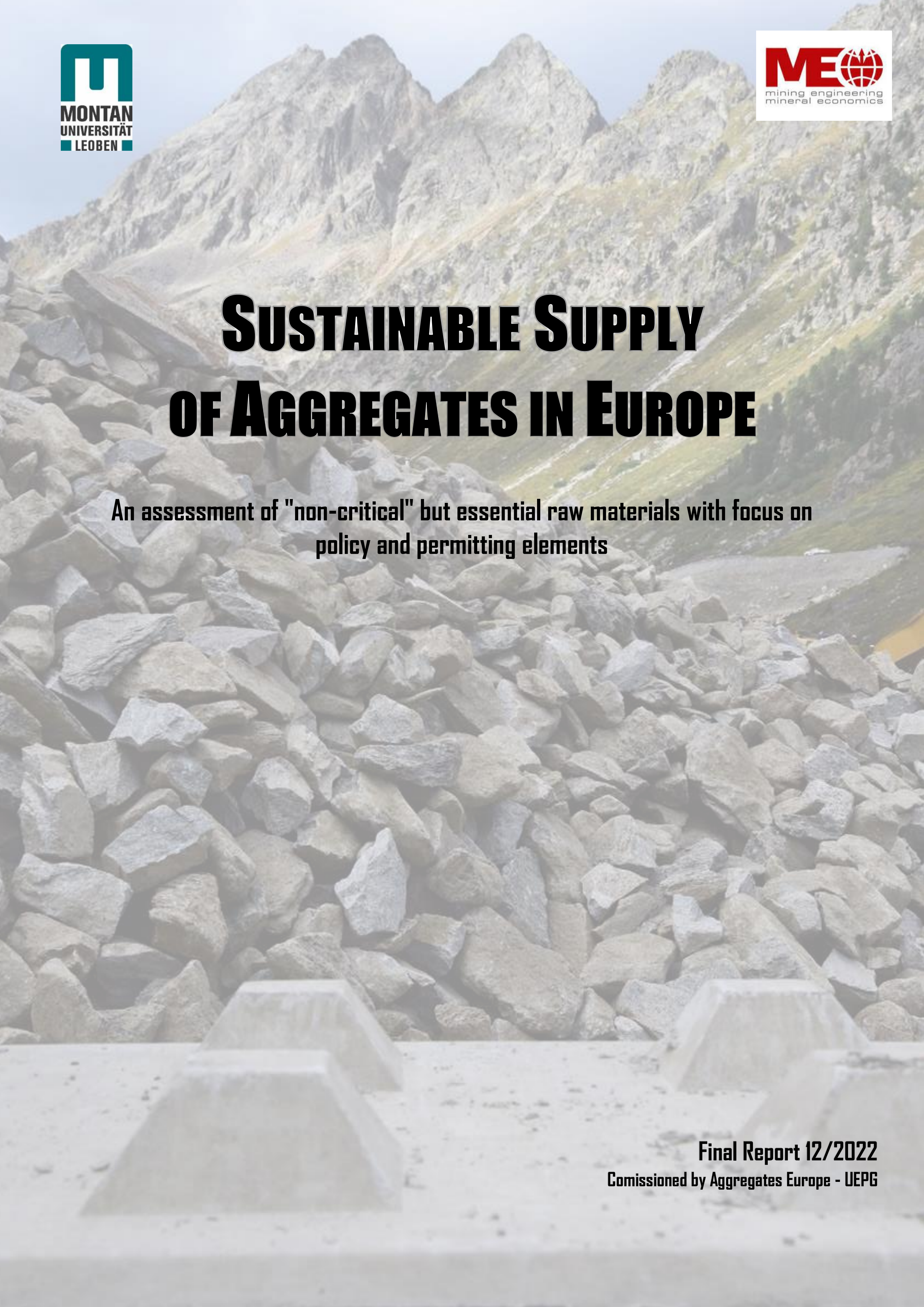

MONTAN UNIVERSITÄT LEOBEN

MEM
mining engineering
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Sustainable Supply of Aggregates in Europe

An assessment of "non-critical" but essential raw materials with focus on policy and permitting elements

Final Report 12/2022

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Impressum

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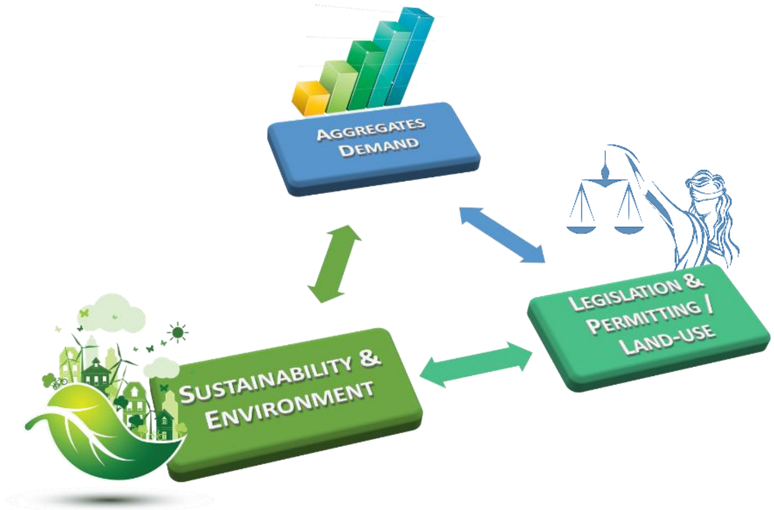
EXECUTIVE SUMMARY

Based on the study from 2010: *"Planning Policies and Permitting Procedures to Ensure the Sustainable Supply of Aggregates in Europe"* [1], Aggregates Europe - UEPG, at the end of 2021 commissioned an update and extension of the study.
Although **planning and permitting** is still a focus, this update has been expanded to include a number of new topics related to **sustainability**, and, in addition to "**facts & and figures**", includes results from academia and recent European projects, that are relevant for the European aggregates industry in the context of the subjects discussed in this study.



The European aggregates sector is the **largest part of the non-energy extractive industry** in the EU, with over **3 billion tonnes** produced every year, of which about 10% are from recycled sources. These mineral resources are a vital input to the economy and are recognised as being strategically important in the provision of buildings and infrastructure, supporting economic expansion and the needs of growing national populations.

Societal intensions concerning a wide range of issues ranging from **climate change, the Green Deal and a circular economy** all the way to increased demands for security and defence, have found their way into European legislation in the last decade. In order to fullfill these intensions and requirements, there will be **increasing demand for aggregates** (and other mineral raw materials) and they will have to play a **crucial role in the transformations** needed, as otherwise these will not be feasible.

A number of actions are needed in order to make the intensions of European society and policy makers, as cummulated in the Green Deal, a reality on the ground over the next decades.

European policymakers need to ensure that we **keep the high level of European independence** in aggregates supply. But this means that they should not be seen "as a given" by policy makers at all levels, as otherwise we might end up in a situation where they do become critical, as defined in the context of the European Commission's regular criticality assessments, as well.

This includes the national and regional level, where the recommentations from the first study in 2010 still stand. **Strategic, long-term, and clear raw material strategies and plans** need to be developed that include aggregates supply and demand scenarios given their geographic market limitations and have these requirements included / considered in land use and spatial planning in order to **safeguard future deposits** from potential sterilisation through other land uses. It also includes the **implementation of European directives**, such as the Water Framework Directive or the Birds and the Habitats Directives into national law, where **significant differences exist in their implementation**, including requirements beyond the intentions of the European directives.

Yet, **land use planning and permitting systems have not yet changed accordingly** and not much has changed in the **permitting systems** of the European countries since the original study was undertaken over a decade ago. **Hence, there is still a requirement for these national or even regional systems to consider European intensions and requirements and to make the systems more efficient and timelier**.

Industry, on the other hand, needs to **continue its drive towards sustainable operations**, considering more stringent sustainability conditions, as for example described in the SUMEX sustainability framework. Focus areas should be **carbon neutrality**, **low water (quality and quantity) impacts**, significant **reductions in dust emissions**, **low impact transport solutions** and a continued push for a **positive impact on biodiversity** (which is also a big opportunity regarding land use). This means that **commitments need to be delivered upon** by all operational sites as this will be crucial to achieve continued social acceptance (SLO) and will help support access to new deposits, i.e. deposits in Natura 2000 areas. This implies also **best in class rehabilitation and site closure**. The development of the rehabilitation requirements will involve local residents and consider regional development plans, the trends specified in the spatial plans and biodiversity considerations.

Both the **involvement of direct stakeholders**, such as academia, industry and civil society organisations (e.g. environmental NGOs), as well as the **public** are of vital importance to a good governance approach of aggregates resources. Stakeholder mechanisms at all levels can be a way to increase public acceptance and establish a sense of 'ownership', but it can also be an opportunity to create legitimacy or include expertise from e.g. academia and industry.

Societal expectations on and public perceptions of the extractive industry have changed significantly in recent decades. Sustainable operations and engagement of society will be crucial for the sector going forward in order to continue achieving SLO and therefore being able to run operations smoothly and to get access to the new deposits required for delivering the Green Deal. Another crucial part of this puzzle is **transparency**, i.e. the **collection and publication of environmental and social performance data**. Gapless data collection, in all areas discussed in this study and well beyond current mainly socio-economic data, as far as possible based on common definitions and methodologies, and the publication of this data should be considered as an opportunity and is also indispensable for achieving SLO and the continued access to new deposits.

1. INTRODUCTION TO AGGREGATES

The consumption of aggregates (sand, gravel and crushed stone) has tripled in the last two decades and is now (2022) estimated at around 50 billion tonnes per year, and demand worldwide is growing exponentially with increasing urbanisation, development, population growth but also with rising sea levels. Aggregates are thus the second most used resource in the world, right after water. [2]

Aggregates Europe - UEPG defines aggregates as *granular materials used in construction. They are sand, gravel (including marine aggregates), crushed rock, recycled and manufactured aggregates.*
Primary aggregates are produced from natural sources, extracted from quarries, sand & gravel extraction sites, and in some countries, sea and/or lakes dredged.
Secondary aggregates include recycled and re-used aggregates. Recycled aggregates are reprocessed materials previously used in construction. Manufactured aggregates are usually by-products of other industrial processes such as blast or electric furnace slags or china clay residues.

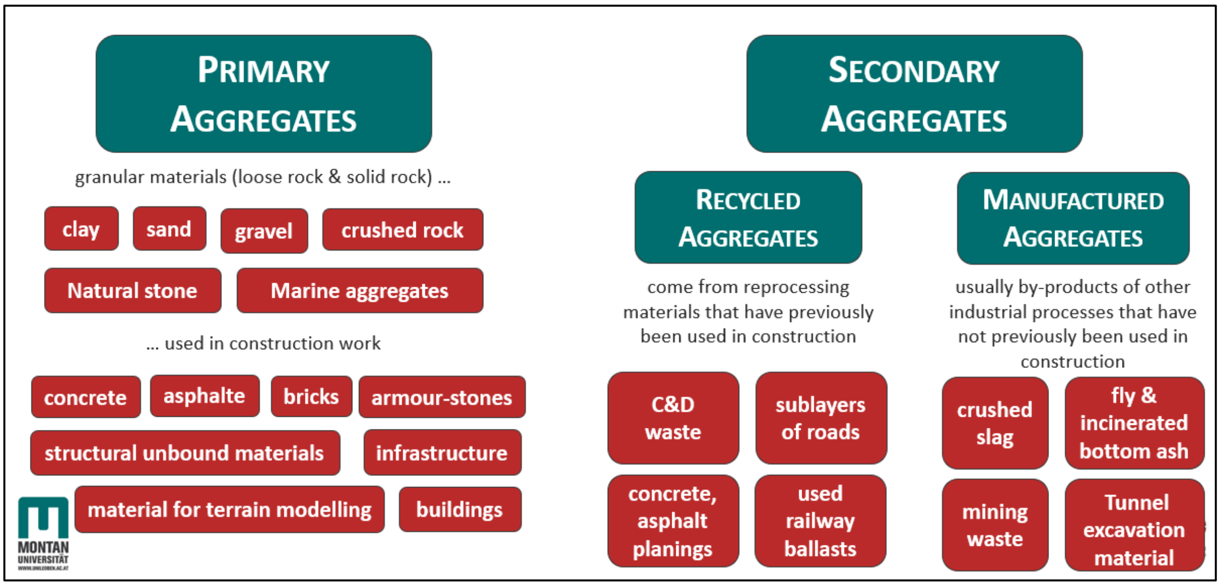


Figure 1 - Classification of aggregates (Source: own illustration)

Aggregates are the most commonly used construction minerals. They are widely used, are a low-cost product and are used and needed in very large quantities. They are essential for our society, especially for the construction and maintenance of buildings and infrastructure.

Recycled aggregates are increasingly becoming an important source of aggregates. For example, they can come from the demolition or deconstruction of buildings and structures or from civil engineering works. Other sources of recycled aggregates include asphalt planings from road resurfacing and railway ballast. The process of 'recycling' removes unwanted materials such as wood, plastic or metal, and processes them through crushing and screening so that the aggregates can be reused, but often for less demanding applications. Once a material originally labelled as waste is processed into a saleable product, it becomes a resource and is no longer "waste". However, when and where in the recycling chain this transition happens is not always clearly regulated by law. [3]

Even if aggregates do not belong to the so called critical raw materials in Europe at the moment, a sustainable extraction and handling of aggregates is essential to avoid a future scarcity of resources. This requires the careful testing of aggregates for the particular application as well as the extraction of aggregates from alternative sources. Not only the European Green Deal, but also climate change will lead to an increased demand for aggregates and construction raw materials. [4]

Aggregate companies are used to taking a long-term perspective. They have to secure the supply of aggregates and obtain permits, which takes years on average. Market prices and their development are an important driver for the supply of sand, gravel and rock.
The European Environment Agency talks of inelastic supply and demand in Europe and lists the following factors:

- Since it normally takes years to bring new aggregates capacity on-stream, the short-run supply is relatively inelastic and prices remain stable.
- Once capacity is in place and fixed costs have been incurred, producers are disinclined to lower production as long as some contribution is being made towards overhead costs.
- Since aggregates are low-cost, high-volume products, the economic supply radius of a quarry is very limited. Companies are very transport-sensitive, with transport costs in the extraction sector accounting for about 13 % of total costs. Therefore, it is simply uneconomical to transport the material further than about 50 kilometres (obviously always depending on the price of diesel). [5]

This view is not shared by all producers, as it does for instance not consider their long-term price expectations. Prospects of permitted reserve shortages for some sources of aggregates (as it is the case for land-based sand & gravel in the UK) could incentivise companies to hold onto their resources in the ground.

The economic success of aggregate extraction is mainly influenced by two factors: On the one hand, the quality (deposit and downstream industry) and quantity of the deposits and, on the other hand, the political, legal, administrative, social and economic environment in which the extraction takes place. The location of sites naturally is determined primarily by geology conditions but also by centres of high demand (large cities, large construction sites, etc.). [6]

One topic that, apart from a few examples, has so far received little attention, is the extraction of aggregates from mining waste or the recovery of aggregates as a by-product in the extraction of other primary raw materials, such as ores.
Mining waste is the largest waste stream on the planet, estimated at 30 to 60 billion tonnes of mining waste generated each year, an order of magnitude higher than all municipal waste combined. The biggest challenges in mining residues recycling are:

1) technical and economic competitiveness with conventional materials
2) as well as their processing to achieve certain properties, since they are residues and not by-products.

A new field of research is the processing of so-called ore sands, which has its origin in the increasing value of sand and the storage costs of mining residues. Research is being conducted primarily on optimising the processing cycles, which gives new impulses to the circular economy and makes an important contribution to sustainable development. [2]

2. BACKGROUND & SCOPE OF THIS STUDY

Based on the Leoben study from 2010: *"Planning Policies and Permitting Procedures to Ensure the Sustainable Supply of Aggregates in Europe"* [1], Aggregates Europe - UEPG, at the end of 2021 commissioned an update and an extension of the study.

