and Seville have a leading laboratory to manage chemical samples from mining but many of those results are still sent to Canada for their analysis due to lack of installed technologies. Furthermore, many of the existing services providers are not mapped in the Andalusia Mining Strategy 2020 or in the monitoring documents (Chapter 4).

Developing a strong knowledge-intensive business services (KIBS) sector around mining can contribute to attaining greater competitiveness and unlocking innovative business ideas. Product-service innovation systems are rarely completely internalised by any single firm. The decision to procure required knowledge-intensive service capabilities is more often the norm than the exception in industrial regions (Vendrell-Herrero and Bustinza, 2020[36]). In the mining sector in particular, given the increasingly important role that "social licensing" carries for a successful mining endeavour, mining companies are more and more naturally inclined to look towards building a local supply base of goods and services. KIBS providers can also facilitate the transition of local firms towards a more competitive stance within the context of Spain's fourth industrial revolution (Vaillant et al., 2021[37])(Box 3.8).

Box 3.8. Knowledge-intensive business services (KIBS) sector

Regions with a dynamic KIBS sector have a potential resource-based relatedness in their "knowledge space" that allows its local industrial value chains to more easily diversify production towards differentiating innovations. In such innovation systems, the role of local KIBS has been found to be crucial for the innovativeness of local industry (Horváth and Rabetino, 2019[40]; Martinez-Fernandez, 2010[41]). Consequently, value-adding innovation and competitive performance of the mining industry in regions is likely to vary according to local knowledge dissemination readily accessible as a result of KIBS (Lafuente, Vaillant and Vendrell, 2019[35])

The role of indigenous knowledge-intensive service provision in a local innovation system is key where KIBS have been found to be crucial for the renaissance of local industry (Horváth and Rabetino, 2019[40]). KIBS are both creators and transmitters of knowledge across local innovation system actors. They are especially important to compensate for the liability of a small structure that often hampers the innovation quest of SMEs that lack the internal resources and capabilities required for internal advanced service development (Lafuente, Vaillant and Vendrell, 2019[35]). KIBS therefore could potentially "inject" knowledge and data-driven competitiveness across new and incumbent players within a mining industry value system. As such, the presence of KIBS in a territory may act as a stimulus to greater value-added in terms of the innovativeness of local industry.

Source: Vaillant, Y. et al. (2021[37]), *Regions on course for the Fourth Industrial Revolution: the role of a strong indigenous T-KIBS sector*, Regional Studies,, http://dx.doi.org/10.1080/00343404.2021.1899157; Horváth, K. and R. Rabetino (2019[40]), *Knowledge-intensive territorial servitization: regional driving forces and the role of the entrepreneurial ecosystem*, Regional Studies 53:3, 330-340, http://dx.doi.org/10.1080/00343404.2018.1469741;.; Lafuente, E., Y. Vaillant and F. Vendrell (2019[35])., *Territorial servitization and the manufacturing renaissance in knowledge-based economies*, Regional Studies,, http://dx.doi.org/10.1080/00343404.2018.1542670.; Martinez-Fernandez, C. (2010[41])., "Knowledge-intensive service activities in the success of the Australian mining industry", *Service Industries Journal*, Vol. 30/1, pp. 55-70.

Creating the conditions for a local supply of local knowledge-intensive mining services (KIMS, a subgroup of KIBS) providers, adapted to the regulations of mining within the European context, can become a competitive advantage for Andalusia. As mentioned before, the global mining sector is increasingly following the path set in the EU for strict environmental and sustainability standards. Most regions and countries will encounter the same challenges currently faced by Andalusia's mining sector and will therefore seek assistance from those local KIMS with the recognised experience and skills to help (Martinez-Fernandez, 2010[41]). The psychic and cultural proximity, as well as accumulated relational capital between Andalusia's mining sector and that of Latin America and Northern Africa, gives it a potential competitive edge over other foreign suppliers of local KIMS.

High-value-added services providers could also help reduce carbon emission in the transformation process of NM minerals and thus support the path towards the supply of carbon-free construction materials. The regional relevance on construction-related mineral extraction and transformation (e.g. cement, gypsum and marble) can be boosted to compete in international markets with innovative services that help to green the construction sector.

Andalusia can make the most of this dynamic and align its institutional tools to generate the virtuous cycle that, beginning with mining companies and continuing with local KIMS, eventually develops into an export-oriented, top-of-class KIMS sector that can ensure sustainable use of a non-renewable resource. For this, the regional government needs to clearly identify the capacity of existing mining service providers and set clear strategies with them to overcome challenges for growth. Knowledge exchange opportunities with foreign-based companies are key for local providers to upscale their offer of services and technologies and meet high standard procurement requirements as well as develop solutions for future industry needs.

Identifying the potential services to be outsourced by the mining value chain (extractive and transformative industry) requires common planning and activities with firms, entrepreneurs/SMEs and universities. For example, in the region of Upper-Norrland, Sweden, the state-owned mining company LKAB has developed important innovations to reduce carbon emissions in the extraction and transformation of iron. This process has been closely developed with the support of mining service providers and the University of Luleå which have supported innovative approaches and conducted various experiments in LKAB mines (OECD, 2021[42]).

In order to be able to take up such a leading role in Andalusia's mining value system, local KIMS providers will need to be empowered by the administration. To encourage the development of a strong KIBS, the regional government of Andalusia should:

- Conduct a comprehensive mapping of local KIMS providers.
- Implement support actions that facilitate the exchange of knowledge and procurement requirements between foreign-based manufacturing and mining firms and KIMS. This could be done through greater networking opportunities or digital infrastructure and platforms.
- Create support programmes to promote high environmental standard processes and uptake of new technology in existent and new mining service providers. These programmes should target service providers for metallic and NM mining.

- Create a testbed for firms and service suppliers to co-create projects around the mining value chain. For example, Andalusia's mining site could be used as a laboratory of continuous learning and expertise development for the local mining value system, beneficial for collaboration among metallic and NM mining providers and firms. Example of physical points for mining experimentation can be found in the LKAB mines in Australia or Norrbotten, Sweden (OECD, 2021[42]) (Box 3.9). A mine site in Aznalcóllar may be a good option due to its central location (86 km/1 hour from Huelva and 40 km/45min from Seville) and easy road connections, but also because of the historic and symbolic significance.

Box 3.9. Knowledge-intensive mining service (KIMS) providers' role in the innovation-based transformation of Australia's mining industry

KIMS are found to have strongly impacted the innovation and competitiveness of mining firms in Australia. KIMS have played a significant role in the transformation of the mining industry, where the interaction between client and KIMS bring content and quality to the industry's innovation process. The purchase of services is seen to have a direct relationship with the capabilities that mining industry firms in Australia are expected to need for the future.

The success of the innovation-based transition of Australia's mining industry has been strongly moderated by the quality of the interaction between KIMS and mining firms. Knowledge interactions are so frequent and critical between KIMS and the mining industry that the Australian mining sites can be considered a laboratory of continuous learning for the companies working on site.

The crucial feature observed in the Australian mining industry is that the activities developed by KIMS for the mining companies (customers) are based on the dynamic supply of knowledge and innovative ideas. This directly influences the way the mining industry interacts with its own clients, how they are able to improve in their solution-based delivery and able to assist in the implementation of innovation. In this way, KIMS act as transformers of the mining industry by transporting innovations from one mining site to the next and by providing enhanced solutions that work well for other clients.

Thus, the interaction of both types of companies constitutes the key to innovative solutions and commercialisation in Australia's mining industry. KIMS working in a particular site constitute a complex network of advanced service providers. Hundreds of contractors can be associated with the mine site, with a significant impact both on the mining company in which they operate and on other industries operating in the area. Mining sites, therefore, constitute hubs of knowledge intensity where internal and external experts participate in knowledge-intensive service development oriented to prepare innovative solutions tailored to specific problems.

Source: Martinez-Fernandez, C. (2010[41]), "Knowledge-intensive service activities in the success of the Australian mining industry", *Service Industries Journal*, 30(1), 55-70.

Boosting the role of the third sector to support mining innovation and entrepreneurship

Universities and research centres also have a key role to play in strengthening the innovation strategies and capacities of mining regions. Andalusia's regional innovation processes face bottlenecks when linking academia and industry. The interaction of universities and research centres with industry-led innovative projects is low and foreign-innovative firms tend to develop their innovations in house or with support from actors outside Andalusia. Some of the barriers to such collaboration include a lack of awareness of channels to reach and collaborate with local universities and long administrative procedures to partner with academia in specific projects (Government of Andalucia, 2020[32]).

Andalusia has supported the creation of research centres around the mining value chain but results have not been sustainable. In 2002, the regional government created the Advanced Technological Center for Stone (CTAP) in Macael, with the aim of offering technological support to companies in the ornamental mining sector to obtain higher-value-added products for the housing and construction market. Yet, this centre has struggled to be self-sufficient and relied heavily on public finance, which led to its bankruptcy in 2016. As with other sectoral research centres in the region, the CTAP lacked a pool of private-led and demand-driven projects as well as co-ordination with other economic activities (metallic mining and manufacturing), which limited the market scalability of many of the new ideas. Research centres in the region also have low levels of co-ordination among them which hinders the development of sustainable linkages with universities.

A research centre or body on mining sustainability could boost innovation in the region. To ensure the body is sustained in time, its research needs to be driven by project demand and aims for self-financial sustainability. The governance of multiple actors (public, private and academia) can ensure a greater impact on this body. The initiative from such a centre might need to come for the public administration acting as a broker to link different actors and define key basic areas of research in line with industry needs. Some projects at the core of this centre could include technological development to support low-carbon processes in metallic and NM mining, research streams on urban mining, mining waste recycling or linkages among renewable energy and mining energy consumption. This institutional R&D body could also promote knowledge and technological transfer among foreign-based metallic mining companies and local mining companies in the NM sector.

Supporting strong linkages between academia, research centres and industry requires clear leadership from the local government administration and incentives for actors to maintain collaboration. This involves changing the mining policy approach of mostly focusing on mining industry development to one that strives to become a mining talent region. As Chapter 4 will argue, there is a need for a formal co-ordinating body that facilitates frequent interaction and ensures linkages among local actors to achieve concrete outcomes for the future of the mining value chain, including the definition of a clear vision and the development of a technological and expert roadmap for the region. To promote incentives for participation, this can be a project-oriented collaboration.

Greater co-ordination with the national government is also instrumental to boost mining research. The national government plays a relevant role in the allocation of research resources in Spain, which calls for closer national and regional co-ordination on education and research. A common area of interest of this vertical collaboration should be the decarbonisation of the mining value chain, which can help Spain attain climate goals and Andalusia develop an innovative environment with research in green mining processes and technologies.

Other OECD regions have relied on local universities to support their innovation process and promote targeted capacitation to firms and entrepreneurs. Universities can collaborate with the regional government in defining regional development strategies and serve as centres to offer training to public officials (see the last section). For Andalusia, partnering with universities in mining research can also attract new talent and strengthen the links with firms. To make this type of partnership materialise, the regional government should enhance academic programmes focused on mining. This type of model has brought positive outcomes to other OECD regions, for example the agreement between the regional government of Värmland and Karlstad University in Sweden to develop the Academy for Smart Specialisation with the aim to promote regional development (Box 3.10).

Box 3.10. The Academy for Smart Specialisation

The Academy for Smart Specialisation aims to utilise research for the benefit of industry, the county administration, the county council and the municipalities in Värmland, Sweden, and to strengthen the research environments in the region. High-quality research is expected to attract more external funding to the university and promote research co-operation. This initiative is a continuation of the agreement of intention that was made for the period 2010-14 when ten new professorships were instituted at Karlstad University.

The six areas of specialisation identified by Värmland's research and innovation strategy are the foundation of the Academy for Smart Specialisation. Karlstad University and Värmland Region will run the academy jointly for the purpose of serving as a meeting place for researchers, companies, financiers and entrepreneurs. By linking research innovation and education, the academy will prepare Karlstad University students for employment to drive industrial development in the six prioritised areas in Värmland.

Source: Karlstad University (2020[43]), *Academy for Smart Specialisation*, https://www.kau.se/en/external-relations/research-and-innovation-collaboration/research-collaboration/academy-smart (accessed on 15 February 2020).

Mobilising exiting incubators for entrepreneurship

Public entrepreneurship promotion policies, programmes and measures can better guide entrepreneurs into needed business solutions in the mining value chain. In a survey to local entrepreneurship experts about the measures that would best improve the entrepreneurial activity levels in Andalusia, they responded that entrepreneurial training and education is a pending project in the region (Ruiz-Navarro, Biedma-Ferrer and Martínez, 2020[44]). Much has been done to bring basic entrepreneurship training to the classrooms in Andalusia, as in most of Spain, but focusing more education and training to improve the confidence and skills of existing entrepreneurs remains a major challenge.

Andalusia has existing entrepreneurship incubation and acceleration capacity but can be further linked to mining and manufacturing activities. A good example is the Minerva technology-based business accelerator promoted by Andalusia's regional government in collaboration with Vodafone. This business accelerator located in Seville is considered to be one of Spain's best at boosting information and communication technology (ICT) entrepreneurship. As is common with such centres, Minerva offers a limited and highly selected number of entrepreneurial projects, training, structured coaching, mentoring and networking opportunities in an organised and guided framework. The incubator has supported the creation of various start-ups that have developed new technological services, including management of geographic information, software to support smart mobility, design of the Internet of Things among others.

This incubator can be better linked with the needs of mining and transformative companies in the mining business environment. The regional government should mobilise the governance and structure of Minerva to promote entrepreneurship and business opportunities around the development of technologies and practices that support the reduction of carbon emission in the mining extractive and transformation process. This can be done by creating a specific branch inside Minerva or creating partnerships between this incubator and research centres and universities focused on mining entrepreneurship. For this entrepreneurial incubation to work, the right composition of mining experts and engineering professionals should deliver such assistance.

Supporting intrapreneurial activities

The most adapted entrepreneurial capital for Andalusia's mining industry is probably the one that originates from within the industry itself. The industry as a whole could stand to benefit by activating the entrepreneurial capabilities of their own employees. This can be done through internal intrapreneurial development programmes (Box 3.11).

The benefits of such programmes are multifaceted. Typically, intrapreneurial programmes are associated with the in-company incubation of employee-driven initiatives that eventually spin-off from the "mother company" in order to assume themselves as independent entrepreneurial entities. Such intrapreneurial incubation and spin-offs can act as an outlet for employees' creativity and innovativeness. This can increase the attractiveness and job satisfaction for employees, helping to retain and attract more and better talent, usually outweighing any human capital loss as a result of spin-offs. Because the links between spin-offs and their companies of origin are often strong, the multiplication of such intrapreneurial venture creation would eventually generate a strongly networked local mining value system.

In order to develop, incubate and be able to scale competitiveness-enhancing innovation, Andalusia's mining companies would need to implement a company-wide innovation management system. Firms and business associations will need support to become intrapreneurial firms. Because such change is likely to be profound from both a structural and cultural perspective for the organisations involved, most will need external advice and consulting in order to maximise their chances for successful implementation. Public and academic institutions can play a role in providing such support and advice. Offering networks assistance and loans to enable local small mining industry firms to outsource the needed help from private consultancy firms is a way that public policy can assist.

Andalusia's mining industry could also benefit from a dedicated intrapreneurship training programme. Such type of training could help promote the intrapreneurship transition of Andalusia's mining industry. Besides pedagogical assistance, intrapreneurship coaches can be made locally available to work alongside the firms so as to help consider, plan and implement the industry's intrapreneurial transition. This training programme can be ascribed to a university or a dedicated research centre for mining. It should support companies in the creation of innovative career paths and support an incubator of projects for mining and industrial related activities (e.g. green technologies).

Box 3.11. Motivations of corporate intrapreneurship programmes

In-company intrapreneurship programmes are rapidly becoming popular amongst many large corporate groups throughout OECD member countries. Despite the common timing for this relatively new corporate phenomenon, intrapreneurship development policies are being implemented in order to reach very different objectives. A list of these has been compiled by intrapreneurship expert Nicolas Bry (Bry, 2020[45])

- Bringing new products and services to market more quickly, with less risk of failure, and improving customer intimacy.
- Protection against start-ups aiming to disrupt the business model.
- Motivating and retaining best staff and grooming new leaders.
- Developing a nimble way to innovate.
- Creating an environment where new ideas can be systematically tested and iterated until they fit the market and company culture.
- Making a societal impact, and linking with internal corporate social responsibility (CSR) policy.

Specific examples

For Deutsche Telekom, the purpose of adopting an internal intrapreneurial approach is simply to help "employees who want to realise their idea and become entrepreneurs". This differs from Bouygues, a French telecommunication company, that uses intrapreneurship programmes in order to "innovate like a start-up". Deutsche Bahn implements intrapreneurship mainly to foster new digital business models and encourage long-term cultural change amongst its employees and business units. Similarly, Air France seeks to "develop new business with an innovative approach" and to build a team-driven ecosystem that shows "initiative, wants to commit and take responsibility" (Bry, 2020[45])

Source: Based on Bry, N. (2020[45]), *The Intrapreneurs' Factory*, Independently published.

In summary, Andalusia can mobilise its assets to make the collaboration among academia, firms and government a sustainable interaction to boost innovation in the region. To this end, the regional government should:

- Create a formalised institutional body that gathers firms, universities, research centre representatives and public officials to agree on innovative projects around the mining value chain. Chapter 4 will elaborate on the relevance of this co-ordinating body to update the regional mining strategy.
- Develop partnerships with universities in the region to strengthen the research and academic programmes on the potential of mining to reduce carbon emissions. This includes first clarifying the research priorities in Andalusia and then developing agreements to align research programmes with innovation opportunities in the mining value chain (e.g. environmental sustainability, urban mining and free carbon raw materials). As previously mentioned with the case the Karlstad University and Värmland Region partnership in Sweden (Box 3.10).
- Act as a broker to facilitate the creation of an institutional platform to conduct R&D in mining (e.g. a renewed technological centre for mining) that is jointly co-ordinated by university representatives and the administration.
    - The roadmap of work for this R&D platform should come from the objectives defined from the formal co-ordination among academia-industry and government. The centre could work through demand-driven projects.
    - Include intrapreneurship training within a technological centre specialised in mining, which would support companies in the creation of innovation career paths and an incubator of projects for mining and industrial related activities (e.g. green technologies).
    - Partner with the Minerva incubator to lead entrepreneurs into business opportunities around the development of technologies and practices that support the reduction of carbon emission in the mining extractive and transformation process.
    - Promote knowledge exchange and technological transfer among foreign-based metallic mining companies and local mining companies in the non-metallic sector.

