OECD Regional Development Papers

Toolkit to Measure Well-being in Mining regions

This paper develops a framework to measure well-being standards in OECD regions specialised in mining activities. It explores the relevant indicators to measure well-being for selected OECD mining regions across the three dimensions of wellbeing: economic, social and environmental, and compare their trends with those of other regions.

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Key messages

Minerals' extraction and transformation are essential for a wide range of technologies needed to attain global climate goals. Indeed, global demand of minerals for carbon free technologies is expected to exceed current supply. The COVID-19 pandemic and Russia's large-scale aggression against Ukraine have added further pressure to the supply and prices of minerals, leading many OECD countries to prioritise reliable access to mineral raw materials.

At the same time, the mining sector is under increasing pressure to adapt to the green and digital transitions. Because mining-activities are highly localised in specific regions, this activity and its adaptation to the green and digital transitions have the potential to shape regional development and well-being standards. For example, while the transition towards a more sustainable mining process is critical to meeting global climate goals and reducing negative environmental effects locally, it will also imply that some regions, such as those specialised in coal, prepare for the mining closure in the short or medium term. Likewise, technological change and automation are central to greening mining value chains and increase productivity, but it will demand new type of skills and providers, which might be a challenge for local economies.

To better understand the effects of mining in regional development and the impact from the green and digital transition, the paper selects 50 OECD regions with a high specialisation in mining activity relative to their respective countries and selects 13 indicators to measure well-being standards across these regions. The selection of 50 OECD regions uses the following criteria. First TL3 regions are set as the building blocks for international comparability. Second, employment location quotients (LQ) for each country with data at TL3 regional level and mining activity are used to identify the regions in each country with high degrees of specialisation in mining. Third, 50 of these regions are selected taking into account their degree of specialisation in mining, the country's weight in the overall mining employment across the OECD, the type of minerals involved, and the geographical diversity.

The 13 indicators of well-being, adapted to the characteristics of OECD regions specialised in mining activities, draw on the OECD's well-being framework, and are structured around the following three core dimensions of well-being:

1. **Economy**: economic diversification, unemployment, employment growth and innovation
2. **Community/ social**: gender balance, population growth, share of young population, death rate and education level.
3. **Environment**: change of green land cover, anomalies in soil water content and greenhouse gas (GHG) emissions from the mining supply chain and the electricity generation.

Analysing the indicators across the 50 OECD mining regions (hereafter benchmark of OECD mining regions) and comparing them to OECD TL3 rural regions, reveals a number of strengths and challenges (Table 1):

- Strengths: OECD mining regions contain a slightly higher share of young population, lower death rates, greater growth of green land cover and lower risks of drought from water depletion.
- Challenges: OECD mining regions show lower levels of innovation, greater greenhouse gas emissions, lower levels of economic diversification and lower shares of women in the workforce.

Table 1. Strengths and challenges of OECD mining regions relative to OECD rural regions and OECD regional average

	Strengths	Challenges
Economy	-**Lower unemployment rate** (average of 8.19% in 2020). than across OECD rural regions (8.34%), but above the OECD regional average (7.77%).	- **Lower levels of economic diversification**. 15% less diversified than OECD rural regions - **Lower growth of employment** (2.6% between 2007 and 2020) than OECD rural regions (2.8%) and almost half of OECD regions (5.4%). This employment growth across mining regions is on average 2.9 p.p below than their national average. - **Lower levels of innovation** (51 patents per million inhabitants in 2020) than both the OECD regional (96) and rural (65) average.
Community/Social	- **Greater share of young population** (17.8% of children in the regional population in 2020) than OECD rural regions (17.2%) and OECD regional average (17.0%). - **Similar death rate** (9.7 deaths per 1 000 inhabitants) than the OECD regional average (9.70), but below the level across OECD rural regions (10.0). - **Similar share of population with tertiary education** *(32.4%) that across OECD regions (32.2%)*	- **Lower population growth.** Half the average population growth rate (3.1% during 2007-20) of OECD regions (6.1%) and about three quarters of the growth rate of OECD rural regions (4.4%). - **Lower share of female in the workforce.** Average of 4.7% more men than women in the workforce in 2020, which is three times the average ratio across OECD regions and twice of OECD rural regions.
Environment	- **Greater growth of green land cover**- trees and vegetation- (0.34 p.p during 2004-19) relative to an average drop across OECD regions (-0.04 p.p.). - **Lower risks of drought from water depletion.** On average, there were not anomalies in soil water content during 2018-19 (relative to the average conditions during 1981-10), in comparison to average drier conditions across OECD regions.	- **Greater greenhouse gas (GHG) emissions per capita,** four times higher than OECD regions and three times higher than OECD rural regions. Looking at sectors linked to the mining value chain, the emissions the from the industry, power and transport sectors are 2.5 times higher than the emissions of these sectors across OECD rural regions. - **Greater GHG from electricity generation**. On average, 31% more GHG emissions from electricity generation per gigawatt hour than OECD regions and 61% more than OECD rural regions.

This analysis also highlights that mining regions are heterogeneous and vary in their stages of well-being. Some mining regions are top performers in some areas of well-being including those where, on average, mining regions underperform, such as GHG emissions per capita. For example, nine OECD mining regions already produce 100% of their electricity from renewable sources and regions such as Norrbotten (Sweden) and Rogaland (Norway) register high innovation levels relative to OECD regions.

This heterogeneity helps nuance some generalisations about the characteristics of mining regions:

- Mining regions are not only remote rural regions. Out of the 50 regions in the OECD benchmark of mining regions, 4 regions are, for example, classified as metropolitan regions and, 46 are classified as rural regions. Within those rural regions, 6 are close to metropolitan regions, 16 are close to small and medium cities and 24 are remote.
- Despite the reliance on mining activities, there is a diverse mix of other economic activities, such as mineral transformation industries, tourism or energy, and types of firms (small and large).
- While GHG emissions per capita of OECD mining regions are four times higher than in OECD regions, some mining regions register lower emissions than the average of OECD regions.

Besides benchmarking the overall levels and trends of well-being across the 50 OECD mining regions, the OECD webtool for mining regions well-being[1] allows to compare well-being standards of all OECD mining regions relative to the 50 selected OECD mining regions and other OECD non-mining regions across the 13 well-being indicators. This tool can help track progress to support well-being standards in all types of mining regions, including those with ongoing exploration projects or with plans to open new mines. Depending on data availability, other regions from non-OECD countries can also be included in the toolkit.

[1] https://oecd-main.shinyapps.io/mining-regions-wellbeing/

1 Toolkit to Measure Well-being in OECD Mining Regions

1.1. Introduction

There is a growing demand for minerals worldwide. Mining extraction and transformation activities increasingly need to align with climate change goals by mitigating their negative environmental impacts, while delivering positive outcomes for local communities and adapting to technological change. A policy focused on improving well-being in mining regions can help attain these multiple goals. These types of policies need to be supported by data to measure well-being at the right scale.

The functioning of many economic sectors and the products that we consume and use every day to work, interact or commute require a reliable supply of minerals. Minerals are the backbone to attain global climate goals, as they are needed to develop the technologies for the energy transition. Moreover, recent global events, as the COVID-19 and Russia's large-scale aggression in Ukraine, have added further pressure to the supply of raw materials and minerals, disrupting value chains and increasing prices.

In this context, increasing autonomy in mineral raw materials has come to the top of the policy agenda and is recognised as of strategic importance for different OECD countries. This is the case of the European Green Deal or the Canada-US joint action plan to increase autonomy and secure supply chains for critical minerals. Improving the supply of minerals can involve recovering new minerals out of existing mines, adopting circular practices (e.g., extracting minerals from mining or technological waste), expanding exploration or partnering with other rich mineral resource-rich countries, among others.

Nevertheless, mineral deposits are concentrated in specific territories, making the interaction of the mining sector and local communities relevant to ensure positive outcomes for both the mineral supply and the regional development. Hence regional and local communities have an important role to play to support environmentally sustainable practices and ensure a reliable supply of minerals. The specialisation on mining brings positive and negative effects for local communities. On the one hand, mining regions can benefit from higher-than-average income levels and regional multiplier effects, such as increased spending on services and business opportunities around the mining value chain (Reeson, Measham and Hosking, 2010[1]). On the other hand, these regions are vulnerable to external economic shocks through price volatility and face lower economic diversification, income inequalities between population groups and risks around environmental impacts, including water depletion and land use changes.

While mining regions play a key role in the supply of minerals for the energy transition, they also face increasing challenges to adapt to the transformations in the mining sector. The sector needs to accelerate its contribution to global climate goals by ensuring that processes across the mining value chain are environmentally sustainable. Reducing carbon footprints and environmental impacts from mining operations will rely on technological progress and innovation. While these transitions can lead to new job opportunities across the mining value chain, without policy intervention it can displace workers and negatively impact the local employment. In some other regions, as those specialised in coal mining, planning mining closure would require greater support, including greater coordination locally and funding.

Place based policies can support a just energy transition and its twin goals for mining regions - adapting to the effects of the green and digital transitions, while supporting local development efforts and well-being standards. This approach can benefit from data at the right scale to identify strengths and bottlenecks in mining communities and, thus, conduct policies fitted to local and regional conditions.

To this end, this paper identifies a number of indicators to help measure well-being in mining regions and monitor their trends over time, including their transition to a zero-carbon economy. For this task, the paper uses a framework of indicators to measure well-being standards in OECD regions specialised in mining activities. Then, it develops a benchmark of 50 OECD mining regions that allow to analyse their trends across the three dimensions of wellbeing: economic, social, and environmental, and compare them with those of other regions.

1.2. What are the relevant dimensions of well-being in mining regions?

1.2.1. The OECD well-being framework

The day-to-day experience of life is essentially local. There is global consensus that measuring prosperity and development cannot rely only on economic measures or national accounts. It needs to be complemented with measurements capturing dimensions that matter to people's life (OECD, 2017[2]). To this end, in 2011 the OECD developed a new framework to measure well-being (Stiglitz et al., 2018[3]) (Organisation for Economic Co-operation and Development., n.d.[4]), which provides a tool to assess the region's strengths and weaknesses, monitor trends and compare their results with those of other regions, nationally and internationally (Box 1.1). Regional indicators of wellbeing help capture whether recovery and prosperity translate into better lives for all. Ensuring greater quality of life locally is an engine to build prosperous communities, improve social cohesion and boost regional attractiveness for people and businesses.

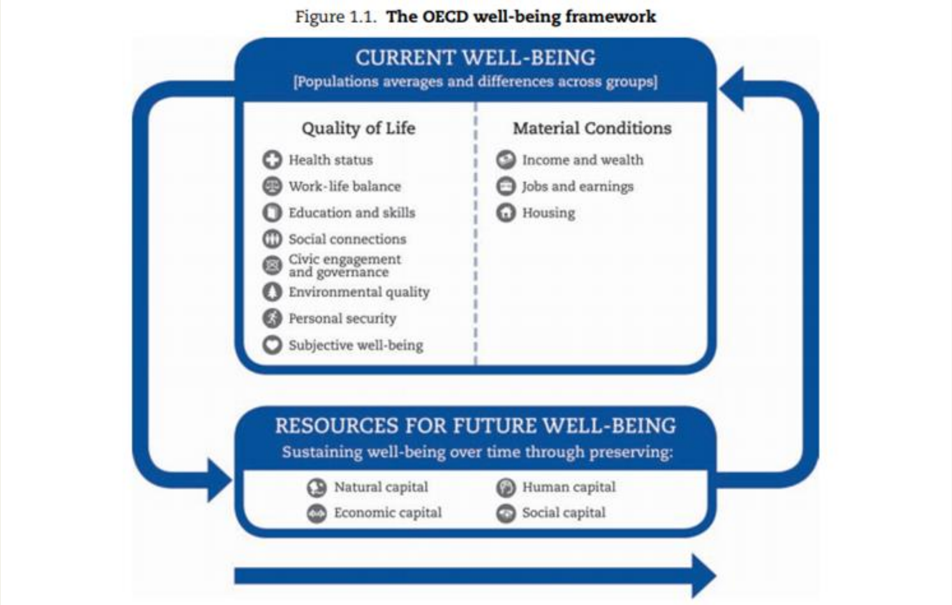
Box 1.1. The OECD Well-being Framework

The OECD Well-being Framework provides key statistics on whether life is getting better for people living in OECD countries. Current well-being data focus on living conditions at the individual, household, and community levels, and describe how people experience their lives "here and now". These data are complemented by statistics on the resources needed to sustain well-being in the future: specifically, via "capitals", countries' investments in (or depletions of) these capitals, and risk and resilience factors that will shape future changes in well-being

In the OECD Well-being Framework current well-being is comprised of 11 dimensions (Figure 1.1). These dimensions relate to material conditions that shape people's economic options (Income and Wealth, Housing, Work and Job Quality) and quality-of-life factors that encompass how well people are (and how well they feel they are), what they know and can do, and how healthy and safe their places of living are (Health, Knowledge and Skills, Environmental Quality, Subjective Well-being, Safety). Quality of life also encompasses how connected and engaged people are, and how and with whom they spend their time (Work-Life Balance, Social Connections, Civic Engagement).

Based on this measurement at the national level, the OECD has also developed a framework for measuring regional well-being. 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.

Figure 1.1. The OECD Well-being Framework



Source: OECD (2020), How's Life? 2020: Measuring Well-being, OECD Publishing, Paris, https://doi.org/10.1787/9870c393-en. OECD (2014), How's Life in Your Region?: Measuring Regional and Local Well-being for Policy Making, OECD Regional Development Studies, OECD Publishing, Paris, https://doi.org/10.1787/9789264217416-en.

1.2.2. The subnational scale is central for rising well-being standards in mining places

Mining plays a relevant role in multiple dimensions of well-being. Economically, this sector is crucial for income and employment in a number of countries. In OECD countries like Australia and Chile, the average export contribution of minerals, metals and coal makes up more than 52% of total exports, while in other countries like Peru it could reach 61%. Moreover, the mineral production value relative to GDP[2] is relevant in various countries, such as in Australia (9.8%) or Chile (13.7%), amongst others (ICMM, 2020[5]). Governments can also leverage mining income, benefit sharing agreements or corporate social responsibility to provide public services and infrastructure (roads, broadband or education and health) in communities where mining take place or in areas where those type of investments require government intervention due to low market incentives (Zhang and Moffat, 2015[6]). Mining can represent the main income source for some regions and be an engine to promote locally business opportunities.

The subnational scale is critical to mobilise the potential of mining activities and address negative externalities that arise from extractive activities. Sub-national governments are essential to implement and monitor mining practices and ensure that local development goals are met. Making the most of mining for global goals and local well-being requires a deep understanding of the benefits and challenges faced by the mining regions and their communities. Mining activity is geographically concentrated where the

[2] Mineral production value expressed as a percentage of GDP in 2016. Note that it does not represent the contribution of mining to GDP – on average around a third of production value represents value addition to the national economy. ICMMs Mining Contribution Index, indicates the relative importance of mining to (182) national economies using a combining data on mining's contribution to countries' gross domestic product (GDP), export earnings and mineral rents that are paid to host governments (ICMM, 2020[5]).

deposits are located, which amplifies positive and negative impacts for local communities and the environment.

At the local and regional level, mining specialisation brings a number of benefits including:

- **Income growth**. Regional multiplier effects, such as increased spending on services due to higher incomes, are important factors for regional development (Reeson, Measham and Hosking, 2010[1]). Mining is a high value-added sector, resulting in higher wages than other economic activities.
- **Job creation**. One job created in the mining sector can lead to the generation of one additional job in other sectors (Moritz et al., 2017[7]).
- **Infrastructure development.** Mining ventures often develop, in coordination with local governments, infrastructure to move mineral and goods as well as support improvements of roads and transport modes for commuting of workers (Söderholm and Svahn, 2015[8]).
- **Technological innovation.** Mining companies across the value chain are exposed to competition on technological innovation. Companies have market and regulatory incentives to improve processes and technologies, for example on enhancing security, overcoming technical difficulties for mining operations in new geographies or evolving towards more environmentally sustainable processes (OECD, 2021[9]). If well-coordinated, innovation in the mining value chain can be expanded to other business in the local economy.