Although planning and permitting is still a focus, this update has been expanded to include a number of new topics related to sustainability, and in addition to "facts & and figures" includes results from academia and recent European projects, that are relevant for the European aggregates industry in the context of the subjects discussed in this study.

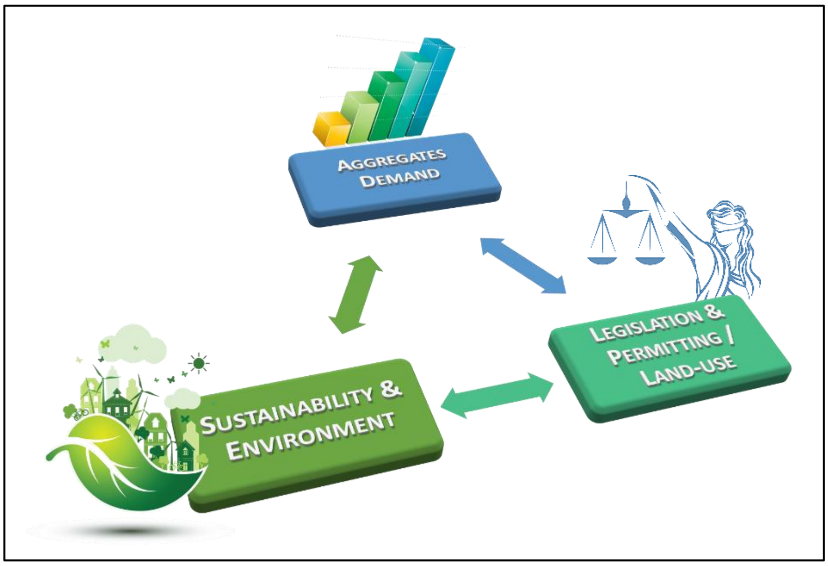


Figure 2 - Focus areas of this study (Source: own illustration)

The structure of this study is as follows:

Chapter 3 presents production and consumption data and is based almost exclusively on figures, data and facts collected by Aggregates Europe - UEPG and provided for this study.
Chapter 4 deals with the topic of material stocks, the lifetime of buildings and infrastructure as well as the aggregates bound in them, as well as reserves and resources as shown in Appendix A for the individual European countries.
Chapter 5 deals with the Secondary Aggregate Section and it's sub categories "recycled aggregates" and "manufactured aggregates", where the issue of *tunnel excavation material* and *mining waste* is also addressed briefly. In Appendix B the individual country profiles and information are documented.
Chapter 6 looks into the wide-ranging issue of raw materials extraction and it's ecological and societal impacts. Focus is set on the issues *transport, biodiversity, water and society*, because raw materials extraction, especially in the field of aggregates, affects many people in their neighbourhood and so quarries are not only "wounds in nature" but also local employer as well as habitat for many species. In Appendix C best practice examples from selected countries are presented.

Chapter 7 deals with the very differently regulated topic of land-use planning, the challenges of protected and competing land-use areas but also the chances of this instrument for raw material protection. Appendix D shows the situation in some selected countries as examples.
Chapter 8 presents planning policies and (mostly) updated results from the MINLAND and MINGUIDE projects, with country-specific results shown in Appendix E.
Chapter 9 deals with permitting systems and the (mostly) updated results from the MINLEX project, with country-specific results in Appendix F.

At the end, Future Trends and Recommondations round off this study.

Methodology

A literature study was carried out on the individual topic areas. In addition, a questionnaire covering all these topics was sent out to the individual Aggregates Europe - UEPG country members and equivalent organisations (EU27+UK+Norway+Switzerland) in order to get detailed, country level information. With some of them -additional online interviews were held. Most of the information and data in *Chapter 3* was provided by Aggregates Europe - UEPG.

Figure 3 UEPG (Aggregates Europe) Members (Source: Aggregates Europe - UEPG 2021)

3. PRODUCTION & CONSUMPTION

Aggregates like sand, gravel and rock are relevant in terms of their contribution to economic and societal progress but also the impact they have on the environment. The European aggregates industry is the largest part of the non-energy extractive sector in the EU, with 3 billion tonnes produced every year (*Figure 4)*. These resources are a vital input to the economy and are recognised as being strategically important in the provision of buildings and infrastructure, supporting economic expansion and the needs of growing national populations.

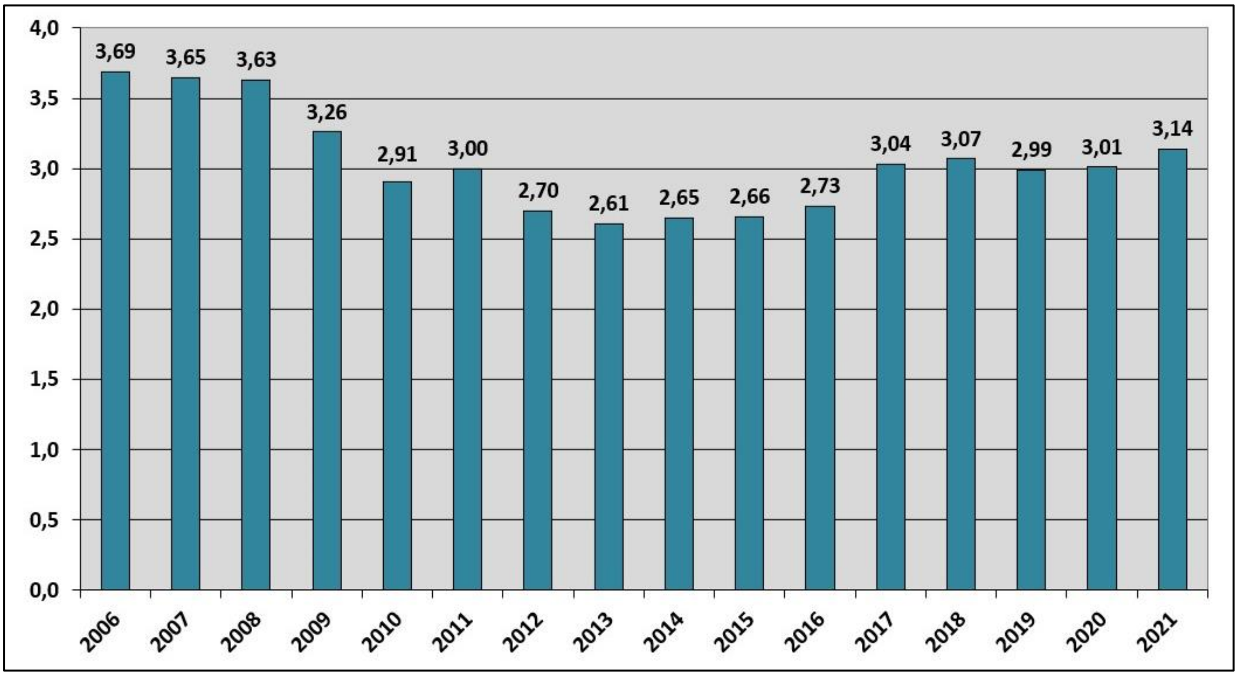
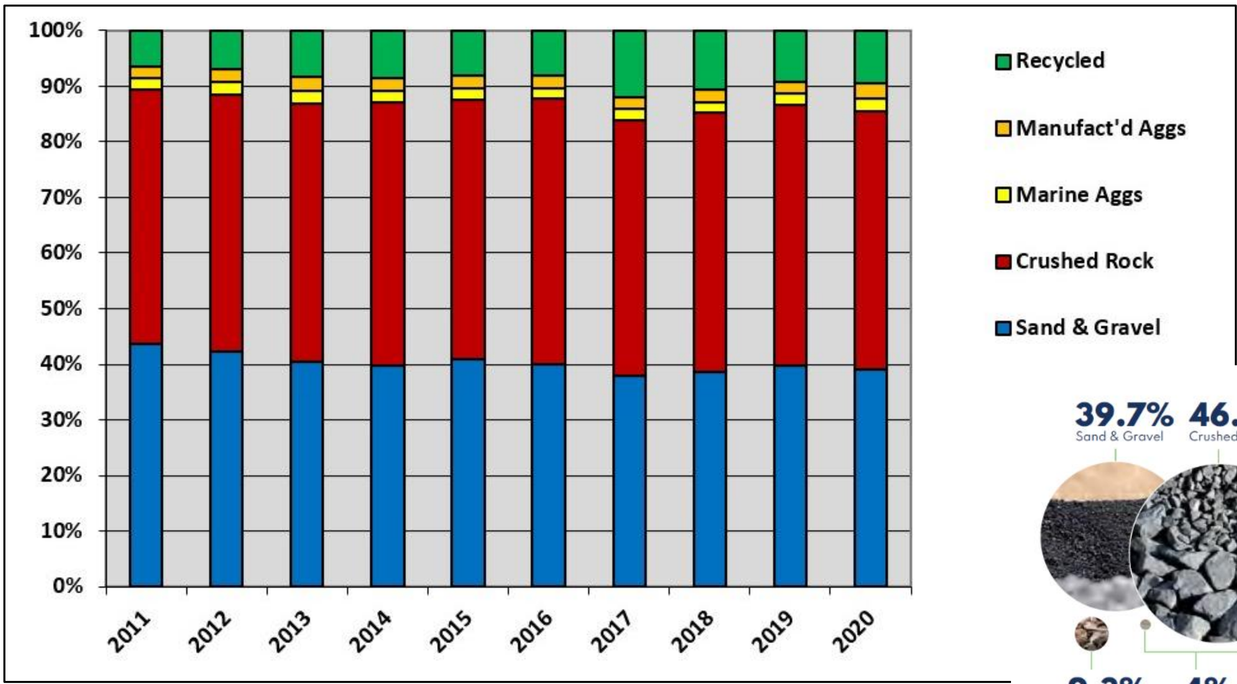


Figure 4 - Trend in production in billion tons [Bnt] per year (EU27+UK+EFTA)
(Source: Aggregates Europe UEPG 2022)

Figure 5 shows the split in terms of type, with crushed rock being the largest portion (45%) followed by sand & gravel (40%). The aggregates industry consists of more than 15 000 companies (*Figure 6*) with 26 000 extraction sites across Europe, and a majority of operators in the sector are small- and medium-sized enterprises.



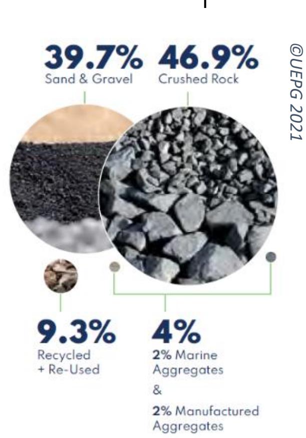


Figure 5 - Trend in aggregates Type in [%] from total production (EU27+UK+EFTA) (Source: Aggregates Europe - UEPG 2022)

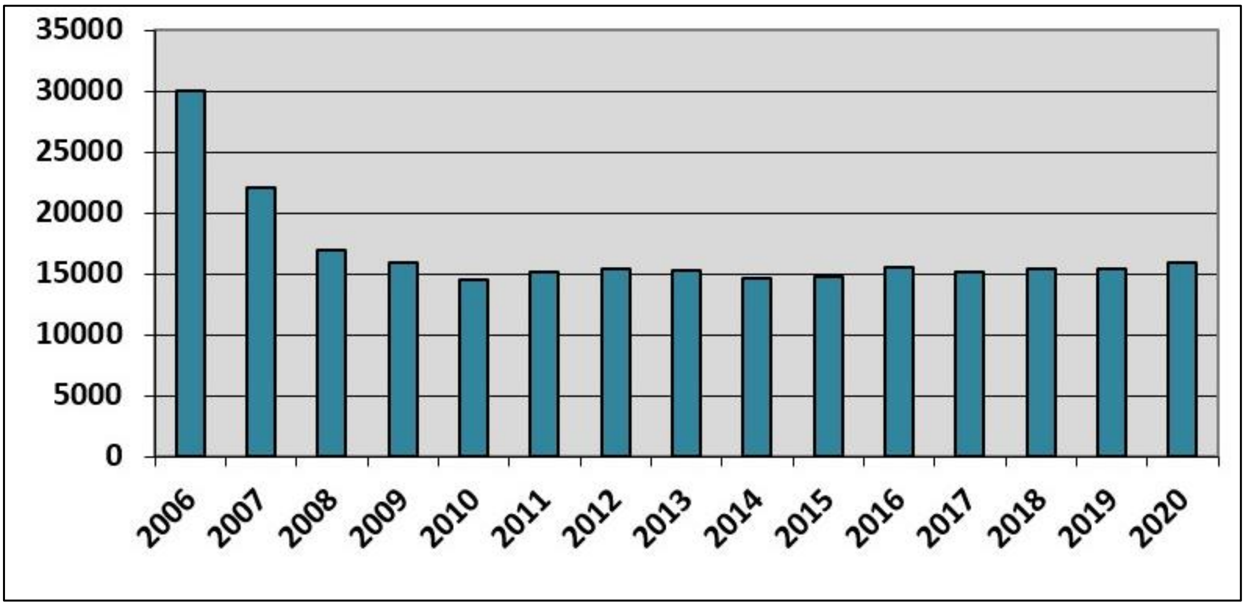


Figure 6 - Number of Companies (EU27+UK+EFTA) (Source: Aggregates Europe - UEPG 2022)

Almost 187 000 people are employed in the mineral aggregate sector in the EU *(Figure 7),* which means a significant reduction in the last 15 years in response to the Global Finanical Crisis, with numbers having stabilised for the last 10 years. It is worth mentioning, that these numbers do of cause not yet include the impact of Covid 19 and of Russia's invasion of Ukraine.