Enhancing collaboration for human capital development

The true challenge in the knowledge and data-driven economy will not come from technology but rather in the process and business model innovations that depend on human ingenuity. Whereas the technology is and will be available to all who can afford it and can keep up with the pace of its advances, the ability to effectively optimise their potential and innovate in their use is conveyed by a relatively scarce form of human capital. This will increasingly be the case over the coming years as the digital transformation of the entire economy will mean that the demand for such talent will outweigh its supply (Llinás-Sala, 2020[46]).

In Andalusia, talent is needed to facilitate an effective digital transformation but also develop the service sector (KIMS) around the mining value chain.

Andalusia has made various efforts to boost human capital in the region, particularly in mining. The Andalusian Mining Strategy (AMS) 2020 has conducted actions to provide basic or entry-level skills for unemployed people in the form of vocational education, mainly geared towards the ornamental rocks segment. The region also benefits from a number of engineering master and is a well-developed university system.

However, the region, and particularly the mining sector, still lacks a highly educated labour force able to produce the added-value activities needed to improve competitiveness (e.g. development of green technologies or service-related companies). Spain in general and Andalusia in particular are not well provisioned in terms of digital and knowledge-based talent and effective, pre-emptive human capital planning and development is even less common (Deloitte, 2018[47]; PWC, 2018[48]). Furthermore, ageing is leading to generational replacement issues in some traditional activities of the NM industry (marble, gypsum). The capacitation and involvement of the young population in these mining activities is a relevant policy for the future competitiveness of the regional mining industry.

In this context, Andalusia needs to better mobilise and co-ordinate its educational assets (universities, capacitation programmes) to boost the educational level of its workforce and, importantly, preparing it to take full advantage of the technological changes and environmental needs that are sweeping through the mining value chain.

Adjusting higher education programmes to future industry needs in the mining value chain

One of the main challenges for Andalusia's mining region is deciding how to train its human capital and who is best suited to deliver such instruction. Most universities and engineering schools in the region have their traditional mining engineering programmes. These programmes are a start but are often very technical and fail to cover the skills and competencies required to address more recent and potential future challenges that the industry will inevitably face. A more multidisciplinary mix of different programmes would help develop a greater heterogeneity of advanced skills that would serve to push the limits of the local knowledge space.

Andalusia has some programmes that are heading in the right direction but there is scope for improvement. The master's programme in Geology and Environmental Management of Mineral Resources, taught by the University of Huelva (UHU) and the International University of Andalusia (UNIA) is well oriented towards the mining industry in its wider sense. Yet, despite being the leading mining region in Spain, few master's programmes in mining and industry rank highest in the country (UPM, 2020[49]). Many students still go to Barcelona or Madrid to pursue careers in geology or engineering (El Mundo, 2020[50]).

The regional government of Andalusia can better utilise relatively high standards of quality of life in the regional to attract national and international talent. Contrary to most mining regions across the world situated in remote areas, with challenges to access public services, Andalusia's mining region offers a high amenity, stable and socially welcoming mining location with an appealing climate in proximity to important urban population centres and logistical connections.

Boosting the regional human capital and integrating it with the innovative potential around mining requires good intraregional co-ordination among government agencies, industry and universities to adapt skills to current and future industry needs. In the high unemployment context, greater collaboration with industry associations to define the main shortage of skills would be a first step to define an action plan of capacitation programmes. The design and implementation of this targeted capacitation would in turn require co-ordination of local actors (regional government, firms and universities) to provide efficient training linked with needs in the mining value chain. Coding programmes, training in environmental

management or computational courses can have a greater impact on the workforce. Ensuring these programmes are well designed requires co-ordination with mining and industrial companies so they can highlight the current and future demands for talent. To this end, Andalusia should:

- Connect universities and research centres with industry to create training programmes that prepare its workforce and young generations to participate in more complex and value-adding (metallic and NM) extraction and processing activities. This can involve vocational education in rational NM mining activities to support generational replacement. For this, practices from the Canadian Mining Innovation Council's "ReThink Mining" initiative can guide Andalusia in preparing its workforce for the upcoming knowledge-intensive mining industry (Box 3.12).

Box 3.12. Lesson for Andalusia from the Canadian initiative ReThink Mining

ReThink Mining (RTM)'s vision is to "transform mining into a zero-waste industry". To achieve this lofty and ambitious goal, it has made its mission to "act as a catalyst for transformation by connecting industry leaders and innovators".

In doing so, it is paving the way for a new, high-tech, innovative and sustainable mining industry that is built upon close collaboration between mining companies and mining equipment, technology and services (METS). Aside from the more technically driven projects (such as microwave-assisted comminution, sensor-based ore sorting or real-time water quality monitoring sensors), RTM's projects included "defragmenting the mining innovation ecosystem".

This initiative allowed RTM to become the Canadian reference point for innovation in the mining sector, as well as ensuring the projects it pursues are relevant to actual mining operators.

This approach could well be transferred to the Andalusian sector. A government-sponsored innovation and collaborative platform would allow Andalusia to:

- Better understand the trends that are shaping the future of mining, as well as the actual concrete needs of its own local mining industry.
- Focus on projects that are immediately applicable and deliver value to the industry.
- Align other sectors (most notably universities and research centres) to ensure adequate skills are taught and added to the pipeline of future mining industry employees.

This, in turn, would cement Andalusia's role as a mining innovation hub, with the potential to export know-how, technology and services throughout the IPB, as well as other jurisdictions around the world.

Source: ReThink Mining (n.d.[51]), *Homepage*, https://www.rethinkmining.org/ (accessed on January 2021)

A strong innovation ecosystem relies on the involvement of youth in the area

Working for the mining industry and remaining to live in the mining region is sometimes not perceived as desirable by younger generations, especially those with high human capital attainments. Young people with higher education degrees often have a misperception of what working in the mining industry may represent and there is a common notion that higher education is a means for leaving the region and accessing more attractive labour opportunities outside (as shown in the migration patterns of Chapter 2), with mining in some cases still perceived as the hard-work, hazardous, low-paid occupation of olden times (INFACT, 2018[23]).

Modern mining operations and labour conditions have more to do with science fiction laboratories than traditional depictions of miners. The average labour conditions offered in Andalusia's mining industry

surpass those of other local industries and are competitive with most alternatives to be found in the national capital, but with a much lower cost of living (see GDP per capita figures in Chapter 2). The social climate for mining in the region is relatively favourable but mining is not seen as a high-achievement career target by those who could most contribute to the industry.

To help break these cultural and psychological barriers and promote new entrepreneurs around the mining value chain, much greater outreach should be done to connect the mining industry with the region's youth. Andalusia has already conducted a number of actions to improve collaboration with schools so that, from an early age, students are familiarised with the modern mine. The region should persist with these efforts whilst organising industrial onsite visits and classroom seminars and educating young people about the modern realities of the industry and its potential attractiveness. This can help to further consolidate the favourable social opinions towards the mining industry in the region.

A very effective means of durably connecting youth with the mining industry is through internship programmes. On-the-job internship programmes that are part of the higher education curriculum would not only get young participants to discover the true character and benefits of working in the mining industry but would also contribute to better preparing and training the new generation of workers for the industry. Internship or "dual" programmes where students rotate back and forth from classroom to on-the-job training are now common in France and other European countries. But the labour and fiscal legislations in these countries have for the most part been specifically designed in order to encourage such human capital development. Spanish and Andalusian legislation are not conceived as such. The public administration should thus work towards enabling the constraints that limit such student apprenticeship programmes in the region.

Another area that requires a better fit for the future needs of the industry is developing and promoting more relevant vocational and professional education. Vocational training (*formación profesional* in Spain) is underdeveloped if compared with some other European countries where modern industries are thriving, such as Germany and the Scandinavian countries. Through vocational training, young people can potentially receive more customised training, fit for the specific needs of the local industry. Graduates would also be able to enter the industry at a younger age, helping to settle the human capital in the region. Once established, they can develop with the industry through further educational offers and collaborations from local vocational and/or higher education institutions, including executive and continuous education programmes.

The offered training must address the human capital needs of the entire local mining value system, not just the mining companies themselves. Therefore, the educational opportunities in the region should allow for the development of future complimentary service suppliers and entrepreneurs as well as more specific mining industry talents.

In sum, to boost local skills and better prepare them for the industry's future needs, the regional government of Andalusia should:

- Map the demand for future job capabilities and available skill level, as a starting point.
- Adequately communicate the reality of current mining employment with the youth population.
- Adapt regulations to further promote internships or "dual" programmes where students rotate back and forth from classroom to on-the-job training.

Overcoming challenges to upscale SMEs around mining

A structural challenge for development in Andalusia is related to the large share of micro and small companies located in low-value-added services (real estate, restaurants and local wholesale trade). Andalusia's economy is made up of a large share of small and micro companies (97.7% with fewer than 20 employees or no employees). The majority of SMEs are micro enterprises (1-9 employees), which

creates greater challenges to benefit from economies of scale and in turn boost innovation. Supporting SMEs to grow in activities of higher value-added and benefit from the strengths of Andalusia's mining business ecosystem will be an important tool to support local development and well-being while closing the income gap with the national average.

Many of the existent micro or small companies in the region are driven by necessity rather than opportunity, which leads to a low level of value-added from their economic activities (Spanish Entrepreneurship Observatory Association, 2020[31]). In fact, according to Spanish Entrepreneurship Observatory Association (2020[31]), when asked about the prime motivation that had led people to create a company, the lack of alternative employment possibilities was mentioned by almost a third of respondents. This rate of necessity-based entrepreneurial activity is ten percentage points above the Spanish average.

This is coherent with the relatively higher unemployment rates in the region that are pushing many to create a business as an alternative to the lack of labour market opportunities (Chapter 2). Some 60% of all new business in Andalusia takes the form of self-employment, with no other job creation than that of the entrepreneur (Spanish Entrepreneurship Observatory Association, 2020[31]).[3] Out of the remainder that is generating new employment, 85% can be considered as micro businesses with less than 5 employees.

Furthermore, as previously described, certain subsectors within the NM mining sector face barriers to absorb new digital technologies and innovate. Many companies conducting activities in the value chain of aggregates, construction and ornamental rocks are small family-owned companies. As in many SMEs in OECD countries, these companies tend to lack the staff or skills to keep up with technological progress and have low capacity to access funds to update technology and invest in innovation. They also face challenges in generational replacement with the ageing of owners.

To solve this challenge the regional government, in collaboration with the private sector and universities, needs to create targeted programmes to redirect and upscale the existent SMEs towards higher-value-added economic activities.

Guiding SMEs towards greater-value-added activities linked to mining to gain resilience

Andalusia has institutional mechanisms that support the development of SMEs in the country. As an example, the Official Credit Institute (ICO in Spanish)'s financing lines for SMEs at a state level as well as the Virtual Office of the Agency for Innovation and Development of Andalusia at a regional level are tools that have contributed to providing – mainly financial – resources to SMEs in creation and development stages. Many of these support programmes acknowledge that starting a business implies taking a risk, not only in the creation itself but also in the management and development along with the business life.

However, regional support programmes to SMEs have room for improvement depending on the nature of their grant aid. Subsidies tend to be the main financial aid for SMEs, yet the use of these financial instruments is limited by the capacity to monitor the use of funds and their effective conversion into investment. Therefore, policy programmes for SMEs require a more holistic view of business challenges, involving not only financial support but also advisory and training programmes, and simplification of regulatory business procedures (OECD, 2018[52]).

The flourishing of SMEs lies not only in their size but also in the economic sector in which they operate. Chapter 2 explored that the low-value-added service sector is the predominant activity in Andalusia (75% overall sector activity). The service sector leads to a low-added-value activity if SME efforts are mainly directed towards tourism or wholesale trade, as is currently the case. As the COVID-19 crisis revealed, tourism-dependent sectors were the most affected by the restrictions of mobility, showing high levels of vulnerability. In Andalusia, the crisis arising from the pandemic led to a shutdown of more than 14 000 companies between February and July in 2020, mainly in the tourism-related sectors (hotels, nightlife and other services), coinciding with the peak period of the COVID-19 pandemic and the fall of

international tourism. For this reason, a focus on SME growth and development in sectors such as industry and mining allows improving the added value of local SMEs with direct effects on SME resiliency.

The expansion of the mining sector in the region could also open up new opportunities for local SMEs. New requirements for mining activities (e.g. management of waste and side streams, environmental reports, multifaceted research) and the increasing use of technology in the sector creates possibilities for SMEs. Many mining companies outsource those services to specialised firms, especially when it comes to activities that require local knowledge. For example, occupational safety and the management of safety risks are highly valued at mines and these tasks are often supported by companies with local know-how.

Small firms in NM mining can also benefit from target programmes to increase scale and technological capacity through network activities and financial programmes. In some OECD mining regions, programmes that connect foreign-based or large mining companies with SMEs have been a core policy to promote technological transfer and help involve SMEs in global value chains. Some of these programmes can be accelerators to build capacity and boost quality in providers or broader platforms inside private companies to improve local capacities of SMEs.

Box 3.13. Increasing SME capacity in partnership with mining companies

Successful supplier development programmes have helped to create clusters of firms that provide goods and services to the mining sector. Such programmes can emerge from the private sector initiative to improve the quality of inputs and improve social acceptance from the local community. These types of programmes are boosted with co-operation of government agencies to reach the right scale and ensure sustainability. The programmes increase capacity and employment in local SMEs, create deep linkages and foster innovation, transfers of technology and business process knowledge.

In 2009, BHP Billiton created the World-Class Supplier Program in Chile to address the competitiveness challenges jointly with local suppliers and create a more sophisticated and export-driven economy in Chile. The programme has successfully introduced standardisation across operations and is continuing to develop the knowledge-intensive expertise of local suppliers. This latter outcome is further serving to reduce Chile's economic vulnerability to commodity market shocks. The success of the programme attracted Codelco, the public mining company, to join in 2010.

The mutually beneficial programme set the goal of creating 250 world-class mining suppliers in Chile by 2020. The programme focused on five areas: water, energy, HSEC (health, safety, environment and community), human capital and operational efficiency.

The methodology of the programme is seeking tenders from local suppliers on problems or challenges identified at the operational level – rather than prescribed solutions – and using a framework to test ideas in real time. BHP has also partnered with the government of Chile and Foundation Chile (a public-private partnership that promotes innovation) to better leverage support for the new suppliers. In the first 3 years of the programme, over 100 innovation projects were submitted for consideration, 20 of which led to contracts with BHP Billiton.

Source: BHP Billiton Chile (2013[53]), *BHP Billiton Pampa Norte Minera Escondida*, https://www.bhp.com//media/documents/community/2014/csr-eng150518sustainabilityreport2014bhpbillitonchileoperations.pdf.

Furthermore, closer co-operation with academia allows small companies to leverage cutting-edge research equipment, techniques and workforce from universities and research institutes (OECD, 2019[54]). This can be done by supporting small and micro companies to access training (i.e. managerial training via webinars or personal counselling) and universities' research equipment and staff. Targeted loans, co-financing

programmes or regional grants for innovation can help to address the financial capacity for technology investment and updates.

In summary, a co-ordinated strategy for SME support is needed to help SMEs move into higher-value-added activities and absorb technological change, especially within mining-related activities. For this, and with the aim to make SMEs more resilient, Andalusia's regional government should conduct a number of actions:

- Unify and co-ordinate the vision for SME development in the region, to connect them with opportunities in the mining value chain. A co-ordination with other strategies (employment, education) can realise policy complementarities and thus help attain regional development goals.
- Strengthen existent technical support office programmes on SME development (e.g. Virtual Office of the Agency for Innovation and Development of Andalusia). The region could boost existent support offices or create specific programmes focused on SMEs in the (metallic and NM) mining value chain. This support should strengthen the provision of training and grants, with a lower reliance on direct transfers, focused on digital transformation and project collaboration.
- Facilitate networking activities with universities and large mining firms. Better linkage with universities can help access training (i.e. managerial training via webinars or personal counselling) and universities' research equipment and staff. Creating fairs to gather with other SMEs and large firms is a helpful tool for knowledge exchange and to unlock business opportunities.
- Simplify the administrative process to create new SMEs and support their progress. The public administration should help SMEs in screening the regulatory environment and dealing with norms as they tend to be less efficient than large firms. Digitalising administrative processes and promoting capacitation for SMEs in this regard tend to have important positive effects on small businesses. High costs and complexity of tax compliance fall disproportionately on small and young firms. Encouraging SME growth based on simple not overly costly steps under an umbrella of certainty within bureaucratic frames is essential to increase the risk capacity of SMEs.

The regional government of Andalusia could also follow some of the OECD recommendations for SMEs to weather the COVID-19 crisis and the subsequent economic recovery (Box 3.14). The region can take stock of the OECD recommendations to make sustainable businesses viable and to address economic recovery by building their resilience.

Box 3.14. Main OECD country policy responses to support SMEs in the COVID-19 crisis

- **Deferral of tax, social security payments, debt payments and rent and utility payments**. Many SMEs face massive challenges in paying wages as well as sick leave for those workers affected. Governments have put measures in place to contribute to wage payments for employees temporarily out of work or on sick leave.
- **Loan guarantees**. Most OECD countries have put in place measures that enable SMEs to postpone payments, in order to avoid further eroding their liquidity. Most countries have introduced such deferrals in corporate and income tax payments, although several countries include value added tax (VAT), social security and pension contributions.
- **Direct lending to SMEs**. Next to providing guarantees to commercial banks to support their SME lending, a large number of governments have also enhanced direct lending to SMEs. In some cases, new loan instruments have been set up. In other cases, existing instruments for disaster relief are opened up for SMEs affected by the COVID-19 crisis. The measures include the expansion of funding available for loans or the easing of the accessibility of loan schemes,

by extending the group of potential beneficiaries, simplifying and speeding up procedures to receive loans, and offering more favourable terms and reduced interest rates.