However, such specialisation in mineral resources can bring negative externalities at the local level including:

- **Low economic diversity and local lock-in with local Dutch disease effects.** A high specialisation in mining can lead local business and its labour force to suffer from the so-called *lock-in effects,* depending mainly on the demand dynamics of mining companies. It can translate in even lower economic diversification and higher vulnerability to shocks from international price volatility. Thus, over-specialisation can in turn lead to “Dutch disease effects”, exemplified in the decline of other economic activities and the appreciation of the real exchange rate following a mining boom (Corden, 2012[10]).
- **Environmental impacts from the activities along the mining value chain.** In all stages of mining production including exploration, extraction and commercialisation, mining activity generates green gas house (GHG) emissions, modifies land use and the environmental ecosystem as well as produces dust, waste, and pollution. In some regions reaching global climate goals has led to a closure of mines, particularly coal mines, and a reduction of national policy support for new mining ventures, which represents a transitional challenge for local communities.
- **Social unrest** due to land use conflicts, perception of local benefits or pressures on infrastructure**.** Mining is highly intertwined with life in local communities as they perceive changes that are done to the ecosystem and directly benefits and costs. Many OECD and non-OECD mining regions are home of a diverse range of population, including indigenous peoples, which requires special governance mechanisms and internal coordination to ensure resources from mining sector benefit the different local communities.
- **Inequality:** Regions with mining and extractive industries are especially prone to inequalities, especially horizontal inequalities, which refer to gaps in average performance between specific population groups, including men and women, or young and old, fly-in fly-out workers and local communities, Indigenous and non-Indigenous peoples.

On top of that, global megatrends including climate change, ageing populations, digitalisation, and automation will generate challenges and bring opportunities for well-being in mining regions. (Box 1.2). For example, the digital transformation in mining can bring various benefits, including new job opportunities in high value-added tasks and with better wages, mitigation of the negative impact of aging on mining operations, and reduction of the environmental impacts of mining.

Box 1.2. Opportunities and challenges of megatrends for mining regions

Mining regions and the industry need to adapt to ongoing megatrends including, automation, climate change and ageing, which will shape the effect of mining on local communities. The effect of these megatrends on the local and regional well-being will largely depends on the policies in place to help adapt labour markets and communities to make the most of these changes.

Infographic 1.1. Opportunities and challenges in mining regions from megatrends

	Opportunities (selected)	Challenges (selected)
Demographic changes	• **Migrants** may enhance labour supply. • **Lifelong learning** for old workforce to keep adding-value.	• **Shortage of labour** from local demographic decline. • **Reduction of cultural activities** from youth out-migration • Higher **pressure to local finances**.
Climate change and environmental pressures	• **Competitive advantage** from high environmental standards in mining • **New jobs** from the development of environmentally friendly technologies.	• **Pressures** to reduce mining **environmental footprint**. • **Strict policies** to issue permits to operate • **Public reluctance** to accept mining explorations and opening
Technological innovation	• **Compensate for shortage of labour**. • **Enhance attractiveness** of mining regions (e-services). • **Raise productivity** with environmentally friendly processes • Greater **labour opportunities for young, women** and various segments of the population	• **Displacement of certain jobds** in mining sector. • **Impact competitiveness** if technological innovation is produced outside the region. • **Reduce the need for certain minerals** from laboratory products or recycling processes

Note: Opportunities and challenges co-built with regions of the OECD mining regions and cities network
Source: OECD (2021[11]), *Mining Regions and Cities Case of Västerbotten and Norrbotten, Sweden*, OECD Rural Studies, OECD Publishing, Paris, https://doi.org/10.1787/802087e2-en.

Overall, making the most of mining activities requires a focus on the place where mining is (or will be) located, rather than solely on the mining activity. If well-managed, regions can foster economic growth with greater inflow of investment in services and infrastructure, and opportunities to internationalise the local business. Yet, without policy coordination and monitoring of activities, they can lead to structural changes in land use and the environment, income inequalities and social unrest. Policy responses need to ensure that those negative effects are minimised and that communities embrace all benefits to enhance living conditions with sound environmental policies that consequently leads to a prosperous regional well-being and a positive net contribution to global climate goals.

1.2.3. Focus on the role of mining in the transition to the zero-carbon economy

The environmental dimension is where mining regions face the greatest challenge to adapt, but also the greatest potential to contribute to global and local well-being. Reducing carbon emissions and the environmental impact of mining operations can further improve environmental outcomes locally and support the decarbonisation of value chains of other sectors.

Estimates reveal that mining might be directly responsible for about 4 to 10 percent of greenhouse-gas (GHG) emissions globally (upstream and direct activities) (Mckinsey, 2020[12]; Azadi et al., 2020[13]), while emissions that occur in the mining products' value chain (downstream activities) can triple this rate.

Upstream and direct emissions are divided in emissions coming directly from the mining operations itself - e.g., GHG emissions form waste mining or from the fuel used in operations - (also called scope 1) and the emissions associated with the generation of purchased energy - e.g., for electricity or heat- (also called scope 2). By far, the methane emissions associated to coal mining represent most of the direct emissions of mining sector. Nevertheless, emissions occurring in the mining value chain (scope 3) –e.g., through transport, smelting and transformation (e.g., leaching) - could amount to 28% globally (Mckinsey, 2020[12])[3]. Moreover, the mining industry increasingly needs to extract minerals from decreasing ore quality or from more difficult geographies, which demands more energy for extraction and transformation (Azadi et al., 2020[13]) .

Mining activities have a great potential of decarbonisation through available abatement technologies (e.g., material efficiency, circularity), electrification (e.g., electrothermal heating, heat pumps) and low- or zero-GHG emitting fuels (e.g., hydrogen, ammonia, and bio-based & other synthetic fuels) (The Intergovernmental Panel on Climate Change, 2022[14]). Emissions vary in terms of the type of ore, mining process and site-specific differences. For example, in iron ore mining, most energy is required for hauling and loading, while crushing and grinding are the most energy-intensive parts for copper mining (Azadi et al., 2020[13]). Simulations of an indicative copper project, from mine-site to refining and smelting, reveals that electrification and renewable-based electricity have a combined potential to reduce emissions intensity by over 80% (IEA, 2021[15]). Therefore, strategies to decarbonise mining need to be tailored to the specific conditions in each mining regions.

At the same time, the mining sector can contribute to accelerate the transition to a net-zero economy by providing the minerals and metals needed to develop the technologies that anchor the net-zero economy transition. International agendas have defined access to minerals and metals as a strategic priority to support the transition to an economy with net-zero greenhouse gas emissions. According to the International Energy Agency (2021[15]), meeting the Paris Agreement goals will require a massive deployment of clean energy technologies by 2040, whose production will, in turn, rely on important amounts of critical minerals such as copper, lithium, nickel, cobalt and rare earth elements.

The demand of some minerals required for the energy transition is in many cases greater than the current production levels. For countries aiming at improving mineral autonomy, it implies extracting new minerals from existing deposits or waste mining, opening new mining deposits, and increasing circular processes in the mining value chain. Clean energy technologies tend to require more minerals than fossil fuel-based counterparts do. For example, a typical electric car requires six times more minerals than a conventional car (e.g. lithium, cobalt, manganese and graphite are crucial for the performance and longevity of its battery), and an onshore wind plant requires eight times as much minerals as a gas-fired plant of the same capacity (International Energy Agency, 2020[16]). Even to increase recycling of many products, greater use of minerals such as magnesite are needed.

Overall, the demand for minerals that are considered traditional (silver, copper, iron) or new/rare (cobalt, chromium, lithium) is expected to increase rapidly in the coming decades (Figure 1.2), in many cases above the current supply. Some pre-COVID scenarios to attain climate neutrality by 2050 estimate 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 (European Comission, 2020[17]).

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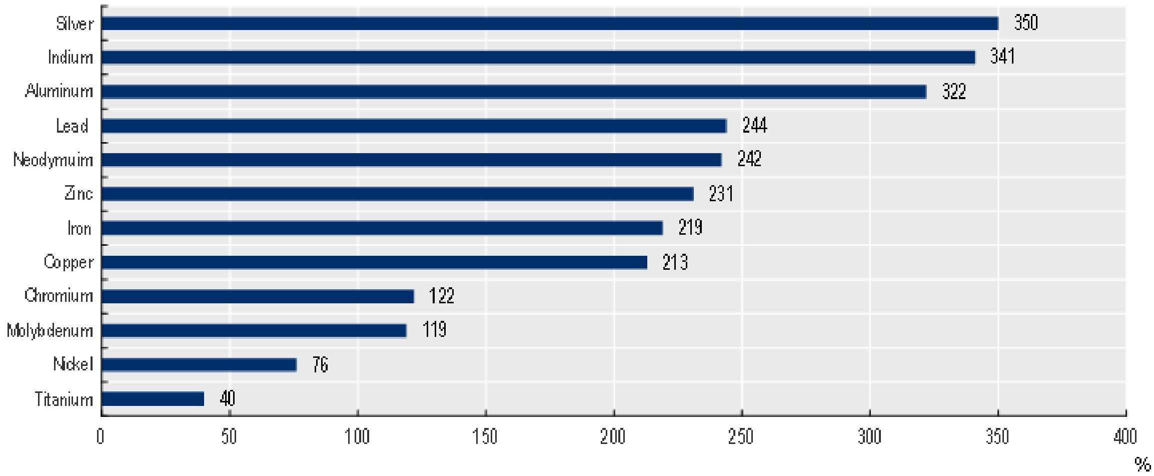
[3] Direct emissions, also called Scope 1 emissions, include vented CO2 from waste rocks, emissions from fuel used in mining and refining operations and GHGs from acid neutralisation, mineral beneficiation (e.g. flotation), extraction and waste streams (e.g. tailings). Scope 2 refers to emissions associated to the generation of purchased energy (e.g. electricity, steam and heat), while Scope 3 includes emissions that occur in the products' value chain (IEA, 2021[15]).

Figure 1.2. Estimated growth of minerals demand from energy technologies (without storage) by 2050



Note: Estimated change in the demand of minerals according to the International Renewable Energy Agency (IRENA) renewable energy roadmap scenario (Remap) relative to base scenario = 4-degree scenario.
Source: World Bank Group (World Bank Group, 2020[18]), 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

However, the production of many energy transition minerals is more concentrated than that of oil or natural gas. For example, for lithium, cobalt and rare earth elements, the world's top four producing nations - Australia, Chile, China, and Democratic Republic of the Congo -- control over three- quarters of global output (IEA, 2021[15]). Such concentration implies vulnerabilities for importing countries, especially for those countries aiming at developing production of batteries and green technologies. Physical or climate disruption, regulatory changes or geopolitical events in major producing countries can also affect global supply of these minerals.

Country's strategies are increasingly focussing on securing a reliable supply of minerals to support the energy transition. For instance, the Green Deal of Europe identifies the access to raw materials as a "strategic security question" to become climate-neutral by 2050 (Box 1.3). Likewise, the new Industrial Strategy for Europe aims to reinforce EU industrial autonomy on access to mineral raw materials, underlying that the transition to climate neutrality could replace today's global reliance on fossil fuels with one on raw materials (European Comission, 2020[17]). This strategy to increase autonomy on mineral raw materials has an important component on supporting resource circularity and establishing partnerships with suppliers. In addition, some EU countries are currently analysing the opening of mine sites to extract critical materials. For example, this is the case of the French department of Allier that identified lithium in a 19th century mine site of kaolin for porcelain and tiles (Le Monde, 2022[19])

Other countries like Canada and the US have developed joint action plans to securing supply chains for the critical minerals needed for strategic manufacturing sectors including communications technology, aerospace and clean technology (Goverment of Canada, 2020[20]) Likewise, Japan has set an official target to raise the self-sufficiency on mineral resources (base metals) to more than 80% by 2030 (IEA, 2021[15]).

Box 1.3. The European Green Deal and the need for raw materials

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, by ensuring no net emissions of greenhouse gases by 2050, an economic growth decoupled from resource use and no person, and no place left behind. The deal will improve the well-being of future generations by enhancing the EU's natural capital and protecting citizens from environmental-related risks.

Access to resources has been set as a strategic security question for Europe's ambition to deliver the Green Deal (European Commission, 2019[21]), Ensuring the supply of sustainable raw materials, of critical raw materials necessary for clean technologies, digital, space and defence applications. To this end, the commission has established an Action Plan on Critical Raw Materials, for strategic technologies and sectors with 2030 and 2050 perspectives. This action plan looks at diversifying supply from both primary and secondary sources, improving resource efficiency and circularity, while promoting responsible sourcing worldwide.

Source: EC (European Commission, 2019[21]), *The European Green Deal*, https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf, (European Commission, 2020[22]), *Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability*, https://ec.europa.eu/docsroom/documents/42849

The green transition also means focusing on a just transition for some mining regions

Coal is a major cause of greenhouse gas emissions warming the planet, whose phasing out process is ongoing but needs to be carefully planned to mitigate negative effects on communities and people. To attain global climate goals, many countries have initiated plans to moving away from coal, including planning the closure of mines and coal-fired power plants. However, this sector still provides employment and income to a number of regions and during the COVID-19 pandemic the use of this fossil fuel rebounded strongly- coal accounted for over 40% of the overall growth in global CO2 emissions in 2021 (IEA, 2022[23]). Only in Europe, coal accounts for about 20% of total electricity production and provides jobs to around 230,000 people in mines and power plants across 31 regions and 11 EU countries (European Commission, 2022[24]). Therefore, setting in place right measures and policies to prepare coal regions for the transition is a priority for many governments.

1.3. Building an international benchmark of mining regions

The scale of which trends, assets and challenges are analysed in a territory matters for policy design and implementation. Given the relevance of the subnational level to make the most of mining for people's well-being, this section introduces an approach to identify mining regions across OECD countries and to build a representative benchmark of mining regions that allows for a comparison of levels of well-being across mining regions and with respect to other OECD regions.

1.3.1. What is a mining region?

While mines tend to be located in one specific geographic area, mining activities often impact on the development of a wider geography. Functional labour markets and economies that are linked with the mining activity can thus involve several municipalities or even sub-national or cross-country regions.

Sub-national regions play an important role in promoting synergies among municipalities around economic, social and environmental activities. Regional policies can help attain economies of scale, bridging urban and rural assets, coordinate investments and local labour markets as well as promote a shared protection of natural assets. Across OECD countries, sub-national government also establish development plans and create links with external markets and investors (OECD/UCLG, 2019[25]). This is even more relevant for Federal countries specialised in mining activities (e.g. Australia, Canada or the United States) where sub-national governments define and conduct mining development strategies and manage natural resources. Moreover, it is at this regional level where most relevant data for well-being are available and can be comparable across the country and internationally.

At the sub-national scale, the OECD defines two types of regions, for which comparative data are collected. The first type of region, classified as Territorial level 2 (TL2), contains the first administrative tier of subnational government (i.e. states in the United States, *estados* in Mexico or *régions* in France). Smaller regions are classified as Territorial level 3 (TL3), which are smaller territorial units embedded in each TL2 region. In most countries, these regions are aligned with small administrative structures, such as provinces in Spain and Chile or counties in Sweden. For some countries, like Australia, US, Canada or Mexico, these TL3 regions do not have any administrative correspondence and they are mainly statistical geographies.

TL3 regions also vary in their degree of rurality. As such, the OECD has developed a typology to classify TL3 into five categories that include large metropolitan regions, metropolitan regions, non-metropolitan with access to metropolitan regions, non-metropolitan with access to small and medium cities and remote regions. (Box 1.2). This paper will refer to non-metropolitan regions as rural regions.

Box 1.4. What is a region?, the OECD TL3 regional 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). The sum of both levels encompass entire national territories.

The OECD extended typology to classify administrative TL3 regions is based on the presence and access to functional urban areas (FUAs). Access is defined in terms of the time needed to reach the closest urban area; a measure that takes into account not only geographical features but also the status of physical road infrastructure.

The typology classifies TL3 regions into two groups, metropolitan and rural regions. Within these two groups, five different types of TL3 regions are identified.

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 (NMRs) 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 FUA with more than 250 000 people.
    - **With access to (near) a small/medium city TL3 region (NMR-S)**, if the TL3 region does not have access to a metropolitan area and 50% 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.

- **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.

Source: Fadic, et al. (2019[26]), *Classifying small (TL3) regions based on metropolitan population, low density and remoteness*, OECD Regional Development Working Papers, No. 2019/06, Paris, https://doi.org/10.1787/b902cc00-en; OECD (2021[27]), *Territorial Grids of OECD Members*, https://www.oecd.org/fr/gouvernance/politique-regionale/42740381.pdf (accessed on 7 October 2022)

The building blocks to define OECD mining regions starts at the lowest comparable regional level, TL3. This scale better captures self-contained geographies relevant to mining activities than larger scale for international comparability. At a greater scale (e.g. TL2 regions), regions can include communities that specialise in economic activities not linked to the mining activity. Likewise, a lower territorial scale (municipality) would ignore functional relationships among labour markets and local economies as well as limit the international comparable data.