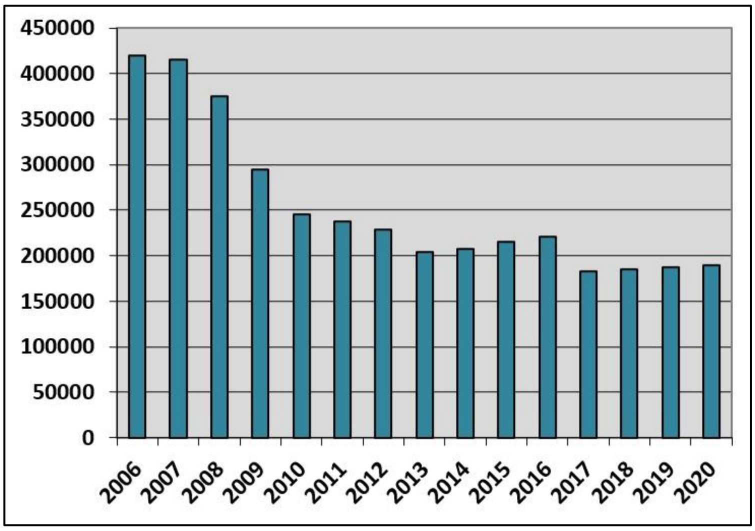


Figure 7 - Trend of employees + contractors (EU27+UK+EFTA)
(Source: Aggregates Europe - UEPG 2022)

The average annual aggregates production represents 6 tonnes per EU citizen. [7] The consumption varies considerably between countries (*Figure 8 and Figure 9*), with northern countries overall showing higher figures than southern ones. [4]

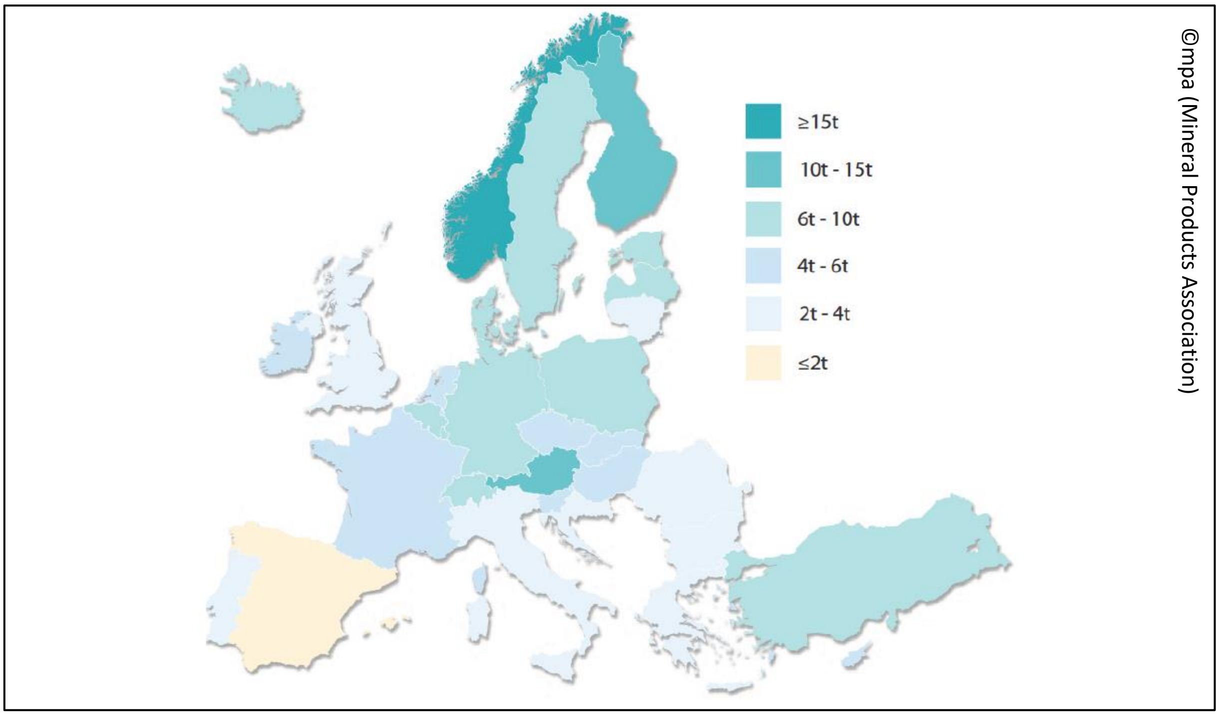


Figure 8 - Annual aggregate consumption per capita in European countries (2016)

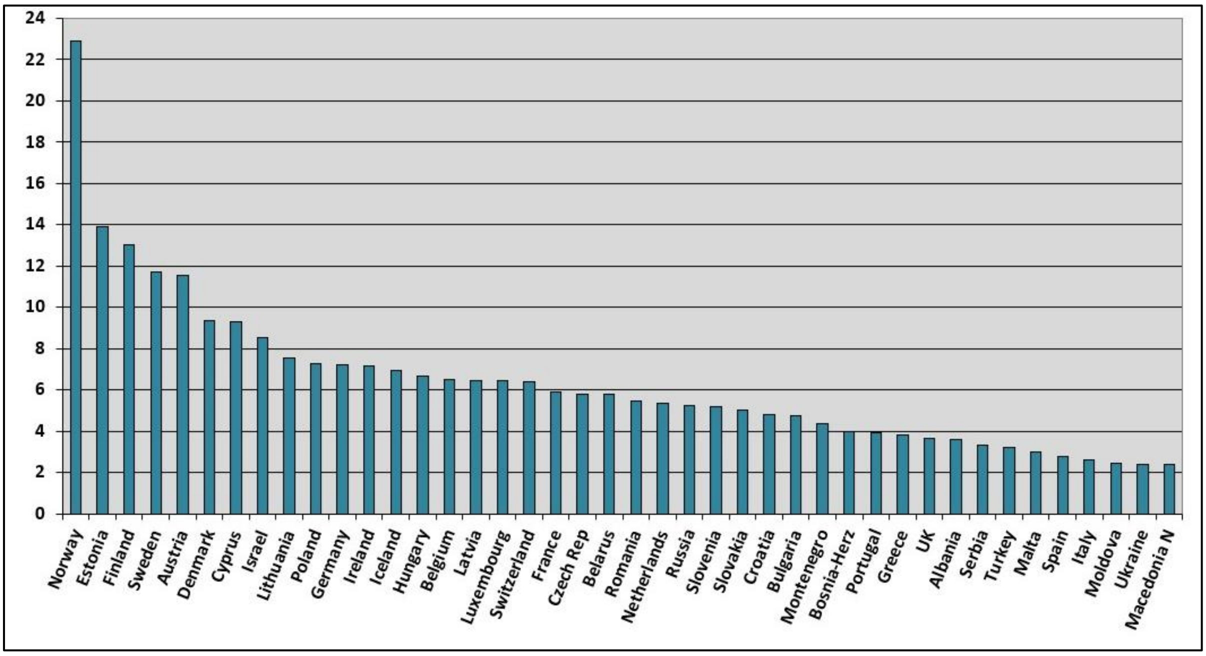


Figure 9 - National Production in tonnes per capita (2020) (Source: Aggregates Europe - UEPG 2022)

The following figures (*Figure 10 - Figure 13*) show the lastest available (2020) production figures and production trends and predictions at the country level.

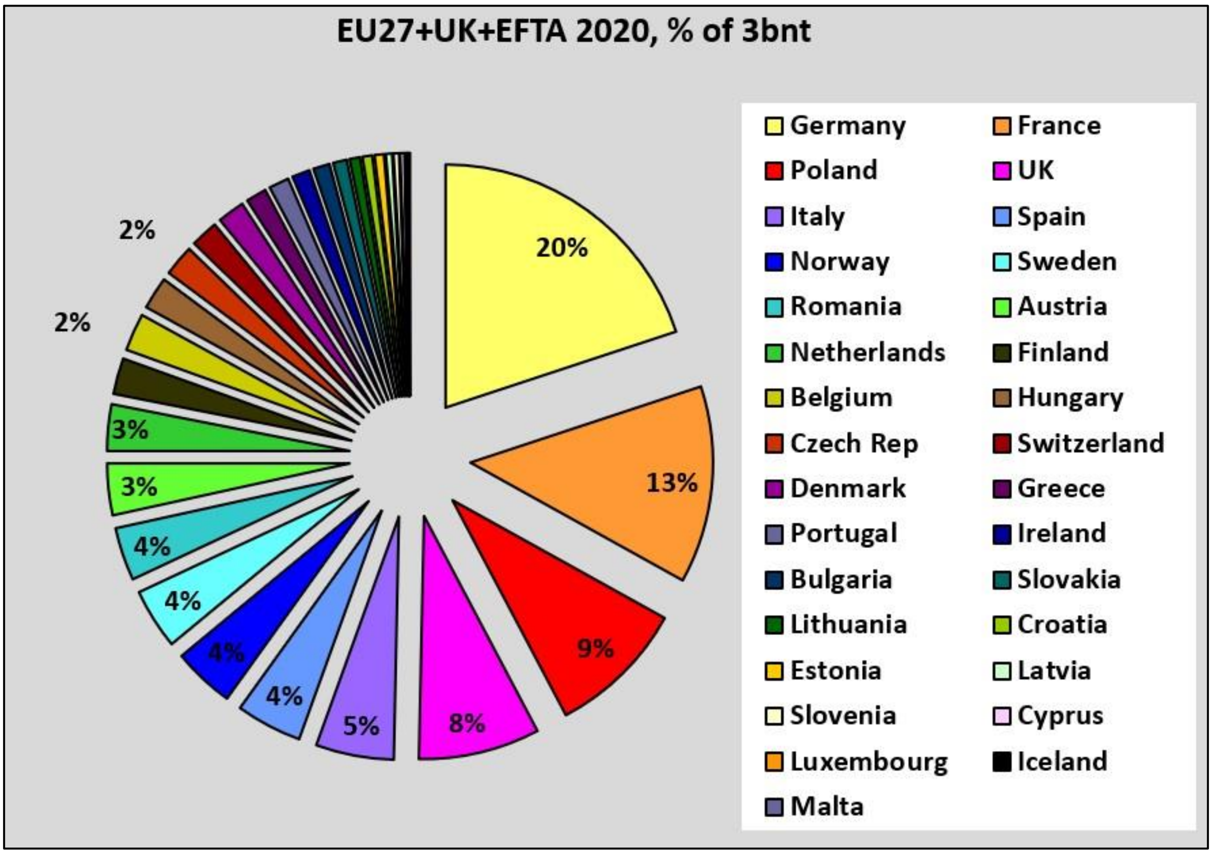


Figure 10 - Aggregates production 2020 in [%] of 3 Bnt total production] (EU27+UK+EFTA)
(Source: Aggregates Europe - UEPG 2021)

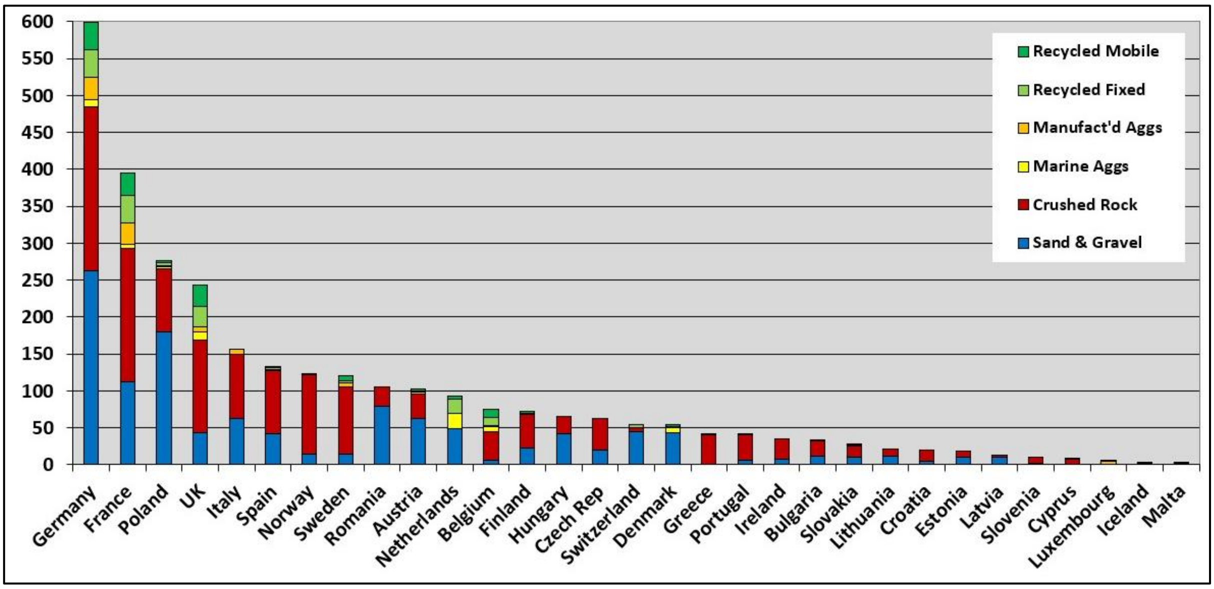


Figure 11 - Total production (2020) in million tons [mt] (EU27+UK+EFTA)
(Source: Aggregates Europe - UEPG 2022)

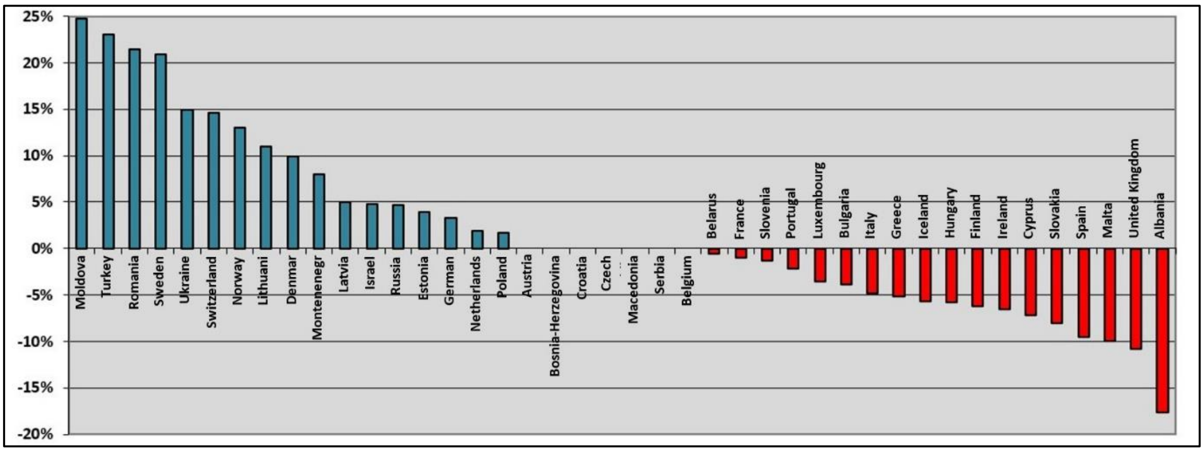


Figure 12 - Production Trends 2020 vs 2019 (Source: Aggregates Europe - UEPG 2022)

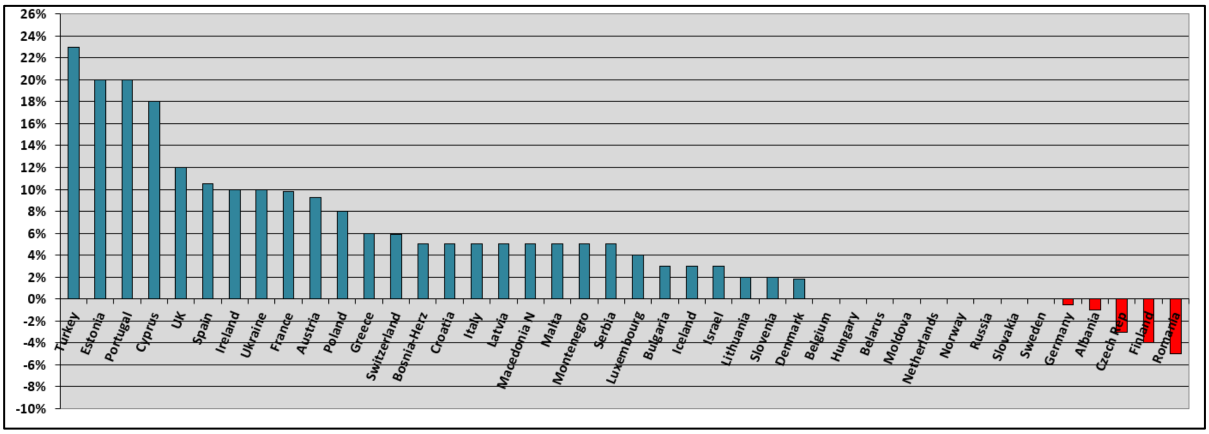


Figure 13 - Production Prediction 2021 vs. 2020 (Source: Aggregates Europe - UEPG 2022)

The extractive industry occupies areas of land only for a limited time. This period can range from a few years to centuries, depending on resource availability and the quality of the deposit. A variety of downstream sectors are vertically linked to extractive industries and their location in places of locally available mineral resources is a logical and direct consequence. Cement producing companies, for example, usually operate their own quarries to ensure the supply of raw materials for cement production and in close vicinity to their manufacturing sites in order to minimise transport costs.

Aggregates are also often used directly as an end product themselves, for example as railway ballast, filter beds or flux materials. However, their main field of application is the construction sector, where they serve as important raw materials for the production of ready-mixed concrete, mortar, precast concrete parts or asphalt. [5]

Figure 14 - Figure 17 show trends in the main applications, again showing the reduction after the Global Financial Crisis and a stabilisation in recent years. Again, it is worth noting that these numbers do not yet include the impact of Covid 19 and Russia’s invasion of Ukraine.