- **Grants and subsidies**. A number of countries, regions and cities have started to provide direct financial support to SMEs. In many cases these are direct lump-sum subsidies; in other cases, they regard tax exemptions. In some cases, existing instruments are being used.
- **Non-banking finance**. Most of the SME policy instruments used in response to COVID-19 are debt finance via bank loans. However, an increasing number of countries also use other forms of finance. In some cases, debt finance is disbursed by other intermediaries than banks, for instance through crowd-funding or fintech companies. In other cases, non-debt financing instruments are being used, such as equity, for instance.
- **Structural policies**. Some countries have taken actions to help SMEs adopt new work processes, speed up digitalisation and find new markets. Such policies aim to address urgent short-term challenges but also contribute to strengthening the resilience of SMEs in a more structural way and support their further growth.
- **Monitoring of impact and governance of policy responses**. Several governments have set up co-ordination mechanisms to monitor the outbreak and develop responses. In most cases, the focus of such co-ordination is on health aspects. In some countries, SME aspects are explicitly considered in these co-ordinated efforts, as are multi-level governance matters, since regional and local governments play an important role in the SME policy response.

Source: OECD (2020[55]), "Coronavirus (COVID-19): SME policy responses", https://www.oecd.org/coronavirus/policy-responses/coronavirus-covid-19-sme-policy-responses-04440101/#section-d1e8167 (accessed on 2 November 2020).

Improving the regulatory and permitting process of mining to unlock growth opportunities

Regulations and administrative processes determine the competitiveness of economies, foster business development while protecting consumers and the environment (OECD, 2018[56]). Mining is a global sector that involves international mining and manufacturing firms, research centres and local firms as well as worldwide interest groups including NGOs and environmental groups. In this context, regulations have a significant role in the success of the development of a mining value chain in a country. The way governments regulate and enforce the mining sector shapes its environmental impact, its attractiveness to investors and its acceptability to local communities. This session assesses the regulatory framework that guides mining and mineral activities in Spain and offers recommendations to improve it.

Spain relies on outdated and complex mining regulation

As in many countries, in Spain, the state is the owner of mineral resources and has the foundation powers to regulate their use, exploit them or assign their exploitation to third parties (Portal Andaluz de la Minería, 2020[57]). As mineral resources constitute a good of public interest, a public authority needs to issue a permit (authorisation or concession) for their exploitation. The requirements to obtain these permits depend on the type of mineral resource, the nature of the petitioner and other conditions related to the exploitation site (e.g. if there were previous mining activities). Given the autonomy of regions in Spain, the public authority issuing these permits is the mining authority of the region. Only when a mining project covers different regions, the permit is issued by the national government.

In Spain, the mining legislation relies on an outdated law with a number of legal guidelines issued at different times and without a legal co-ordinating document The Mining Law of 1973 is the legislation governing mining exploration and extraction, authorisations and permits and the applicable offences and

sanctions. The national government has tried different opportunities to update the law (notably in 2003 and 2015) but without any success due to lack of consensus within the government as well as with regional governments and the private sector.

The Spanish mining law is outdated in many senses and the regulatory framework involves a multitude of authorities and different regulations. The mining law in Spain was issued prior to the Constitution of 1978 and the accession of the country to the EU (1986). Therefore, and despite a number of modifications, the governing mining law has scope to better align with the general administrative competencies set by the constitution and with the normative framework after the EU accession. Furthermore, the additional sets of regulations lead to multi-layered legislation that requires greater co-ordination among economic and environmental authorities. This is particularly evident in the environmental-related regulation. As a result of EU acquis, the national government has issued new environmental laws and decrees to include environmental concerns into the overall mining regulation (Table 3.6).

Apart from the national legislation, each region in Spain has additional laws for mining development. Regions have autonomy with the legislation related to environmental evaluation, environmental protection, site rehabilitation and land use. Some of these legislations are at the regional and provincial level, as is the case of land use planning. In Andalusia, at least 8 provinces have land use plans containing specific limitations to mining activities, while such limitation covers less than 2% of the regional territory (Regional Government of Andalusia, 2013[18]). Andalusia also has a law (42/2007) to protect its environmental assets and biodiversity. The protected areas (165 areas) have different levels of protection as some of them are included in the European network of specially protected areas (Natura 2000).

Table 3.6. Main national regulatory framework in Spain for mining exploration and extraction

Instrument	Main function
Spanish Constitution (1978)	Establishes that the state has exclusive powers over the foundations of mining law and provides power to autonomous communities on environmental protection, regional economic development and development of basic mining state rules.
Mining Law of 1973	Main piece of legislation in this matter ruling on mining resources, the authorisations and permits required and the applicable offences and sanctions.
Royal Decree 2857/1978	Enacts the General Regulation for the Mining Regime.
Law 54/1980	Modifies the Mining Law with regard to mineral energy resources.
Real Decree 1389 of 1997	Approves requirements to protect the security and health of workers in mining activities.
Royal Decree 975/2009	On the management of extractive industries waste and the protection and rehabilitation of the sites affected by mining activities.
Law 21/2013	On environmental assessment, governing the procedure for the environmental assessment of projects, including certain mining projects.

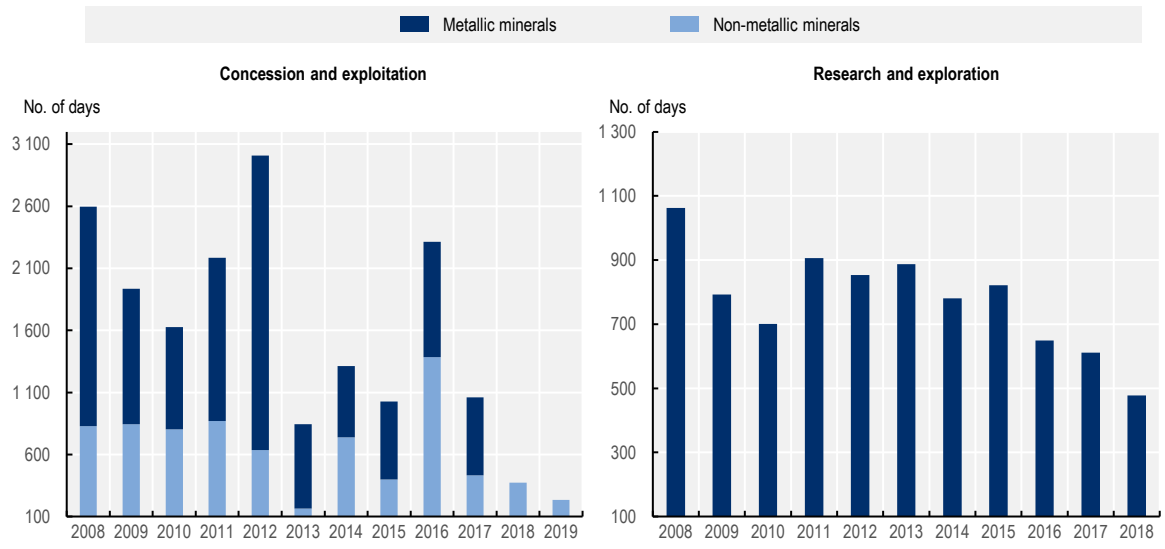
As Chapter 4 will mention, the lack of a national mining strategy makes it difficult to have a clear and co-ordinated vision and practices for mining activities across the territory. The Ministry for the Ecological Transition and of the Demographic Challenge gathers annual meeting among regions to discuss mining regulatory issues. However, as mining is mostly in the remit of the regions, the effort from the national government is rather passive and guidelines issued from the meeting tend to be non-binding documents. To promote a competitive and sustainable mining sector, the Ministry for the Ecological Transition and the Demographic Challenge should update its mining law in order to co-ordinate legislation consolidate different decrees on the matter.

Despite the issues with the national mining regulatory framework, the degree of efficiency and predictability of the application of this regulation relies heavily on the administrative capacity of each region. Regional governments have scope to reduce the administrative burden on mining regulation and, in turn, increase the attractiveness for international investors. This degree of autonomy can also be positive in terms of adapting the regulation to the region's needs and development goals.

Andalusia's permitting process has scope to improve predictability and reduce delays

Andalusia has conducted efforts to reduce times of response in the permitting process of mining ventures. The Andalusia Mining Strategy 2013-20 included an objective to improve administrative procedures for mining activities and adapt them to industry needs (Chapter 4). This strategic effort brought some positive results with an average reduction of approval times for mining rights' requests. The reduction occurred across all different types of minerals and types of permits: research/exploration permits or mining concession/exploitation permits (Figure 3.6).

Figure 3.6. Average time for approval of mining permits in Andalusia



Source: Portal Andaluz de la Minería (2020[58]), *Consultation of the Andalusian Mining Registry (CMRA)*, https://ws050.juntadeAndalusia.es/portalandaluzdelamineria/ConsultaRMA (accessed on December 2020).

However, the average approval times still lack predictability with high variation among similar types of permits' request. Since the launch of the strategy, approval times of concession permits for metallic mining have had an important time variability (an average standard deviation of 130 days). Some demands of concession permits have taken up to two and half years to be solved, while others have received approval in three months or less. Lack of standardisation on approval times also occurs in research permits. Since 2014, the average approval time for research and exploration permit requests was close to 2 years (709 days) but there is still an important share of requests being resolved in more than 2 years (35%). This contrasts with the average time needed to obtain exploration permits in many OECD countries. A study by Stedman and Green (2018[59]), based on a survey of 160 executives and managers, shows that in many OECD mining jurisdictions, most respondents obtained the exploration permits in less than 14 months. Notably, British Columbia in Canada (94%), Western Australia (91%), Sweden (90%) or Finland (84%).

The regulatory framework (national or regional) does not have a clear directive on the maximum time needed or expected to solve mining permit requests. OECD regions that lack legal clarity on timelines and a high disparity in response times tend to create uncertainty for firms based on low predictability on the mining administrative processes (OECD, 2021[42]). Delays in the permitting process of Andalusia, as in many mining jurisdictions with a similar issue, are linked to insufficient staffing, imprecise timelines for public administrations to respond, vague guidelines for the assessment of cases and unclear specification of lead agencies, which leads at the same time to issues in the applications from the private sector.

Delays in Andalusia also seem related to the legal vulnerability of public officials in charge of mining-related decisions. Environmental appeals and legal actions of public interest groups against mining ventures in Andalusia increasingly deter public officials from taken decisions on permits as the legal consequences on those appeals can rely on them (Government of Andalucia, 2020[32]). To address this issue, an institutional body to support the decision of public officials in charge of permits can provide an *ex ante* analysis and formal opinion over the permit's demand to validate to back public officials on their decision. Furthermore, in the context of increasingly complex mining operations, the need for staff with updated training is a pressing issue for the region (Government of Andalucia, 2020[32]), which should require greater specialised training.

The region has also the scope to improve co-ordination among ministries to reduce delays in mining permits and procedures. Firms have indicated frustration with the lack of co-ordination among different responsible ministries in Andalusia when it comes to administrative decisions on mining permits (Government of Andalucia, 2020[32]). As mining ventures involve different types of administrative permits, from environmental to economic and land use, the co-ordination of administrative tasks among different ministries is crucial to reduce delays of responses.

While Andalusia's mining strategy aims to decrease the delay times, there is no specific goal on response times by the type of permit. In fact, the objective of the former strategy (2014-20) to reduce administrative times included two performance indicators to monitor response times and the number of mining permits managed electronically that were never created. The region seems to co-ordinate mining administrative procedures with frequent meetings among ministries. Yet, such exchanges of information are set under an informal type of setting. It creates particular delays between authorities in charge of economic and environmental regulation as well as separate communications with the private sector.

The regional government has also created the Project Accelerator Unit to accelerate strategic projects (in 2019). Specifically, this unit promotes the streamlining of all the procedures of the Andalusian public administrations for effective processing of regional interest projects. The unit also guides and informs firms about the existing procedures in the different administrations. This unit is directly attached to the regional Ministry of Presidency, Public Administration and Interior (Regional Government of Andalusia, 2020[60]). However, it manages all priority projects for the region and faces trade-offs on the decision about project prioritisation.

To address this co-ordination bottleneck within the administration, Andalusia should establish a formal co-ordination mechanism that brings together, on a regular basis, representatives from different regional ministries to decide on mining permits and mining procedures on a project-by-project basis. This mechanism could be in the form of a one-stop-shop, a single decision-making body or a specialised body inside the Project Accelerator Unit.

This institutional platform should create procedures to reduce the legal risk faced by public officials when taking administrative decisions on mining. For this, this structure could rely on external actors (universities or specialised consultants) to help validate the demands of mining projects and provide advice to better align them with local needs.

To support the work of this co-ordination mechanism and reduce uncertainty, Andalusia needs to introduce standardised procedures with roadmaps for environmental impact assessments (EIAs). There have been cases where exploration projects are being conducted without consulting the local community, which leads to social unrest. Dealing with potential environmental issues in the early stages can provide greater legitimacy of the next steps in the administrative process and reduce firms' uncertainties with projects while promoting the early involvement of public interest groups in mining plans.

The regional government of Andalusia can put in place a number of actions to improve the administrative procedures for doing business in mining. These actions aim to reduce delays in response times for mining permits, upskill public staff in charge of mining procedures and back their decisions regarding permit

requests as well as ensure a transparent and inclusive process for mining projects from the exploration phase. For this, the regional government of Andalusia should:

- Establish a formal co-ordination mechanism within the regional government to evaluate and deal with administrative processes for mining projects, including awarding permits. This institutional body or mechanism (e.g. a one-stop-shop, a single decision-making body) could follow a similar structure to the Project Accelerator Unit and gather responsible officers from different regional ministries to accelerate mining administrative processes. It should promote co-ordination across regional regulations (e.g. environmental and land use) and with the national legislation. This body could also rely on external actors (universities or specialised consultants) to issue formal recommendations on mining projects to reduce the legal vulnerability of public officials.
- Create specific programmes to train staff and provide digital support in relation to mining administrative processes and a new type of mining operations. Partnering with metallic and NM mining business associations would be needed to deliver this task.
- Setting clear administrative timelines to deal with demand and development of mining projects, including environmental evaluations. Expected timelines can be set in the mining strategy as a clear goal for improvement. Andalusia can find inspiration in the roadmap set by Canada (Box 3.15).

Box 3.15. Canada process for environmental assessment

Canada sets out roles and responsibilities for each agency together with timeline-based targets, which are published at the start of the application process. This ensures that all parties involved have a predictable time schedule. The only time periods not defined are those for submission by the mining company itself; any delays in the permitting process are more likely to be the responsibility of the mining company rather than the federal agency. This way, intermediate steps of the decision-making process are clear and all involved parties know when feedback can be provided before determinations are made. This can also avoid appeals at a later stage and make sure that public consultation with stakeholders is conducted as early as possible.

Table 3.7. Key milestones for the environmental assessment, Canada

Milestone for Hardrock Deposit (Gold)	Lead	Timeline/Completion date
Notice of commencement on CEARIS	CEA Agency	13 June 2014
Public and Aboriginal group comment period on the draft Environmental Impact Statement (EIS) guidelines	CEA Agency	13 June 2014 – 13 June 2014
Finalise the EIS guidelines and provide them to the proponent	CEA Agency	14 July 2014 – 5 August 2014
Submit the EIS and EIS summary	Proponent	To be determined by the proponent
Perform conformity check of the EIS	CEA Agency	Day 45-51 (7 days)
Public and Aboriginal group comment period on the EIS summary	CEA Agency	Starting between Day 52 and 76 (for a duration of 30 days)
Review and provide comments on the EIS to the CEA	Federal Authorities (FAs)	Day 52-91 (40 days)
Review and provide information requests on the EIS to the proponent	CEA Agency	Day 52-109 (57 days)
Submit a response to information requests	Proponent	To be determined by the proponent
Review and provide comments on the additional information to the CEA	FAs	Day 110-139 (30 days)
Review and provide information requests on the additional information to the proponent	CEA Agency	Day 110-144 (35 days)
Prepare the draft the Environmental Assessment Review (EAR)	CEA Agency	Day 145-225 (81 days)

Public and Aboriginal group comment period on the draft EAR	CEA Agency	Day 226-255 (30 days)
Review and provide comments on the draft EAR to the CEA	FAs	Day 226-260 (35 days)
Finalise the EAR and submit it to the minister	CEA Agency	Day 261-335 (75 days)
Minister makes environmental assessment (EA) decision	Minister	Day 336-365 (30 days)
Issue and post the minister's EA decision statement on the CEARIS	CEA Agency	Day 365 (0 days)

Note: CEA Agency stands for Canadian Environmental Assessment Agency, CEARIS refers to the Canadian Environmental Assessment Registry Internet site
Source: SNL Metals & Mining (2016[61]), Permitting, Economic Value and Mining in the United States, http://www.SNLmetals.com (accessed on 11 February 2020).

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Notes

[1] This mining past is in evidence today in many forms; from the many ancient paleolithic sites (Aramo, Cerro Muriano, Rio Tinto, etc.) dating to the third millennium BC, to the very toponymy of Andalusia: its Sierra Morena mountains derive their name from Sextus Marius, Roman owner of the rich copper and gold mines of Mons Marianus, in the time of Emperor Tiberius (first century AC).

[2] Also noteworthy in this regard is Minas de Alquife's ownership structure, which is own by Spanish company.

[3] Entrepreneurial activity is defined as the percentage of working people between 18 and 64 years old, with initiatives in the take-off phase between 0 and 3 months of activity, or in the consolidation phase between 3 months and 3.5 years.

4 A new mining strategy to make Andalusia a frontrunner on sustainable mining

The chapter starts with an overview of the relevant international and national policy framework for mining development in Andalusia, emphasising the need for a national mining strategy to support a sound mining value chain in Spain and the transition to a low-carbon economy. Then, it analyses Andalusia's mining policy and provides recommendations to make the updated regional mining strategy a powerful tool to help Andalusia become a frontrunner in sustainable raw material technologies and practices to support the European climate neutrality goal and increase local well-being.

Assessment and recommendations

Assessment

- The European Union's new priorities, driven by the Green Deal, the new Industrial Strategy and the Raw Materials Strategy, will stimulate the future demand for sustainable raw materials in Europe and support programmes to develop environmentally friendly mining value chains to attain climate neutrality by 2050. This represents an opportunity for Andalusia to leverage its mining sector and become a frontrunner in the development of clean energy technologies and circular processes to support a reliable supply of sustainable raw materials.
- Spain is one of the few European Union (EU) countries with mining resources that does not have a national strategy on mining or minerals. Despite current efforts for national co-ordination, the lack of a national strategy on mining development leads to missed opportunities to spur synergies across regional mining ecosystems and among national policy strategies to boost innovation, attract investment and increase well-being. Furthermore, the absence of sound national co-ordination mechanisms prevents the establishment of a coherent approach for environmentally sustainable mining and a greater sharing of mining benefits with local economies. Developing a national mining strategy will help to better mobilise the potential of the Spanish mining sector, strengthen its alignment with EU climate goals and support regional development.
- Andalusia's updated mining strategy for the short and medium terms (2027) is a unique opportunity to support the transition to a low-carbon economy while facilitating new growth opportunities for local communities. This mining strategy should overcome the shortcomings of the previous strategy. These include establishing a clear and long-term vision for mining activities in the region that is well-aligned to its regional development goals and identifying concrete outcome objectives with a timeframe of actions. It also needs to enhance the engagement of municipal governments and communities, strengthen co-ordination with other regional development policies and improve national and international collaboration.