As mining is geographically concentrated in territories, this paper identifies a mining region when its regional employment in the mining sector is high relative to the national standards. Therefore, to analyse trends of OECD regions with mining activity, this paper identifies a sample of 50 regions with the higher share of mining employment relative to national standards, proxied by the share of the regional workforce involved in mining and quarrying activities, which includes extraction activities and mining supporting service activities, also referred to as upstream activities (e.g. exploration services, drilling, test-drilling, construction services related to the mine, cleaning, bailing and draining) (United Nations, 2008[28]). These 50 regions are selected by following a three-step procedure:

1. **Identifying the small regions in OECD country (Territorial Level 3)**. The OECD has more than 2,400 TL3 regions in its 38 member countries. The distribution of these regions by country are a mix of statistical and administrative boundaries that are at a geographically comparable scale and consistent with national classifications. Thus, the segmentation of the country into these territories is consistent for the cross-country analysis. The OECD territorial classification (OECD, 2021[27]) provides an updated list of all TL3 regions for OECD countries
2. **Defining regional mining specialisation based on employment location quotients (LQ).**[4] The degree of regional specialisation in mining is obtained by comparing the share of mining employment in the region, with the share of mining employment in the country.[5] A value of LQ above one implies that the region is more specialised than its respective country. The employment specialisation on mining, based on LQ values, is ranked from highest to lowest. For example, a region with an LQ above 1.5, means that the region has 1.5 times more workers in mining activities than their own country. In this case, applying a threshold of LQ above 1.5 to the OECD TL3 regions sample results in 360 OECD regions.
3. **Select 50 regions** based on their degree of specialisation in mining, the country's weight in overall mining employment across the OECD, the type of minerals involved, and broad geographical

[4] Location quotient for mining specialisation is measured as follows: LQ: $\frac{(regional\ employment\ in\ mining)/(regional\ employment)}{(national\ employment\ in\ mining)/(national\ employment)}$

[5] The share of workers in mining is obtained from the following sources: for **Denmark, Finland, Japan, Korea, Portugal, Switzerland and United Kingdom,** the mining employment data was obtained from the Structural Business Statistics (The ISIC rev. 4) using the sector 'B - Mining and quarrying' and taken out regions specialised in "extraction of crude petroleum and natural gas"). For **Chile and Mexico**, the mining national department's information along with discussion with experts from those countries helped select the top mining TL3 regions in terms of employment. For the remaining **27 countries**, mining employment values were obtained from the OECD database (OECD, 2021[54]) with an estimation of mining employment based on the subtraction of manufacturing employment from industry.

diversity. Therefore, the methodology first ensures that the regions with the highest LQ in each OECD country with available data on mining employment at the TL3 regional level (See Annex 1.A) are included (it gives 30 regions). . Then, to ensure that countries highly specialised in mining are represented with a proportional number of regions with a group of 50 regions, the methodology assigns 20 regions based on the country's weight in total OECD mining employment and following the LQ regional raking (Annex 1.A depicts this share of mining employment). A desk research process and exchange with the OECD mining regions and cities network helped examine the selected regions to check their mining relevance in the country and the presence of mining activities.

This procedure acknowledges that regions with mining activity can be at different stages of mining development and thus perceive a different effect from this activity on the local labour market and economy. For example, some regions with coal mines are planning for mine closure and the employment share in this activity has reduced drastically in recent years (e.g., regions in east Europe). Other regions with metallic mining have had a steady growth with increasing demand of minerals in recent years (e.g. regions producing cooper or iron ore). Some of these regions and others without mining ventures in the past have increased explorations on rare minerals and issued plans to open mines. Given this context, other measures to select mining regions based on absolute mining employment threshold or mineral production will rule out those regions where mining is in a growing phase or represents a relevant regional activity relative to other regions in the country.

These 50 TL3 OECD regions with mining activities (hereinafter *OECD mining regions* benchmark) are listed in Table 1.1 along with their corresponding TL2 regions and the countries. These are not the only mining regions in OECD countries. This methodology and the OECD webtool for mining regions well-being allow to analysis other regions from OECD countries and, depending on data availability, could include regions from non-OECD countries.

Table 1.1. Selected top 50 Mining Regions for the OECD mining regional benchmark

Country	TL3 mining regions	Corresponding TL2 region
Australia (AUS)	Western Australia Outback	Western Australia
	Queensland Outback	Queensland
	Mackay	Queensland
Austria (AUT)	Östliche Obersteiermark	Styria
Belgium (BEL)	Arr. Huy	Wallonia
Bulgaria (BGR)	Starazagora	North West
Canada (CAN)	Athabasca-Grande	Alberta
	Yorkton/Melville	Saskatchewan
	Keewatin	Nunavut
Chile (CHL)	Tocopilla	Antofagasta
	El Loa	Antofagasta
	Limarí	Coquimbo
Czech Republic (CZE)	Karlovy Vary	Northwest
	Ústí nad Labem	Northwest
Denmark (DNK)	South Jutland	Southern Denmark
Estonia (EST)	Northeast Estonia	Estonia
Finland (FIN)	Kainuu	Eastern and Northern Finland
France (FRA)	French Guiana	French Guiana
Germany (DEU)	Spree-Neiße	Brandenburg
	Bottrop Kreisfreie Stadt	North Rhine-Westphalia
Greece (GRC)	Grevena, Kozani	Western Macedonia
Hungary (HUN)	Tolna	Southern Transdanubia
Italy (ITA)	Carbonia-Iglesias	Sardinia

	Agrigento	Sicily
Japan (JPN)	Kochi	Shikoku
	Iwate	Tohoku
Korea (KOR)	Gangwon-do	Gangwon region
Lithuania (LTU)	Utena county	Central and Western Lithuania
Mexico (MEX)	Cananea/Fronteras	Sonora
	Guerrero/ Madera	Chihuahua
	Concepción del Oro/ Mazapil	Zacatecas
	Caborca/ Puerto Peñasco	Sonora
Netherlands (NLD)	Noord-Drenthe	Drenthe
Norway (NOR)	Rogaland	Agder and Rogaland
	Finnmark	Northern Norway
Poland (POL)	Rybnicki	Silesia
	Legnicko-Glogowski	Lower Silesia
Portugal (PRT)	Baixo Alentejo	Alentejo
Romania (ROU)	Gorj	South West Oltenia
Slovenia (SVN)	Lower Sava	Eastern Slovenia
Spain (ESP)	Huelva	Andalucia
Sweden (SWE)	Norrbottens County	Upper Norrland
Switzerland (CHE)	Uri	Central Switzerland
United Kingdom (GBR)	Aberdeen City and Aberdeenshire	Scotland
	Orkney Islands	Scotland
USA	Minot	North Dakota
	Casper	Wyoming
	Abilene	Texas
	Wichita Falls	Texas
	Midland-Odessa	Texas

The descriptive statistics amongst the 50 OECD mining regions reveal that 92% are classified as non-metropolitan regions (hereinafter, rural regions), with the majority being rural remote regions (44%), some close to metropolitan regions (10%) and others close to small and medium cities (24%). There are however four mining regions classified as metropolitan regions (Rogaland/Norway, Aberdeen City and Aberdeenshire/UK, Kochi/Japan, Bottrop Kreisfreie Stadt /Germany).

Mining regions are home to about 300 thousand inhabitants on average, slightly higher than average population of rural regions. In contrast their land surface area is significantly higher (101,788 km2 against 18,829 km2), thus population density is 62% lower than in rural regions (75 population per km2 against 120). Due to their larger surface area, their share of green land cover is also higher (62.4% against 57.5%).

Table 1.2. Descriptive statistics of OECD mining regions benchmark

	OECD benchmark of mining region (TL3)	OECD rural regions (TL3)
Population average	291,870	271,993
Population density (pop. Per Km2), average	75.2	119.9
Regional surface (km2), average	101,768	18,829
Working age population (% of total population), average	63.8%	63.0%
Green land cover (%of regional land)	62.4%	57.5%

Note: Data refers to year 2020 or latest reported by the country. Green land cover is the sum of the share of forest, Grassland, Shrubland and Sparse vegetation cover.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en .

Mining regions in the OECD benchmark are diverse in terms of the type of minerals, companies and inhabitants present in the territory:

- Differences in minerals. Regions of Eastern and Central Europe (in Belgium, Slovenia, Poland and Germany) are focused on coal and lignite, holding commitments to phase out this production before 2050. Other regions are global producers of Copper (Antofagasta, Chile) and Lithium (Antofagasta, Chile and Western Australia outback in Australia). Regions in Canada are some of the largest producers of rare earths and precious stones. Others are highly focused on non-metallic mining, like aggregates and construction rocks.
- Differences in mining companies. OECD mining regions also contain a mix between large mining multinationals and medium and small companies. For example, in Huelva in Andalusia Spain Non-metallic mining is mainly conducted by small local family businesses (with an average of 6.8 employees per establishment) that represent an important source of jobs for rural communities (44% of all extractive industry jobs in Andalusia fall within the Non-metallic sector) (OECD, 2021[9]).
- Differences in population. Mining regions in Canada, Australia, Chile, Mexico and Sweden have a relatively high proportion of indigenous communities in their population.

1.4. Measuring well-being of mining regions: a comprehensive approach

This section adapts the OECD regional well-being framework to the characteristics of OECD regions specialised in mining activities. The aim is to identify indicators that are well suited to measure well-being standards in OECD mining regions. The section identifies13 indicators, depicted in Table 1.3 in each of the three dimensions of well-being, the economic, the social and environmental, taking into account the specific characteristics of regions specialised in mining activities and data availability.

Table 1.3. Indicators to monitor well-being in OECD mining regions

Dimension	Outcome indicator	Underlying formula	Unit	Period
Economic[6]	Jobs	Unemployment rate 15 years old or more	%	Latest year available (…2020)
	Economic diversification	Herfindahl index (*based on employment distribution*)[7]	Index	Latest year available (…2020)
	Economic growth	Growth of total employment at place of work	%	Latest year available (…2020) vs Mid-year (…2007…)
	Innovation level	Patents per million inhabitants	Per million inhabitants	Latest year available (…2020)
Community/social	Share of female in workforce	Sex ratio in working age population 15-64 years old *(No. man/No. women)*	%	Latest year available (…2020)
	Share young population	Share of 0-14 years old in population	%	Latest year available (…2020)

[6] Due to the lack of DGP or value-added measurements at the TL3 regional level, the economic dimension of this toolkit uses employment statistics as a proxy for economic growth in mining regions. 0 presents an exercise using GDP per capita and labour productivity using a combination of data available at the TL2 and TL3 regional level.

[7] The Herfindahl-Hirschman index is adapted to measure employment concentration across sectors. The value of the index is the sum of the squares of the employment shares of sectors over the regional economy. Higher values indicate greater concentration. An index above 2,500 means a highly concentrated economy; while an index below 1,500 means a rather diversified economy in terms of employment distribution. The formula of the Herfindahl index below represent the sum of the employment share (*X*) of the sector J in economy *m* for the time *t*.:

$$\text{HHI} = \sum_{k=0}^{J} X^2\, j, m, t$$

	Population growth	Growth of total population	%	Latest year available (…2020) vs Midyear (…2007…)
	Long-life[8]	Death rate (deaths per 1 000 total population)	Per 1 000 inhabitants	Latest year available (…2020)
	Education level*	Share of population 25-64 with tertiary educational attainment*	%	Latest year available (…2020)
Environment	Change of trees/vegetation	Change in the share of Grassland, Shrubland, Sparse vegetation and Forest cover.	p.p	Latest year available (…2020) vs Midyear (…2007…)
	Green electricity generation	Greenhouse gas emissions per unit of electricity generated	Tons of CO2 equivalent per gigawatt hour (tCO2eq per GWh)	2019
	Green value chains	Greenhouse gas emissions per capita from the energy, industry and transport sector	Kilograms of CO2 eq. per capita	2018
	Soil water content	Mean soil moisture anomaly of 2018 and 2019 compared to the reference period 1981-2010	Index	Average of 2019 and 2018

Note:*data only available at the TL2 level. Data available at OECD (2022), OECD Regional Statistics (database), OECD, Paris.

As most of the 50 OECD mining regions are classified as rural regions, this paper compares the OECD mining benchmark with the average of OECD (TL3) regions and the average of OECD rural regions. The comparison with rural regions is relevant as these type of regions, as many mining regions, are characterised by higher cost of access to services and trade goods due to greater distance to markets and smaller internal economies with difficulties to attain economies of scale (OECD, 2020[29]). Many of these regions also have Indigenous communities and a large number of environmental conservation lands, which call for special attention in the management and relationship with extractive industries.

1.4.1. Economic dimensions of mining regions

The economic dimension looks at diversification efforts in mining regions, unemployment and employment growth and innovation. While mining has been associated with higher than average income and increased employment, these benefits tend to distributed unevenly between population groups (OECD, 2019[30]) (OECD, 2014[31]).. Moreover, many regions highly specialised in mining, with few economic activities outside this sector, are vulnerable to recessions when commodity prices drop, their deposits become exhausted or lose economic value due to technological changes that diminished their global demand (Breul and Atienza, 2022[32]).

Mining regions have a lower economic diversification

A diversified regional economy is an important building block for long-lasting growth (Hausmann and Hidalgo, 2010[33]). It helps increasing economic resilience to external shocks, unlocking synergies among different economic sectors and involving greater population in the local economic. Research shows that regions undergoing a catching-up process in their stages of economic development are characterised by a relatively high level of diversification and greater share of concentration in tradable activities (OECD,

[8] Due to the lack of data on life expectancy at TL3 regional level, the toolkit uses death rate as a proxy of length of life across regions. This measurement require caution when comparing across regions, as it can be indicative of different age structures rather that quality life conditions for length of life. In other words, a region may have a greater death rate due to the higher share of elderly population, rather than lower life expectancy at birth (e.g. because of access to quality health services)

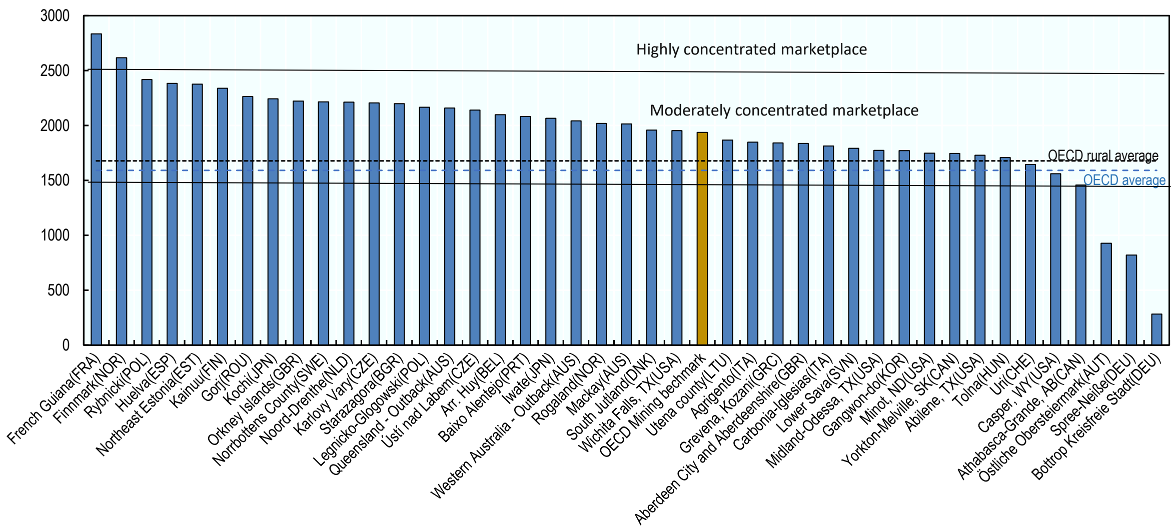
2016[34]). Diversification strategies for mining specialised economies should pay special attention to local assets and knowledge, beyond policy instruments that are used to diversify resource-rich countries, including fiscal or trade policies (Breul and Atienza, 2022[32]; Syahrir, Wall and Diallo, 2020[35]).

Economic diversification can help mitigate the high external dependence. The first indicator in the economic dimension of mining regions is the degree of diversification. This is calculated based on an employment concentration index, following the Herfindahl-Hirschman index (HHI) (Rhoades, 1993[36]). According to this index, OECD mining regions, on average, are 15% less diversified than the OECD rural regions and 20% less diversified than the OECD regional average (Figure 1.3).

Only four mining regions have more diversified economies than the OECD average: Bottrop Kreisfreie Stadt and Spree-Neiße in Germany; Östliche Obersteiermark in Austria and Athabasca-Grande in Canada. In contrast, small economies as the mining region of French Guiana in France and Finnmark in Norway are the most specialised regions.

Mining regions that host coal mines (e.g. Germany, Poland or Slovenia) have advanced in diversifying their economies to phase out coal, as part of the climate commitments. For example, in Europe, since 2012, total coal power generation has dropped by almost a third (European Commission, 2022[24]). The European commission has introduced a special Just Transition Mechanism alongside tailored financial and practical support to generate the necessary investments to areas affected by the energy transition, like the EU coal regions. In Germany, mining regions host mainly lignite extraction, but they also have advanced industries, like the "Schwarze Pumpe" industrial area in Spree-Neiße region that gathers a brown coal power plant along with energy technology companies, companies from the chemicals and plastics sectors and metal and paper production.