Trends in production in EU27+UK+EFTA

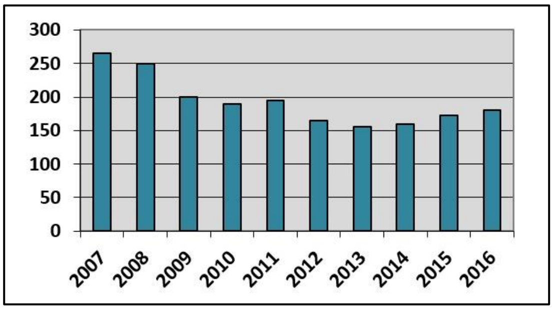


Figure 14 - Cement in million tons [mt]
(Source: Aggregates Europe - UEPG 2022)

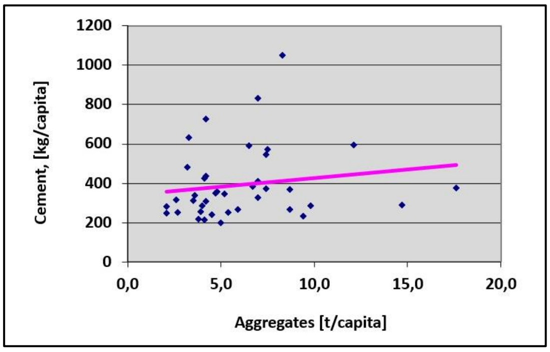


Figure 15 - Cement/Aggregates Ratio (Europe)
(Source: Aggregates Europe - UEPG 2022)

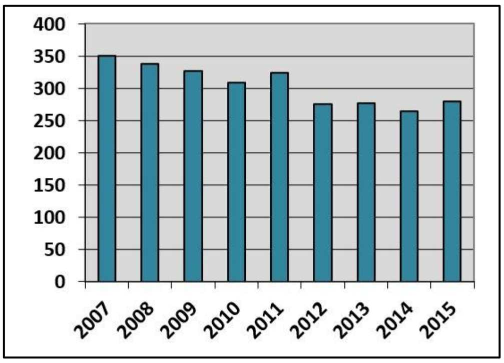


Figure 16 – Asphalt in million tons [mt]
(Source: Aggregates Europe - UEPG 2022)

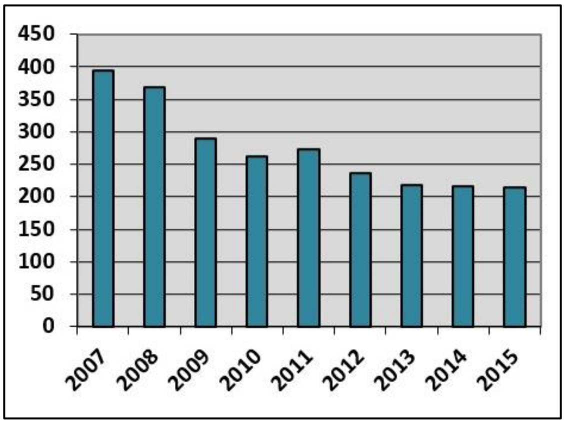


Figure 17 - Redaymixed Concrete in million [m³]
(Source: Aggregates Europe - UEPG 2022)

Despite the strategic importance, aggregates and construction can be considered a stable market in Europe over the last 10 years.

In regional terms we see two effects:

- "Roller- Coaster" Economies (*Figure 18*), mainly in Southern Europe, where production dropped sharply after the Global Financial Crisis, but then recovered again slightly; and
- "Power- House" Economies (*Figure 19)*, mainly in Central Europe, where production remained in a stable position or even increased slightly.

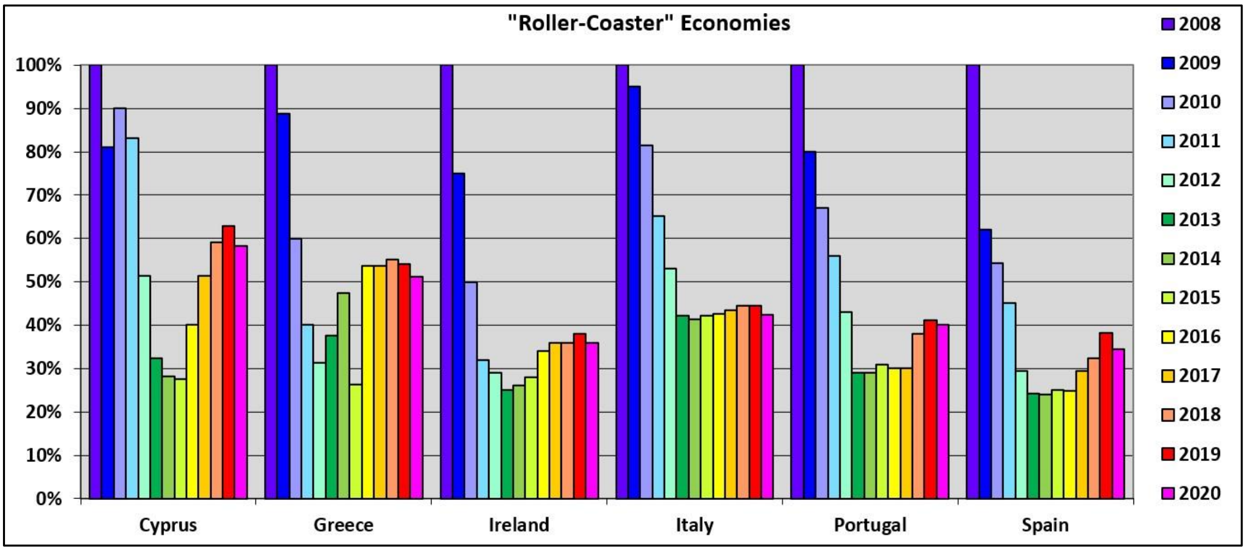


Figure 18 – „Roller-Coaster“ Economies (Source: Aggregates Europe - UEPG 2022)

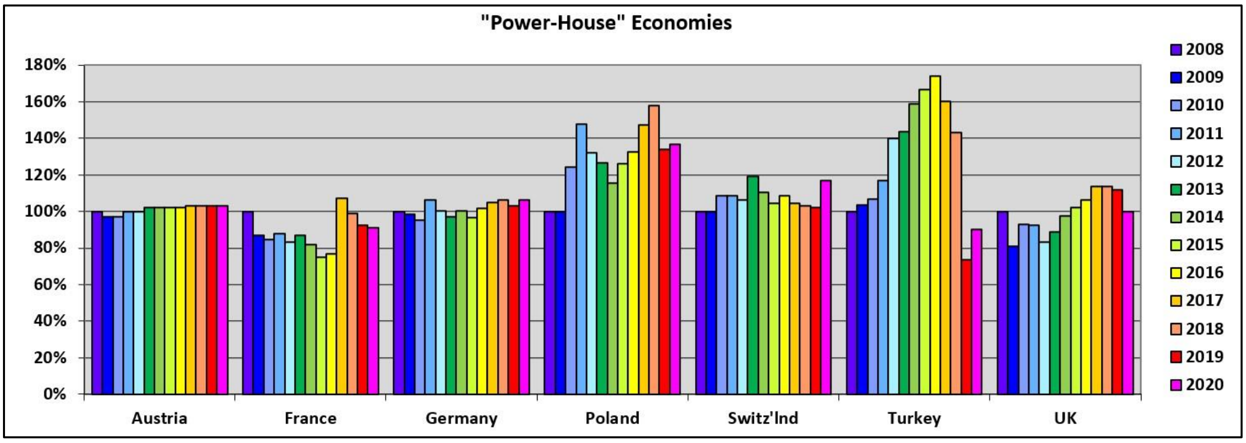


Figure 19 - "Power House" Economies (Source: Aggregates Europe - UEPG 2022)

Demand for aggregates is closely related to the level of new housing construction, commercial offices, retail towers, maintenance and repair of existing buildings and the number of civil engineering projects. In times of weak economic growth, repair and maintenance of the existing building stock dominates demand, but this in turn must always be seen in correlation with national and local urban renewal programmes. [5]

Population density also plays a role in aggregates demand. In the EU it ranges from 18 people per km² (Finland) and 25 per km² (Sweden) with the lowest population densities to 1 595 people per km² (Malta) and 507 people per km² (Netherlands) at the other end of the range.
Comparing 2019 with 2001, there was an increase of the population density in around two thirds of the Member States. On average in the EU, the population density increased from 104 people per km² to 109 during this period.[1] *(Figure 20)*

[1] *Source: Eurostat*

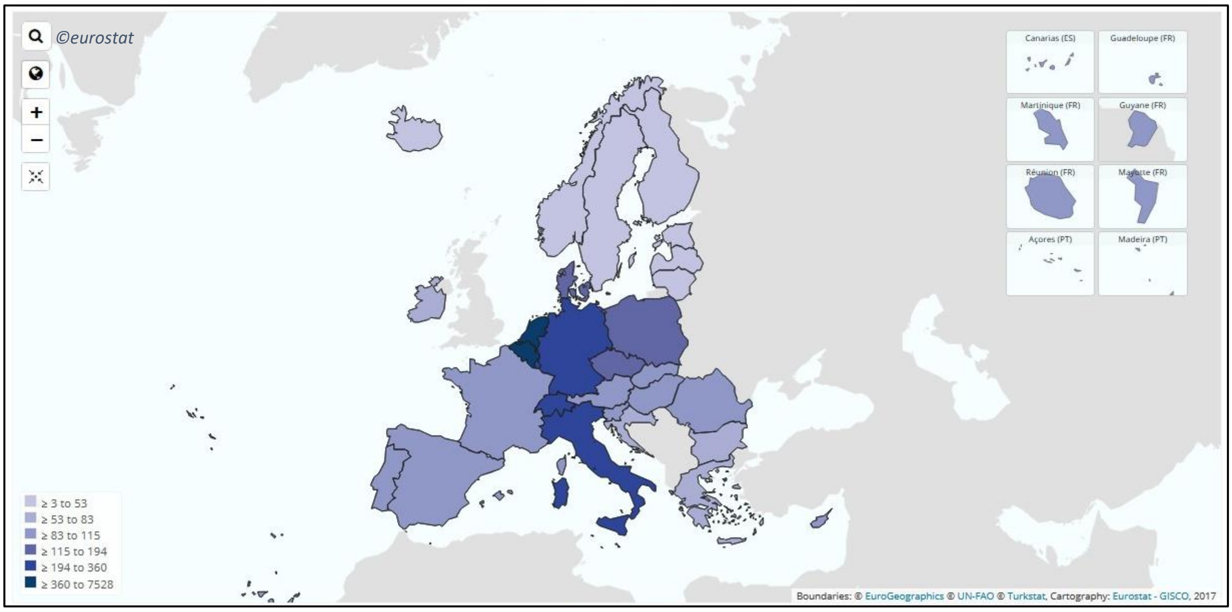


Figure 20 - Population density (2019) in [persons per km²] (Source: Eurostat, ©EuroGraphics)

Figure 21 shows the intermediate and end use of aggregates. Buildings account for about two-thirds of the final use of aggregates, with residential homes being the largest category. For example, the construction of a typical new house uses up to 400 tonnes of aggregates (both end product and concrete) from the foundation to the roof tiles (excluding associated infrastructure).

Second place is shared by aggregates used in social buildings, commercial buildings and infrastructure. For example, up to 3,000 tonnes of aggregates are needed to build a school or an office building.

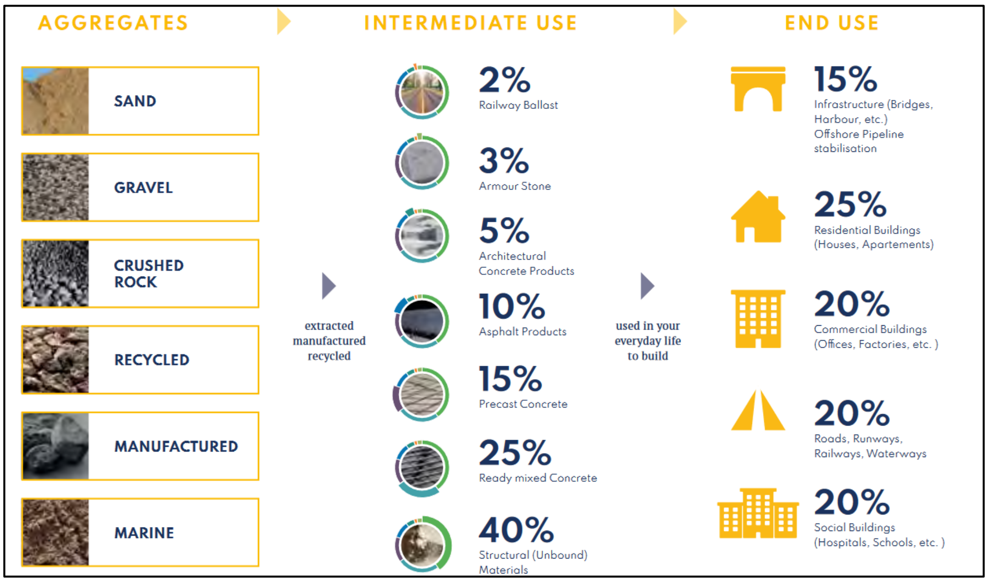


Figure 21 – Intermediate and end use of aggregates (Source: Aggregates Europe UEPG 2021)

Up to 30,000 tonnes of aggregates are used to build 1 km of motorway and up to 9 tonnes of aggregates are used to build 1 m of rail for high-speed trains (TGV).
About 15% of end uses are for infrastructure ranging from bridges to coastal protection, a development mainly based on sea storms, sea level rise and erosion of the coastline. [8]

EU and global aggregates trade

Given aggregates' low value/weight ratio and relatively high transport costs, their trade is highly sensitive to transport distances. International trade is mostly limited to local transactions across neighbouring countries and influenced by the scarcity of local supplies. Exceprations are small quantities exported from Norway to the Netherlands, Denmark and Germany or from North-Western Germany over the Rhine river to the Netherlands. But this represents a tiny amount compared to the 3 billion tonnes produced in Europe overall. [2]

The total annual EU imports between 2012 and 2016 were on average 20.5 [Mt], and the total annual exports between 2012 and 2016 on average amounted to 9.5 [Mt]. [9]

Global trade in industrial mineral commodities is around 1 billion tonnes per year between 2014 and 2018[3]. The most traded goods are sand and gravel (37% in 2018) as well as cement (19% in 2018, but 45% in 2017). Global trade in sand and gravel, quartz, cement, concrete and ceramics (category code: SGQCC) is increasing at a regular rate with a doubling of the traded mass over the last 20 years, from 318 [Mt] in 1996 to 620 [Mt] in 2018 (based on UN Comtrade data, harmonized by the CEPII in the BACI database). Comparing with the current global base estimate of 50 [Bt] of aggregates consumed globally per year, traded sand and gravel, quartz, cement, concrete and ceramics are likely to be equal to about 1% to 2% of the annual global aggregates production. [2]
The largest importers over the period 1996-2018 cumulatively are Singapore (983 [Mt]), the USA (915 [Mt]), the Netherlands (907 [Mt]), Germany (539 [Mt]) and Belgium-Luxembourg (498 [Mt]). It is worth noting that most international trade is regional with the exception of South America which imports more from the rest of the world than what is traded within the region. [2,10]

[2] Export and import figures for individual EU countries can be found in Appendix C under the topic area of transport.
[3] based on UN Comtrade data, harmonized by resourcetrade.earth

4. MATERIAL STOCKS

During the last one hundred years, the world's population quadrupled to 8 billion people and global economic output as measured by GDP, has increased more than twenty-fold. This unprecedented expansion of the global socio-economic system has been accompanied by fundamental changes in the relationship between society and nature and by a massive transformation of natural systems. [11]

The term *"social metabolism* or *socioeconomic metabolism"* refers to the totality of human-controlled flows of materials and energy that occur between nature and society, between different societies, and within societies. They are a feature of all societies and their extent and diversity largely depend on specific cultures or sociometabolic regimes. [12]