Recommendations

Improving national co-ordination on mining to help attain EU strategic goals and support national and regional development and well-being

For this, the Spanish national government should:

1. Develop a national strategy on raw materials and/or mining. This strategy should build on the ongoing process of developing the *road map for the sustainable management of raw materials*. The strategy should include a long-term vision for mining development, clear mechanisms for co-ordination with other national development policies, tools to promote environmentally sustainable mining processes and technologies, as well as strategies to attract investors, improve communication and boost the well-being of local communities.
2. Improve the financial and institutional capacity of the Geological and Mining Institute of Spain (IGME) to help co-ordinate the national mining strategy and boost its research and exploration activities. This institute can also help promote the Spanish mining value chain internationally. Spain may find of interest the structure and role of the Geological Survey of Finland (GTK).

Strengthening the Andalusia Mining Strategy 2021-27 to make the regional mining value chain a frontrunner in environmentally sustainable mining and an engine to increase income and well-being

For this, the regional government should:

3. Define a unified vision of the role of mining for regional development by:
   - Agreeing on a clear vision for mining development in the updated mining strategy. This vision should include a long-term timeline (e.g. 2050 as the EU Green Deal) and be comprehensive to mobilise all of the comparative advantages of the region. This requires consensus within the regional government and across different actors at the local level (municipalities, companies, universities and communities).
   - Enhancing the mining brand in the region and creating a plan to promote it internationally as part of the mining strategy. This brand and its promotion activities need to be developed and co-ordinated with other branding strategies and actors in the region. The brand should aim to attract new firms and skilled workers, based on an image of an innovative business environment that produces essential materials and know-how for the low-carbon transition.
4. Establish concrete objectives with measurable targets and a timeframe of actions in the mining strategy. This includes refining existing indicators and creating a timeframe for objectives by indicating which axis and action lines are a priority for the next few years (e.g. 2021-27) and which ones are inscribed in a longer timeline (2030).
5. Strengthen the monitoring framework of the new mining strategy by:
   - Differentiating among outcome and output indicators to measure long-term objectives and operative tasks differently.
   - Developing horizontal indicators that measure transversal objectives in the strategy and avoid duplication across specific tasks, while creating complementarities.
6. Improve the involvement of municipal governments and local communities in the mining strategy by:
   - Aligning the new mining strategy with municipal development plans. This can be done through formally frequent dialogue sessions with municipal governments and their early involvement in the development process of the strategy and its monitoring.
   - Improving co-operation with municipalities through the new institutional platform to promote research and development (R&D) in mining and the proposed multi-stakeholder co-ordination platform for mining development.
   - Including in the new strategy a guideline/toolkit to structure and implement benefit-sharing mechanisms for mining in Andalusia. This includes identifying the models used in the region and facilitate capacitation programmes for companies and communities to make the most of the benefit-sharing process.
7. Unlock synergies with other regional policy strategies and promote local networks to support a regional mining cluster based on innovation by:
   - Establishing a formal mechanism within the regional government to better co-ordinate the different sectoral policies (e.g. aeronautic, industry, construction) with the aim to mobilise the innovative potential of the mining sector. This mechanism should gather representatives from different units of regional and municipal governments.
   - Promoting in the new mining strategy the creation of a multi-stakeholder platform for mining development that gathers all relevant actors in the mining value chain to identify synergies and projects of common interest. This should include representatives from companies of different sizes, universities and the third sector as well as local governments. This group

should have a role in the preparation and monitoring of the mining strategy. The platform can help promote network activities and the international visibility of actors. For this, the regional government can get inspiration from the Mining Finland programme.

8. Boost collaboration with other Spanish mining regions, EU mining initiatives and Portuguese mining regions to promote joint mining projects, enhance knowledge and funding access by:
   - Developing partnerships with regional mining initiatives in Spain (e.g. the Iberian Sustainable Mining Cluster). Andalusia's new mining strategy should map out the existing national and regional mining initiatives and specify the mechanisms to involve Andalusia in those initiatives, articulate common projects and promote a co-ordinated approach to reach European support programmes.
   - Taking an active role in the EU mining networks to promote common projects with EU mining regions and consolidate Andalusia's role as the bridge for EU mining innovation and sustainable practices with Latin American and North African markets. This collaboration should also aim at improving the competitiveness and internationalisation of local small- and medium-sized enterprises (SMEs) in the mining ecosystem.
   - Defining the new mining strategy tools and flagship projects to materialise the co-operation with Portuguese regions located in the geological formation of the Iberian Pyrite Belt (IPB). This can involve a common strategy to attract investors and reach EU funding.

Introduction

Andalusia is the largest mining producer in Spain and benefits from a diverse mining value chain with the potential to contribute to the EU climate neutrality goals and create high-value-added jobs and greater well-being. The new European Green Deal has placed at the top of the agenda the need for raw materials and sustainable mineral transformation processes as a cornerstone to support the EU climate neutrality goal by 2050. This long-term strategy offers Andalusia the support and opportunities to leverage on its mining value chain to become a frontrunner in green technologies and low-carbon mining practices.

To harness this strategic potential, Andalusia needs to fully mobilise the strengths of its mining sector and address its structural challenges. As mentioned earlier in this report, the region benefits from a strategic geographic location with important access to non-European markets, an international, diverse mining and industrial environment and a community supportive of mining with a young demographic structure. The region has long faced a number of structural challenges to mobilise these strengths and create high-value-added activities. These are notably a low innovative business ecosystem around mining, a large share of low-value-added SMEs and entrepreneurship along with an outdated regulation for mining development (Chapter 3).

Realising all of the potential of Andalusia's mining ecosystem requires sound governance mechanisms and a clear strategy that creates strong networks and consensus towards a unified vision of development. The process of preparing the new Andalusia mining strategy for 2021-27 is an opportunity to create the right conditions to help attain higher growth and quality of life through high-value-added activities across the mining value chain.

This chapter provides recommendations to improve the governance mechanisms around mining that can already be introduced in its new regional mining strategy for 2021-27. With effective planning and implementation, this strategy could help Andalusia become a frontrunner in green technologies and sustainable extraction and transformation practices of raw materials. The chapter starts with an overview of the international and national institutional environment for mining development in Andalusia, emphasising the need for a national mining strategy to support a sound mining value chain in Spain and the region. It then provides a number of policy recommendations to enhance Andalusia's mining strategy for 2021-27.

External forces shaping Andalusia's mining strategy

Andalusia has the potential to play a key role in the EU goal of climate neutrality

The EU has defined access to certain types of minerals and metals as a strategic priority to support the transition to an economy with net-zero greenhouse gas emissions. The European Commission (EC) has developed a number of strategies that recognise the strategic role of mining for a sustainable and resilient future. The European Green Deal identifies the access to raw materials as a "strategic security question" to become climate-neutral by 2050 (Box 4.1). Likewise, the new Industrial Strategy for Europe aims to reinforce EU industrial autonomy on access to raw materials, underlying that the transition to climate neutrality could replace today's reliance on fossil fuels with one on raw materials (EC, 2020[1]).

Box 4.1. The European Green Deal

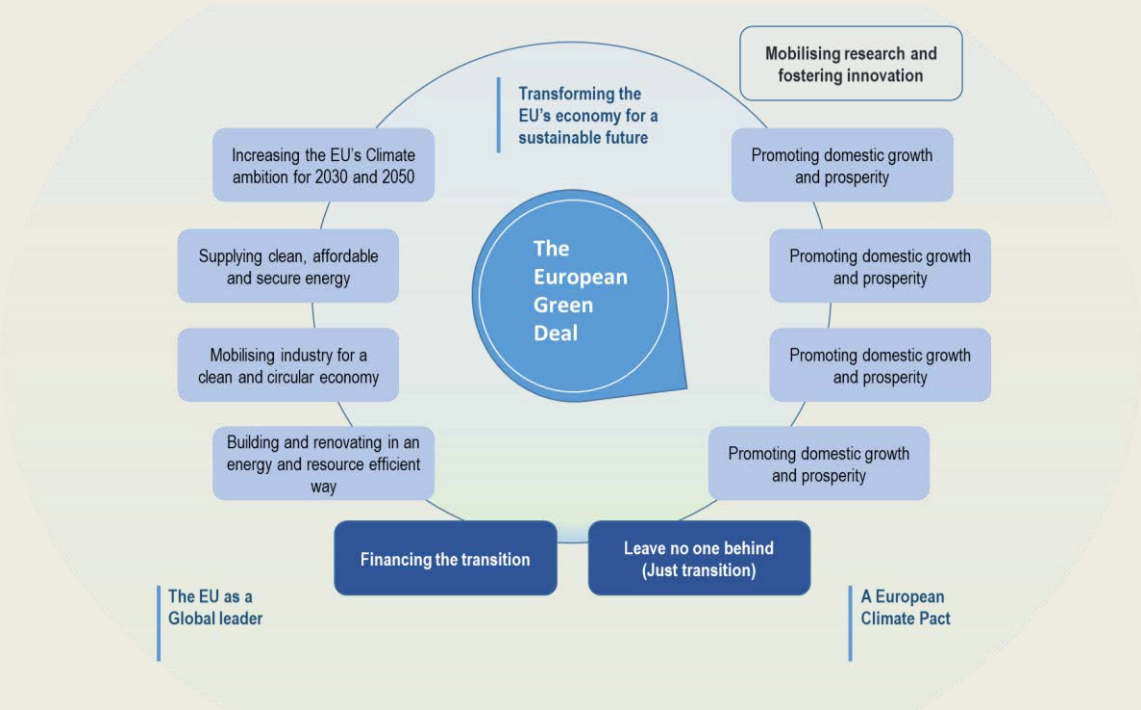
The European Green Deal is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy with net-zero emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use.

It also aims to protect, conserve and enhance the EU's natural capital and protect the health and well-being of citizens from environment-related risks and adverse impacts. At the same time, this transition must be just and inclusive by putting people first and paying attention to the regions, industries and workers who will face the greatest challenges.

The EC has presented an initial roadmap of the key policies and measures needed to achieve the European Green Deal, which will be updated as needs evolved. All EU actions and policies will have to contribute to the European Green Deal objectives. As part of the Green Deal, the EC will refocus the European process of macroeconomic co-ordination to integrate the United Nations (UN) Sustainable Development Goals (SDGs), to put sustainability and the well-being of citizens at the centre of economic policy and SDGs at the heart of the EU's policymaking action.

This deal includes various elements and objectives (Figure 4.1). Acknowledging the overall goal of supporting the circular economy by increasing recycling rates of materials, the access to resources is a strategic security question for Europe's ambition to deliver the Green Deal. Ensuring the supply of sustainable raw materials, in particular those necessary for clean technologies, digital, space and defence applications, by diversifying supply from both primary and secondary sources, is, therefore, one of the prerequisites to make this transition happen.

Figure 4.1. Elements of the European Green Deal

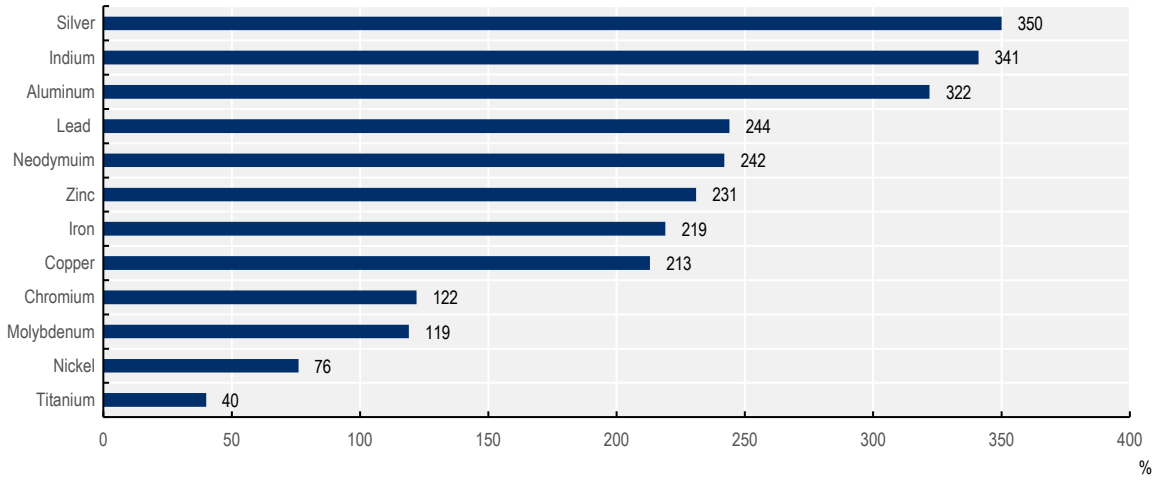


Source: EC (2019[2]), *The European Green Deal*, https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf.

In this context, raw materials stand out as essential inputs for the development of technologies that are needed to achieve the EU climate goal (EC, 2020[1]). These technologies include wind turbines, batteries, fuel cells and autonomous cars among others. Clean energy technologies tend to require more minerals than fossil fuel-based counterparts. An electric car uses five times as much minerals as a conventional car and an onshore wind plant requires eight times as much minerals as a gas-fired plant of the same capacity (IEA, 2020[3]).

The amount of some of the minerals required for these technologies is in some cases greater than the current production levels. Some pre-COVID scenarios to attain climate neutrality by 2050 estimated that the EU would need up to 18 times more lithium and 5 times more cobalt in 2030 compared to the current supply to meet the demand for electric vehicle batteries and energy storage (EC, 2020[1]). While this is particularly the case for new and rare minerals (e.g. cobalt, lithium), the demand is also expected to increase for other traditional metallic minerals, such as copper, the main product from Andalusia's mining production (Figure 4.2).

Figure 4.2. Relative change in demand for minerals from energy technologies (without storage) through 2050



Note: Change in demand according to the International Renewable Energy Agency (IRENA) renewable energy roadmap scenario (Remap) relative to base scenario = 4-degree scenario.
Source: World Bank Group (2020[4]), *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition*, http://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf.

Pursuing sustained access to raw materials is then a strategic matter for economic resilience. Currently, many of the raw materials needed to develop green technologies in Europe are sourced from elsewhere and concentrated in a few producers. For example, China provides 98% of the EU's supply of rare earth elements (REE), whereas South Africa supplies 71% of the EU's platinum. While import dependency is not a critical issue per se, the commercial reliance on only a few sources can create production and sourcing risks. In fact, the COVID-19 pandemic exposed the vulnerability of some markets that faced supply shortages because of distortions in global value chains (OECD, 2020[5]). Sourcing risks are a particular production concern in the context of the shortage of some rare minerals (see Table 4.1) that are in high demand due to their use in technological innovations (electric vehicles, solar panels, etc.).

In response to this, the EU strategy on raw materials establishes a number of priority actions to increase resilience and build the path to a model of open strategic autonomy in raw materials (EC, 2020[1]) (Box 4.2). The strategy builds on the identification of a number of critical non-energy and non-agricultural raw materials that are highly important for the sustainability of the EU industry. Those critical raw materials (30)

are especially relevant for the EU goal of resource security, though this also applies to other raw materials, including metallic and industrial minerals, aggregates and biotic material that represent the backbone for sustainable production.

The strategic actions of this European strategy on raw materials aim to promote greater diversification of mineral sources and resource efficiency and circularity (reuse and recycling of materials). Besides the need for reliant and resilient sourcing of minerals, the extraction and transformation process needs to adopt an environmentally sustainable process. The growing demand for materials coupled with the environmental consequences of uncontrolled mineral extraction, processing and waste, is likely to jeopardise the actions towards a low-carbon economy. To address multiple goals, EU raw materials strategy along with the industrial strategy have proposed the development of new industrial alliances on raw materials. This includes financial and strategic support for projects in collaboration with different actors. For example, it can leverage on the European Investment Bank's new energy lending policy to support projects relating to the supply of critical raw materials.

Box 4.2. EU's Raw Materials Initiative and its role in the EU COVID-19 recovery plan

Access to resources is a strategic security question for Europe. The new EU industrial strategy aims to reinforce Europe's open strategic autonomy, with a future vision of increased global reliance on raw materials to sustain growth. Many of these minerals are sourced from outside the EU, in a context where global competition is becoming fiercer (EC, 2020[6]).

Achieving resource security requires action to diversify supply from both primary and secondary sources, reduce dependencies and improve resource efficiency, including sustainable product design. This is true for all raw materials but is even more necessary when it concerns those raw materials that are critical for the EU.

In this context, the EC has developed a list of critical raw materials for the EU since 2011, which is updated every three years. In 2020, the assessment to identify these materials screened 83 materials (5 more than in 2017), based on the average for the most recent 5 years. Economic importance and supply risk are the two main parameters used to determine criticality for the EU.

The resulting list of critical raw materials provides a factual tool to support EU policy development. The EC takes the list into consideration when negotiating trade agreements or seeking to eliminate trade distortions. The 2020 EU list contains 30 materials:

Table 4.1. 2020 Critical Raw Materials

Antimony	Hafnium	Phosphorus
Baryte	Heavy Rare Earth Elements	Scandium
Beryllium	Light Rare Earth Elements	Silicon metal
Bismuth	Indium	Tantalum
Borate	Magnesium	Tungsten
Cobalt	Natural graphite	Vanadium
Coking Coal	Natural rubber	**Bauxite**
Fluorspar	Niobium	**Lithium**
Gallium	Platinum Group Metals	**Titanium**
Germanium	Phosphate rock	**Strontium**

Note: New critical raw materials, as compared to 2017, in bold.
Source: EC (2020[1]), *Critical Raw Materials Resilience: Charting a Path towards Greater Security and Sustainability*, European Comission

As if the challenge to achieve sustainable raw materials security was not enough, the COVID-19 crisis has revealed just how fast and how deeply global supply chains can be disrupted. The Commission has proposed an ambitious COVID-19 recovery plan to increase resilience and open strategic autonomy and to foster the transition towards a green and digital economy.