Figure 1.3. Diversification index of Mining Regions compared to OECD average, 2020



Note: Y-axis depicts the value of the Herfindahl-Hirschman index (HHI). Higher value indicates greater concentration. A value of HHI < 1,500= diversified marketplace, HHI between 1,500 and 2,500 = moderately concentrated marketplace, HHI > 2,500 = a highly concentrated marketplace. Unweighted average.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en

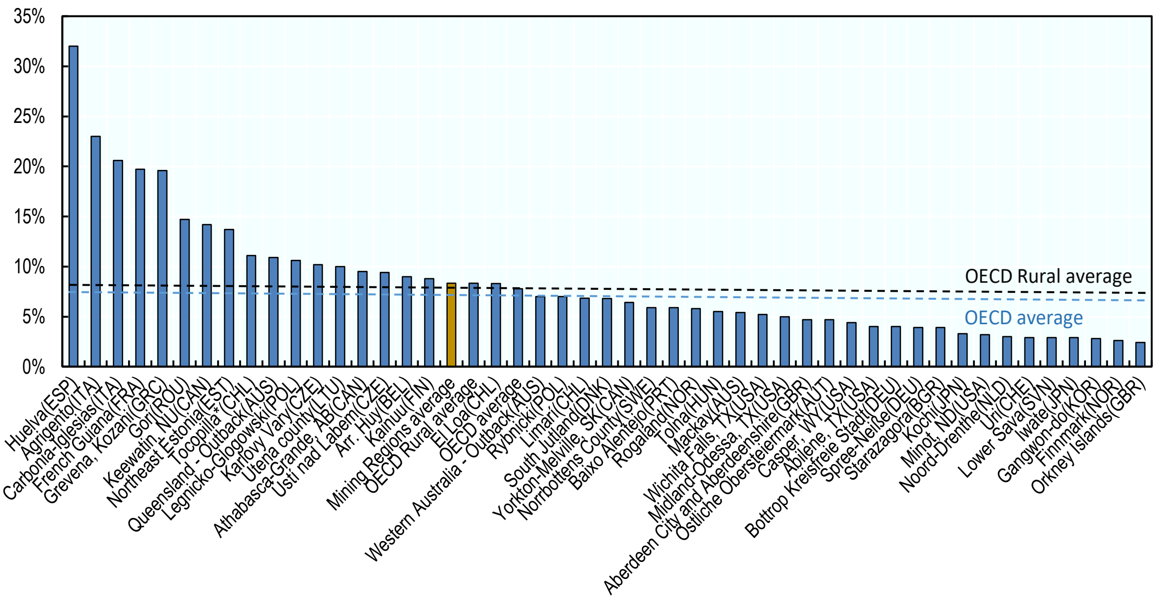
Mining regions have relatively low unemployment rate...

Mining industry can play an important role in local job creation, both directly for the mining activity itself (e.g. construction, extraction and transportation) and indirectly for maintenance of equipment or provision of goods and services. When mining occurs in remote rural regions, it tends to become the main source of income and employment. The extent of the local labour market and industrial structure determines the capacity of the local economy to benefit from mining ventures (Moritz et al., 2017[7])

In parallel, mining is becoming more capital-intensive, with modern mining increasingly relying on automation and high technological standards. This trend creates some challenges for local workforce and local firms to adapt to new demands of skills and technological services. In fact, mining jobs are among the top five occupations in terms of jobs at risk of automation, particularly in tasks such as drilling, blasting or driving (OECD, 2018[37]). Yet, technological change can be leveraged to create new quality jobs (e.g. data scientist, supervisors and maintenance of autonomous machines) and involve different segments of population in the mining activity (Mining Technology, 2017[38]). For example, in mines in Kiruna, Sweden, women are increasingly integrating mining activities as truck managers or quality controllers, benefiting from technology to perform tasks into a traditionally male-dominated mining sector (Landau and J. Lewis, 2019[39]).

Our second indicator for the economic dimension is the unemployment rate. Figure 1.4 depicts the unemployment rate for 2020 in mining regions, which is slightly lower in mining regions (8.19%) than across OECD rural regions (8.34%), but above the OECD regional average (7.77%). This average, hides important differences, as more than half of the regions in the OECD mining benchmark (28 out of 50) display lower unemployment rates than the OECD rural and regional average. Nonetheless, some mining regions have three or two times more unemployment than the OECD mining regions average, driven by structural effects in the national labour market (Huelva in Spain and Agrigento and Carbonia-Iglesias in Italy).

Figure 1.4. Jobs (unemployment rate in %) in OECD Mining Regions, OECD rural and regional average, 2020



Note: Y-axis reflects unemployment rate of population over 15 years old (%) in the region. Unweighted average.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en

…But employment growth rate is relatively low.

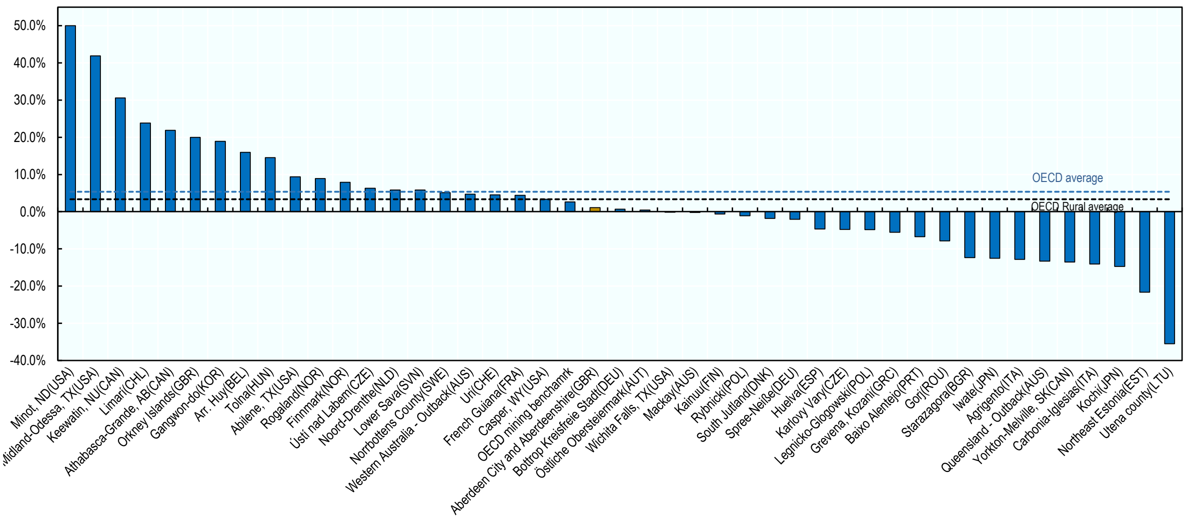
Our third indicator is the employment rate, shown Figure 1.5 for 2020. Mining regions on average experienced employment growth since the global financial crisis, but the rate of new jobs between 2007 and 2020 (2.6%), is slightly below the OECD average of rural regions (2.8%) and far below the OECD regional average (5.4%). When compared to the average employment growth of the respective countries, the employment growth across OECD mining regions is on average 5.7 p.p below the national average.

However, this average figure hides a high heterogeneity across regions. During the same period, 47% of OECD mining regions with available data experienced a net fall of employed people. The regions with greatest employment drop were Utena in Lithuania (-35.5%) and Northeast Estonia (-21.6%). This contraction in employed population is influenced by depopulation (see next section) and the impact of the 2008 financial crisis, particularly in rural regions that have faced industrial transition, after the delocalisation of some economic activities in other countries and lower employment opportunities in more traditional sectors (OECD, 2020[29]). All but three of the regions with contraction in employed population also experienced a fall in population during 2007 and 2020.

The top five mining regions with greatest employment growth are located outside Europe and Asia, mainly in North and South America. Minot, North Dakota and Midland-Odessa, Texas in US registered the highest employed growth (50.0% and 41.9%, respectively). Both regions are also among the top 10 mining regions with greatest population growth.

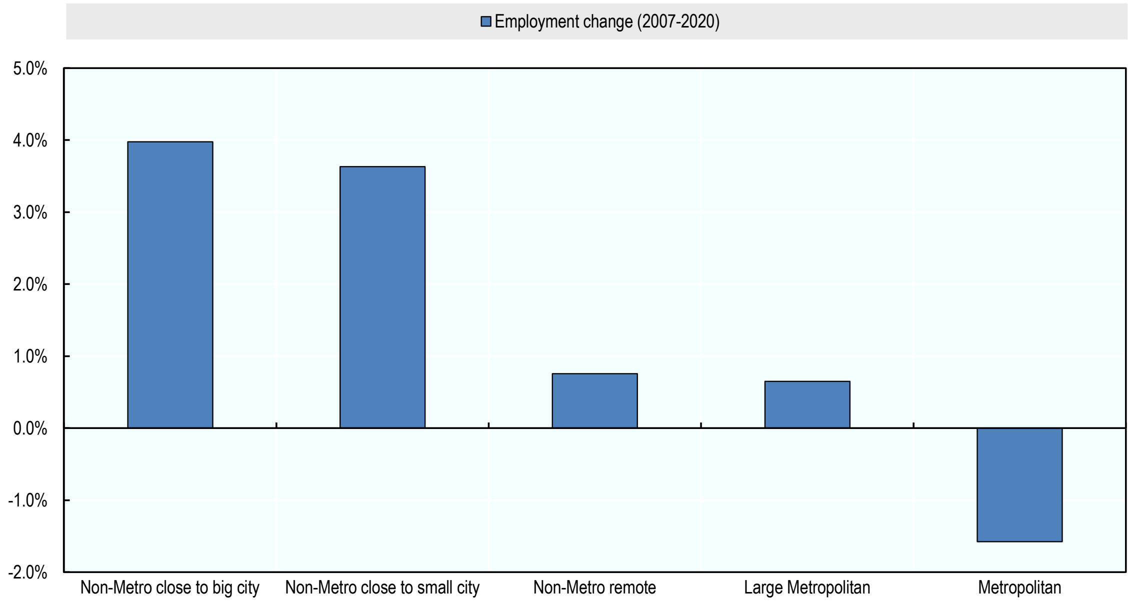
When looking at the territorial distribution of job creation, rural mining regions close to cities (big and small cities) registered a more rapid employment growth than mining regions classified as metropolitan and remote (Figure 1.6). The volume of mining activity, as well as the size of the local labour market and access to nearby cities appear to be important factors driving the employment performance of mining regions. Economies of scale and coordination of labour markets in regions close to cities have the potential to meet mining industry demands for skills and goods.

Figure 1.5. Employment growth of OECD mining regions, 2007-2020



Note: Y-axis reflects change in total employment (2020 vs 2007) (%). Unweighted average.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en

Figure 1.6. Employment growth by OECD territorial typology of Mining Regions, 2007 -2020



Note: Typology developed according to OECD based on accessibility to urban functional areas. Unweighted average.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en

Innovation intensity in mining regions is relatively low, despite some outstanding cases.

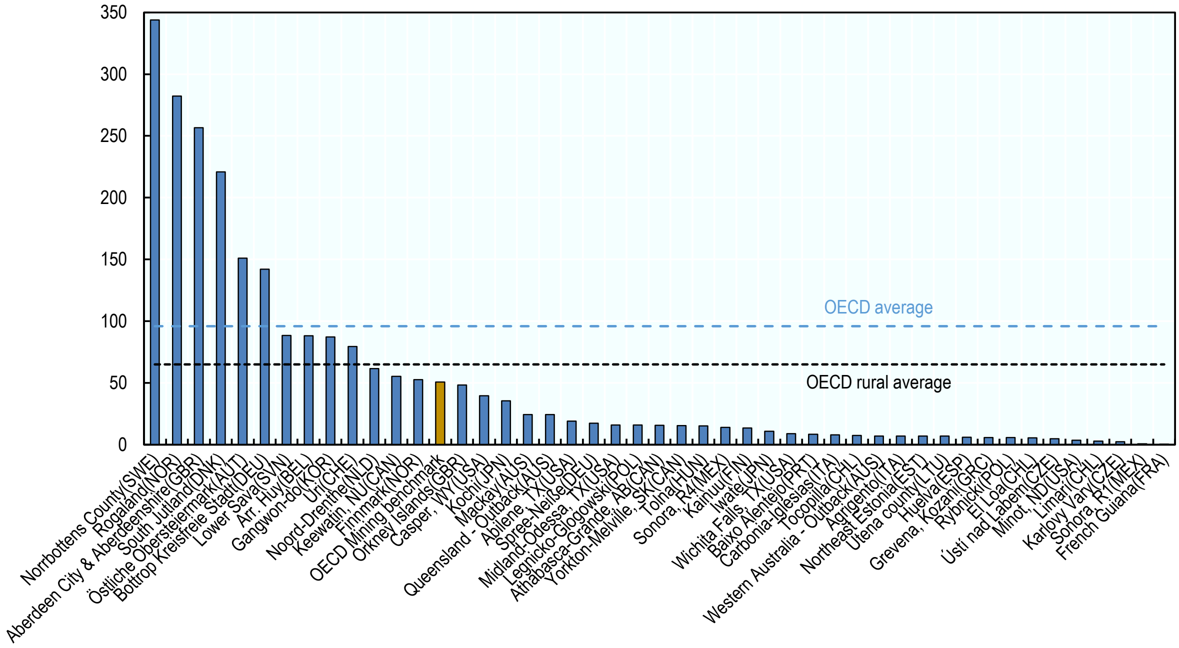
Innovation is a main driver for economic growth and resilience. Across the OECD, regions are increasingly seeking ways to support their innovation eco-system to unlock new business and a face global megatrends like climate change or demographic challenges (OECD, 2021[40]).

We proxy the innovation intensity in regions with patents, our fourth indicator in the economic dimension of mining regions. It is worth nothing that patents however, contain some limitations since they capture a restrictive view of innovation, based on science and technology, and suffer from measurement biases that arise when the location where the innovation took place does not correspond to where it was recorded (OECD, forthcoming[41]). Therefore, this measure can underestimate the innovation capacity in rural regions and in resource dependent regions. Furthermore, many mining companies tend to record their patents in the headquarters of their companies, often time located in the capital region or large metropolitan regions. Despite these drawbacks, data on patents is widely available for international comparisons among mining regions and rural regions, which reduces incongruences from biases on innovation location. Other measures of innovation, like start-up activities or research and development investments, have limited data availability at this regional level.

On average, mining regions have a lower innovation intensity (51 patents per million inhabitant in 2020) than both the OECD regional (96) and rural (65) average (Figure 1.7). Out of the 47 OECD mining regions with data available, 79% have a lower number of patents per million inhabitants that the average of OECD rural regions. This aspect is of particular importance for mining regions, as innovation and technological change is a central axis to advance in a more environmentally sustainable mining.

Notwithstanding this fact, there are six mining regions that are innovation champions, with levels above the OECD average. In particular, the region of Norrbotten in Sweden registers four times more patents per million inhabitant than the OECD average, similarly Rogaland in Norway and Aberdeen City & Aberdeenshire in UK register three times more patents.

Figure 1.7. Patent intensity in OECD mining regions benchmark compared to OECD rural and regional average, 2020



Note: Y-axis depicts patents per million inhabitants. Unweighted average.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en

In sum, the specialised nature of mining regions entails a number of advantages and disadvantages. Mining regions have a lower level of economic diversification, which makes them more dependent on sector-specific fluctuations, especially in commodity markets. Fluctuations in turn makes their regional economy, jobs and level of well-being also vulnerable to external fluctuations and calls for policy responses that can help diversify their economic base. Employment opportunities in rural areas are sometimes scarce, and mining activities bring job-opportunities, especially in mining regions close the small and medium cities, which would otherwise likely not exist. The analysis on innovation intensity measured by patents show that although mining regions record on average lower patents than in OECD rural region, patents is certainly possible and very active amongst a groups of champion patent mining regions.

1.4.2. Community/social dimensions of mining regions

The community/social dimension contains a mixture of demographic components, all relevant for communities to flourish. Many mining regions tend to suffer from a seasonal workforce and male-dominated labour market. Managing a more balanced population mix and attracting skilled labour plays an important role in driving the competitiveness of regions.