Between 1900 and 2014 the domestic extraction of primary resources and all end-of-life recycling flows has increased globally from 7.6 to 95.2 [Gt/year], which means an annual increase of 3.5% since 2010 alone (*Figure 22*). The quantitatively most important use of processed materials has become stock-building, which increased from 1.2 to 49.8 [Gt/yr], or from 16% to 53% of annual globally processed materials between 1900 and 2014 (*Figure 23*). The Global in-use stocks of manufactured capital amounted to 928 [Gt] in 2014, a 26-fold increase since 1900 and an annual 3.9% increase since 2010 (*Figure 24*). Most of these materials were aggregates used in construction (concrete, asphalt, bricks, sand and gravel) but also 33 [Gt] of metals, 15 [Gt] of wood, 3 [Gt] of plastics and 3 [Gt] of glass were employed in in-use stocks. In summary across all 14 material categories 39% of end-of-life wastes from stocks were re- and down-cycled in 2014. [13] [14]

Global material stocks and flows, from 1900 to 2014

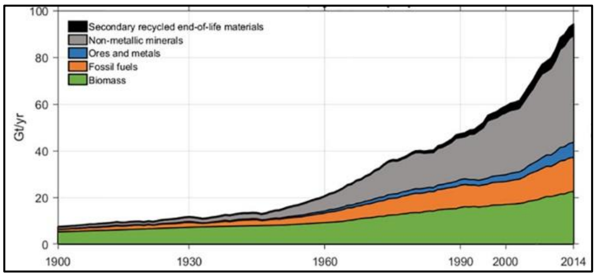


Figure 22 - Annual flows of primary and secondary processed materials by material properties (Source: [13])

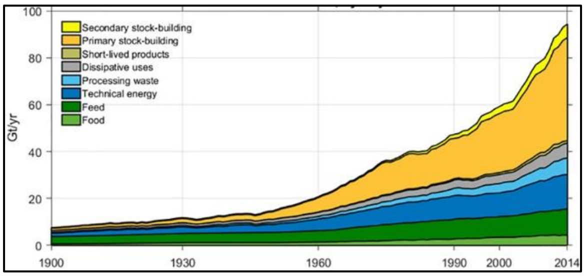


Figure 23 - Annual flows of primary and secondary processed materials processed materials by use (Source: [13])

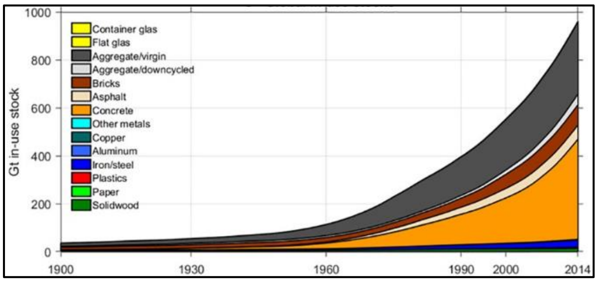


Figure 24 - Annual flows of primary and secondary processed materials by global in-use stocks (Source: [13])

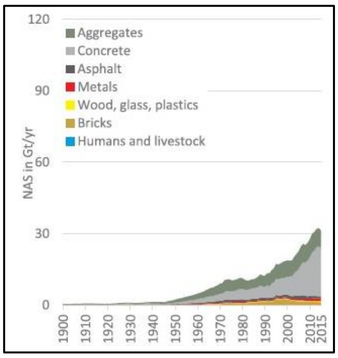


Figure 25 - Yearly net additions to stocks (NAS) (Source: [14])

In the 20th century *socioeconomic metabolism* has changed as materials accumulate in stocks rather than being consumed shortly after extraction. Currently more than half of all materials are used to build up long living stocks of manufactured capital. In combination with technical energy, these in-use stocks provide essential services such as housing, mobility, supply and discharge or communication. Materials remain in use in stocks for a certain period of time until they are subsequently discarded and either become end-of-life waste or they are reused, remanufactured or re- or downcycled into secondary material inputs. [14]

Economy-wide material flow accounting (ew-MFA) is an established method to monitor resource use across scales and its headline indicators are widely used in policy. *Wiedenhofer, Krausmann et al.* expanded the ew-MFA framework towards jointly addressing material flows, in-use stocks of manufactured capital and waste, using a fully consistent dynamic model of Material Inputs, Stocks and Outputs (MISO-model). [13]

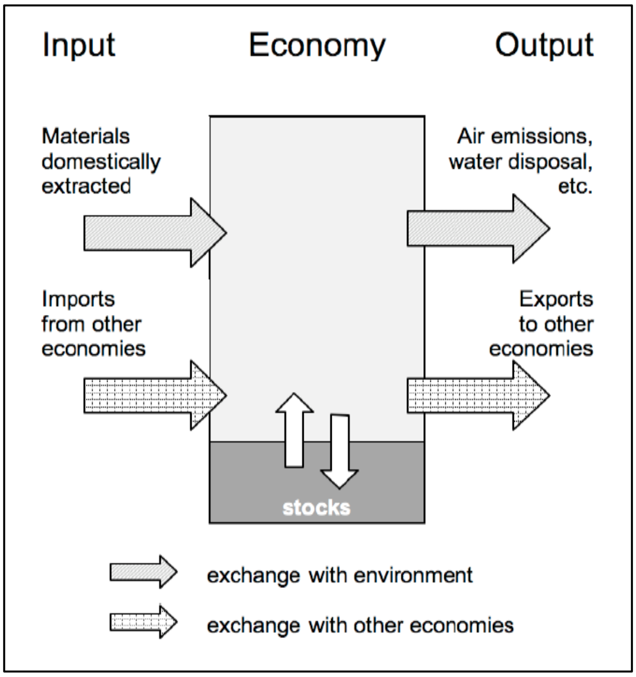


Figure 26 - Scope of economy-wide material flow analysis (MFA) (Source: [15])

With this model, they also did future scenarios for material flows. In their *Resource use stabilization scenario*, end-of-life wastes from stocks more than double until 2050, from 15.7 [Gt/yr] in 2014 to 34.5 [Gt/yr] in 2050 (*Figure 30*). These materials are partially recycled into secondary stock-building materials (*Figure 28*). The increase in secondary materials in combination with the constant inflow of primary stock-building materials[4] (*Figure 27*) results in a slight increase of annual stock-building from 49.8 [Gt/yr] in 2014, to 54.1 [Gt/yr] in 2050. Subsequently, global in-use stocks are projected to double from 928 [Gt] in 2014, to 1869 [Gt] in 2050. However, final waste remaining after recycling also doubles to 23.2 [Gt/yr] in 2050 (*Figure 31*). Even if primary resource use stabilises, environmental impacts are expected to further increase due to the predicted doubling of waste flows. [13]

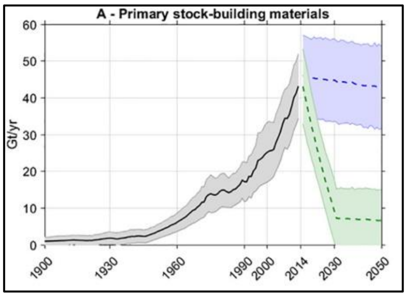


Figure 27 - Results from two prospective scenarios of the global dynamics of primary material inputs into stocks

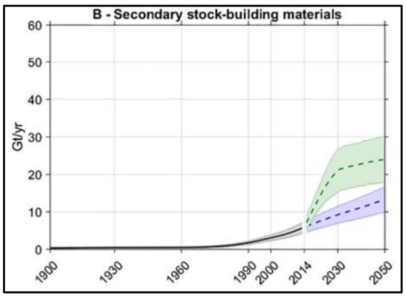


Figure 28 - Results from two prospective scenarios of the global dynamics of secondary materials inputs into stocks

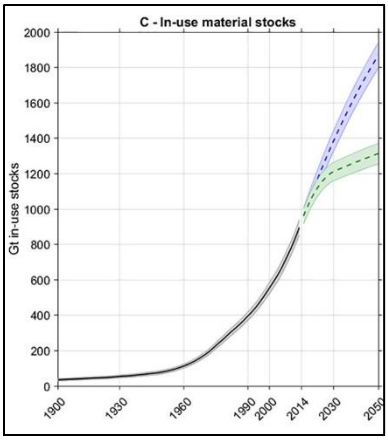


Figure 29 - Global in-use stocks of manufactured capital

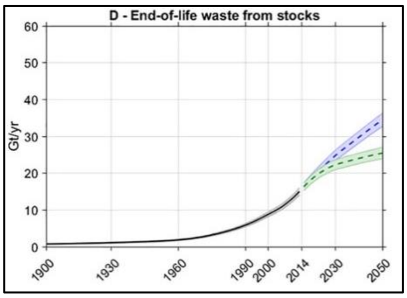


Figure 30 - End-of-life waste from stocks

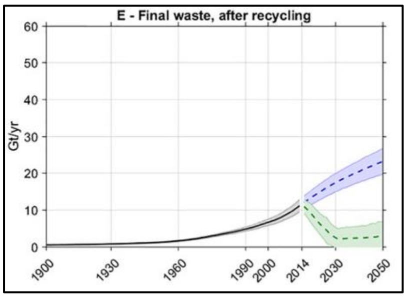
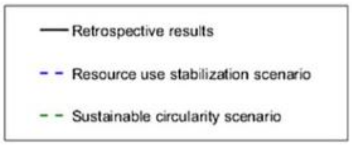


Figure 31 - Final waste, after recycling



(Source: [13])

[4] The demand for primary aggregates is calculated from the gap between secondary aggregates available and the requirements for sand and gravel due to the quantities of asphalts, bricks and concrete, as well as sub-base and base-course layers. Therefore, the global stabilization scenario shows slight reductions of primary stock-building materials *(Figure 27)*, caused by the increased availability of secondary aggregates due to in- creasing end-of-life wastes from stocks and their recycling.

In the *Sustainable circularity* scenario, final waste flows after recycling are substantially reduced to only 2.8 [Gt/yr] in 2050, or 24% of the modelled amounts in 2014 (*Figure 31*). Due to aging in-use stocks and drastically improved recycling, increasingly more secondary materials become available for stock maintenance and even expansion (24 [Gt/yr] in 2050), in spite of the assumed absolute reduction of primary material inflows to only 6.6 [Gt/yr] (*Figure 27, Figure 28, Figure 30*). Subsequently, global in-use stocks still increase by 42% compared to 2014, to 1 314 [Gt] in 2050 (*Figure 29*). With this simplified scenario of the sustainable circular economy, considerable progress can be achieved, if the circular economy is implemented with the goal to absolutely reduce resource use. [13]

In the year 2016, 39.7 ±6.1 [Gt/year] of raw materials were extracted, of which 23% turned into waste during processing, resulting in 30.7 ±5.7 [Gt/year] of global primary **g**ross-**a**dditions-to-**s**tock (GASprim). Since the 1990s, China has dominated global dynamics in terms of annual per-capita GASprim. Wiedenhofer, Krausmann et al. find that per capita GASprim and GDP have decoupled over time (in all countries). However, there is no finding of new economic developments that are significantly less material-intensive in terms of stockpiling than in the past. [15]

Tracing global primary materials (extraction – processing – use)

Most waste is generated during the early stages of production (mining waste, processing tailings), while the waste generated is reduced during the subsequent processing stages. In 2016, concrete accounted for 72% of total GASprim, followed by brick with 9% and asphalt with 6%. In terms of primary raw materials extracted, sand and gravel accounted for 57%, limestone and clay made up 13% each, and iron ores and non-ferrous metal ores accounted for 5% respectively 6% of global extraction. If the figures are compared with those from 1950, a dramatic change can be seen. At that time, concrete accounted for only 36% of total GASprim, asphalt for 14%, bricks for 25%, wood and paper for 10% and iron and steel for 7%. Obviously, concrete has become the predominant building material. [15]

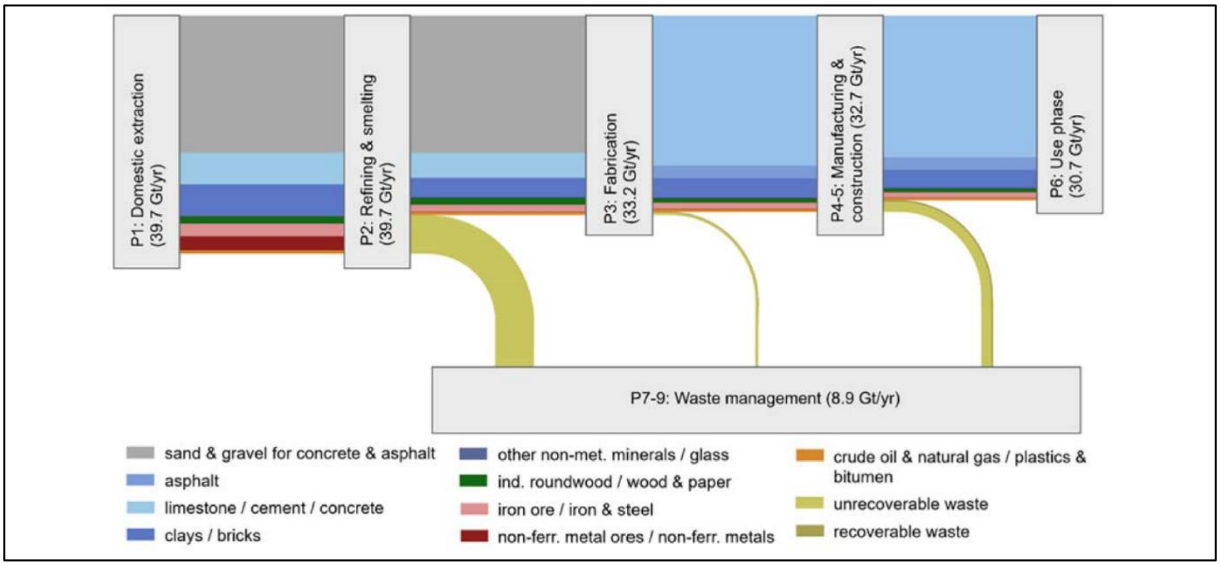


Figure 32 - Global primary stock-building materials traced from extraction via processing of raw, semi-finished and final products to use (2016) (Source: [15])

4.1. RESOURCES & RESERVES

Resources

Definition: The term is synonymously used for "mineral resource", "inferred mineral resource", "indicated mineral resource" and "measured mineral resource". In this case, confidence in the existence of a resource is indicated by the geological knowledge and preliminary data, while at the same time the extraction would be legally, economically, and technically feasible. [5]

Reserves

Definition: The term is synonymously used for "mineral reserve", "probable mineral reserve" and "proven mineral reserve". In this case, confidence in the reserve is measured by the geological knowledge and data, while at the same time the extraction would be legally, economically and technically feasible, and, when possible, a licensing permit is available.[6]

Appendix A presents country specific data, collected in the course of the Minerals4EU project[7], an EU project designed to meet the recommendations of the RMI (Raw Materials Initiative). Data can be found in the RMIS: *https://rmis.jrc.ec.europa.eu/?page=country-profiles#/*

An EU Mineral intelligence network structure has been developed, which provide data, information and knowledge on mineral resources around Europe, based on an accepted business model, making a fundamental contribution to the European Innovation Partnership on Raw Materials (EIP RM), seen by the Competitiveness Council as key for the successful implementation of the major EU2020 policies.

Supporting the development of the European Union Raw Materials Knowledge Base (EURMKB) and responding to a specific action of the 2015 Circular Economy Action Plan, the Joint Research Centre (JRC)[8], in collaboration with DG GROWTH, has developed the "Raw Materials Information System" (RMIS). The RMIS is the EC's reference web-based knowledge platform for non-fuel, non-agricultural materials from primary and secondary sources.

However, the data is not (yet) complete, inconsistent and mostly from 2015, so there is an enormous need for research and updating, which is beyond the scope of this study.

It would also be very useful to then compare the supply (reserves and resources) figures with predicted demand figures, both at the country level, as well as for the whole of Europe.