The Commission sees critical raw materials as one of the areas where Europe needs to be more resilient in preparation for future shocks and to have more open strategic autonomy. The EU should act urgently to ensure a secure, sustainable supply of raw materials, pooling the efforts of companies, sub-national and national authorities as well as the EU institutions (EC, 2020[1]). To achieve this, the EU action plan for critical raw materials should:

- -Develop resilient value chains for EU industrial ecosystems;
- -reduce dependency on primary critical raw materials through circular use of resources, sustainable products and innovation;
- -strengthen the sustainable and responsible domestic sourcing and processing of raw materials in the European Union, and
- diversify supply with sustainable and responsible sourcing from third countries, strengthening rules-based open trade in raw materials and removing distortions to international trade

The Commission intends to develop and implement these priority objectives and the action plan with the help of Member States and stakeholders, in particular the European Innovation Partnership on Raw Materials and the Raw Materials Supply Group. It will also draw on the support and expertise of the European Institute of Innovation and Technology (EIT) Raw Materials.

Source: EC (2020[1]), Critical Raw Materials Resilience: Charting a Path towards Greater Security and Sustainability, European Comission

European countries and regions with the right mining potential and know-how have a unique opportunity to benefit from these European strategies and their support programmes to unlock new growth opportunities. The European Green Deal strategy has explicitly highlighted the need for “climate and resource frontrunners’ to develop the first commercial applications of breakthrough technologies in key industrial sectors by 2030” (EC, 2019[2]). Priority areas of investment include clean hydrogen, fuel cells and other alternative fuels, energy storage and carbon capture, storage and utilisation. Certain European mining regions, such Andalusia, and their business ecosystems are well-positioned to meet this technological demand through a low-carbon production process across the mining value chain.

Andalusia is in fact one of those regions that are instrumental for the EU strategy of raw materials. As mentioned in previous chapters, Andalusia is the largest mining producer in Spain and holds the greatest deposits of metallic minerals in the country, which includes copper, a basic material for power transmission. The region stands out by its foreign-based mining and transformative business ecosystem that has invested in installed capacity and technology to extract and transform minerals in line with high environmental standards. Andalusia is also a leading producer of non-metallic (NM) minerals in Spain and Europe, notably gypsum, marble and cement.

The diverse and relevant mining ecosystem of Andalusia would allow the new green technologies to have a greater impact on mining-related carbon emission and in those of connected activities. Technologies to reduce fossil fuel consumption from mines and the use of water (and other resources) in the mining process can have an incremental effect on all of the mines located in the region. Furthermore, new innovations to reduce carbon emission in mineral transformation and facilitate recycling and reuse of metallic and NM minerals would have a direct impact on the carbon footprint of Andalusia’s mining sector and other connected sectors, notably construction (e.g. through innovations in cement or gypsum). Furthermore, the geographic location with access to Africa and cultural proximity to Latin America represent important

strategic assets for Spain and the EU as market opportunities to export environmental mining practices and technologies.

Mobilising Andalusia's mining value chain potential to accelerate the transition to a low-carbon economy requires political and strategic support from national and regional governments, with a clear vision to unlock growth opportunities and increase well-being through mining-related economic activities.

The lack of a Spanish mining policy is an obstacle to unlocking growth opportunities

A national mineral (or mining) strategy is a core policy of national interest to secure a sustainable supply of raw materials, ensure economic resilience and support the transition to a low-carbon economy. A national mining strategy is useful to co-ordinate and boost growth and well-being in a country by leveraging the local mining and industrial competitive advantages. National mining strategies also help countries set clear rules on permit award and regulation processes, support the co-ordination across regional mining projects and among development strategies at the national level, unlock innovation and ensure the environmental sustainability of mining projects (OECD, 2021[7]).

Spain is one of the few EU countries with mining production that does not have a national mineral strategy/policy (Table 4.2). Instead, mining policy in Spain is a combination of the regional mining policies. While the national state has exclusive powers over the foundations of the mining law, which is the main legislation for mining in Spain, the regions are the ones in charge of mining policy design, mining permitting and mining policy implementation (Chapter 3). Furthermore, as mentioned in Chapter 3, the exiting Spanish mining law is very old (1973) and the country lacks overarching legislation that compiles all the new regulations, for example on environmental and waste management.

Table 4.2. National mining policies in selected EU countries with mining production

	National mining or mineral strategy/policy
Austria	Yes
Bulgaria	Yes
Czech Republic	Yes
Finland	Yes
France	No
Ireland	Yes
Germany	Yes
Greece	Yes
Portugal	Yes
Poland	Yes
Spain	No
Sweden	Yes

At the national level, the Ministry for the Ecological Transition and the Demographic Challenge (MITERD) is in charge of mining with a limited role in strategic planning. This ministry, through the Directorate General for Energy Policy and Mines, has a general monitoring role, mainly in charge of overseeing mining security, waste mining and issues related to mining processes when a mine is located across two regions. It also manages the sectoral statistics and promotes guidelines on sectoral practices. While the national government promotes the exchange of good practices around administrative procedures and regulations, this exchange takes place on a case-by-case basis and should be reinforced with a more active role from regions as competent authorities.

At the regional level, different regional ministries are responsible for mining issues. In the case of Andalusia, the Ministry of Economic Transformation, Industry, Knowledge and Universities has the main responsibility on mining development. Through the Secretary of Industry and Mining (regional vice-ministry level), the ministry elaborates the regional mining strategy, co-ordinates the regulatory and licensing process and interacts with private companies.

Since 2020, the ministry has made further efforts to co-ordinate mining policy and began a process to establish a *roadmap for the sustainable management of raw materials* (MITERD, 2020[8]). This roadmap aims to guarantee the supply of mineral resources for Spain in a more sustainable and efficient way while maximising benefits throughout the value chain. With this road map, the national government acknowledges that the transition to a climate-neutral economy in 2050 will involve increasing consumption of certain mineral raw materials and that the COVID-19 crisis calls for a greater need to ensure economic resilience through raw materials.

This roadmap could be used to complement other national directives for the sustainable mining process. They include the National Energy and Climate Plan 2021-30 (PNIEC), which establish the need to develop new tools for research and innovation in energy and climate and update information on mineral reserves. Also, the Long-Term Strategy (ELP), which highlights the relevance of the circular economy process and the extraction of minerals under high environmentally sustainable standards, by reducing the reliance on mineral imports.

This road map is welcomed as a useful step towards greater co-ordination of mining, yet it is still at an early stage and would require formal tools and a unified vision to co-ordinate regional mining value chains. The MITERD has scope to perform a more active co-ordinating role in relation to mining policy, through a clear strategic vision on the role of mining for regional development and a policy approach that fosters regional co-operation on mining investment and promotes policy complementarities among mining and other national sectoral plans. Without overall co-ordination, the multiplicity of regional strategies leads to duplication of actions and investments among regions, which decrease efficiency and make for missed opportunities for knowledge exchange and innovation in the country.

Table 4.3. Role of national and regional governments in mining development in Spain

Ministry for the Ecological Transition and the Demographic Challenge	Regional government (in Andalusia: the Ministry of Economic Transformation, Industry, Knowledge and Universities)
• Mining security and management of explosives • Waste mining • Mining processes when a mine is located across two regions • Sectoral statistics	• Regional mining strategy • Regulatory and licensing process • Investment attraction • Geological study and information

The EC has highlighted the importance of national mineral policies to ensure that mineral resources are exploited in an economically viable way and based on sustainable development principles (EC, 2011[9]). In its 2011 communication on raw materials, the EC identified the development of the national mineral policy as a mechanism to foster the sustainable supply of raw materials and harmonise mineral policies with other national policies, including a commitment to provide an appropriate legal and information framework. Likewise, the private sector in Spain has repeatedly highlighted the need for a national strategy on mining. The Spanish Confederation of Mineral Raw Materials Industries (PRIMIGEA) initiated a conversation with national authorities to raise awareness of the advantages of a co-ordinated national strategy for Spain, in terms of productivity, business attractiveness and improvement of social perception on mining.

A new national mining strategy would add value in a number of areas

A Spanish mineral policy could help regions develop projects around the mining value chains that create new job opportunities for regions. The development of business ideas around the national mining value chain could help Spain overcome some of its most pressing challenges, including population decline, high unemployment rates and low levels of innovation. Given that mining is highly localised in the territory, usually taking place in rural locations, planning for new business opportunities in this sector could contribute to retaining and attracting the population to rural places and bring with it high-value-added jobs.

A national policy strategy can mobilise the diversity and richness of Spanish mining value chains (e.g. leading mining and energy companies, mineral manufacturers and refineries) and such co-ordination can create synergies among firms of different sizes and within different sectors to boost innovation rates in the country. These types of co-ordinated actions are a priority for a country to compete in a global market where the need for minerals to support green technologies has become a growing source of productivity and well-being.

To this end, the national government of Spain, particularly the MITERD, should leverage the roadmap for the sustainable management of raw materials to develop a national mineral strategy to accelerate the transition to a low-carbon economy and create new opportunities for regional growth.

Spain could follow some good practices of other national mining or mineral strategies. Many OECD national mining or minerals strategies set a vision for development, define specific co-ordination mechanisms with other strategic plans and strategies to attract investors and boost the well-being of local communities. Some of these strategies are designed in close collaboration with private actors and communities, which provides greater legitimacy and ownership of the objectives. Box 4.3 provides a summary of three OECD national mining plans (Canada, Finland and Germany). These national plans have multiple common objectives such as fostering growth and innovation, reducing environmental impacts from mining projects and ensuring a sustainable supply of raw materials.

Many regions in Spain have experience in developing regional mining policies, which could be leveraged by the national strategy. Andalusia, Castilla la Mancha and Murcia, among others, all have different regional policies to support the development of the mining sector and its value chain. Each region has expertise in involving local stakeholders in the development of the strategy, defining priorities and creating indicators to monitor the implementation.

Furthermore, the Geological and Mining Institute of Spain (IGME) has room to play a stronger role in national mining development. The IGME serves as a repository of geological information that gathers the outcomes from various regional geological research. However, this institute does not have a strategy for long-term exploration or research around minerals and materials. Instead, it conducts research on the basis of projects with specific funding (national, regional or EU funding). In other OECD countries (e.g. Finland, Sweden), national geological bodies play an active role in co-ordinating exploration around the country and researching materials, technologies or transformation processes. In Finland, for example, the geological institute is in charge of co-ordinating and conducting the national mineral strategy and supporting the international promotion of the country's mining potential (Geological Survey of Finland, 2010[10]). Spain can improve the capacity of its IGME to help co-ordinate mineral research and exploration, as well as promote the Spanish mining value chain internationally.

In summary, the development of the Spanish mining (or mineral) strategy can help the country better contribute to the EU goal of climate neutrality, accelerate the national transition to a low-carbon economy and support regional development and well-being. For this, the national government, particularly the MITERD, should:

- Develop a national strategy on raw materials and mining. This strategy should build on the ongoing process of developing the *road map for the sustainable management of raw materials*. The strategy should include a long-term vision for development, clear horizontal co-ordination mechanisms with

other development policies, tools to promote environmentally sustainable mining processes and technologies, as well as strategies to attract investors and boost the well-being of local communities.

- Improve the capacity of the IGME to help co-ordinate mineral research and exploration, as well as promote the Spanish mining value chain internationally.

Box 4.3. Mineral or metal strategies in Canada, Finland and Germany

Canadian Minerals and Metals Plan

The Canadian Minerals and Metals Plan, established in 2019, sets a vision to make Canada the leading mining nation, home to a competitive, sustainable and responsible minerals industry that benefits all Canadians. The plan defines six strategic directions to achieve this vision:

1. Canada's business and innovation environment for the minerals sector is the world's most competitive and most attractive for investment.
2. Increased economic opportunities for Indigenous peoples and supporting the process of reconciliation.
3. The protection of Canada's natural environment underpins a responsible, competitive industry. Canada is a leader in building public trust, developing tomorrow's low-footprint mines and managing the legacy of past activities.
4. A modern and innovative industry supported by world-leading science and technology – across all phases of the mineral development cycle.
5. Communities welcome sustainable mineral development activities for the benefits they deliver.
6. A sharpened competitive edge and increased global leadership for Canada.

Finland's Minerals Strategy 2010 with a vision for 2050

Finland's 2010 Minerals Strategy is the guiding document that outlines the route for the future of mining in the country and sets the vision for 2050. The government has set the target to make Finland a global pioneer in the sustainable utilisation of minerals, with the mineral sector as one of the foundations of its national economy. To achieve this, the Minerals Strategy has set three strategic objectives:

1. Promote domestic growth and prosperity.
2. Solve global mineral chain challenges.
3. Mitigate environmental impact.

The German government's Raw Materials Strategy

In 2010, the German Federal Government elaborated elements of a raw materials strategy on the basis of intensive dialogue between industry and policymakers. The Federal Chancellor established an inter-ministerial Committee on Raw Materials – chaired by the Federal Ministry for Economic Affairs and Technology (BMWi) – to identify problems for commerce deriving from raw materials and to produce inter-ministerial solutions. The committee is chaired by BMWi. This strategy sets nine objectives:

1. Reducing trade barriers and distortions of competition.
2. Helping German commerce to diversify its sources of raw materials.
3. Helping commerce to develop synergies from sustainable economic activity and enhanced materials efficiency.
4. Developing technologies and instruments to improve the conditions for recycling.

5. Establishing bilateral raw materials partnerships with selected countries.
6. Doing research into substitution and materials in order to create new options.
7. Focussing research programmes relating to raw materials.
8. Creating transparency and good governance in raw materials extraction.
9. Integrating national measures with European policy on raw materials.

Source: Federal Ministry of Economics and Technology (2010[11]), *The German Government's Raw Materials Strategy*, https://foes.de/pdf/rohstoffstrategie%20bundesregierung%20englisch.pdf; Geological Survey of Finland (2010[10]), *Finland's Mineral Strategy*, http://projects.gtk.fi/export/sites/projects/mineraalistrategia/documents/FinlandsMineralsStrategy_2.pdf.

Mining strategy of Andalusia, from old to new

The experience across several OECD countries and regions has shown that strategic planning for extractive sectors is an important tool for growth, environmental protection and increased well-being. A mining strategy connects the different actors across the mining value chain and promotes external networks by clarifying the role of mining for regional and national development. In a context where mining faces concerns from some parts of the society, a well-designed strategy can help raise awareness among local communities of the opportunities and challenges involved in mining development and outline ways to better share the mining benefits.

Objectives and structure of the Andalusia Mining Strategy 2013-20

Andalusia developed a mining strategy in 2013 in light of the growing relevance of mining in the regional economy. During the years after the 2008 financial crisis, Andalusia's mining sector underwent a transformative period with decreasing extraction of NM minerals due to the crisis in the construction sector, while metallic mining experienced an increased demand due to higher international prices of materials and technological advances that made old mines profitable (Regional Ministry of Work, Business and Trade, 2013[12]). The trend of increasing profitable metallic mining has continued during recent years (Chapter 3).

This mining strategy leveraged the 2013 Agreement for the Economic and Social Development of Andalusia, signed between Andalusia's regional government and a pool of representatives from the private sector and civil society. This agreement positions the mining sector as one of the pillars to support the regional development by underlying its relatively high levels of productivity. The strategy also aimed to be a continuation of the Management Plan of Mineral Resources 2010-13, conceived as a planning instrument to strategically orient research activities and exploitation of mineral resources (Regional Ministry of Work, Business and Trade, 2013[12]).

The Andalusia Mining Strategy 2013-20 was built around the following 4 objectives, each of them with a strategic axis (5 in total) and action lines (13 in total) (Table 4.4):

- Unlocking mining potential in Andalusia and creating employment and improvement of mining competitiveness.
- Improving public services linked to the mining sector, adapting public to sector needs.
- Integrating an environmental aspect into mining activity and increasing the value of Andalusia's mining heritage to boost the tourism, cultural, social and economic sectors.
- Boosting and developing the implementation of a framework on labour relations, with a specific focus on occupational health and safety.

The strategy is built hierarchically with action lines defining specific tasks and identifying the actors in charge in order to meet the specific axis and, in turn, the objective. The four objectives emerged from a comprehensive diagnostic of the mining potential, the socio-economic relevance of the mining value chain and the environmental effects of the activity. This is a welcome diagnostic that used data from different regional ministries, statistical agencies and business associations, and identified the characteristics of the mining value chain of different minerals in terms of employment, production and weight at the provincial level. The diagnosis also elaborated a detailed analysis of the strengths and weaknesses in the value chain. Some of those challenges are still present in the region and closely related to those identified in this report (Chapter 3).

Table 4.4. Objectives, axes and actions of the Andalusia Mining Strategy 2020

Objectives	Axes	Action lines
Unlocking mining potential in Andalusia and creating employment and improvement of mining competitiveness	1. Promoting Andalusia's mining potential	1.1 Increasing knowledge of mining potential 1.2 Boosting government support to mining activity 1.3 Enhancing image and social perception of mining 1.4 Supporting research on the mining potential (e.g. deposits)
	2. Enhancing the business environment around mining	2.1 Expanding research, innovation, co-operation and competitiveness 2.2 Promoting trade and internationalisation
Improving public services linked to the mining sector, adapting public to sector needs	3. Modernising mining policy and governance	3.1 Improving administrative management 3.2. Co-ordinating mining policy across government bodies 3.3 Strengthening the online information portal
Integrating the environment into mining activity and increasing the value of Andalusia's mining heritage to boost touristic, cultural, social and economic sectors	3. Integrating the environmental aspect into the mining activity and increasing the value of Andalusia's mining heritage	4.1 Supporting the environment 4.2 Strengthening linkages with tourism and culture
Boosting and developing the implementation of a framework on labour relations, with a specific focus on occupational health and safety	5. Boosting human capital	5.1 Promoting occupational risks' prevention, health and safety 5.2 Increasing training and qualification

Source: Regional Ministry of Work, Business and Trade (2013[13]), *Estrategía Minera de Andalucia 2020*, https://ws050.juntadeAndalusia.es/portalandaluzdelamineria/pamapps/archivos/_archivos_/pormian/Estrategia_Minera_de_Andalusia_2020.pdf.