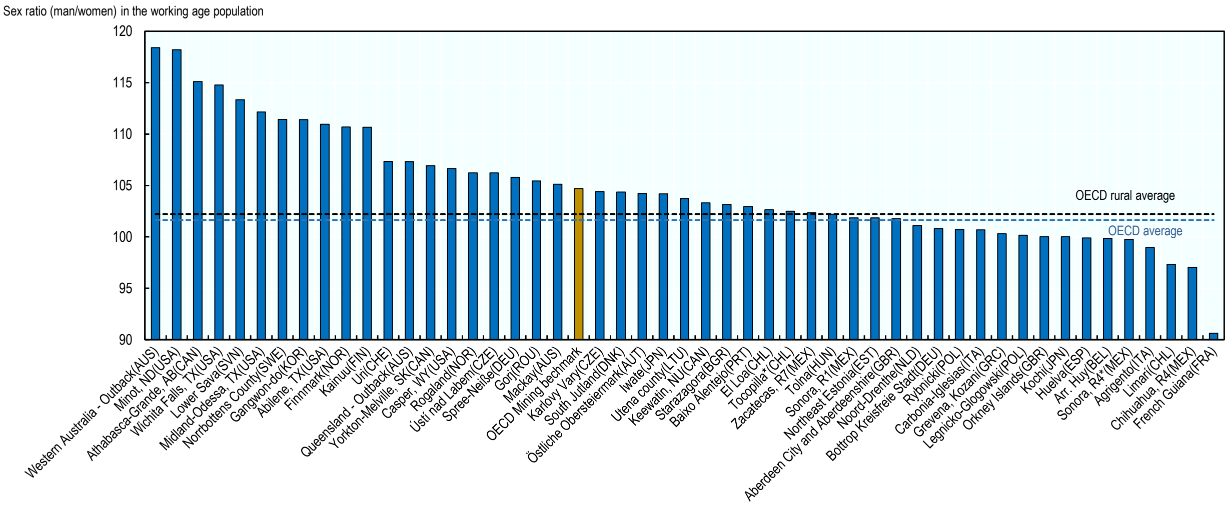
OECD mining regions have a higher share of men than women in the working age

Traditional economic sectors, like mining, tend to provide fewer labour opportunities for women, given the physical based tasks demanded in these activities. OECD rural regions tend to experience outmigration of women in the working age, given limited labour opportunities in some rural economies (OECD, 2020[29]). The first indicator for the community/social dimension of mining regions is the men-women ratio in the working age population.

In 2020, OECD mining regions had on average 4.7% more men than women in the workforce, which is almost three times above the average ratio across OECD regions (1.6% more man than women) and twice of the OECD rural regions (2.2%) Figure 1.8. When compared to the average ratio of their respective countries, the ratio of men-women employment across OECD mining regions is on average 4.2 p.p higher than their national average (more men than women compared to the national average). The overrepresentation of man in the labour force of mining regions like Western-Australia outback in Australia and Minot in the US (18% more men than women) is almost four times the average man-women ratio of OECD mining regions.

While on average the men-women ratio in mining regions' working age population has not changed much since 2007 (4.5% more men than women), more than half of the 50 mining regions (58%) decreased the relative number women in the population. Regions with a greater drop in the relative number of women include Minot and Midland-Odessa from US. In contrast, Athabasca-Grande in Canada and Makay in Australia are the mining regions that experienced the greatest increase of women relative to men in the working age population. As mentioned in previous sections, the increasing digitalisation of the mining sector has the potential to enhance women's involvement in mining activities, which is coupled with increasing efforts from private companies to improve gender balance.

Figure 1.8. Men-women ratio in the working age population, 2020



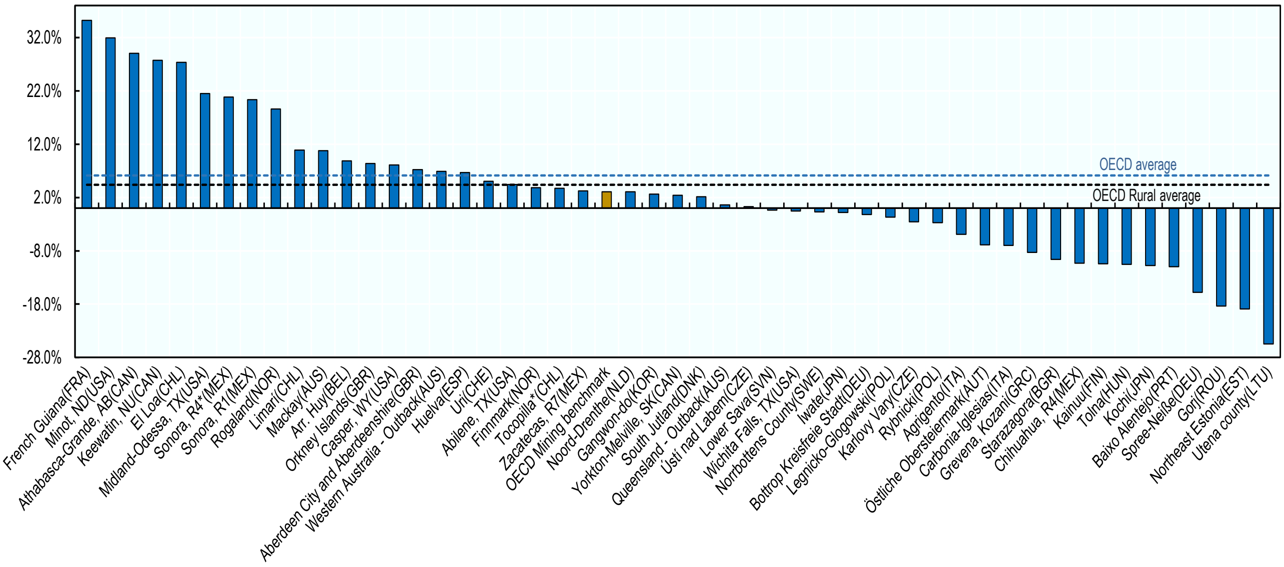
Note: Sex ratio (man/women) in the working age population 15-64. A higher number means more male in the labour market. Unweighted average.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en

Mining regions face lower population growth

Mining regions, like other rural regions in the OECD, face on average a challenge of depopulation. This structural trend is driven by outmigration of youth and skilled workforce to larger cities in search of job opportunities and greater accessibility to amenities and services (OECD, 2020[29]).

Our second indicator in the community/social dimension of mining regions is population growth. Over the period 2007-2020, the average population growth rate in OECD mining regions (3.1%) was half the rate of OECD regional average (6.1%) and less than three quarters the population growth rate across OECD rural regions (4.4%) (Figure 1.9). While 38% of the 50 OECD mining regions in the benchmark experienced greater population growth than the OECD rural average, 44% registered a pattern of demographic decline. Population decline affects investment attraction and reduces tax base given a shrinking labour force as well as increases per head cost in the provision of public services (OECD/EC-JRC, 2021[42]). A shrinking population also boosts the cost to maintain local infrastructure (e.g. water supply, sewerage, public transportation).

Figure 1.9. Population change of Mining Regions and OECD regions average, 2007-2020



Note: Y-axis depicts population change between 2007 and 2020. Population change is calculated as absolute change. Unweighted average.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en.

Despite low population growth, mining regions are younger than OECD average

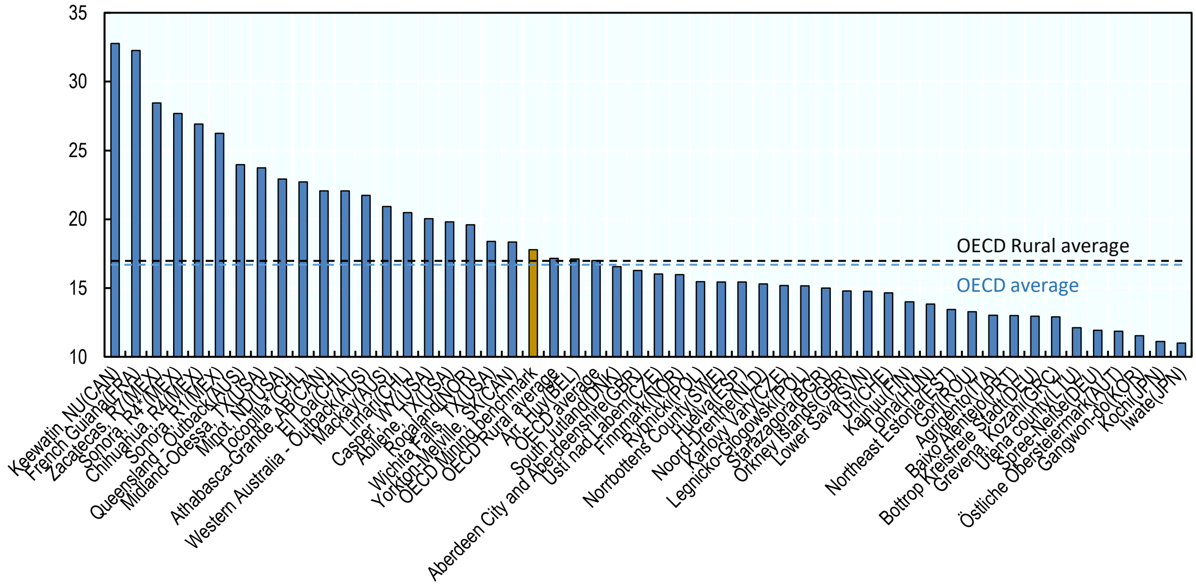
Our third indicator in the community/social dimension of well-being is the percentage of youth in the population. In 2020, OECD mining regions have on average a greater share of youth (aged 0-14) in their population (17.8%) than the OECD rural average (17.2%) and OECD regional average (17.0%) (Figure 1.10). Mining regions in non-EU countries explain most of this relatively younger demographic structure. Out of the 20 mining regions that have higher share of children than the OECD rural average, 18 regions belong to non-EU countries, mainly Canada, Mexico, Chile, US and Australia. A high share of children represents an important regional assets, as it is a potential for future workers and entrepreneurs, increases regional attractiveness, particularly for families, and is a driver of cultural activities.

The analysis on age population groups also shows a lower share of elderly people on average in OECD mining regions (18.4%) when compared to the OECD regional average (19.3%) and the OECD rural average (19.8%). Asian and European mining regions tend to have higher levels of elderly share than other regions, with Kochi and Iwate in Japan registering the greatest shares of elderly population (35.8% and 33.8%, respectively), while the lowest are Keewatin and Athabasca-Grand in Canada (3.7% and 4.1%, respectively).

Over time however OECD mining regions are ageing and losing their higher youth share: 74% of OECD mining regions experienced a fall of the share of youth (aged 0-14) since 2007 and 96% registered a growth in the share of elderly population. The mining regions experiencing the greatest fall of the share of children included Gangwon-do, in Korea, El Loa, Chile and Sonora in Mexico. In contrast, the top 3 mining regions that increased the share of children are Minot in US, Athabasca-Grande in Canada and Spree-Neiße in Germany. These population dynamics reveal a shrinking labour force in mining regions (from 66.3% in 2007 to 63.8% in 2020). These trends prove that mining projects find it difficult to retain young and attract skill workers to meet labour needs locally (e.g. Norrbotten, Sweden estimates a need of about 100, 000 people for current and new mining ventures).

These average patterns mask the regional variations. Understanding the demographic composition by age segment is important to plan and tailor service delivery, given that older populations tend to require more intensive social services (e.g. health, social assistance), while communities with a higher share of young people require more development opportunities (e.g. employment, education).

Figure 1.10. Young population share over the total population, 2020



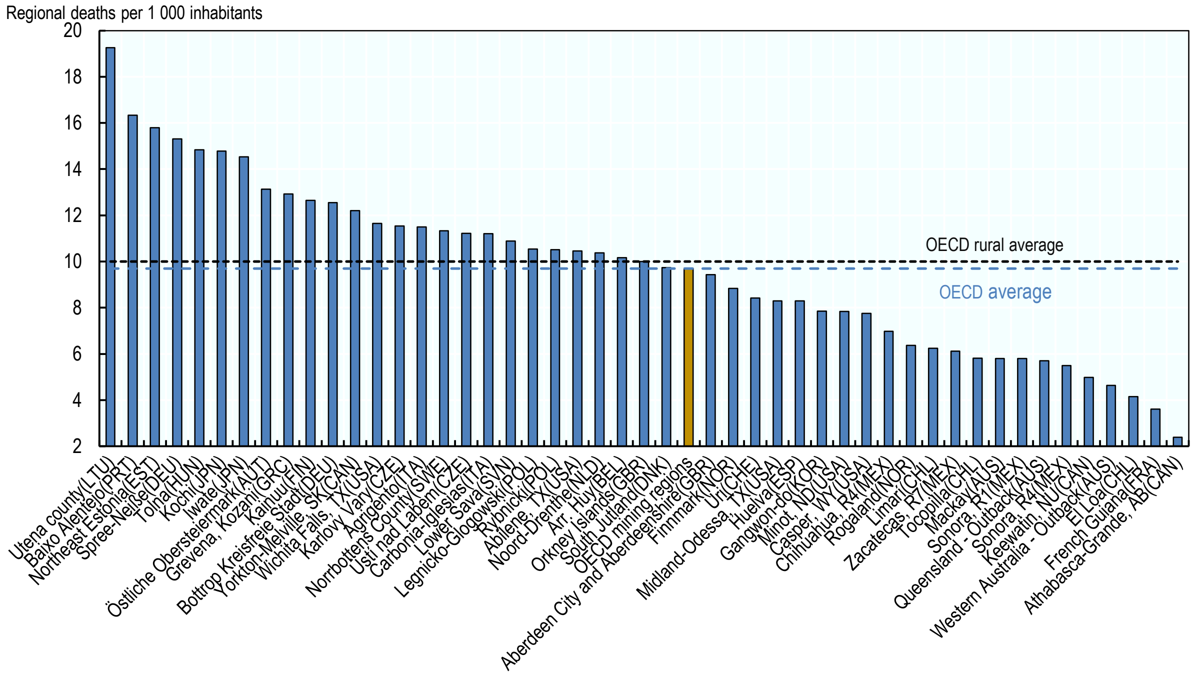
Note: Y-axis depicts share of 0-14 in regional population (%). Unweighted average.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en.

OECD mining regions have slightly lower death rates than OECD rural regions

Our fourth indicator life expectancy examines whether death rates in mining regions are on average higher or lower. Mining regions have on average rather similar death rate (9.71 deaths per 1 000 inhabitants in 2020) than OECD regional average (9.70), but below the level across OECD rural regions (10.0) (Figure 1.11). This difference does not reveal any striking difference in safety levels or health outcomes among mining and non-mining regions. Out of the 48 OECD mining regions with data, Mining regions with a higher death rate include Utena County, Lithuania (19.26) and Baixo Alentejo Portugal (16.36). In contrast, some mining regions such as Athabasca-Grandem Canada (2.4) and French Guiana, France (3.6) register levels far below the OECD average. These differences of death rates among regions is partially associated with the age structure, especially the share of elderly population in the regions.

In line with the ageing trend discussed before, the death rate of mining regions registered a slightly increase between 2020 and 2007 (0.7 more deaths per 1 000 inhabitants). This growth pattern, however is lower than the increase of death rates in OECD regional average (0.93 more deaths per 1 000 inhabitants). While the data coverage of this indicators does not allow to make conclusions on the health impacts from the COVID-19 disease, mining regions did not seem to experience marked difference on excess mortalities vis-à-vis other regions (OECD, 2020[43]).

Figure 1.11. Death rate of OECD mining regions benchmark and OECD regions, 2020



Note: Y-axis depicts regional deaths per 1 000 inhabitants. Unweighted average.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en.

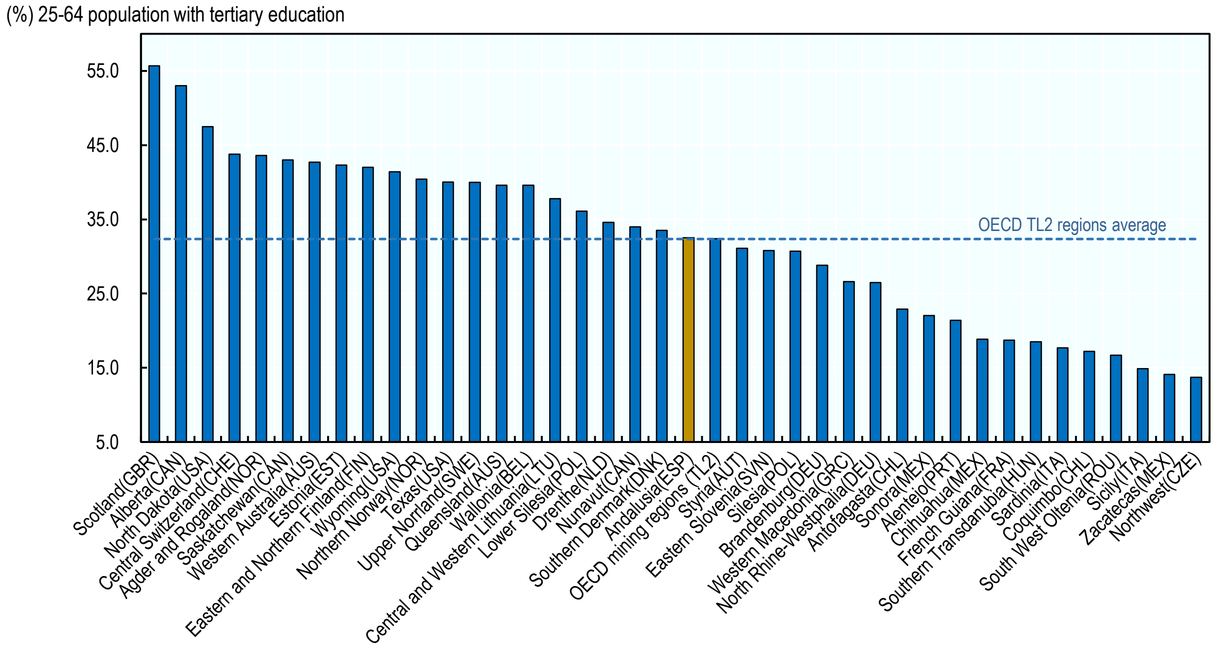
Mining regions enjoy similar rates of tertiary education attainment than OECD averages.