APPENDIX A RESOURCES & RESERVES – COUNTRY PROIFLES

[5] Minerals4EU, accessible at http://minerals4eu.brgm-rec.fr/m4eu-yearbook/ *(05.12.2022)*
[6] Minerals4EU, accessible at http://minerals4eu.brgm-rec.fr/m4eu-yearbook/ *(05.12.2022)*
[7] http://www.minerals4eu.eu/ *(05.12.2022)*
[8] The Joint Research Centre is the Commission's science and knowledge service. The JRC employs scientists to carry out research in order to provide independent scientific advice and support to EU policy.

5. SECONDARY AGGREGATES

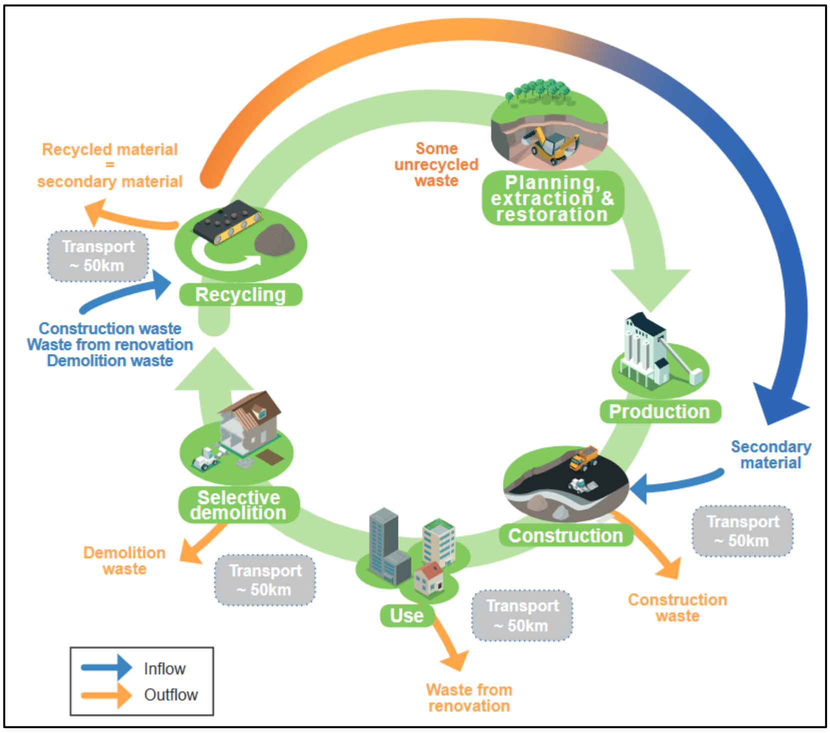


Figure 33 - Towards a circular economy for aggregates
(Source: UEPG - 2020 Vision for a Sustainable Aggregates Industry)

The circular economy is based on a simple principle: responsible production based on resource conservation and waste reduction. Ideally, this means that nothing is thrown away anymore, instead everything can be recovered. The circular economy pursues a harmonious intergrowth and sustainable development of both the economic and the social system without harming the natural ecosystem.

The use of recycled aggregates helps to save resources by reducing the extraction of primary raw materials and moreover also reduce the generation of waste. The construction sector is one of the largest producers of waste. Recycling of construction raw materials represents a great opportunity to recover inert waste instead of landfilling it.
The biggest challenges in recycling demolition materials are clean and pure separation directly at the demolition site, reduction of transport distances (< 50 km) and processing into raw materials for new building materials via local, short supply cycles.
The shortness of the transport routes plays a crucial role not only economically but also environmentally, as a reduction in the transport distance goes hand in hand with a reduction in greenhouse gas emissions. Alternatives to road transport (river/rail) or alternative drives (hydrogen/electric) are often not feasible or difficult to achieve due to the lack of infrastructure or technologies that have not yet been implemented in heavy transport.
An increase in material productivity is achieved through various looping options within the life cycle of aggregates. Best case scenarios loops should not to be run through only once, but as often as possible. The further a material is processed along the supply chain, the lager the looping for reusing can become. That said, the tighter the loop, the quicker the materials return to consumption and the fewer resources are needed. [16,17]

5.1. RECYCLED AGGREGATES

Construction and Demolition Waste (CDW) is mostly inorganic material, such as concrete and masonry. It is by far the largest source of alternatives to natural aggregates. The most important sources of CDW include demolition and construction work in urban areas, which has the advantage of being close to existing markets at the same time. Other sources for CDW further from the market can be found in the removal of large infrastructural facilities (e.g. runways, old hospitals, old military bases, etc.) in the countryside.

The disposal of waste directly at the construction site (as hardstanding, beneath 'block and beam' floors, and in landscaping bunds, etc.) opens up considerable cost advantages.

Asphalt road surfaces are another important source of recycled aggregates. Also spent railway ballast is recycled into lower grade uses. [3]

The approach of the circular economy requires that CDW, when it can no longer be reused, should be recycled. The current goal of 70% recycling rate set in the *Waste Framework Directive* is not met in many Member States. [18]

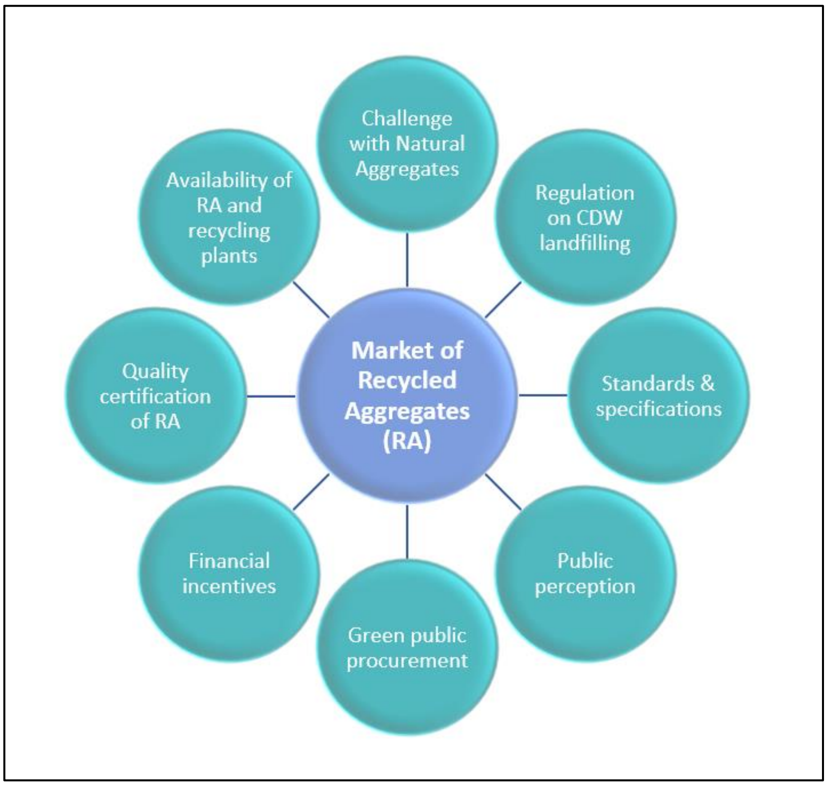


Figure 34 - Parameters influencing the aggregates recycling market (own illustration; Source: [19])

This is due to national legislation - the definition of "waste" and the resulting regulations, availability awareness - there is no database listing the availability (time/place/quantum) of recycled aggregates and a variety of further parameter that influence the market *(Figure 34)* [19].

Often primary raw material suppliers see direct competition in recycling companies. However, this is improving as many primary raw material extraction companies are now entering the recycling market. Public awareness, sustainable mind-sets and environmental public procurement as well as financial incentives for the recycling of CDW are boosting the market significantly.

It's all about the quality and economy

A major challenge for aggregate producers is that the assessment of quality depends on the intended use of the aggregates. Different customers have different quality requirements and thus the products have to be manufactured according to their end use and different standards as well as specifications. The quality of a crushing process is often assessed in terms of process capacity, reduction rate and energy efficiency. The main objective of the crushing process is the size reduction itself, but there are many additional factors that contribute to a good/bad quality of the crushed product. These include the fines content and the grain band (particle size distribution). Another important quality feature of aggregates is the particle shape (round grain, angular grain). For construction raw material producers, it is crucial that the quality (in all parameters) of their raw materials remains consistent, and this often challenges recycling and aggregate producers. [4]

To make recycled aggregates from CDW competitive, they must meet the same quality requirements as primary aggregates. This requires separation by type directly at the demolition site, as otherwise recycling/processing cannot take place in the required quality.

An important term in this context is "recyclable building". Many construction materials currently on the market represent composite systems that will only be recyclable with considerable mechanical effort or not at all. As early as 2013, the *European Construction Products Regulation* stipulated the sustainability or recyclability of buildings as a basic requirement, but this has often not yet been implemented nationally.

In addition, the transport routes for CDW and the downstream processing must not exceed the selling costs of the recycled aggregates, as the whole process is no longer economical. This often presents recycling companies as well as construction companies, which are increasingly entering the field of recycling CDW, with major logistical challenges.

Figure 35 and *Figure 36* show the amount of recycled aggregates in the individual countries in absolute numbers and as percentage of the total.

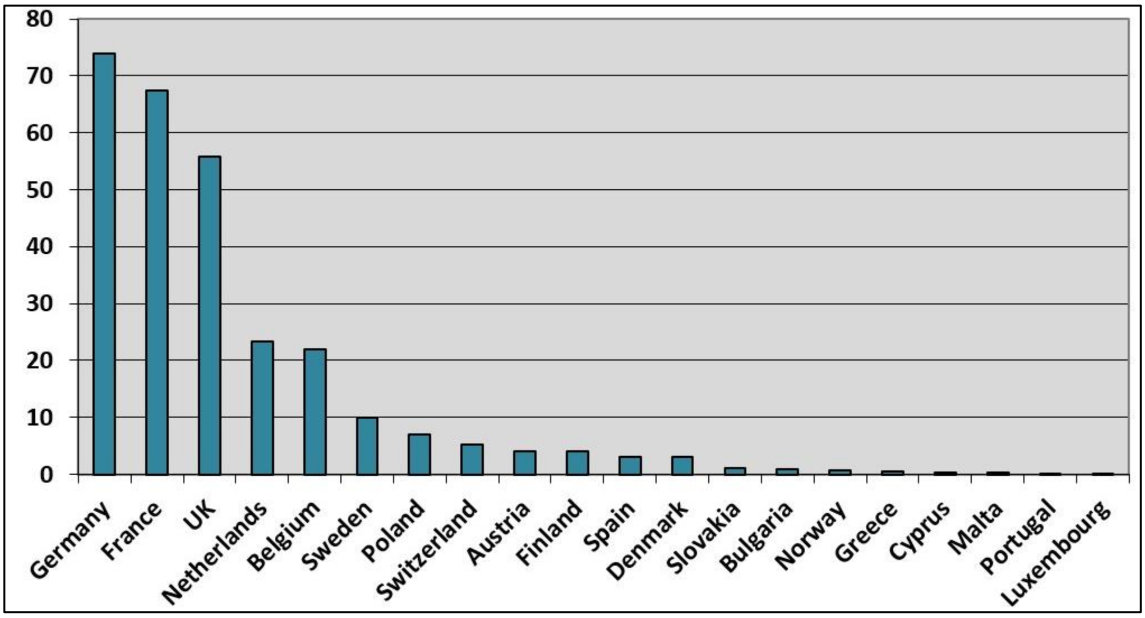


Figure 35 - Recycled aggregates in [Mt] (2020) (EU27+UK+EFTA) (Source: Aggregates Europe UEPG 2022)

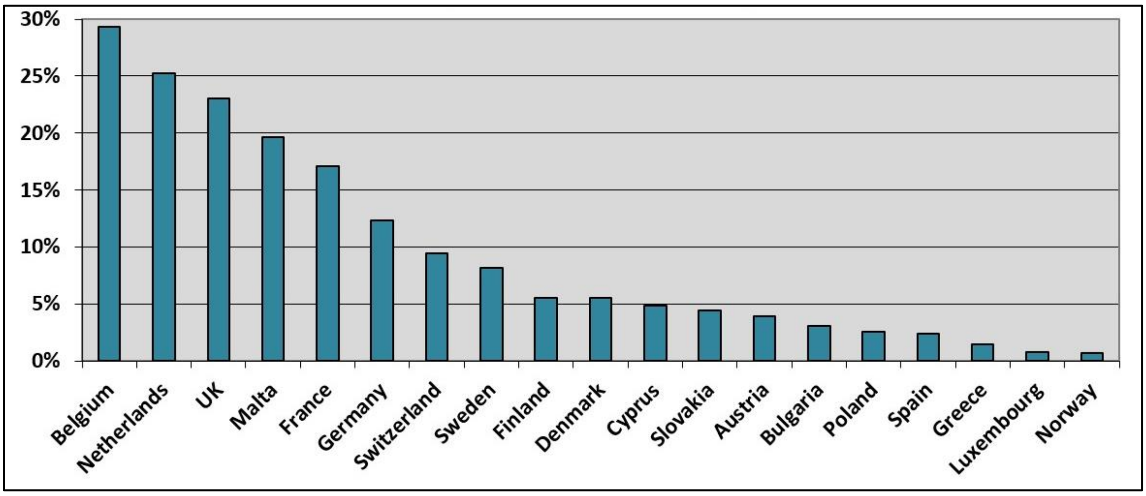


Figure 36 - Recycled aggregates as [% of national tonnage] (2020) (EU27+UK+EFTA) (Source: Aggregates Europe UEPG 2022)

Eurostat provides also figures for the recovery rates of CDW *(Table 1)*. Overall for Europe and except for Eastern and some Southern European countries, these rates are above 90%. What this shows is, that even if all of the CDW is recycled, **it can not cover the demand and hence primary (and manufactured) aggregates will still be needed to cover the majority of demand**. As an example, Belgium recovered 97% of CDW in 2018, but this would have only covered less than 30% of their aggregates demand in 2020.

Table 1 - Recovery rate of construction and demolition waste in [%] (2018)
(Source: Eurostat (online data code: CEI_WM040))

GEO \ TIME	2010	2012	2014	2016	2018
European Union - 27 countries (from 2020)	:	:	87	87	88
European Union - 28 countries (2013-2020)	:	:	89	89	90
Euro area - 19 countries (from 2015)	:	:	:	:	:
Belgium	17	18	32	95	97
Bulgaria	62	12	96	90	24
Czechia	91	91	90	92	: (bc)
Denmark	:	91	92	90	97
Germany (until 1990 former territory of the FRG)	95	94	: (c)	: (c)	93
Estonia	96	96	98	97	95
Ireland	97	100	100	96	100
Greece	0	0	0	88	97 (p)
Spain	65	84	70	79	75
France	66	66	71	71 (e)	73
Croatia	2	51	69	76	78
Italy	97	97	97	98	98
Cyprus	0	60	38	57	64
Latvia	:	:	92	98	97
Lithuania	73	88	92	97	99
Luxembourg	98	99	98	100	98
Hungary	61	75	86	99	99
Malta	16	100	100	100	100
Netherlands	100	100	100	100	100
Austria	92	92	94	88	90
Poland	93	92	96	91	84
Portugal	58	84	95	97	93
Romania	47	67	65	85	74
Slovenia	94	92	98	98	98
Slovakia	:	:	54	54	51
Finland	5	12	83	87	74
Sweden	78	81	55	61	90
Norway	44	75	77	71	63
Switzerland	:	:	:	:	:
United Kingdom	96	96	96	96	98

Special value:
(:) not available

Available flags:
(bc) break in time series, confidential
(e) estimated
(c) confidential
(p) provisional

This is also aligned with predictions by the EU. Even in an optimal recycling scenario, more than 85% of the aggregates consumed will still need to be extracted from nature, as shown in the European Commission's Sankey Diagram on the aggregates flow for the EU. [20]

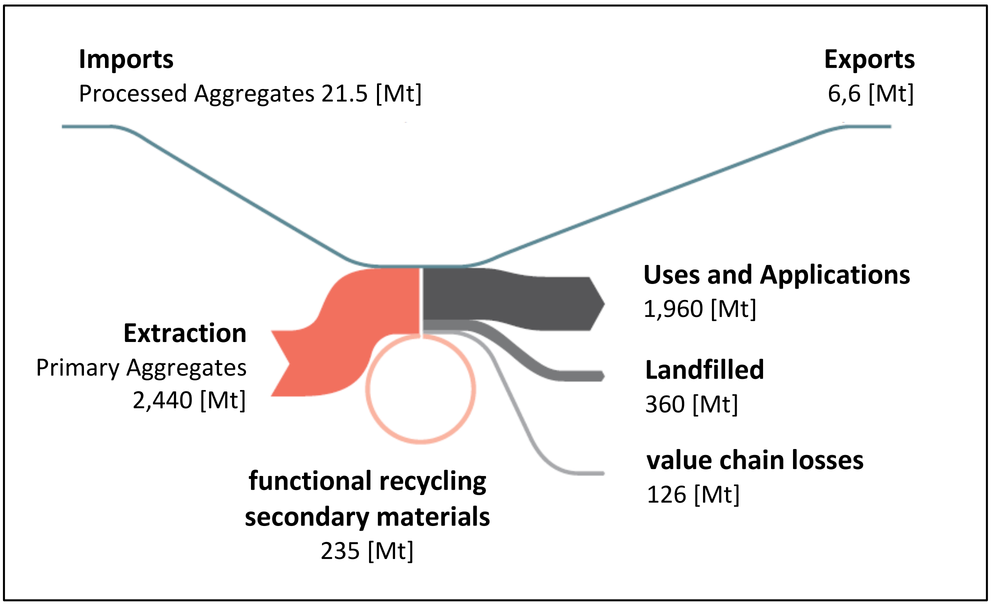


Figure 37 - Sankey Diagram on the aggregates flow for the EU (2022)
(Source: European Commission; [20])

End of waste status

Article 6 of the Waste Framework Directive defines the conditions under which a waste, after it has undergone a recovery operation, is no longer considered waste.
These include the following:

- The substance or object is to be used for specific purposes.
- There is a market for or demand for the substance or object.
- The substance or object meets the technical requirements for the specific purposes and complies with existing legislation and standards for articles.
- The use of the substance or object does not lead to overall adverse environmental or health impacts.