Besides the detailed diagnosis and well-structured hierarchy of actions, Andalusia's strategy also stands out with:

- A comprehensive mapping of its links with other policy instruments and strategies at the international and regional levels. Andalusia's strategy aligns with a number of EU strategies on industrial and mining development, including the 2008 EU initiative on raw materials, and with a large variety of regional sectoral policies, including economic, energy, industry, tourism, environment and land management plans (Table 4.5). This strategic effort is welcomed and reveals the government's will to leverage regional development through the synergies between mining and the local economy.
- A detailed monitoring and evaluation framework for the implementation of the action's lines. For this, the Regional Ministry of Work, Business and Trade co-operated with other public entities, business and labour associations as well as universities and technological centres to gather information for the monitoring and evaluation indicators. These partnerships are relevant as the

indicators also monitor the actions that some local actors need to conduct for the attainment of the objectives.

Table 4.5. Regional sectoral plans outlined in the Andalusia Mining Strategy

	Overall goal	Synergies with the Andalusia Mining Strategy (selected)
The Agenda for Employment: Andalusia Economic Plan 2014-20	Promote economic growth and employment in coherence with the European Cohesion Policy within the framework of the Europe 2020 Strategy	The sub-objective on modernising traditional sectors where there is high specialisation includes a number of actions for mining development
Andalusian Innovation Strategy 2020	Establish objectives regarding research, innovation and the use of information and communication technology (ICT), as well as the specialisation priorities	The objective of sustainable use of endogenous resources includes a focus on environmentally sustainable mining as an engine of territorial growth
Energy Strategy of Andalusia 2020	Transition towards a low-carbon energy system	The sub-objective on promoting and financing actions to improve energy efficiency and use of renewable energies supports the uptake of green energy in mines and linked activities
Industrial Strategy of Andalusia 2020	Strategic orientation of the industrial policy in line with economic, social and environmental plans in order to improve competitiveness based on innovation	Various objectives including an efficient industry, technological improvement, internationalisation and innovative SMEs can all enhance the mining value chain
Sustainable Tourism Plan of Andalusia 2020	Improve the creation and diffusion of touristic assets and promote the rehabilitation of tourism destinations	Developing new tourist attractions, including industrial, mining and scientific tourism as well as enhancing the link between tourism of events (e.g. Mining and Minerals Hall) and other tourist attractions
Environmental Plan of Andalusia 2020	Reduce climate change, attain socio-economic development with an environmental approach and recognise the potential of green jobs	The objective of reaching greater well-being and employment with lower environmental impacts places mining as a key sector to promote the energy transition
Comprehensive Development Plan for the Construction Sector and a Sustainable Rehabilitation	Increase employment and professional qualification in construction and make this sector an international referent in innovation	Improving innovation and co-ordination in the construction value chain is closely linked with a sustainable mining sector

Source: Regional Ministry of Work, Business and Trade (2013[13]), *Estrategía Minera de Andalucia 2020*, https://ws050.juntadeAndalusia.es/portalandaluzdelamineria/pamapps/archivos/_archivos_/pormian/Estrategia_Minera_de_Andalusia_2020.pdf.

However, the 2020 mining strategy carries a number of drawbacks that can be addressed during the updating process of the strategy for 2021-27. The most relevant missing points in the strategy are:

- A clear vision to define the role of mining for regional development.
- Concrete objectives with a timeframe of actions in the short and long terms.
- Strategies to involve local actors (provincial governments, public interest groups, universities and communities) from design to implementation and evaluation of the strategy.
- Clear goals and implementation mechanisms for cross-sectoral co-ordination.
- Clear strategies to improve the collaboration at the national and international levels.

The next sections will explore each of these areas of improvement to build a 2021-27 (or longer) mining strategy that helps Andalusia's mining value chain become a frontrunner to meet EU climate goals and increase income and well-being for local communities.

Defining a clear vision of the role of mining for regional development

Setting a clear and ambitious goal in the strategy is useful to align efforts within the government, create partnerships with international actors and attract new investors. The goal of the current mining strategy is rather broad, aiming at "becoming the planning instrument that strategically guides research activities and exploitation of mineral resources in the territory of Andalusia in accordance with social interests and in co-ordination with economic, land use and environmental planning". For this goal, the strategy identified four objectives described (Table 4.4) but without a clear vision of what the ultimate outcome is when achieving these four objectives.

An overarching objective for the strategy needs to clarify the role of Andalusia's mining value chain in the future of regional and national development with a specific dateline. The overall objective should emerge from an initial diagnosis (similar to that done for the 2020 strategy) of the strengths and weaknesses of the mining sector and its potential to support other economic sectors and well-being goals. This ultimate vision should have a timeline that can be linked with the end of the strategy (2030) or with other national or EU strategies (e.g. 2050 as the EU Green Deal).

The vision also needs to be comprehensive to mobilise all comparative advantages of the region and not only from the mining sector. By going beyond mining, it can integrate other strategic visions of economic sectors and exploit synergies. Furthermore, it has to be ambitious to promote actions to solve the bottlenecks for development. For example, in the case of Finland, the national mineral strategy has three strategic objectives with four thematic actions that aim to achieve a single vision for 2050 making Finland "a global leader in the sustainable utilisation of mineral resources where the mineral sector is a key foundation of the national economy" (Geological Survey of Finland, 2010[10]) (Box 4.4).

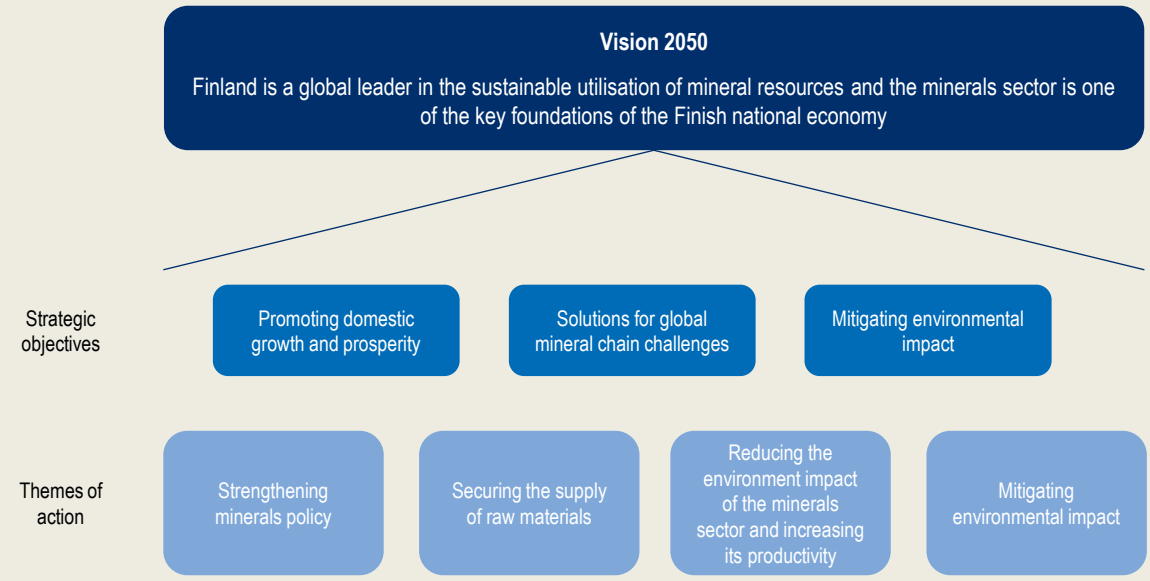
Developing this overarching vision requires consensus within the regional government and across different actors at the local level. This vision needs to gather views on the role of mining for local development and the concerns of the effects of this activity on the environment and society. According to the OECD (2018[14]), some useful techniques to set strategic visions are interactive methods of brainstorming and roundtable discussions. This vision is usually defined first by a small group of main stakeholders and then shared with wider stakeholder groups for discussion and consensus. The vision statement should be concise, short, clearly written, easy to remember and should clearly provide future direction (Vági and Rimkute, 2018[14]).

Box 4.4. Vision and objectives in the National Mineral Strategy of Finland

Finland's diverse mineral resources represent a significant part of the Finnish national wealth. Finnish expertise and innovations in the minerals sector also have a significant global impact, through the provision of exploration and mining equipment and processing technologies and services. Effective utilisation of Finnish mineral resources both secures the supply of raw materials and creates the prerequisites for balanced and sustainable regional development far into the future. Through the country's expertise in the minerals sector, Finalnd can also actively promote a global minerals economy that is both efficient and socially and environmentally responsible, as well as generate new international business opportunities.

Three strategic objectives and 4 distinct themes of action that involve 12 action proposals have been defined to facilitate the implementation of the mineral strategic vision (Figure 4.3).

Figure 4.3. Vision and objectives of Finland's Mineral Strategy



Source: Geological Survey of Finland (2010[10]), *Finland's Mineral Strategy*, http://projects.gtk.fi/export/sites/projects/mineraalistrategia/documents/FinlandsMineralsStrategy_2.pdf.

Materialising the vision through a regional brand: A raw material talent system

Regional branding contributes to building territorial identity and is an important aspect in a global business environment. A common branding is more than a question of labelling: it could be used to shape the vision, projects and stakeholders that can be empowered to join forces and act stronger together. Andalusia is mainly renowned for its touristic and cultural characteristics, which place it as one of the most attractive regions for tourists in Spain (de las Herras Pedrosa, Jambrino and Iglesias, 2013[15]). Yet, Andalusia also has a rich mining history, current competitive geology and diverse mining value chain, which can be better promoted. The region also hosts one of the most important events in mining in Europe (the Mining and Minerals Hall), which has repeatedly attracted more than 10 000 participants (Box 4.5).

The common vision on the role of the mining sector could be materialised through a clear brand that makes the region internationally visible as an attractive place for a new way of mining and processing minerals. By benefitting from its nature-based touristic appeal and its progress in renewable energy production, Andalusia should establish an image that goes beyond mining as a purely extractive sector towards a branding where the region is seen as a raw material talent system with a local high-tech business environment that produces essential minerals and materials for the low-carbon transition. It would help the region to gain visibility internationally and pull investors into high-value-added activities.

This regional branding can involve other ministries and in parallel to the vision. The objectives defined for the regional brand on Andalusia's capacity to transform materials sustainably could be manifold:

- Promote the geographic location (close to Africa) and cultural proximity with Latin America as well as its geology and good infrastructure to attract innovative companies working on sustainable mineral extraction and transformation processes, and development of green technologies.
- Advertise the mild climate, beaches and culture to pull in skilled workers able to meet the industry's needs.

- Improve the image of mining by moving away from the old-fashioned view of activity with high environmental impact and low-quality jobs to one closer to modern mining that follows strict standards and utilises technology to reduce environmental effects and provide high-value-added jobs for men and women of all ages.

As part of the branding effort, Andalusia could be distinct as a mining jurisdiction within international mining rankings or lists. One first step to propose is for Canada's Fraser Institute to consider including Andalusia as a stand-alone region within its Annual Survey of Mining Companies. This survey is a key industry indicator of the mining potential and investment attractiveness of selected countries and regions and currently encompasses Andalusia within Spain. However, Spain does not appear every year (it is not present in the 2019 edition) and the country players' responses (as a whole and not by region) to the institute's survey tend to be rather low (Yunis and Elmira, 2021[16])). There are several countries (Argentina, Australia, Canada, the United States) that are surveyed on a per-region basis and this would help position Andalusia as an established and up-and-coming mining jurisdiction.

Box 4.5. The Mining and Minerals Hall

As part of Andalusia's public policy on promoting its mining industry, the regional government identified the advantage of creating an Andalusian international congress (Action 1.2.1 of the Andalusia Mining Strategy 2020). Under this initiative, Andalusia hosted one of the world's leading industry conferences. With this, Andalusia boosted its international image, which can continue to grow by considering its participation in other events such as the African and Latin American INDABA in South Africa, EXPOMIN in Chile and PERUMIN in Peru.

This event – a joint project with AMINER, the Andalusian mining company's sectoral institution – takes place every two years and is a meeting point for mining sector participants as well as a forum to present and showcase Andalusian mining to the world. The conference's maiden edition was held in November 2015 and was named at the time the Metallic Mining Hall. A total of 114 exhibitors and 10 000 participants attended this first event. The conference was again repeated in October 2017, with a total attendance of 130 exhibitors and 11 000 participants. The event has been gathering momentum and for its latest edition was re-named the Mining and Minerals Hall (MMH), catering for the NM mining sector as well.

The latest edition took place in October 2019 and included a total of 150 exhibitors and more than 10 000 attendees. According to AMINER, the MMH is now considered to be among the most relevant (if not already the leading) Spanish mining industry event and one of the most important events in Europe.

Source: Mining and Minerals Hall (n.d.[17]), MMH, el evento de la minería del siglo XXI, https://mmhseville.com/# (accessed on January 2021)

In summary, the regional government of Andalusia should implement a number of actions to define the role of mining for regional development and establish an overarching common objective in the new strategy:

- Agreeing on a clear vision for mining development in the updated mining strategy. This vision should include a long-term timeline (e.g. 2050, as the EU Green Deal) and be comprehensive to mobilise all of the region's comparative advantages. This requires consensus within the regional government and across different actors at the local level (municipalities, companies, universities and communities). This vision should be aligned to make Andalusia a frontrunner in meeting EU climate goals.

- Enhancing the mining brand in the region and creating a plan to promote it internationally as part of the mining strategy. This brand and its promotion activities need to be developed and co-ordinated with other promotion strategies and actors in the region. The brand should aim to attract new firms and skilled workers. It should help change the image of regional mining to a raw material talent region with an innovative business environment that produces essential materials and know-how for the low-carbon transition.

Improving the strategy with concise objectives, a timeframe of actions and sound monitoring

The strategic planning for mining development requires the definition of different levels of objectives formulated in a concise manner. The current strategy has two levels, four general ones and five strategic (also called axes) (Table 4.4). Some of the four objectives in the current strategy are lengthy and cover a large array of topics in one single statement. For instance, the third objective "Integrating environment with mining activity and increasing the value of Andalusia's mining heritage to boost touristic, cultural, social and economic sectors" covers a goal on the environment and on tourism at the same time. Furthermore, the multiplicity of goals is not clarified in the axis, which in the former example has a similar formulation to the general objective.

The objectives need to involve a short- and long-term timeframe. The current strategy does not classify objectives or axes according to a timeframe, overlooking that some tasks take longer to achieve than others. In very practical terms, a timeframe of objectives is needed to set the order of priorities and thus the action lines. While the general objectives are usually defined for the long term or the culmination of the strategy, they can also be ordered in a sequential timeframe. In turn, the axis (or specific objective) should be organised according to ambitious but realistic deadlines.

To make a new mining strategy with clear goals ordered in a sequential time, the regional government of Andalusia should:

- Establish objectives that represent a clearer and longer-term goal, framed with basic statements in a way that informs the direction of the strategic actions. Andalusia could use the SMART (specific, measurable, achievable, realistic and time-bound) model to define the length and formulation of objectives (Box 4.6).
- Create a timeframe for objectives by indicating which axis and action lines are a priority for the next few years (e.g. 2021-24) and which ones are inscribed in a longer timeline (2030).

Box 4.6. Governance SMART model to define general objectives in a strategy

Objectives serve as the basis for creating the framework of the policy and are fundamental to the monitoring and evaluation of performance.

The suitability of objectives should be tested against the so-called SMART model. Objectives should be:

- Specific – an objective must be concrete, describing the result to be achieved, and focused, contributing to the solution of the problem.
- Measurable – an objective should be expressed numerically and quantitatively in relation to a specific benchmark and should allow the progress of implementation to be tracked.
- Action-oriented/attainable/achievable – an objective should motivate action and should state what is to be improved, increased, strengthened, etc., but should also be reachable.

- Realistic – an objective should be realistic in terms of time and available resources.
- Time-bound – the realisation of the objective should be specified in terms of a time period.

The set of objectives should tell the "story" of the strategy in a logical and sequential way, so they should be logically connected. They should be connected to all of the defined and selected problems that require reform and – where multiple layers of objectives are used – should be linked to each other, in order to provide a complete picture of the reforms envisaged.

Source: Vági, P. and E. Rimkute (2018[14]), "Toolkit for the preparation, implementation, monitoring, reporting and evaluation of public administration reform and sector strategies: Guidance for SIGMA partners", https://doi.org/10.1787/37e212e6-en.

Strengthening the monitoring and evaluation process

As mentioned before, Andalusia's mining strategy has a comprehensive monitoring framework of mining strategy. This framework includes a number of specific tasks with performance indicators to measure the implementation status of each action line. For example, Action line 1.2 "Boosting government support to mining activity" includes two specific tasks: "Development of the Mining and Minerals Hall in Seville (MMH)" and "Promotion of strategic sectors of the region for investment attraction". Each specific task includes a number of performing indicators to track its achievement. As a single task requires actions from different local actors in charge (government agencies or private sector), the monitoring framework evaluates the status implementation for each of the actors.

Andalusia has the scope to improve the monitoring framework of the new strategy through a clear differentiation among outcome and output indicators (Box 4.7). Most indicators in the 2020 strategy measured the achievement of operative tasks rather than the ultimate achievement of the actions. Indicator-measuring operative tasks are considered as output indicators that track the operative actions needed to achieve the axis or specific objectives (Schumann, 2016[18]). In turn, outcome indicators measure the reason for implementing the actions in the first place. In the previous example, the monitoring indicators for Action line 1.2 measure whether the MMH was conducted and the promotion of the strategic sector was undertaken. However, there is no outcome indicator to track whether the tasks in Action line 1.2 led to a greater attraction of investment or requests for permits.

Box 4.7. Example of a result policy chain in the EU

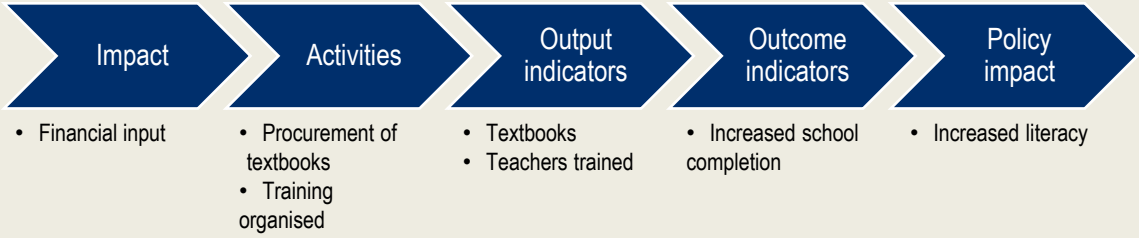
The monitoring of the achievements of the 2014-20 European Cohesion Policy is based on specific indicators (common indicators), associated with the priority axis, category of regions (where relevant) and investment priority in each European operational programme. Each indicator has a baseline target to reach and is monitored during the entire programming period.