As previously mentioned, data for education attainment are only available for larger regions (TL2 regions). Thus, our firth indicator reports the value of tertiary education attainment from the higher TL2 regions that correspond to each of the 50 OECD mining TL3 regions (Figure 1.12). While this depicts an estimated value over a broader geographic area, the estimate can already capture the level of human capital for mining regions.

According to this indicator, in 2020 OECD TL2 mining regions had a similar share of working age population with tertiary education (32.4% of the 25-64 years old population with tertiary education) than the OECD average of TL2 regions (32.3%). In 40% of the OECD TL2 mining regions, the share of population with tertiary education is higher than the OECD TL2 regions average, with the greatest shares recorded in Scotland in UK, Alberta in Canada and North Dakota in US.

Over time, the share of population with tertiary education in TL2 mining regions has recorded a significant increase since 2007 (7.8 percentage points), although this growth rate has been below than the growth in OECD regional average (9.4 pp). Therefore, despite a relatively high share of high educated population, mining regions need to maintain efforts to avoid lagging behind in education outcomes and thus coupling mining activities with skilled worker force. The revenues from mining ventures and the digitalisation process of the industry should be leveraged to further upskill workforce in these regions.

Figure 1.12. Tertiary education attainment in TL2 mining regions 2020



Note: Y-axis depicts the share of population 25-64 with tertiary educational attainment (ISCED 5-8). Given the lack of data at TL3 level, education attainment is calculated for the TL2 regions that contain the benchmark of the OECD TL3 mining regions. Unweighted average
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en.

The indicators across the community/social dimension already reveal the following patterns:

- Mining regions face important challenges of population growth with almost half of the regions in the benchmark registering population decline. This is coupled with a relatively lower share of women in the working age population, which threatens generational replacement. Despite this, OECD mining regions seem to have high fertility rates as they record greater share of children, and a lower share of elderly people than the OECD regional average and the OECD rural average. However, a shrinking working force in the regions is indicative of youth outmigration rates, as children are leaving the region for the working age.
- Mining regions do not reveal any striking difference in safety levels or health outcomes compared to other regions, and instead register relatively higher levels of education attainment.

OECD mining regions should aim to mobilise their relatively high share of children with education and labour opportunities locally, which can be linked activities in the broader mining value chain. Digitalisation and climate change are transforming the mining industry offering new job opportunities to youth and women. Educational policies that can raise skills and competences can help to leverage benefits from these transformations. Enhancing services and cultural amenities can also help attract labour, women and skilled workers.

1.4.3. Environmental dimensions of mining regions

Accelerating the transition to a zero-climate change is at the heart of the OECD policy agenda over the coming decades and mining regions have an essential role to play. Mining regions in the past have often been regarded as the villains to climate change with low commitment to environmental goals. Over recent times however, societal pressure and a changing political agenda is demanding mining regions to take a more active role in the climate goals.

If unattended and not well managed, mining activities can generate negative local environmental externalities and social conflicts on the use of natural resources and land. Environmental externalities can range from land use changes, water pollution and scarcity, air and visual contamination, noise and biodiversity loss (Noronha and Nairy, 2005[44]) (Hendryx, 2015[45]) (World Economic Forum, 2016[46]). Furthermore, these environmental impacts can affect the health status of individuals living in mining regions (e.g. with air and water pollution) and their level of wellbeing and capacity to attract and retain people (e.g. with availability of green spaces) (OECD, 2011[47]) (OECD, 2014[31]).

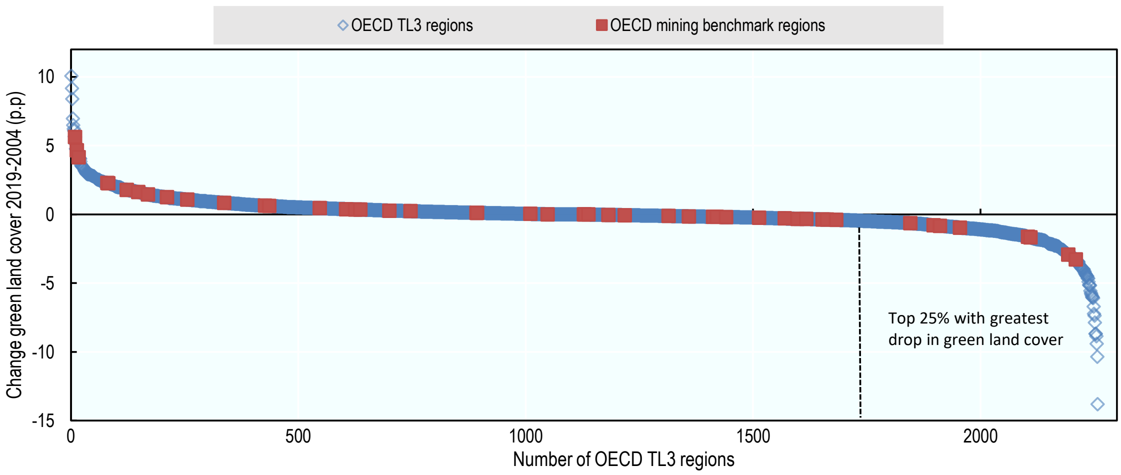
Mining activities also increase the competition for natural resources and can lead to conflicts with local communities and other economic sectors within mining regions. For instance, the significant use of water in processing ore and the risk of water pollution from discharged waste mining and rock impoundments can not only damage the ecosystem but also create conflicts with local communities and other agricultural activities. Clarifying and managing the use of resources in mining regions is of chief importance to boost economic growth and quality of life locally.

Green land cover in OECD mining regions has slightly increased

Our first indicator in the environmental dimension covers share of green land cover. Green land cover is measured as the sum of the share of grassland, shrubland, sparse vegetation and forest cover. This share has remained relatively stable in OECD mining regions over the last 15 years, when compared to the average of OECD regions (Figure 1.13). On average, the green land cover of the OECD mining benchmark slightly increased (0.34 percentage points), in contrast with the average drop across OECD regions (-0.04 pp).

Overall, half of the regions in the OECD mining benchmark (25 regions) have seen an increase in their share of green land cover. This can be partially related to the recovery of industrial and mining sites or public policies aiming at increasing green areas and parks in urban and rural areas in the region, like in the case of Tocopilla, Chile. There are only eight OECD mining regions within the top 25% of the OECD regions with greatest loss of green land cover.

Figure 1.13. Change in green land cover across OECD mining regions and OECD regions (2004-2019)



Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en.

Greenhouse gas emissions of mining regions are high, but with some good examples

The entire mining value chain produces greenhouse gas emissions from a variety of sources. They can be divided in direct emissions (scope 1 and 2) that are associated to the mining process itself (methane emitted from extraction or use of fuel for machines) and the energy needed to power the mining process. Other group refers to indirect emissions (scope 3), which are associated mainly to transformation of minerals and transportation of the ore (either to transformation facilities or the final consumer) as well as goods for the mineral extraction. Direct emissions from mining often contribute only to the GHG emission of the region itself, while indirect emissions can occur inside the region where mining operations take place and also in other regions.

This paper looks at two type of indicators to shed light on the trends and performance of GHG emissions in mining regions: i) GHG emission from industry, transport and power sectors and ii) GHG emission from electricity generation.

Mining regions emit four times more GHG per capita than OECD regions.

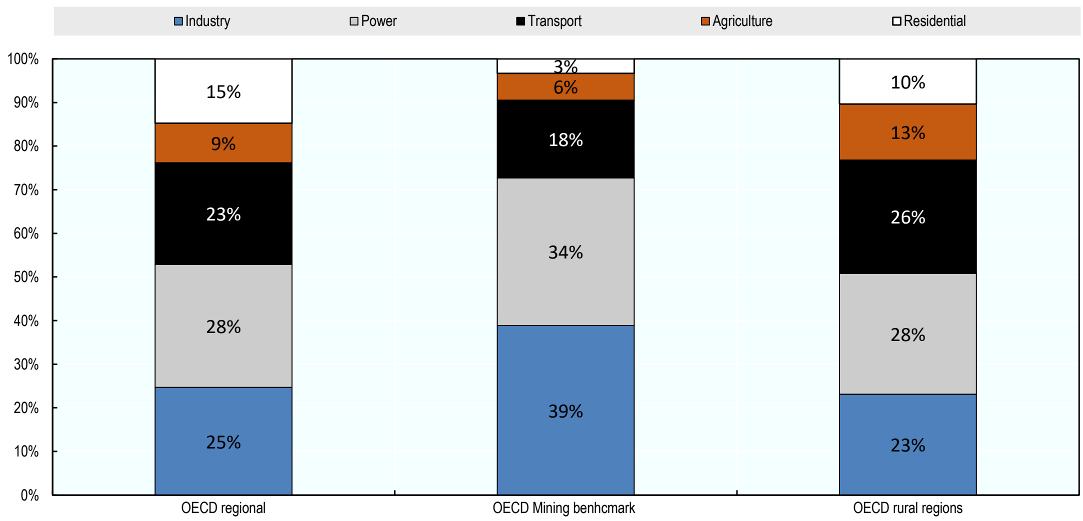
While total GHG emissions from mining regions are relatively low, the GHG emissions per capita of these regions are way above OECD averages. OECD mining regions benchmark represent 4% of OECD emissions and 10.5% of the GHG emissions in all OECD rural regions. However, adjusting for population, the GHG emissions per capita of the OECD mining regions (45,000 Kilograms of CO2 eq. per capita) are four times higher than the emissions per capita of OECD TL3 regions and three times greater than the emissions of OECD rural regions.

Most of the GHG emissions in mining regions are generated by the industry sector (39% of the GHG emissions of the OECD mining regions benchmark), followed by the power – i.e. electricity generation, combined heat and power generation, and heat plants- (34%) and transport (18%) sector. Agriculture and residential sectors represent a minor emissions' source for these regions (6% and 3%, respectively) (Figure 1.14). We thus proxy the emissions from the mining value chain looking at the emission from industry, transport and power sectors, as these three sectors represent 91% of the OECD mining regions benchmark's emissions. While this GHG indicator cannot be attributed entirely to mining activities, it can help shed light on sources of emissions across economic sectors and tailored solutions at the regional level.

Looking only to the emissions produced by industry, transport and power sector, on average, mining regions emit 2.5 more GHG per capita (47,605 Kilograms of CO2 eq. per capita) than the average of OECD rural regions (18,455 Kilograms of CO2 eq. per capita). As mentioned before, the contribution of the industry sector to the OECD mining regions GHG emissions is far above its contribution to the emissions in OECD regions (25%) and OECD rural regions (23%). The power sector's contribution is also relatively higher in mining regions when comparing to all OECD and rural regions. This sector emits three times more GHG in OECD mining regions than in OECD rural regions, which reveals greater share of CO2 intensive sources for electricity and heat generation.

Figure 1.14. Sectorial contribution to GHG emission, OECD regional average and OECD mining regions benchmark (2018)

Share of sectors GHG emissions over regional GHG emissions



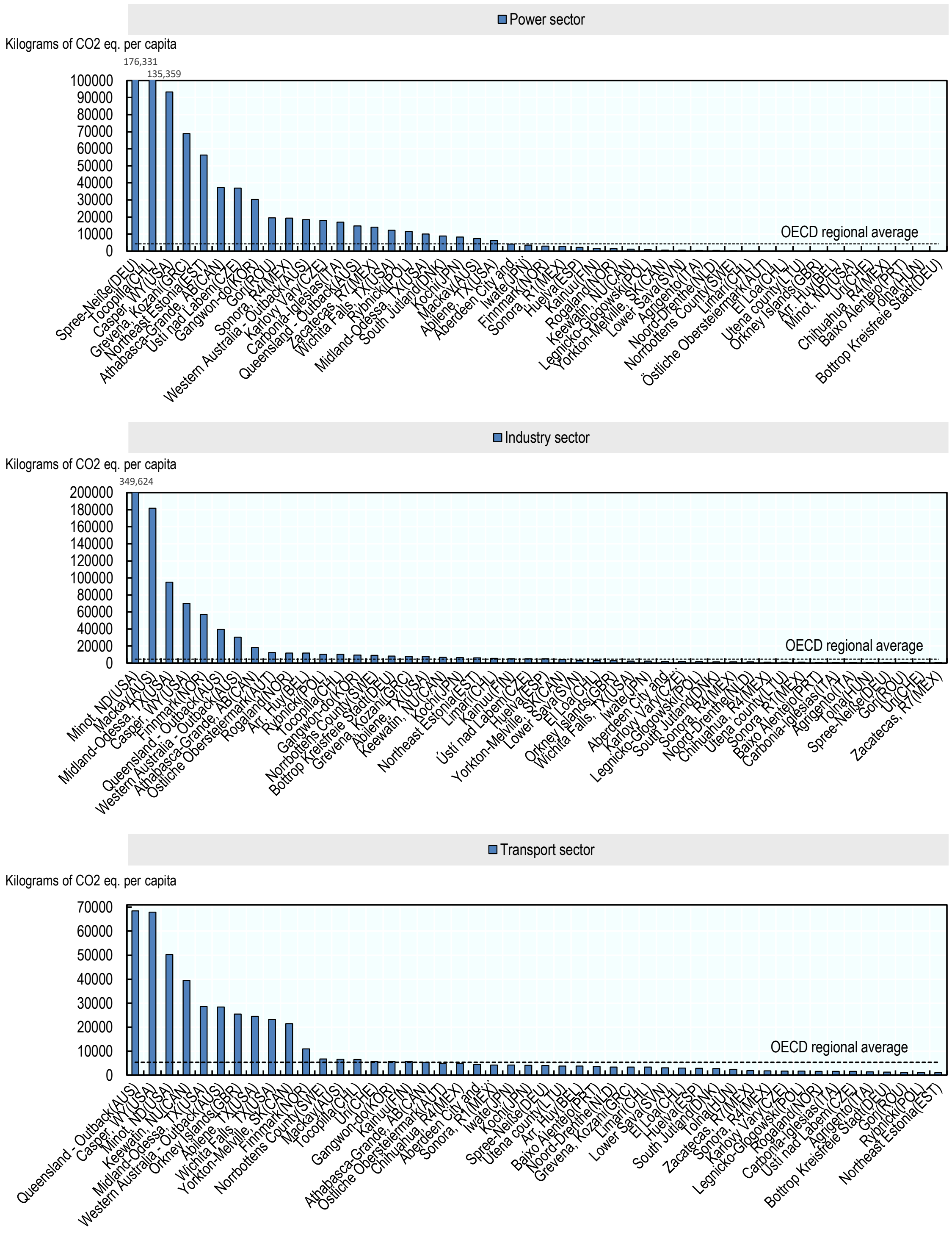
Note: GHG emissions exclude emissions from land use and land use change. Power refers to GHG emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants (IPCC 1996:1A1a). OECD countries, Bulgaria and Romania
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en. OECD calculations based on EC (2020[84]), EDGAR - Emissions Database for Global Atmospheric Research, Joint Research Centre, European Commission.

Most of the regions in the OECD mining regions benchmark (60%) are located in the top 25% of OECD regions with highest GHG emissions per capita from industry, power and transport combined. The top three mining regions with the highest emissions per capita from these three sectors are Minot, North Dakota (7.4 times the OECD mining regions average), Casper, Wyoming in USA (4.5 times) and Makay in Australia (3.6 times). In contrast, only one mining region (Arigento, Italy) locates in the bottom 25% of OECD regions with lower emissions from these sectors. Other OECD mining regions with relatively low GHG per capita (located in the middle bottom 25% of OECD regions) include Tolna-Hungary, Legnicko-Glogowski- Poland and Alentejo, Portugal.