According to Recital No. 22 of the Waste Framework Directive, CDW is one of the possible categories of waste for which end-of-waste criteria should be developed. In 14 European countries[9], end-of-waste criteria have already been defined at national level, as shown in *Appendix B1 & B2 – Secondary aggregates.*

9 *Austria, Bulgaria, Belgium (Flanders), Croatia, France, Germany, Hungary, Italy, Luxembourg, Netherlands, Poland, Portugal, Romania, United Kingdom*

Legal and regulatory framework – Different levels of maturity across the EU27+UK [21]

Different levels of maturity[10], scope and level of implementation are observed in different MS. Some MS have had waste management legislation since the 1970s (e.g. Germany, France, the Netherlands, Belgium) and the waste management sector is satisfactorily regulated. Most Member States have only recently adopted specific waste management legislation and are at different stages of implementation. All EU MS have successfully transposed the Waste Framework Directive (2008/98/EC) into national legislation. Thus, there is a common basis defining the principles of waste management according to the waste hierarchy. However, the level of implementation of the various provisions of the Waste Framework Directive in the Member States varies widely in reality.

More and more Member States are adopting legislation regulating the management of construction and demolition waste. There are an increasing number of regulations also at local or regional level that regulate the management of construction and demolition waste, and it is these regulations that have the greatest impact on the growth of CDW recycling. In Germany, for example, each province has its own regulations for CDW management, while in Denmark and Estonia the responsibility for planning CDW management lies with the municipalities.

Member States with decentralised government systems may lack adequately harmonised national legislation on CDW management (this is particularly the case in Spain). Each region within a Member State is entitled to enact its own local legislation for the sustainable management of CDW, to meet local conditions (e.g. there are no landfills in Brussels, focus: waste prevention) and to be more flexible than national governments, e.g. the Basque Country and Catalonia in Spain have higher requirements compared to the national level.

Taking Austria (high recovery rate) and Greece (low recovery rate) as examples, it is observed that Austria has only one piece of legislation specifically referring to the sorting of CDW and the overall performance is very high, while in Greece a very specific piece of legislation exists detailing the proper CDW management along the construction and demolition value chain, but its effectiveness is practically non-existent, mainly due to the persistence of illegal disposal of CDW. This shows that the establishment of a strong legal framework alone is not always sufficient to guide the management of CDW towards resource efficiency.

The enforcement of legislation is very important to achieve the objectives of each regulatory instrument. Most Member States have clearly defined responsibilities for CDW legislation enforcement, often relying on local authorities in charge of inspections related to environmental legislation.

If illegal practices are detected, sanctions are usually applied. Although responsibilities and sanctions are clearly defined, it is difficult to assess the effectiveness of these frameworks, as illegal dumping is still widespread, mainly due to the relatively poor value of this waste stream.

[10] Levels of maturity were defined according to: period of application of relevant legislation (number of years since the legislation is in place); level of specificity of legislation (general overarching legislation on waste management vs. targeted legislation on CDW management); level of implementation of the existing legislation (effective application vs. infringement); forward-looking elements (draft proposals for new legislation, new WMP in place, etc.).

MS with mature legislation	
Austria Belgium Denmark Finland France Germany Luxembourg Netherlands Sweden	**Main characteristics may include:** • existing legislation with specific requirements on CDW prior to the WFD (Waste Framework Directive) • ambitious targets on CDW prevention or recycling (either higher than the one defined by the WDF or defined by materials) • further legislation in progress showing a step forward is taken above the WFD requirements • specific standards defined within the legal framework to facilitate the law enforcement
MS with mature legislation	
Czech Republic Estonia Hungary Ireland Italy Malta Portugal Spain United Kingdom	**Main characteristics may include:** • existing legislation with specific requirements on CDW, possibly prior to the WFD • defined targets • existing specific standards/framework on specific issues but where law enforcement is weaker showing a lower level of maturity
MS with mature legislation	
Bulgaria Croatia Cyprus Greece Latvia Lithuania Poland Romania Slovakia Slovenia	**Main characteristics may include:** • existing legislation with specific requirements on CDW, mainly defined in application of the WFD • only a few legal specifications regarding specific CDW management issues, poor law enforcement

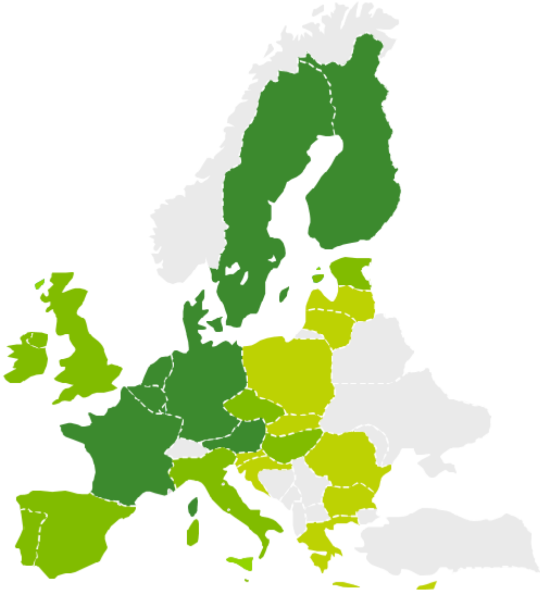
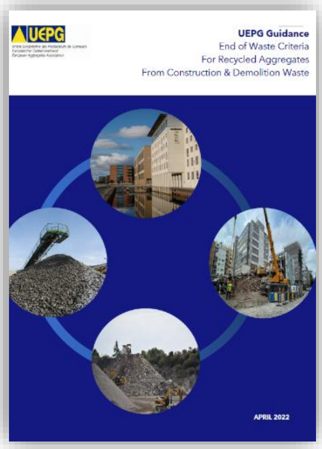


Figure 38 - Level of maturity of legal framework in MS (Source: [21])

In April 2022, Aggregates Europe - UEPG presented a Guidance document with end of waste criteria for recycled aggregates from Construction & Demolition Waste. Although this guide does not have any legal force, it does set out requirements for recycled materials to cease to be waste and thus to comply with the relevant product standards.



The Guidance has four main objectives [22]*:*

1. *clarifying the point at which waste management controls are no longer required;*
2. *providing users with confidence that the aggregate they purchase conforms to an approved industry specification defined in accordance with an appropriate European aggregate standards;*
3. *providing users (specifiers and designers) with confidence that the aggregate is suitable for a use within a designated market sector(s) by conforming with the industry standard; and*
4. *protecting human health and the environment (including soil).*

5.2. MANUFACTURED AGGREGATES

Blastfurnace and steel slags are by-products of iron and steel production and serve as a source of manufactured aggregates. Blastfurnace slag, in particular, can be used directly as an alternative to natural aggregates for more demanding applications.
Ash used as manufactured aggregates is derived primarily from burning pulverised coal in coal-fired power plants. Incinerator bottom ash (IBA), produced from burning municipal wastes can be used but it is only produced in small quantities and generally has inconsistent qualities. Most of the ash produced in coal-fired power plants is a fine powder called pulverised fuel ash (PFA), which can be used as a material for cement production, as fill material and for soil remediation. Furnace bottom ash (FBA) is a coarser agglomerated ash, which is sold as a lightweight aggregate for concrete block production. [3]

Controlled burning of municipal waste converts waste into heat, ash and flue gas. The heat is used to generate steam for electricity production, as a process steam in nearby industrial zones, or in some cases to provide district heating services. The ash by-product is either collected in the flue (fly ash) or at the bottom of the furnace (bottom ash).
Bottom and fly ash can contain heavy metals and dioxins that can cause serious environmental and human health risks if disposed off improperly. Options for proper disposal include bottom ash as an aggregate for road base, asphalt and in cement for construction. Fly ash, and hybrid mixtures of bottom and fly ash, can be used in producing glass, ceramics and as an additive in mortar.
It is the scale of the Waste-to-Energy market that makes these waste by-products interesting as a manufactured aggregate alternative to primary sand and gravel use. [23]

Two potential future sources of manufactured aggregates that have received too little attention so far are tunnel excavation material and mining waste:

5.2.1. TUNNEL EXCAVATION MATERIAL

In Norway, the term “short-transported aggregates” [Kortreist stein] has gained importance in recent years. The term illustrates the interest in increasing the use of local aggregates, if they are available in suitable quality. This is called a bottom-up approach: the available resources are mapped and analysed before a structure is designed in such a way that the local resources can be used. Traditionally, a top-down approach is followed: a structure is designed based on central guidelines, and local resources are used - if they fit the chosen design.
An example of the use of local aggregates is the use of excavated material from tunnels in the production of high-quality concrete and HMA *(**H**ot **M**ix **A**sphalt is a combination of approximately 95% stone, sand, or gravel bound together by asphalt cement, a product of crude oil)* to be used in the same tunnel. Such an application requires a stable supply of aggregates with defined properties. During the construction of a tunnel, significant variations in mineralisation and hence aggregate properties can occur along the tunnelling section. Classifying and separating high-quality resources during tunnelling is both area- and time-consuming – Both are resources that are usually very limited on tunnel construction sites. As a result, tunnel excavation material is often used for low-grade applications without separation of higher-quality sections, or is landfilled at all. Required high-quality aggregates must then be delivered to the tunnel construction site from a quarry. [4]

Challenges:

- Contamination by explosives of the blasted material & shotcrete (processing & separation); quality / legal requirements
- Who is responsible for this? Employer or employee?
- Definition of waste → Principle: "Recycle BEFORE disposal" (Recycling on site vs. recycling externally) → Who monitors and executes?
- Quality Requirements
- At the moment: stockpiles/dumps, earthworks (dams, noise barriers, etc.), bulk material (frost coats, etc.), sometimes as aggregates for concrete, for the production of a growing medium for recultivation purposes
- Transportability of the excavated material → Logistic (Truck/Railroad/Ship)
- Legal framework (what about EIA?)

Potential:

- Construction of secondary deposits (no dumps!)
- Circular economy strategy
- always a question of the availability and time requirements of the material
- Placement according to different qualities (quality control during "re-mining")
- unlimited storage possibility analogous to the primary construction materials and no “dropping out of the waste regime”)
- Maximum recycling of the excavated material for the purpose of maximum possible self-sufficiency → optimum economic efficiency of the entire materials management
- Minimal environmental impact through minimisation of transport processes and extensive conservation of resources

5.2.2. MINING WASTE

For most mined commodities (with the exception of construction materials and some industrial minerals), the valuable minerals or metals of interest represent only a small portion in the overall mined volumes. Thus, the global mining industry generates billions of tonnes of waste every year. Due to the relatively low value of potential by-products from mine waste, remote location of most mines, as well as conventional waste management practices and environmental regulation allowing for massive waste storage, most mine waste currently ends up in waste storage facilities, such as waste rock dumps and tailings dams. In fact, mine waste is the largest waste stream on the planet, estimated to be in the range of 30 to 60 [Bt/yr] [24] [25], an order of magnitude higher than all urban waste (i.e. 2-3 [Bt/yr] [26]). There has been no global reporting and no detailed estimates on the actual amount of mine waste being beneficially reused. The general assumption is a few per cent at best, with the majority of mine waste still destined for disposal. One explanation for the slow rate of uptake is that for the most part, reuse has focussed on mining residues, rather than producing by-products that require their own optimisation during mineral processing. This is a crucial distinction, as mineral residues are not automatically optimally usable for the intended reuse and may, for example, contain environmentally harmful minerals, elements and compounds (such as sulphides and metals) that have to be removed before further processing. [2]

Mining waste mostly accumulates as waste rock and tailings (processing tailings). In order to access the valuable mineral in a deposit, it is often unavoidable to mine the barren rock as well. This often results in large quantities of uneconomical overburden, which has to be stored in dumps and, depending on its size and mineralogical composition, often has to be separated first in order to avoid negative environmental impacts. Tailings originate from the processing of the extracted valuable mineral (e.g. gravity-based separation, magnetic separation, flotation, etc.). Consequently, tailings consist mainly of fine to very fine material (sand, slit and clay size particle). Due to their fine nature, tailings usually have to be stored in specially designed tailings dams, which require regular maintenance and monitoring with regard to their physical & geochemical stability. When mining operations are to be closed down, these tailings ponds also require special rehabilitation measures. [2]
The most comprehensive database of tailings storage facilities assembled, estimating that at least 8 100 (active, inactive and closed) facilities are present in the landscape, with 10 billion m^3 (~13 [Bt]) of additional tailings per year requiring storage in existing or planned facilities over the coming five-year period. [27]
The amount and types of generated mine waste can vary drastically, depending on the type and size of the ore deposit, mineralization, mining and processing methods, and may also be affected by water and waste management practices, which in turn are influenced by geographical location, climate, environmental regulation, technical expertise and social licence to operate. The opportunities for mine waste minimization, reuse, and repurposing have been investigated for a long time. However, due to technical and economic barriers, these research results never led to serious global uptake. At the same time, significant efforts are often required to mitigate environmental impacts from mine waste storage facilities, e.g. acid and metalliferous mine drainage and dust emissions, ensuring their physical stability, rehabilitation and return to natural environment and/or finding another alternative land use at the end of mine life.
Whether mine waste is characterised as a hazardous or non-hazardous material, there may be opportunities for reuse and recycling that can provide alternatives to conventional waste management. This would allow additional valuable by-products (with potential substitution of other natural resources) to be recovered, as well as minimizing or avoiding massive waste storage facilities, which are often associated with the risks of geochemical and physical (in)stability over time and have been the cause of some of the most severe environmental disasters of humankind. [2,27,28]

Prevention of extractive waste generation and the use as by-products

In order to reduce the generation of extractive waste as much as possible, it is necessary to focus on the source of generation. For example, by establishing appropriate equipment and technology changes during the extraction of mineral resources, pre-sorting of materials can be undertaken to maximise the alternative uses of the extracted materials and minimise the amount of extractive waste to be deposited.
The total amount of extractive waste generated during mineral resources extraction is the result of the extractive process itself (including for example the mineral processing), technological possibilities and the economic context (the cut-off grade might vary depending on energy price, commodity price, etc.). Hence, operators in charge of extractive waste management might not always have a direct influence on the quantities and properties of extractive waste generated during the extraction process. [29]

Three main options exist to reduce the total amount of extractive waste to be deposited:

- Placing back materials into excavation voids
- Use of materials for internal purposes
- Use of materials for external purposes (e.g. as secondary raw materials): This option includes, for example, aggregates used in earthworks and infrastructure construction, hydraulic engineering, landfill construction or as products (for example as raw materials in different

applications such as cement production, tiles or brick manufacturing, soil amendment), when complying with Regulation *(EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011* laying down harmonised conditions for the marketing of construction products and repealing *Council Directive 89/106/EEC.* [29]

In the past, some attempts have been made to give mining waste a second life, and its suitability for certain applications has also been scientifically proven. However, a serious implementation of the research results and a use of mining waste has been impeded by the fact that:

1) these residues must be technically and economically competitive with conventional materials and
2) they were residues, rather than by-products that required their own optimisation to achieve specific properties during mineral processing.