Figure 4.4 below shows an example of how an EU-funded project – in the field of early childhood education – would trigger (measurable) changes at different levels forming a "result chain". After the initial financial commitment and the activities implemented on the ground, it generates a direct output (in this example, the number of textbooks distributed to the students and the teachers trained by the project), producing the intended outcome of the project (increasing school completion). The outcomes of multiple projects generate the overall policy impact (e.g. increased literacy).

Indicators associated with each stage of the chain should be carefully monitored and evaluated against suitable counterfactuals (what would have happened without the project/policy?). Monitoring and

evaluation should be part of gradual, transparent evidence-based policy learning (Crescenzi, de Blasio and Giua, 2018[19]).

Figure 4.4. Example of result chain in the EU



Source (figure): Adapted from EC (n.d.[20]), *EuropeAid - DEVCO 06 - Quality and Results*, European Commission; Crescenzi, R., G. de Blasio and M. Giua (2018[19]), "Cohesion policy incentives for collaborative industrial research. Evaluation of a smart specialisation forerunner programme", https://doi.org/10.1080/00343404.2018.1502422; Crescenzi, R. (n.d.[21]), "Indicators for territorial public policy: the case of the European Union".

The new strategy also needs to avoid duplication, while promoting horizontal indicators. The current strategy does not have indicators with a sense of complementarity and transversality. Some key challenges like innovation in the mining value chain are measured separately within different actions lines. In this case, these types of horizontal goals should have a horizontal indicator that gathers all of the different efforts on this matter. These types of horizontal indicators help improve the clarity over the responsibilities of each ministry or local actors and avoid duplication of some performance indicators. For instance, in the current strategy, the action on supporting research on mining potential (Action line 1.4) includes specific tasks on articulating measures to promote research, something similarly measured in the action line on expanding research, innovation, co-operation and competitiveness (2.1).

Objectives and monitoring indicators in the strategy can also be linked with global agendas. Linking objectives and outcome indicators to global agendas such as the SDGs can have a twofold benefit. On the one hand, it can help improve social and political perception on mining and reveal the benefits of this sector over regional well-being. On the other, this alignment can help identify and develop synergies with the regional strategies and link local objectives with longer timeframes. Many OECD regions have linked different sectors with SDGs (OECD, 2020[22]).

To improve the monitoring framework of the new mining strategy, the regional government of Andalusia should:

- Differentiate among outcome and output indicators to measure ultimate objectives and operative tasks differently.
- Develop horizontal indicators that measure transversal objectives in the strategy and avoid duplication across specific task indicators, while creating complementarities.

Involving municipal governments and local communities in the mining strategy

The updated mining policy has scope to further take into account the municipal development strategies and the communities' needs and vision. While the diagnosis for the 2020 strategy analysed the mining characteristics of municipalities, the strategy fell short in identifying specific roles for municipal governments to meet strategic objectives and strategies to create partnerships with communities for policy implementation. As mines are geographically located, mining requires a place-based policy approach that accounts for the singularities of the hosting areas. It is instrumental to define the possible effects of mining

on local economies and ensure local governments are aligned with the policies so as to increase social license to operate mining ventures.

Collaborating with municipal governments

Involving local governments in the strategic planning for mining development provides legitimacy and consolidates the vision, objectives and implementation mechanisms of the strategy. Local governments are complementary to the strategy as they provide a local vision and support with resource management and policy implementation. In Andalusia, municipal governments can be key players in supporting the mining permit process by creating a dialogue mechanism with local communities and addressing environmental concerns.

The 2020 mining strategy lacks clarity on the roles of municipal governments in mining development. Unlike with the private sector, the preparation and monitoring process of the strategy rarely states the role of local governments in the definition or achievement of the strategic objectives. For example, in the monitoring framework, only a few indicators monitor the actions of municipal governments to meet the goals.

Integrating municipal development plans and views in the mining strategy can be done through active and formal co-ordination mechanisms. While the regional government has regular interaction with local governments, this co-ordination is not formally institutionalised. Instead, it occurs through a case-by-case scenario for specific projects or to address particular issues. Aligning the mining strategy with the municipal development plans should be the first step to closer collaboration. The regional government should also establish a formal communication channel to ensure the continuity of co-ordination over time. This channel could be included within a formal multi-stakeholder platform on mining development that meets regularly (see next section).

Involving local communities in the mining strategy

The updated mining strategy also needs to strengthen the engagement of local communities and public interest groups within policy design and implementation. Defining mechanisms to involve citizens in future development and incorporate their feedback can improve the quality of policy outcomes (OECD, 2020[23]). Local dwellers not only have a better knowledge of local conditions but also the capacity to adapt policies according to the context. Greater participation of communities in policy definition increases public satisfaction, ownership and trust in the policy (OECD, 2017[24]). Modalities of engagement vary from basic communication, the weakest form of engagement, to full coproduction and co-delivery of policies with a balanced share of power among stakeholders (OECD, 2020[23]).

A first step in the engagement with communities would be to involve public interest groups in the preparation and monitoring process of the new strategy. It is worth noting that the Secretary of Industry and Mining of Andalusia has tried in the past to identify and involve community representatives and public interest groups in the mining policy process but it encountered challenges in identifying the right counterpart at the local level and obtain an active response and participation.

Apart from the private sector and universities, with which the regional government seems to have frequent interaction, the Secretary of Industry and Mining of Andalusia should establish institutional channels to engage with the local community. Some OECD regions have implemented citizens' platforms combined with local elected officials, local businesses and other relevant stakeholders (universities), which contribute to promoting specific regional development strategies and oversee implementation (Box 4.8). The General Secretary of the Industry and Mining could also find useful the engagement strategy that Canada undertook when designing its national mineral plan.

Box 4.8. The Citizen Engagement Summit

The Baltic Urban Lab is a European initiative based on the concept of people-private-public partnership (4P), involving a wide variety of projects in Nordic countries.

Within this framework, a project for the inclusion of citizens in deciding on climate change adaptation options was carried out in 2011 called "Citizens vote on climate change adaptation options in Kalundborg". Kalundborg is a municipality located on the island of Sjælland in Denmark and home to 20 000 inhabitants. It is threatened by the impacts of climate change as it has a coastline, lowlands and sensitive areas with delta characteristics. Sea level rise and changes in rainfall, as well as infrastructure and water quality, are the main risks associated with climate change. The municipality of Kalundborg together with the Danish Board of Technology (DBT) organised a citizens' summit where 350 local citizens discussed how Kalundborg should adapt to a future with a warmer climate.

Before the summit, citizens were given relevant information material and presented with the pros and cons of the different adaptation options obtained through a scenario workshop. The methodology used for the workshop was to present to local stakeholders the implications of the possible flooding of the Kalundborg area. On this basis, they developed different solutions to the challenges in a scenario workshop. Finally, citizens debated and voted on these options.

As a result, two-thirds voted in favour of phasing out the current land use – mostly farmland – to turn it into wetlands, rather than building dykes. In terms of the period for action, the vast majority of citizens (90%) requested that the municipality act now and develop long-term plans based on climate change scenarios. Thanks to the participatory nature of the decision-making process, local politicians were able to make broader decisions taking into account a broader view of local interests.

Source: Interreg Central Baltic (2012[25]), "Citizens vote on climate change adaptation options in Kalundborg", https://www.balticurbanlab.eu/goodpractices/citizens-vote-climate-change-adaptation-options-kalundborg.

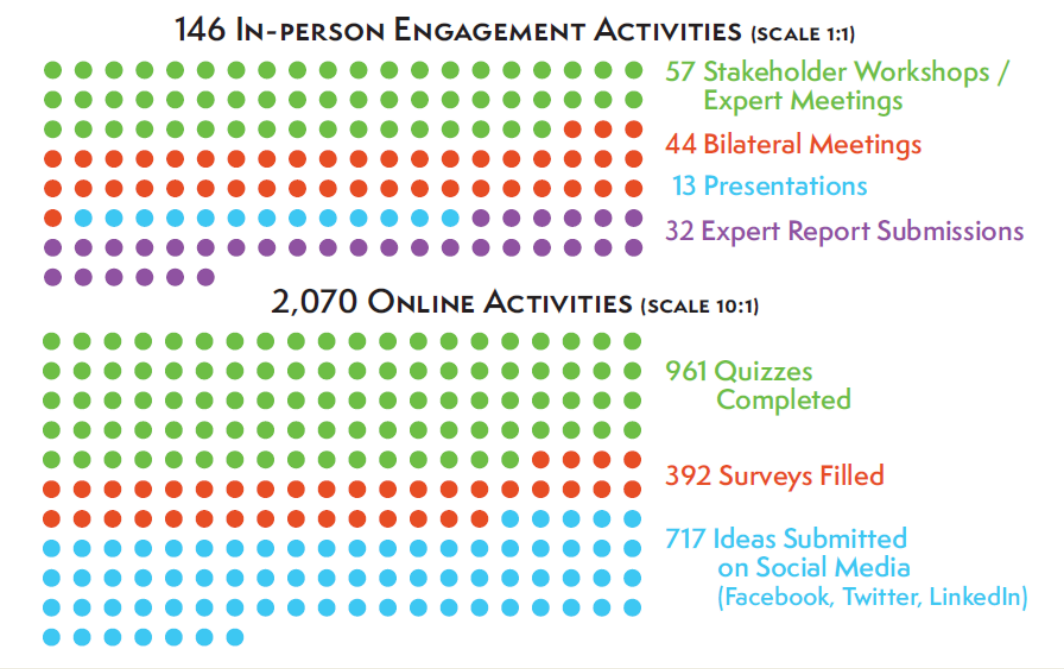
Box 4.9. Engagement strategy in the Canadian Minerals and Metals Plan

The Canadian Minerals and Metals Plan includes a vision, principles and strategic directions that governments, industry and stakeholders can pursue to drive industry competitiveness and long-term success. This generational initiative aims to raise Canadians' awareness of the importance of the minerals and metals sector, respond to ongoing and emerging challenges and help position Canada for opportunities offered by an evolving economy.

This plan was informed by engagement with Indigenous peoples, innovation experts, private companies, industry associations, non-governmental organisations, young people, other stakeholders and partners, as well as Canadians from across the country.

The government developed an engagement approach with civil society to gather main concerns, ideas and suggestions to fit into the plan. This engagement process included in-person activities with workshops, bilateral meetings and expert report submissions. It also adopted online activities through quizzes, surveys and ideas submitted through social media (Figure 4.5).

Figure 4.5. Analytics of the engagement strategy in the Canadian Minerals and Metals Plan



Source: Government of Canada (2019[26]), *The Canadian Minerals and Metals Plan*, https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/CMMP/CMMP_The_Plan-EN.pdf.

Reflecting the community interest in the strategy also needs to clarify the mechanisms and measures to increase local benefits from mining activities. Host communities tend to be on the front line regarding the negative externalities from mining ventures, while benefits span across regional governments and firms. A clear framework on benefit-sharing agreements can help mining regions promote a more even distribution of the benefits of mining ventures. If well designed, these agreements are important tools to increase economic opportunities and quality of life for host communities and reduce social conflict around mining (O'Faircheallaigh, 2013[27]). There are different types of benefit-sharing agreements:

- Monetary benefits (also known as benefit funds) include payments, profit sharing, tax-sharing (e.g. royalties) and investment funds.
- Non-monetary benefits comprise local hiring, skills development, education, cultural support and environmental protection and remediation. In terms of governance, agreements can be government-controlled, voluntary company-led initiatives, partnership models among others (Söderholm and Svahn, 2014[28]).

Besides the type of agreement, the extent to which benefit-sharing agreements deliver robust results for communities comes down to how they are governed and implemented. Some agreements are privately negotiated and legally enforceable (some non-monetary benefits agreements), while others are general financial structures with revenues collected by governments (e.g. benefit funds). These agreements can be government-controlled, voluntary companies-led initiatives, partnership models or ownership and control models. While the government leads actions in the government-controlled type, it may equally play some role in voluntary, company-led and partnership models as a facilitator (Box 4.10).

In Andalusia, distribution of benefits from mining operations occurs through tax/royalties and company-led voluntary initiatives. Taxes from mining operations in Andalusia are collected at the regional level and distributed to various activities, including but not restricted to the development of mining communities.

Private companies such as CLC have established programmes to promote local development through funds to support local SMEs and entrepreneurship as well as activities for economic diversification . Leveraging these initiatives and promoting clear structures to increase their local impact would benefit from a clear route map at the regional level.

Box 4.10. Lessons from benefit-sharing agreements in the context of Indigenous communities

Benefit-sharing agreements and funds are often established at the onset of resource development or the extraction process and set out a financial or working relationship that spans its lifetime. Benefits may include payments, profit sharing, local hiring, skills development, education, cultural support and environmental protection and remediation.

Benefit sharing takes several forms and governance types:

Table 4.6. Benefit-sharing models and governance types

A. Government-controlled benefit sharing	
Resource sharing revenues/benefit funds	Sharing of industry revenues collected by governments with Indigenous peoples and/or communities. This includes but is not limited to taxes, royalties, penalties, permits and other fees.
Local content obligations	Targets for the hiring of local workers and procurement of local goods and services may be included in host government agreements with companies and in some cases is legislated. Government-mandated local content is frequently interpreted as "national" content, rather than targeting local and Indigenous communities.
Mandatory social investment	Social investment spending can be mandatory as part of a host government agreement or national legislation, whereby companies are required to invest in infrastructure programmes, such as road construction or health facilities, as a condition of their licence.
B. Voluntary company-led initiatives	
Voluntary engagement	Companies may voluntarily engage in community engagement and/or investment in addition to their mandatory obligations under the law. For example, the International Council on Mining and Metals (ICMM) *Community Development Toolkit* and *Good Practice Guide: Indigenous Peoples and Mining*.
Strategic social investment	Social investment spending on programmes is designed to survive beyond the life of the industrial project and/or to create value for the industrial project. These might include micro-credit programmes, local livelihood support programmes, skills training, enterprise development support or conservation programmes.
C. Partnership model	
Voluntary local content initiatives	Companies may develop partnership programmes based on voluntary targets and initiatives to train and bring in the local and Indigenous workforce to a project, with training and enterprise support linked to opportunities to secure employment or contracts, often with an element of preferential contracting. This may or may not form part of a wide benefit-sharing agreement.
Privately-negotiated benefit-sharing agreements	Benefit-sharing agreements are negotiated directly with communities and may include payments, profit sharing, local hiring, skills development, education, cultural support and environmental protection. These are likely to be closely related to impact assessments and may also provide the basis for a process that reflects principles aligned with the concept of free, prior and informed consent (FPIC). Benefit-sharing agreements may include benefit funds: the payment and management of royalties from development activities to affected Indigenous communities and peoples.
D. Ownership and control	
Communities' ownership	Communities' ownership of companies or equity shares in enterprises involved in extracting or processing resources or enterprises providing services to the industry. Opportunities can be enhanced through government support and preferential contracting.

Communities control	In the case of Indigenous peoples, control relates to Indigenous peoples' right to determine their own development priorities and strategies and includes participation in strategic-level decision-making on resource-related policies, programmes and regulations, including resource mapping, zoning and land allocation and environmental processes (such as remediation) and FPIC.

Source: Adapted from Raderschall, L., T. Krawchenko and L. Leblanc (2020[29]), "Leading practices for resource benefit sharing and development for and with Indigenous communities", https://dx.doi.org/10.1787/177906e7-en and Wilson, E. (2019[30]), "What is benefit sharing? Respecting Indigenous rights and addressing inequities in Arctic resource projects", http://dx.doi.org/10.3390/resources8020074.

In sum, to improve engagement and make sustainable partnerships with municipal governments and local communities for mining development and support even distribution of its benefits, the new mining strategy should:

- Align the new mining strategy with municipal development plans. This involves ensuring frequent dialogue with municipal governments and early involvement in the development process of the strategy. Co-operation with municipalities can be done through the renewed technological centre for mining and the proposed multi-stakeholder co-ordination platform for mining development.

Include in the new strategy a guideline/toolkit to structure and implement benefit-sharing mechanisms from mining in Andalusia. It includes outlining the models used in the region and facilitates capacitation programmes for organisations and communities to make the most of the benefit-sharing process.

Unlocking synergies with other policy strategies/sectors to boost innovation

Mining activity has important links with the local economy, especially with regards to services. Yet, in Andalusia, the links of the mining sector with other economic activities seems low, with particular scope to improve linkages with the service sector (Chapter 3). In fact, the mining strategy for 2014-20 lacks objectives to upscale associated services to mining operations and link them with mining firms. While the mining strategy maps the different regional strategic policies with which mining development has a potential relationship (economic, innovation, environmental), the strategy does not describe the tools or institutional mechanism to co-ordinate policies across the different sectoral strategies.

The new mining strategy needs to map the contribution of mining to regional development and smart specialisation strategies. The updating process of the regional development plan 2021-27 is a good opportunity for the regional government to recognise the potential of the mining value chain to meet regional goals. This new development plan of Andalusia (Strategy for Economic Transformation of Andalusia 2021-27) aims to prepare the local economy and population to face the increasing global challenges related to digitalisation, globalisation of value chains, climate change and low demographic growth (Regional Government of Andalusia, 2019[31]). To this end, the region has set five main priorities of development for the period 2021-27 (Table 4.7).

Table 4.7. Objectives of the Strategy for Economic Transformation of Andalusia 2021-27

Objectives	Mechanism
Increase regional competitiveness	Transformation of regional productive fabric through innovation and assimilation of new technologies by companies, especially SMEs. At the same time, it aims to reinforce entrepreneurship, new industries and advanced services, modernisation of traditional sectors as well as adapting the educational system. All these actions will contribute to attaining greater productivity gains.
Transitioning towards a low-carbon economy and preparing for the consequences of climate change	Through supporting the prevention of risks, the management of water resources and the reduction of polluting emissions. At the same time, understanding these challenges as an opportunity for the transition towards a low-carbon economy and the development of new energy systems and alternatives such as the circular economy.
Correcting the structural backwardness of Andalusia's economy	Improving the transport network and the digital connectivity to reduce the cost of distance, achieve higher levels of integration and real convergence.
Reducing the levels of inequality and the risk of social exclusion	Strengthening health policies, care for dependency, housing, as well as the activities of public services on employment and training.
Contributing to the reduction of existing territorial imbalances within Andalusia	Through differential and specialised attention to supra-municipal areas that make up coherent areas, due to their physical, functional and socio-economic characteristics or the existence of inter-municipal co-operation formulas. It will promote integrated and sustainable urban and rural development, based on the unique characteristics of each area.