There are stark differences on the major sources of GHG emission per capita across OECD mining regions (Figure 1.15)

- In eleven mining regions, the power sector accounts for more than half of the regional GHG emissions. Spree-Neiße, Germany and Tocopilla, Chile are the OECD mining regions with the highest emissions per capita from power sector, which are more than 30 times the average emissions from the OECD regions and between 7 and 10 times higher the average of OECD mining regions. In these two regions, emission from this sector account for more than 85% of total emissions, which could represent an important policy target in the region.
- In eight mining regions, the industry sector accounts for more than half of the regional GHG emissions. Minot, North Dakota in US and Makay in Australia are the OECD mining regions with the highest emissions per capita from industry sector, which are 70 and 37 times higher than the average emissions from OECD regions.
- In four mining regions, transport sector accounts for more than half of the regional emissions. Queensland – Outback in Australia and Casper, Wyoming in USA are the OECD mining regions with the highest emissions per capita from transport sector, which are around 12 times higher than the average across OECD regions.

Figure 1.15. GHG emission from industry, power and transport across OECD mining benchmark regions (2018)



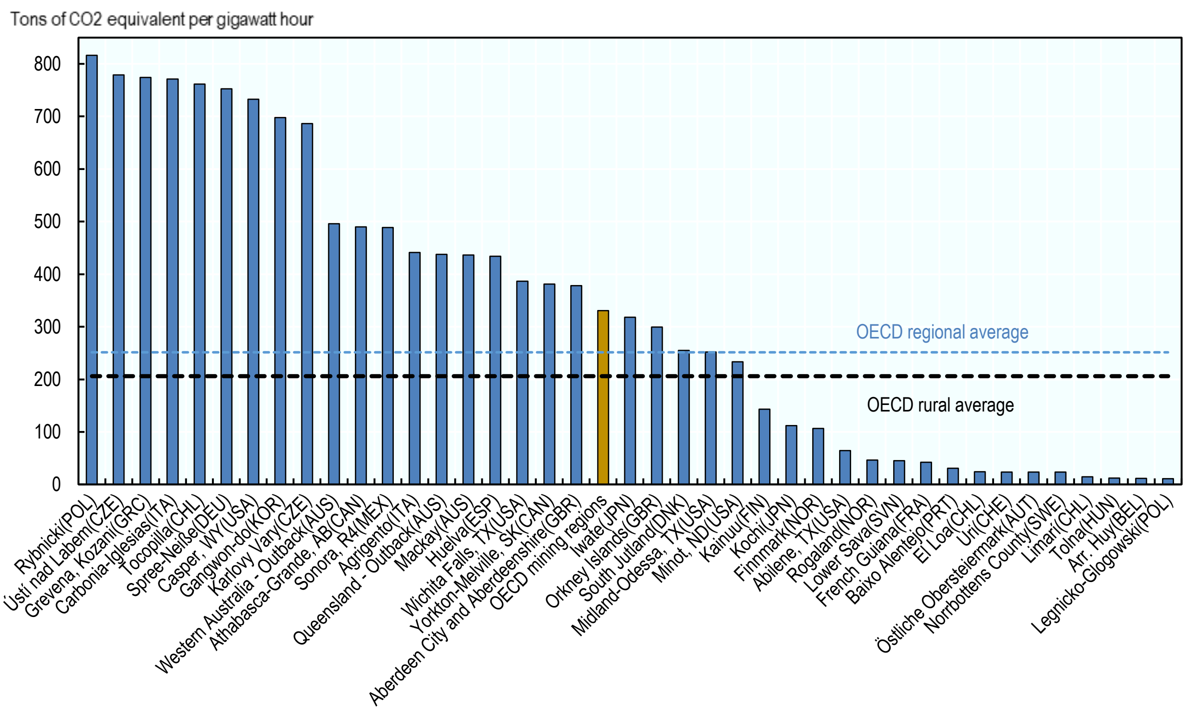
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en. OECD calculations based on EC (2020), EDGAR - Emissions Database for Global Atmospheric Research, Joint Research Centre, European Commission.

Mining regions emit more CO2 from electricity generation than OECD regional averages

Moving towards zero CO2 electricity generation plays an important role in the strategies to decarbonise mining sector. Electricity is not only needed to light mines underground but is also a key component in the ongoing strategies to phasing out fossil fuels to power machines and electrify the mining process. On average, OECD mining regions generate 1.6 times more electricity per capita (36 MWh per capita in 2019) than OECD rural regions (22MWh) and more than twice the level of OECD regions (16MWh).Thus, identifying how electricity is generated can guide efforts to reduce the carbon footprint of mining sector and help regions decarbonise downstream activities.

OECD mining regions emit on average 31% more GHG emissions from electricity generation (331 Tons of CO2 equivalent per gigawatt hour in 2019) than OECD regions (252) and 61% more than OECD rural regions (206) (Figure 1.16). More than half of the mining regions with data (58%) emit more than the OECD regional average. Nine of these regions rank among the top 25% OECD regions with greatest GHG emissions form electricity generation, which is associated to a heavy reliance on coal and fossil fuels for electricity generation, as it is the case for Rybnicki in Poland (99% from coal), Ústí nad Labem in Czech Republic (88% from coal and 11% from fossil fuels) and Grevena, Kozani in Greece (94% from coal).

Figure 1.16. CO2 emissions from electricity generation in OECD mining regions, 2019



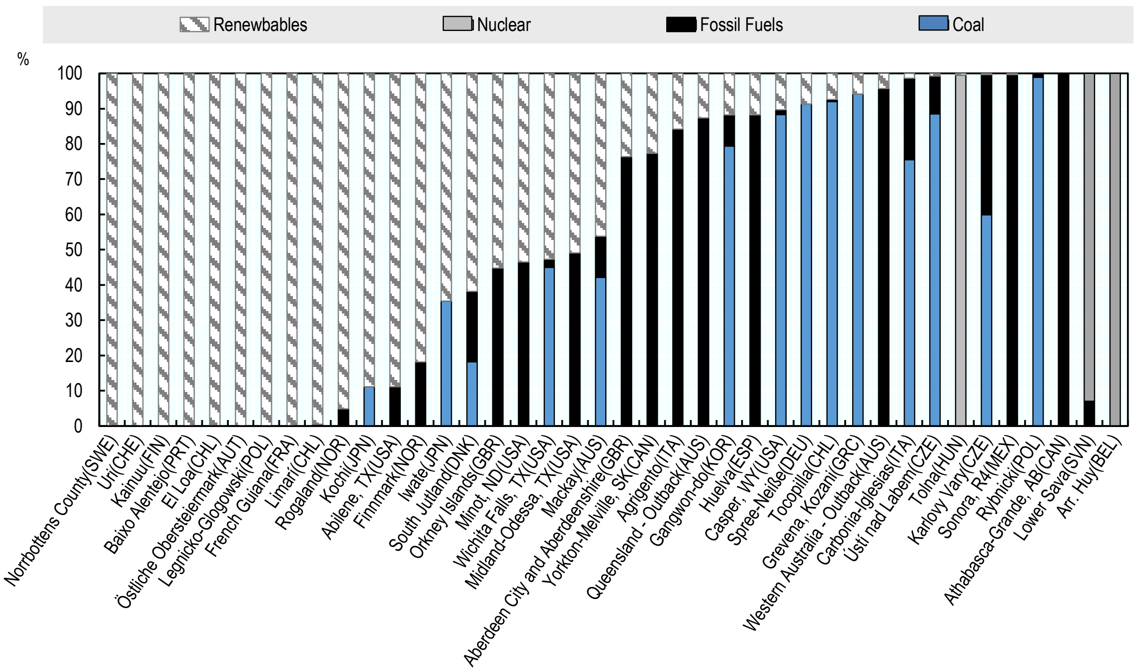
Note: 40 regions of the OECD mining benchmark with data available. Unweighted average.
Source: OECD computation based on World Resources Institute (2021), Global Power Plant Database, https://datasets.wri.org/dataset/globalpowerplantdatabase

Some mining regions emit 100% of their electricity from renewable sources

Some mining regions have made progress in generating electricity from low carbon-intensive sources, such as renewables or nuclear. 13 mining regions already produce more than 80% of their electricity from renewable sources (Figure 1.17) and in nine mining regions, renewable sources represent 100% of the electricity production. They include top producing regions of iron ore like Norrbotten in Sweden or copper like El Loa and Limari in Chile. This represents a competitive advantage to support mine digitalisation with low carbon power technologies and advance towards new methods to produce energy that can lead to net zero emission, for example green hydrogen.

Figure 1.17. Source of electricity generation in OECD mining regions, 2019.

Share of source in total electricity generation



Note: 40 regions of the OECD mining benchmark with data available.
Source: OECD computation based on World Resources Institute (2021), Global Power Plant Database, https://datasets.wri.org/dataset/globalpowerplantdatabase.

Technology in mining industry is progressing swiftly across many regions. The achievement of 100% renewable electricity supply has been combination of public investments in renewables and private projects to install deconcentrated energy supply systems to power mining extraction and transformation processes. One of the most promising innovations on this regard is hydrogen technology, which can be used to power mines and processing plants, store renewable energy or produce carbon-free fuel for machines and haul trucks (IRENA, 2022[48]). In some regions like Norrbotten in Sweden, Antofagasta in Chile or Western Australia in Australia, hydrogen is being obtained from renewable sources (hydropower or solar plants) to processing the minerals. For example, in Norrbotten, this technology is being used to process iron pellets and create in turn carbon-free steel (OECD, 2021[11]).

Mining regions experience on average lower anomalies in soil water content

The interdependence between the mining sector with water resources have long been recognized as central issue, with water-related impacts becoming a one of the main source of conflict between the community and mining companies (Kunz, 2020[49]). Unlike many other industries, mining activities have unique interactions with water as mine sites typically span across large geographical areas (under or above ground), with storage dams connected to groundwater and fluxes of water from and within the mine. As mentioned before, mining projects can also interfere with supply of water to other economic activities and local communities.

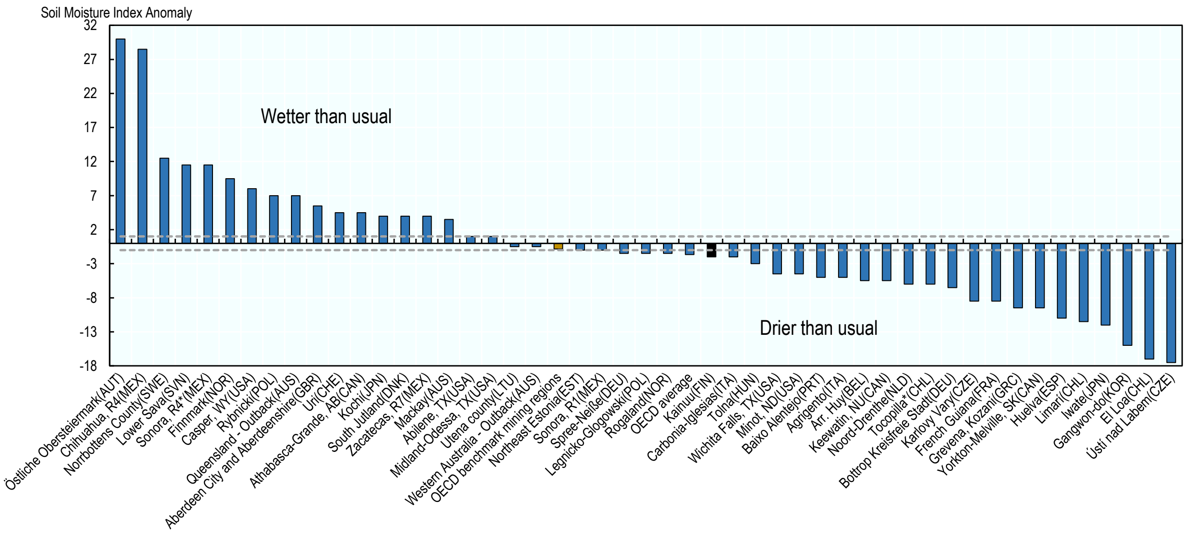
Experiences around the world have demonstrated that managing mining-water interaction can lead to positive outcomes in communities. For example, a mining project in Peru created a positive outcome for communities by treating and reusing otherwise contaminated water as a source of operational water supply for mining companies and communities (Fraser, 2018[50]).

The OECD mining toolkit uses Soil Moisture Anomaly (SMA) to monitor water supply conditions in mining regions. This indicator is used to determine the start and duration of soil drought conditions, which arise when soil moisture (or soil water content) availability to plants drops below a threshold that adversely affects crop yield. The SMA is related to the occurrence of drought since it represents the deviation of the current conditions from the usual status of water availability. In this regard, negative anomalies are usually associated with drought conditions.

OECD mining regions, on average, register lower anomalies in soil water content (-0.8 during 2018-2019) than the average of OECD regions, that registers drier conditions than usual (-1.64) (Figure 1.18). However, this average hides important differences, as an important share of mining regions register drier than usual conditions (53% of mining regions with data). Such drier conditions in soil water content are particularly high in Ústí nad Labem (Czech Republic), El Loa (Chile) and Gangwon (Korea).

Figure 1.18. Anomalies in soil water content in OECD mining regions

Anomaly during 2018-2019 vs average conditions during 1981-2010



Note: Value is considered anomaly in soil water content if it is above 1 (wetter than usual) or below -1 (drier than usual). This interval is represented in the figure by the dotted lines.
Source: OECD Environment database

In sum, environment is an important concern around mining operations. This paper reveals that most mining regions have increased their land share of green land cover and a number of mining regions generate all their electricity from renewable energy sources. Also, OECD mining regions, on average, register lower anomalies in soil water content. However, GHG per capita emissions from mining regions are above the OECD regional and rural average. It is driven mainly by high emissions from the industry and power sector. In fact, most of the OECD mining regions (60%) are in the top 25% of OECD regions with highest GHG emissions per capita from industry, power and transport combined. Efforts in energy transition in some of these mining regions can provide guidance to others with high level of emissions.

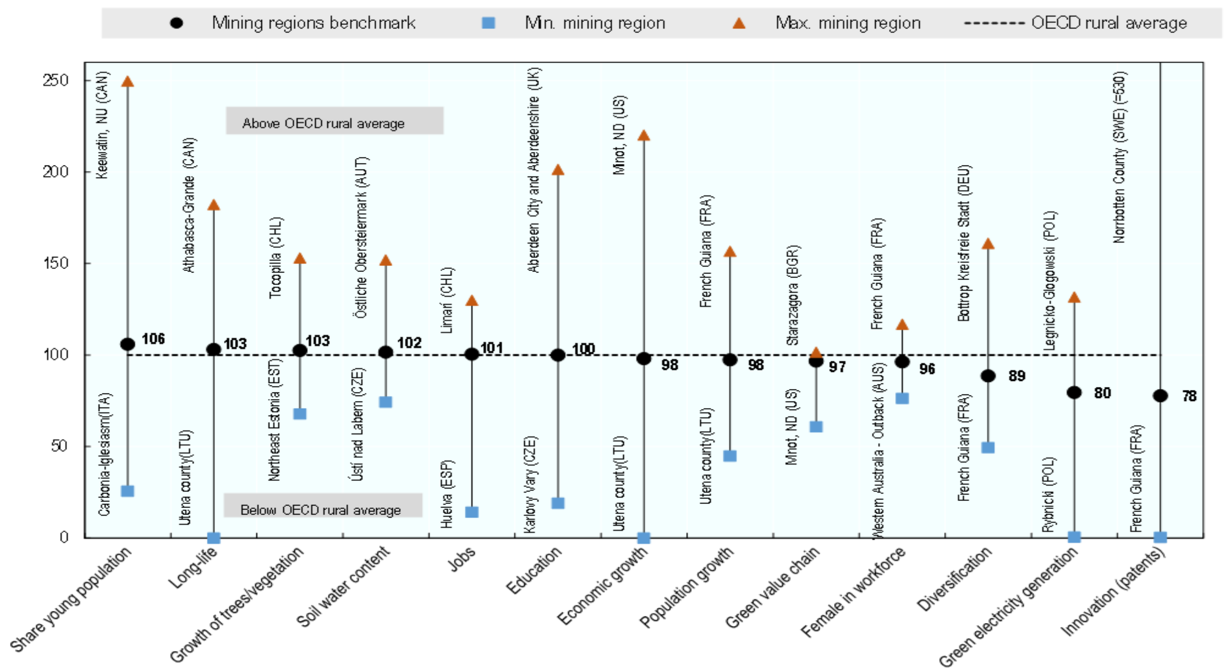
1.5. Mining regions well-being in a nutshell and policy takeaways

The analysis has so far examined 13 indicators of well-being in OECD mining regions relative to OECD rural regions and all OECD TL3 regions. Taking rural regions as the first comparative group, Figure 1.19 depicts the performance of OECD mining regions across the 13 indicators well-being, which reveals a number of trends in mining regions:

- Economic dimension: On average, mining regions have a slightly lower unemployment rate (jobs) than OECD rural regions, but above the average of OECD regions. In contrast, mining regions have a slightly lower level of employment growth (proxy of economic growth in this toolbox) and a low level of economic diversification and innovation, relative to OECD rural regions. Economic weaknesses are amplified when comparing against the OECD regional average.
- Community/social dimension: Mining regions stand out by greater share of young population and lower death rates (proxy of long-life in this toolbox) than OECD rural regions. Conversely, mining regions register lower population growth, share of female participation in the workforce and slightly lower education levels than OECD rural regions average.
- Environmental dimension: Mining regions stand out by greater growth of green land cover (trees/vegetation) and lower risks of droughts from water depletion. In contrast, mining regions generate more CO2 emissions (GHG) across energy, industry and transport sectors (called in the toolbox mining value chain) than OECD rural regions average. Moreover, the GHG produced by electricity (measured as green electricity generation) is higher in mining regions, due to greater use of fossil fuels and coal in this process.

Figure 1.19. Well-being of OECD mining regions benchmark relative to OECD rural average

Normalised index where 100= OECD TL3 rural regional average. Greater value means better performance.



Note: Normalised index is the ratio of the OECD benchmark of mining regions average over the OECD TL3 regional average. The average of each variable is calculated using a Max-Min indicator as follows. $(Xi - Xminoecd)/(Xmaxoecd - Xminoecd) * 10$, where Xi is the variable X for region i, Xminoecd is the minimum value in OECD regions for variable X, Xmaxoecd is the maximum value in OECD regions for variable X.

Improving data availability to measure well-being at this regional level remains an important action to inform policymaking. Granular and comparable date on indicators like productivity, local procurement, start-ups' creation and Indigenous peoples-related indicators (e.g. Indigenous firms linked to mining) can complement this initial list of indicators to better monitor and plan actions for an increased well-being in mining regions.

There is scattered data of some indicators that can lead to relevant comparisons. For example, Annex 1.B explores the effect of including indicators of regional income and productivity in the set of well-being indicators, subject to data availability. As supported by the literature, it reveals that mining regions register greater labour productivity and GDP per capita than both OECD regional average and OECD rural average (Figure 1.B.3). In fact, when including these variables, labour productivity and GDP per capita rank as the first and third variables where mining regions depict the higher level of relative well-being.

1.5.1. From data to policy practices

This analysis emphasises that mining regions are heterogeneous in their stages of the different dimensions of well-being. While the average of mining regions underperform in some indicators like innovation or GHG emissions from electricity generation, some mining regions are in fact top performers across OECD rural regions in different well-being variables. For example, Norrbotten (Sweden) in Innovation and GHG emissions, Tocopilla (Chile) in growth of green land cover, Alberta (Canada) in education levels, Keewatin (Canada) and French Guiana (France) in terms of share of children population or Minot, US in employment growth.

Environmental effects from mining are increasingly important for policy action. Across OECD countries, mining and extractive activities are regulated closely to reduce environmental risks and impacts such as the erosion of soil, sinkholes, and the contamination of soil and water. An essential aspect to prevent environmental damage should be a further development of Environmental Impact Assessments (EIA) to identify potential effects and damages caused by specific projects and help to foresee costs, losses and consequences. Improving valuation of environmental preservation, ecosystem services and life quality aspects will help governments and companies better integrate and anticipate the environmental effects from mining ventures.

Some OECD mining regions are increasing the strategies to protect the environment, highlighting the need to do it in partnership with private sector and communities. They include greater focus on more efficient use of resources (using less water, power and land), starting remediation processes alongside mining operations and reusing and recycling resources and minerals. Meaningful initiatives to prevent, mitigate and offset impacts on the environment should cover the entire life cycle of a mine – from exploration to post-mine rehabilitation (World Economic Forum, 2016[46]) (Wold Economic Forum, 2015[51]) (Carvalho, 2017[52]).

Table 1.4 identifies an initial set of policy takeaways that come from the analysis undertaken in this paper and the lessons from previous OECD case studies on mining regions. A more detailed explanation of good practices across mining regions would be part of an additional paper.

Table 1.4. Initial policy takeaways to improve well-being in OECD Mining Regions

Dimension	Challenge	Practices from mining regions (selected)
Community	**Women**: are not fully integrated in the labour force in mining regions	• Adopting new technologies to increase the share of female in mining value chain. Mining automation in Norrbotten has driven to higher participation of female and youth in the mining industry. • Ensuring that mining codes and laws do not discriminate against women and are inclusive of everyone. It needs strategies to uncover gender roles, division of labour, and main discrimination patterns via a gender analysis. The Gender Canada's Gender-based Analysis Plus is a good example. • Institutional capacities on gender equality and mining governance. Gender-equality trainings can be implemented at broader scales involving local and national staff. • Leading by example by recruiting retaining, and promoting women in mining-related positions
	Population growth: Mining regions have gained population over the last 15 years, but less than both OECD rural and regional average**.**	• Ensuring provision of childcare and public amenities and gathering areas for families and children (e.g. parks, cultural events for families and networks of families). • Adopting active migration policies to bring complementary skills into the labour market • Targeted start-up support programmes as well as on-site and online education opportunities.
	Delivery of public services-education and health. Education attainment is lower in mining regions, than in the average of OECD rural regions. A partial explanation is the fact that mining companies attract people with secondary studies or none with relatively higher salaries than other local economic activities.	• Promoting partnerships between companies and universities to enhance local training and education. It can be in the form of new research programmes to improve knowledge on environmentally sustainable mining value chain (e.g. Holcim Chair for Sustainable Construction project in Andalucía, Spain). • Collaborating with mining companies to ensure that private investments can complement gaps on education and health provision, for example focusing on infrastructure or attraction of skilled education and health professional. This should promote better complementarities among ESG investments or community benefit sharing agreements with public policies.
	Sharing benefits with local and Indigenous communities. A global business operating locally might lead to communities perceiving few benefits from hosting mining activity.	• Evaluating the functioning and acceptance of monetary benefit-sharing mechanisms including investment funds, equity-sharing and tax-sharing mechanisms between regional and national governments • Promoting local content policies to increase use of local products and workforce into mining operations.. • Promoting formation of companies by local and Indigenous communities or allowing participation of these communities in mining ventures. In The Northwest Territories (Canada), the Det'on Cho – Nahanni Construction Co, an Indigenous-own company, was chosen to lead a project of rare earth minerals
Economic	**Diversification:** Mining regions are less diversified than other OECD regional economies**.**	• Activating support programmes for entrepreneurs and start-ups to diversify in activities linked to mining. For example, new business to support the decarbonisation of the mining value chain or circular economy (e.g Outokumpu, Finland and Norrbotten, Sweden) • Incentive public-private programmes for internationalisation and digitalisation of SMEs and local mining suppliers (e.g. Antofagasta, Chile) • Formalising networking policies between mining companies and local business to generate development spill overs.
	Jobs. Unemployment rates are similar to those of rural areas in the OECD. Yet some regions still face high levels of unemployment, due to mismatch of skills with industry needs or low labor demand outside mining activities.	• Adopting the diversification strategies stated above to increase job offer. • Greater capacity building and training to local communities. • Adapting academic curriculum to local needs • Promoting internship programmes since secondary school.

	Innovation. Some mining regions are frontrunners in creating new technologies for mining, that area scalable for other industries (hydrogen), while others are still lagging behind. Overall innovation outside mining activities in these communities seems challenging	• Promoting the patents of mining companies be register or allocated to the region. • Bringing together universities, companies, and the public sector in mining regions to work on industry-demanded projects. • Integrating local suppliers and SMEs in innovation processes (Antofagasta, Chile)
Environmental	**Greenhouse gas emissions:** Mining regions emit in average more greenhouse gases than non-mining regions, mainly because the emissions in industrial sector.	• Incentivising technological development focused on reducing CO2 emissions in mining. It can be done by easing regulations for technological frontrunners to support the transition towards more environmentally sustainable mining process • Adopting joint environmental strategies with local suppliers and governments to decarbonise the supply chain. • Improving data on geological potential of existing mines or location of tailings (waste mining) • Facilitating permit processes for projects on mining tailings.
	Green land cover and mining restoration. The change in land use, especially green land cover is slightly positive in mining regions. This reveals the potential of policies to promote recovery of mining sites...	• Setting clear guidelines on restoration and land recovery since the beginning of the operation. • Adopting standardised methods of dialogue with the community to socialise mining effects on land cover and restoration strategies**.**
	Water: mining makes an important use of water for its activity, which can lead to environmental impacts such as scarcity and pollution. While soil water depletion in mining regions does not stand out as a major risk vis-à-vis other regions, it is an important issue.	• Supporting innovation to make use of fewer natural resources is essential for a better coexistence between an extractive activity and the environment

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Annex 1.A. Countries in OECD mining benchmark

Annex Table 1.A.1.shows the OECD countries selected to be part of this OECD mining benchmark, ranked by their share of mining employment relative to the total OECD mining employment.

Annex Table 1.A.2. Selected countries in the OECD mining benchmark.

Country	Share of mining employment across OECD, 2021	Number of regions in the group of 50 mining regions
United States	25.0%	5
Mexico	17.9%	4
Chile	13.0%	3
Australia	10.5%	3
Canada	8.8%	3
Poland	6.0%	2
Norway	2.4%	2
Germany	2.4%	2
United Kingdom	2.2%	2
Romania*	2.0%	1
Czech Republic	1.1%	2
Italy	0.9%	2
Spain	0.9%	1
Bulgaria*	0.9%	1
Japan	0.7%	2
Korea	0.6%	1
France	0.6%	1
Sweden	0.4%	1
Portugal	0.4%	1
Netherlands	0.4%	1
Austria	0.3%	1
Finland	0.3%	1
Greece	0.2%	1
Switzerland	0.2%	1
Denmark	0.2%	1
Estonia	0.2%	1
Hungary	0.2%	1
Lithuania	0.1%	1
Belgium	0.1%	1
Slovenia	0.1%	1

Note:*Romania and Bulgaria are not OECD countries, but partners in OECD regional programmes. Other OECD countries (e.g. Colombia or Israel or Türkiye) were not included due to lack of data at TL3 regional level.
Source: OECD (2022), OECD Regional Statistics (database), OECD, Paris http://dx.doi.org/10.1787/region-data-en.

Annex 1.B. Analysis of different comparisons and variables for mining regions well-being

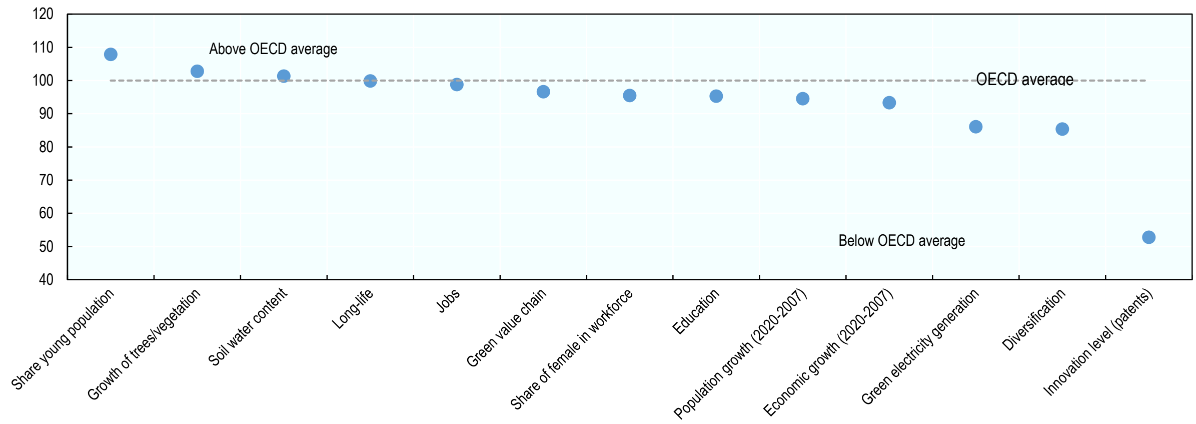
Well-being of OECD mining regions benchmark relative OECD regional average

The relative well-being of OECD mining regions vis-à-vis OECD regional average do not change much compared to the one made with OECD rural average (Figure1.19). When comparing against OECD TL3 regional average, mining regions present greater gaps in innovation, diversification, economic growth and population growth (Figure 1.B.1). All these gaps are substantially reduced when comparing against OECD rural regions, yet still stand out as relative challenges for mining regions. Instead, the biggest difference is that the death and unemployment rates shifted from being a relative advantage for mining regions in comparison to OECD rural regions, to a challenge when comparing to OECD regional average.

When comparing to OECD regional average, the overall picture of mining regions across the three dimensions of well-being reflects a greater gap in economic dimension (driven by innovation) (Figure 1.B.2)

Annex Figure 1.B.1. Well-being of OECD benchmark of mining regions relative to OECD regional average

Normalised index where 100= OECD TL3 regional average



Note: Normalised index is the ratio of the OECD benchmark of mining regions average over the OECD TL3 regional average.
Source: Authors calculation

Including income and productivity variables in the pool of well-being indicators

Labour productivity (regional GDP per worker) and income (measured as GDP per capita) are variables with important missing values at TL3 regional level for major OECD mining countries (Australia, Canada, Chile, Mexico). For these countries, these variables are only available at the TL2 regional level, which by definition cover a lager territory and greater variety of economic activities. Therefore, these variables were not included in the toolkit of indicators to measure mining regions well-being, but further work on data collection at TL3 regional level could help include them in the future.

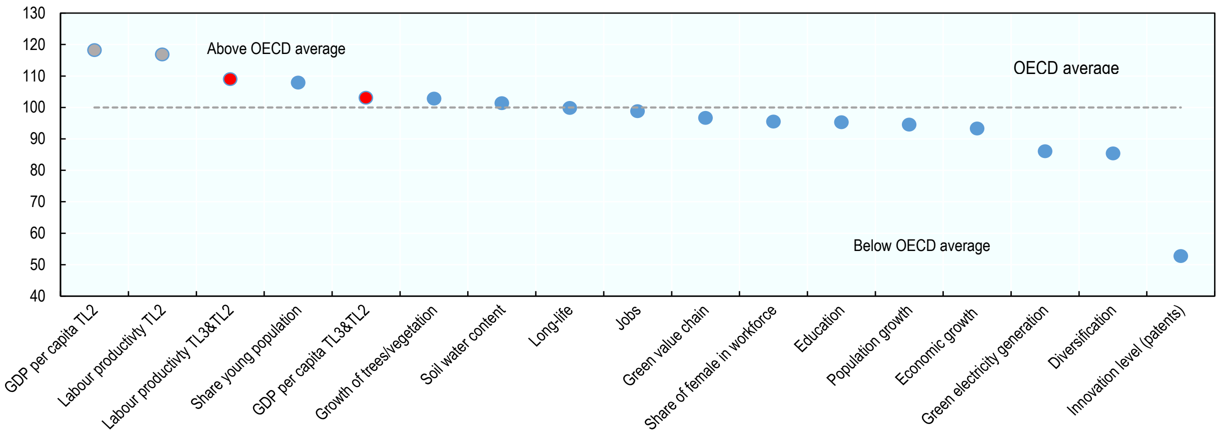
This sub-section depicts the outcome of including those variables in the analysis of mining well-being. Two possible measures are done to describe the average trends of mining regions in these indicators.

- First, the average labour productivity and GDP per capita of mining regions is calculated using TL2 level data for regions from Australia, Canada, Mexico and Chile and TL3 level data for the rest of mining regions. With this average, mining regions register greater labour productivity and GDP per capita than the OECD regional average (Figure 1.B.3). In fact, labour productivity and GDP per capita rank as the first and third variables where mining regions depict the higher level of relative well-being.
- A second possible approach to measure the average labour productivity and GDP per capita of mining regions is calculated using regional data at TL2 level for all regions. With this average, mining regions register a much greater labour productivity and GDP per capita than the OECD regional average (Figure 1.B.3).

Overall, irrespective of the approach, the 50 OECD mining regions rank in average high in labour productivity and GDP per capita relative to OECD regional average.

Annex Figure 1.B.2. Well-being of OECD mining regions benchmark relative to OECD regional average, with indicators of labour productivity and GDP per capita.

Normalised index where 100= OECD TL3 regional average



Note: Normalised index is the ratio of the OECD benchmark of mining regions average over the OECD TL3 regional average. Red coloured points refer to the average of labour productivity and GDP per capita of mining regions based on TL2 level data for regions from Australia, Canada, Mexico and Chile and TL3 level data for the rest of mining regions. Grey coloured points refer to the average of labour productivity and GDP per capita of mining regions using regional data at TL2 level.