Note: Objectives are taken from a preliminary version of the strategy. They can differ in the final document.
Source: Regional Government of Andalusia (2019[31]), "Aprobación de la formulación de la Estrategia para la Transformación Económica de Andalusia (ETEA) 2021-2027", *Boletín Oficial de la Junta de Andalusia*, No. 218, page 47.

The new mining strategy can identify the role of the local mining value chain to attain the five objectives in this regional development plan. Some links include:

- Increasing the productivity in the mining value chain can help Andalusia to enhance its regional competitiveness (Objective 1 of the economic strategy). Mining is one of the most productive sectors in the region due to the important participation of multinational companies that compete in the global market through innovation. Leveraging the international characteristics and technological progress in this sector can support local innovation and productivity (Chapter 3).
- The relatively high productivity and connectivity of the regional mining sector, particularly the metallic subsector, can ultimately support the convergence of the regional economy towards higher income levels (Objective 3 in the economic strategy).
- Efforts in the mining value chain to reduce carbon emissions across the mining value chain can accelerate the regional transition towards a low-carbon economy (Objective 2 in the economic strategy). Mining companies are increasingly investing in new technologies to minimise environmental impact in terms of water consumption and land restoration. This practice and technological progress can also support circular practices in other related sectors and enhance the environmental outcomes of the regional industry.
- Mining activity can also help Andalusia reduce the territorial and income inequality in the region. Mining extraction in Andalusia is located in rural municipalities, where it represents the main income source. Huelva, the mining province in the region, has in fact a higher gross domestic product (GDP) per capita and productivity than the regional average. Likewise, the labour demand of mining in rural places can attract unemployed population from other provinces and migrants, thus contributing to reducing regional income inequality. Supporting the connections of the mining extraction with other activities in the rural places can help to meet a more balanced territorial development.

Furthermore, the right co-ordination with the regional smart specialisation strategy can make the mining sector an engine of innovation in Andalusia. The regional Smart Specialisation Strategy 2014-20 was built on six objectives that aim to create a common framework of intelligent specialisation, in which ICT and

support infrastructures allow the development of creative environments where networking constitute basic dimensions for the advancement of innovation (Table 4.8). The fifth objective of this strategy acknowledges the relevance of environmentally sustainable management of natural resources, leveraging metallic mining as a referent of innovation in the region (Regional Government of Andalusia, 2012[32]).

Table 4.8. Objectives of Andalusia's Smart Specialisation Strategy 2014-20

1.	An Active Andalusia, in which entrepreneurs can make their projects come true, creating wealth and quality employment for all, developing an innovative and high-productivity economic model that advances in convergence with Europe.
2.	An Advanced Andalusia where quality education and training promote talent, a talent necessary for research of excellence in universities, knowledge agents and companies, and also necessary for entrepreneurs and companies to transform that knowledge into new industrial products and innovative services.
3.	An Andalusia Open to people and exchange, articulated inland and internationalised, that benefits more from the elements that differentiate it (its geographical position, climate, natural environment, rural environment, marine environment and system of medium cities) in which Andalusia is a benchmark; improving competitiveness and achieving greater social and economic growth.
4.	A Healthy Andalusia, attractive to work, live and visit with a high quality of life and well-being in which health, food, leisure and culture converge.
5.	A Sustainable Andalusia, more efficient, in which natural resources are valued in an intelligent way and in which progress continues in respecting and protecting the environment.
6.	A Social Andalusia in which all citizens participate actively and responsibly in public life, within the framework of an inclusive society in which cultures, history and traditions are elements of cohesion and co-operation, with each administration more agile, transparent and respectful in the management of the public.

Source: Regional Government of Andalusia (2012[32]), *Innovation Strategy of Andalucia 2020 (RIS3)*, https://www.juntadeandalucia.es/export/drupaljda/Documento-Ris3-version-final-8-27-02-15.pdf.

To promote closer collaboration among mining and the smart specialisation strategy of Andalusia, the mining strategy needs to outline the different links with sectors identified as the pillars of regional innovation. Some of these sectors include aerospace and aeronautics, renewable energies, environmental industries and services, construction and tourism. These sectors not only require specific minerals and materials to improve their competitiveness but can also benefit from the technologies and practices developed from mining companies (water management, automation of process, etc.). If Andalusia is to boost innovation, the regional government needs to create the co-ordination mechanisms to put into action the synergies among these key sectors, as mining policies on their own cannot unlock all of the potential of the mining value chain and related activities. To promote such horizontal co-ordination among policies, many OECD regions and countries have established inter-ministerial committees in the form of advisory councils, platforms, networks or regional committees as well as conditionality schemes to combine deferent policies (OECD, 2017[33]).

Ensuring greater co-ordination between the different autonomic authorities in charge of infrastructure and services within the region can also facilitate the development of mining projects. Energy, ports, water, IT and logistics are all the responsibility of different areas of the administration, in some cases under non-centralised agencies (e.g. *Andalusian Energy Agency, Public Agency of Ports of Andalusia*). Including these authorities within the platform for dialogue on mining development should be an important strategy to co-ordinate service and infrastructure policies. Likewise, the active participation as a facilitator of Andalusia's Innovation and Development Agency is a key aspect to promote effective co-operation across the government to unlock the potential synergies on innovation between mining and other sectors.

Making the most of the mining sector's contribution to the regional objectives requires governance arrangements to promote policy complementarities across ministries and levels of government. To mobilise the co-ordination among levels of governments, the regional government of Andalusia should:

- Implement a formal inter-ministerial platform within the Government Council of the regional government to co-ordinate sectoral policies focused on mobilising the potential of mining

development. This mechanism should involve regional ministries, governmental provinces and some key non-centralised agencies responsible for key service and regional infrastructure (e.g. *Andalusian Energy Agency*). It is important for this collaboration to set objectives in the short and long terms and make them publicly available.

Promoting local networks and a mining cluster to boost innovation

As mentioned in Chapter 3, Andalusia has the potential to develop a strong cluster around mining. Clusters have been identified as a well-established mainstay of regional development policy that can promote economies of scale and innovation within a group of firms connected through one or more linkages (colocation, skills, input-output relationships) (OECD, 2018[34]).

The region has different strengths across the mining value chain that can be mobilised to form an international competitive cluster, including foreign-based international mining and manufacturing companies, the connection to external markets and an extensive network of universities and research centres, among others. A well-functioning cluster often requires policy to support sound linkages and spill-overs among the regional economic activities in a related industry (Ketels, 2017[35]). In Andalusia, those linkages inside the mining environment are fragmented. Chapter 3 has already explored the institutional setting that can help Andalusia create sustainable linkages. Acknowledging the mechanisms to improve those links within the new mining strategy can institutionalise the channels for collaboration among local actors and build the path toward higher value-added activities.

The region has already some traditional clusters located in specific municipalities, which are socio-economically relevant and can be further scaled up. The Macael Marble District (MDD) has been the area where regional policies have tried to strengthen a cluster dynamic around NM mining in the past (Chapter 3). The regional government has conducted a number of policy actions to boost co-operation within this ornamental marble industry in Almería, including branding and internationalisation strategies. Yet, the MDD remains composed of small and micro companies, along with some big players that struggle to benefit from agglomeration economies and collaboration. The absence of clear links with other types of mining or sectors and the lack of collaboration based on demand-driven projects led to a growth stagnation in this marble ecosystem.

Developing a cluster cannot be a top-down policy led by policymakers. Instead, policy should create the right conditions for co-operation among local actors, beyond simple geographical proximity (colocation) (Crescenzi, Nathan and Rodríguez-Pose, 2016[36]). Companies already integrated around a similar industry can exploit a number of linkages including social collaboration (exiting or previous business collaboration between two actors), innovation (partnerships on research) and commercial collaboration, among others. Andalusia has had some experience of these type of dialogues, particularly in the formation of the Andalusian aeronautical cluster, which involved high-level meeting with local actors to agree on roadmaps and a schedule of commitments. This cluster allowed the arrival of new companies and collaboration with suppliers.

In the specific case of the mining sector in the region, the NM sector can further collaborate with the construction sector to attain the regional goals of producing more sustainable construction materials. This type of mining can also benefit from practices and technologies from metallic extraction. Likewise, the metallic mining industry can exploit stronger collaboration with refineries and manufacturing players, especially on research partnership and commercial collaboration through clear project-based co-operation, aiming at developing the green process and technologies required by the EU Green Deal.

To support a closer collaboration among local actors in the mining value chain and facilitate the formation of an innovative cluster, the new mining strategy should:

- Formalise in the new mining strategy the creation of the multi-stakeholder co-ordination platform for mining development that gathers all relevant actors in the mining value chain to identify

synergies and projects of common interest. This group should have regular meetings, in a formal setting, and help prepare and monitor the mining strategy. For this, the regional government can get inspiration from the Mining Finland programme, which is a membership fee-funded association that provides various services to its members (Box 4.11).

- Include support programmes for collaboration among firms and local actors to generate and diffuse ideas and improve connections to the external market.

Box 4.11. Mining Finland programme

- The Mining Finland programme is a non-profit and membership fee-funded association promoting export of Finnish mining technology, foreign investments to Finnish mining cluster and facilitating R&D and education collaboration among mining sector actors working in Finland or co-operation with Finnish companies. It was one of the Finnish government´s initially publicly funded growth programmes.
- This platform now condenses all of the information related to the mining activity in the country in a single website. It includes information on current active mines, exploration mining projects and the perspective of resources. The platform also displays the current composition of the Finnish mining cluster and promotes the mining and services companies established in the country.
- Mining companies, universities and other associated companies need to pay an annual fee to be members of the programme. The membership gives companies and organisations access to all of the services offered by the programme, including:
  - Company visibility on programme websites, brochures and publications.
  - Direct contact with international mining industry actors, Finnish embassies and Business Finland export centres.
  - Free participation in the programme's international trade shows, congresses and roadshows, excluding own travel and accommodation costs.
  - Free participation in the programme´s networking and match-making events, excluding own travel and accommodation costs.
  - Generic training events.
  - Access to GTK's and Business Finland's expert services and network.

Source: Mining Finland (2020[37]), *Mining Finland Programme*, www.miningfinland.com (accessed on 15 November 2020).

Enhancing national and international collaboration

Multi-level governance co-ordination is a key ingredient to implement an efficient territorial approach for sustainable development. Given the autonomy of Spanish regions to develop their own mining strategy and the commonalities among different regional markets, increased co-ordination among regional governments can lead to a stronger mining business environment. At the same time, the prominent role of European policies to increase self-sufficiency in raw materials, provide funding to sustain regions in transition and promote smart specialisation strategies, among others, is an opportunity for regional strategies to find common ground on macro-national policies and pursue their implementation at the local level.

Boosting collaboration with other Spanish mining regions

Different regions in Spain play a relevant role in the mining and mineral value chain and mining production of the country (Chapter 2). Given the regional autonomy in Spain, different regional governments with mining potential have developed their own mining strategies. Many of the regional strategies recognise the potential of the mining sector to boost regional industry and support rural economies as well as the increasing strategic importance at the EU level.

Each Spanish mining region has its own competitive advantages and hosts different types of minerals. Some are planning to phase out coal-related mining (Asturias, Castilla y León), others have ornamental stones and rather small aggregates mining forms (Castilla-La Mancha, Galicia), while yet more have a higher specialisation in industrial minerals and transformation (Catalunia). Some Spanish regions are also global leaders in the production of specific raw materials, as is the case of Castilla y León with slate production.

Collaboration with these regions can be instrumental to share good practices for mining development, unlock synergies and develop new projects. Furthermore, due to the relatively small weight of the Spanish mining sector in global markets, promoting critical mass in mining ventures and associated projects should be seen a main objective of regional co-operation. For example, regional co-operation in research, in education and training and in shared branding can boost competitiveness of regional business networks.

Despite the lack of national co-ordination, some regional initiatives have aimed to support stronger collaboration across mining regions in Spain. The most prominent of those is the Iberian Sustainable Mining Cluster (ISMC) set-up by the International Center in Advanced Materials and Raw Materials of the Castilla y León region. This is a national cluster that brings together over 60 companies and organisations from the mining sector and its associated services with the aim to promote sustainability and circularity while fostering competitiveness and innovation in the mining value chain. The cluster is creating regional offices and units (subclusters) as part of a National AEI (*National business association of excellence and innovation*). The initiative has already presented more than seven projects to obtain funds from the EU and finance circular economy strategies. Andalusia can better collaborate with this initiative to reach greater funding and attain critical mass.

Regions that submit a joint project to EU funds increase the probability of being selected for technical assistance and financing. The type of projects that cover more than one single geographical area and aim to have a greater impact in a territory have preferential access to finance from the European Bank for Reconstruction and Development (EBRD) or the European Investment Bank (EIB). Furthermore, this collaboration can improve knowledge on mining practices and innovations. For example, Asturias and Castilla y León have made great progress in the rehabilitation of old mining sites by creating hubs that are specialised (Castilla y León) or part of international networks (Asturias) on this specific topic.

To improve collaboration with other Spanish regions, Andalusia's Secretary of Industry and Mining together with the regional government should:

- Map Spanish initiatives for mining development and promote partnerships with them. The new mining strategy should specify the goals of these regional partnerships.
- Involve Andalusia in existing regional initiatives for mining development in the country to articulate common projects and apply for EU funding. This can involve joining the ISMC.

Increasing co-operation with European regions and EU strategies

Andalusia's mining strategy acknowledges the relevance of close co-ordination with EU strategies and initiatives, including the EU Green Deal, the EU Raw Materials Initiative and the EU industrial policy, among others. As mentioned before, the EC plays a decisive role in the mining development of European countries. EU policies determine many aspects of environmental regulations, mining operation and closing.

These supranational policies have set mining development as a strategic tool to support the transition to a low-carbon economy and the resilience of European economies. Andalusia can leverage EU strategic and financial support as well as EU regional mining networks to strengthen its local mining environment in a sustainable fashion.

The next programming period of EU investment funds (2021-27) will allocate a greater role to projects around raw materials and ecological transition. Projects aiming to obtain critical raw materials from local sources (existing mines or waste materials or minerals) or to reduce CO_2 emissions in the extraction and transformation of minerals could find good financial and technical support from EU funds. Some of these facilities for technical support and funding are related to the EU Raw Materials Initiative, the EU Green Deal call for projects, EIB funding for raw materials and the Just Transition Fund. Accessing this international support will require a clear strategy to design and define projects in Andalusia.

Connecting with EU mining networks also needs to be a key objective for Andalusia's mining strategy. Networks, co-operation and political representation can be important elements in mining regions' economic and institutional processes. There are mining region networks throughout the world and the EU with different thematic or functional purposes (e.g. political or technical). The potential benefits of co-operation may vary according to the type of co-operation (formal/informal), the resources involved, the motivation and the organisations involved. Benefits from strengthened regional co-operation include:

- Increasing territories' profile and "voice".
- Achieving critical mass.
- Unlocking financial resources and a means of learning and exchanging best practices.
- Addressing innovation challenges.

The EU has a number of co-operation programmes promoting collaboration among mining and metallurgy regions across Europe. These programmes include:

- The Smart and Green Mining Regions of EU (REMIX) project, a network that links EU mineral-rich resource regions to support innovations of large- and small-scale companies in their regional mining value chains.
- The Mining and Metallurgy Regions of EU (MIREU) project, a network of mining regions aiming to develop guidelines and recommendations for the sustainable supply of mineral raw materials to the EU.
- The European Institute of Innovation and Technology (EIT) RawMaterials initiative. Funded by the EIT, this initiative aims to enable the sustainable competitiveness of the European minerals, metals and materials sector along the value chain by driving innovation, education and entrepreneurship.

Andalusia is currently part of MIREU and is involved in the development of the counsel of mining and metallurgic European regions (COMMER). The region is also participating in the INFACT project on mining exploration and is now taking part in the SUMEX project on sustainable mining exploitation. The regional government is also represented in the EIT RawMaterials operational group.

The region has scope to take a leading role in those initiatives, highlighting the specificities of its mining value chain (metallic and NM industry, proximity to cites, etc.). Using these networks to actively promote technological exchange and build common projects with other regions could be beneficial to spark new business opportunities in the region and gain international visibility.

Andalusia can also leverage these networks to consolidate its role in Europe as a bridge with Latin American and North African markets for EU mining innovation and sustainable practices. Putting in use the region's comparative advantage (its geographic location and cultural proximity with Latin America) can be a useful tool to create new partnerships and projects within the EU networks.

At the same time, the region shares a privileged geological location with Portuguese regions, which can be a driver for strategic co-operation. Andalusia has a unique opportunity to create a strong mining collaboration with southern regions of Portugal and is the only Spanish region located in the geological formation of the IPB, shared with other regions in Portugal, including Alentejo (Chapter 3).

Unlike Spain, Portugal has a clear national mining strategy and promotes active co-ordination to mobilise growth opportunities from mining development. Conducting a partnership with those regions in Portugal could also be a vehicle to structure a cross-border mining project and reach foreign investors and EU funds with a unified voice. The possibility and objective of this partnership should be materialised in the new strategy. Clearly setting the intention to promote cross-border collaborations on mining innovation and suitable practices could give a positive signal to the community, other regions and international companies.

To enhance the co-operation with EU mining initiatives and programmes and the collaboration with other EU mining regions, the regional government of Andalusia should:

- Join the EU mining networks to promote the exchange of practices and collaboration on projects to mobilise assets of Andalusia's mining value chain. This involves creating partnerships for projects around sustainable practices on mining and technology developments.
- Define new mining strategy tools and projects to materialise the co-operation with Portuguese regions located in the geological formation of the IPB. This can involve a common strategy to attract investors and obtain EU funding.

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Mining Regions and Cities Case of Andalusia, Spain

Andalusia is the largest mining producer in Spain, the second-largest copper producer in the EU and a leader in marble and gypsum production. The region benefits from two distinct mining subsectors, each with a rich network of suppliers that are relevant for local development: metallic sector (e.g. copper and zinc), which accounts for most of the regional mining production, and the non-metallic sector (ornamental rocks, aggregates and industrial minerals) which is highly dispersed across the territory. The regional mining value chain has the potential to leverage the increasing global and EU demand for sustainable raw materials and thus become a frontrunner in leading technologies and circular processes for environmentally sustainable mining. This study identifies how Andalusia can build on its strengths and address current and future challenges to improve regional productivity and well-being while accelerating the transition to a low carbon economy and assisting EU climate goals.

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