After a series of catastrophic failures of mine tailings storage facilities in recent years that left severe environmental, social, economic, and human costs, the United Nations Environment Programme, International Council on Mining and Metals and the Principles for Responsible Investment introduced a new Global Industry Standard on Tailings Management. This and other recent reforms of mining, environmental and waste policy mean that large volumes of mine waste, in particular tailings, now need to be managed differently in many places in the world.

Some well-known options for the reuse of mine waste include feedstock for cement, bricks, tiles, and ceramics; aggregates for concrete, roads and other construction related applications; agricultural use such as soil amendments, pH control, and fertilisers; and feedstock for the chemical industry, e.g. pigments, and sulphuric acid production. [2,30]

Many examples of the reuse of tailings and other mining waste can be found directly in the mining industry itself, and this is particularly relevant where there is a lack of suitable local construction materials. These include materials for road base materials, walls and embankments construction, fill and backfill materials for underground and open-cut mines, landscaping reuse and rehabilitation of mining areas and/or waste storage facilities. The quality of these materials when reused in the mine does not have to fully comply with the strict requirements that apply, for example, to civil construction, environmental regulations, agriculture and recreational land uses, etc.. [2]

The rising value of sand globally, the costs of storing mining residues, and the possibility of optimising mineral processing circuits for both primary commodities and “ore-sand” may give new impetus to circular economy synergy with the potential for a strong contribution to sustainable development. “Ore-sand” is a type of processed sand sourced as a co-product or by-product of mineral ores.

Critical factors for both recycled aggregates and the use of mining waste as a new source of aggregates are primarily economic and technical. It will be also vital for the industry to overcome regional and national regulatory barriers and to work closely with its customers and "allies" to establish a robust sustainability agenda, including a holistic assessment of environmental and social impacts and risks. A change in the mining method and/or processing technique has a direct impact on the amount and type of mining waste produced, so that adjustments to waste management are necessary. Recovery of aggregates results in a decrease in the amount of overburden and tailings, but their physico-chemical properties also change. Accordingly, storage type, deposition method, water management, rehabilitation approach, long-term risk management and post-closure land use options need to be adapted, which can have both positive and negative impacts. [2]

Mineral ores as an alternative source of sand [2]

The reuse of mine waste as alternative construction materials has been known for a long time. To date, however, most examples at scale refer to the reuse of wastes as alternatives to crushed rock and gravel size materials, mainly for road construction, and not sand.

When regenerating and exploiting sand from mining waste, the following aspects deserve special attention:

- Ore-sands are a new input material that comes from an unconventional source for the aggregates market. While there is currently no perfect solution to substituting sand in concrete, this material offers some potential worth exploring.

- The recovery and use of this material require some degree of process innovation within mining companies (crushing, upgrading, tailings management, as well as within the use sectors, depending on the application for which naturally extracted sand is being substituted.

- Diffusing technical and process innovations for ore-sand will require changes in policy, legislation, sourcing and use practices, and a transformation of the operating environment for aggregates sourcing and use.

Main questions/challenges for “ore-sand” still remain:

- What proportion of naturally-sourced sand and gravel can be replaced in concrete and construction applications?
- Who are the major private sector entities willing to take a lead in changing the status quo?
- What other “green concrete” alternatives are there currently under consideration?
- Limitations of mine tailings (direct) reuse in comparison with ore-sands
- Potential contaminants in sand recovered from different mineral ores and other associated risks
- Possible changes in the management of (residual) tailings
- Potential to impact or displace existing sand producers from the introduction of ore-sands
- Transportation distances from mines to markets (i.e. in comparison to primary sourced materials) and their economic and environmental costs, see *Figure 39* and *Figure 40*.

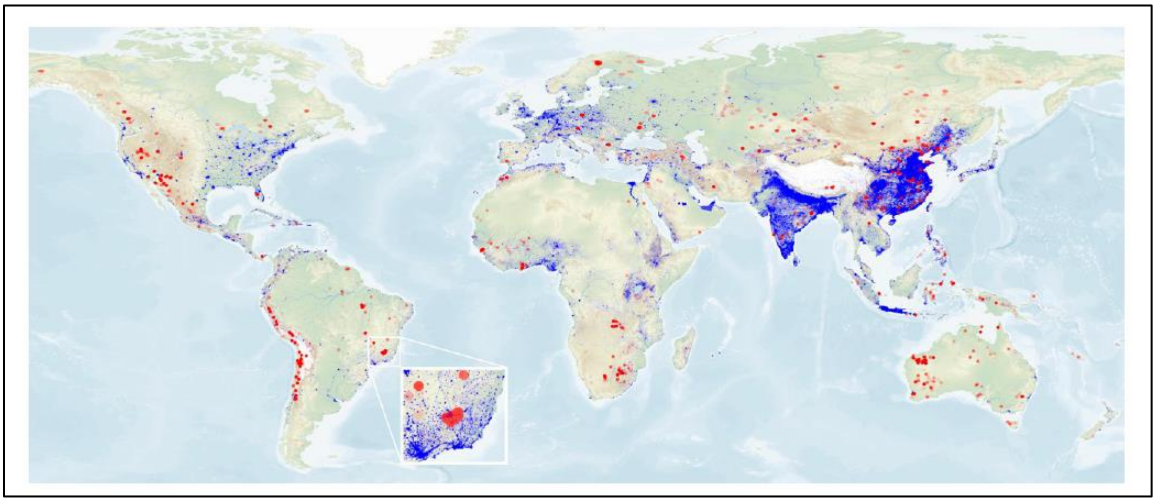


Figure 39 - A Comparison between the demand for sand and aggregates (BLUE) and the potential supply of alternative aggregates from mineral ores (RED) – (Note: The potential supply pounts are shown as points with a radius of 50 [km], a typical distance over wich transporting sand is economic.) (Source: [1])

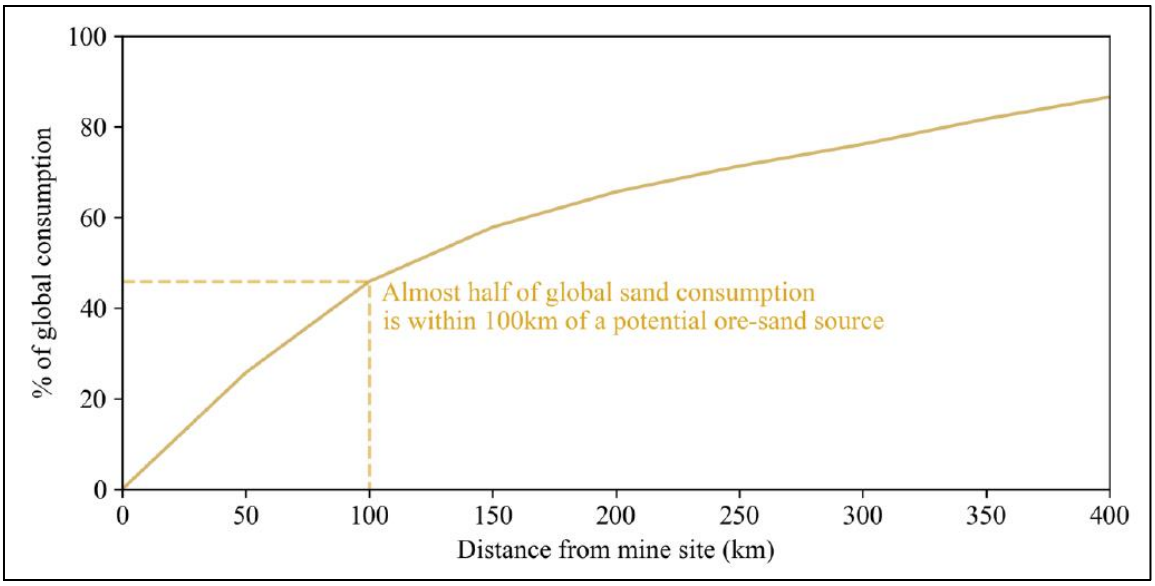


Figure 40 - Comparison between the location of demand for aggregate and sand, and the location of mining projects (Source: [1])

In summary, whilst manufactured aggregates from slags and fly ashes have been used for many years now, manufactured aggregates from tunnel excavation and mining waste have only been used in niches. However, given their large volumes and increasing environmental and societal pressures mean that tunnelling and mining companies will increasingly be under pressure to find (better) solutions for these waste materials. It is therefore suggested for Aggregates Europe - UEPG and member companies to keep this topic on the radar and indeed potentially play a proactive role in finding solutions rather than having to respond when others do so.

APPENDIX B1 & B2 – SECONDARY AGGREGATES – COUNTRY PROFILES

6. ENVIRONMENT & SUSTAINABILITY

Environmental pressures, i.e. associated with rising temperatures and climate change such as droughts, heatwaves, floods or storms have certainly been high on the agenda in recent years. Whilst they might have been side-lined recently by a number of other crisis such as Covid 19 or the invasion of Ukraine by Russia, or related inflationary pressures especially in Europe, the underlying need to change our economic system, i.e. our energy system, has not changed at all.

The extractive industry is and will continue to be a key player in the sustainability transformations needed in the coming years and decades. **Two crucial aspects that will need to be addressed are i) the switch from a fossil fuel-based energy system / economy to a materials-based, low carbon energy system / inclusive and circular economy where ii) the provision of these materials needs to be sustainable.** In the EU, the European Commission wants to establish such an economy via the Green Deal.

The European Green Deal [31]
With the *European Green Deal Communication (2019)*[11] the EU has launched a new growth strategy with the aim of improving the quality of life of current and future generations, based on a modern, resource-efficient and competitive economy with zero net greenhouse gas emissions by 2050 and where economic growth is decoupled from resource use. Another objective is to protect, preserve and even enhance the EU's natural capital in order to protect the health and well-being of citizens from environmental risks and impacts. The European Green Deal commits the Commission to review measures to fight pollution from large industrial installations and to consider how they can be fully integrated with climate, energy and circular economy policies. The European Green Deal includes the following actions:

- The proposal for a Regulation establishing the framework to achieve climate neutrality by 2050 and amending Regulation (EU) 2018/1999 (*European Climate Law*)[12] (March 2020). Reaching this target will require actions by all sectors, including investing in environmentally-friendly technologies and supporting industry to innovate.
- The adoption of the *European Industrial Strategy*[13] (March 2020), whose main drivers to empower industry and SMEs (Small-Medium Enterprises) are the green transition *(European Green Deal*), the digital transition[14] (*European digital strategy*), and the competitiveness on the global stage.
- The proposal of a *Circular Economy Action Plan*[15] (March 2020), with actions to design sustainable products and to further promote circularity in industrial processes in the context of the review of the IED (*Industrial Emissions Directive*).
- The presentation of the *European Biodiversity Strategy for 2030*[16] (May 2020), which is aimed at establishing protected areas, restoring degraded ecosystems and addressing the global biodiversity crisis.

[11] COM(2019) 640 - https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf *(05.12.2022)*
[12] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588581905912&uri=CELEX:52020PC0080 *(05.12.2022)*
[13] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-industrial-strategy_en *(05.12.2022)*
[14] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age_en *(05.12.2022)*
[15] https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf *(05.12.2022)*
[16] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/eu-biodiversity-strategy-2030_en *(05.12.2022)*

- A new *Zero Pollution Action Plan for water, air and soil*[17] (presented in 2021), which is aimed at preserving biodiversity and reducing pollution in water, reviewing air quality standards, reducing pollution from industrial installations, improving prevention of accidents and presenting a new chemicals strategy for sustainability for a toxic-free environment.
- A commitment to review EU measures to address pollution from large industrial installations and how to make them fully consistent with climate, energy and circular economy policies. Among others, the extractive industry has been identified as a sector where improvements might be possible.

Figure 41 - The European Green Deal (Source: European Commission)

Environmental Impacts of Aggregates Extraction and Use

In the context of sustainability, the extraction and use of aggregates has of cause environmental, but also social and economic impacts, which are described in Chapter 6.3 (Social Aspects).
Table 2 gives an overview of the environmental impacts during the life cycle stages of aggregates. These are well known by now and are therefore not further described in this report.

What was however not possible as part of this study was the quantification of these impacts. It is recommended that Aggregates Europe - UEPG, in addition to its current collection of socio-economic data from its members establishes a scheme over the next years to also collect environmental data to at least the same level of accuracy.

[17] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/eu-biodiversity-strategy-2030_en *(05.12.2022)*

Table 2 - Direct and Indirect Environmental Impacts of Aggregates Extraction and Use (Source: [8])[18]

	Direct Impact	Indirect Impact
Extraction phase	• Resource depletion • Irreversible landscape alterations • Noise, air and water pollution • vibrations • Impacts on groundwater, biodiversity and biochemical cycles • Energy use for extraction processes and transport within the quarry • Emissions of energy use and transport within the quarry • Temporary land-use for quarrying	• Hidden flows (excavation, overburden)
Processing phase and transport		• Energy use and emissions • Transport of aggregates from quarry to manufacturer • Production of concrete, asphalt, etc. • Transport from manufacturer to construction site • Construction processes
Use phase (construction)		• Land-use for build-up area: soil sealing, land filling • Energy use and emissions through use and maintenance of buildings and infrastructures • Land filling
Demolition phase and recycling		• Energy use and emissions through transport from demolition site to recycling company and sorting of materials

The environmental relevance of aggregates is a combination of the environmental impact of their extraction, the high volume of use and the expected increase in demand in the future. Despite comparatively long utilization phases, all construction minerals will ultimately end up as waste. Resource extraction, production chains, life cycle impacts, waste generation and recycling measures require deeper analysis in connection with socio-economic and sectoral prospects. It is clear that the aggregates industry and their supply to construction activities are crucial for a sustainable resource economy in Europe, in particular in relation to the EU thematic strategy and the Lisbon agenda of decoupling GDP growth from resource use. [8]

Collection of available techniques for the prevention or reduction of environmental impacts in non-energy extractive industries (NEEI) [31]

The sustainable production of raw materials from EU sources is the second of the three pillars of the EU *Raw Materials Initiative* (RMI)[19]. While the overall potential of non-energy mineral resources in Europe is strong, the access to these resources is becoming more and more difficult, thereby increasing

[18] *exploration, development and (post-) closure phase of the quarry operation are not shown in this chart*
[19] European Commission, 2008. Communication from the Commission to the European Parliament and the Council, The raw materials initiative - meeting our critical needs for growth and jobs in Europe

EU dependency on imports. This was addressed in the *European Innovation Partnership on Raw Materials Strategic Implementation Plan* (EIP-RM SIP) under "*Priority Area II.A: Improving Europe's raw materials framework conditions*" where three priority areas were defined [32]:

- II.1: Minerals policy framework
- II.2: Access to minerals potential in the EU
- II.3: Public awareness, acceptance and trust

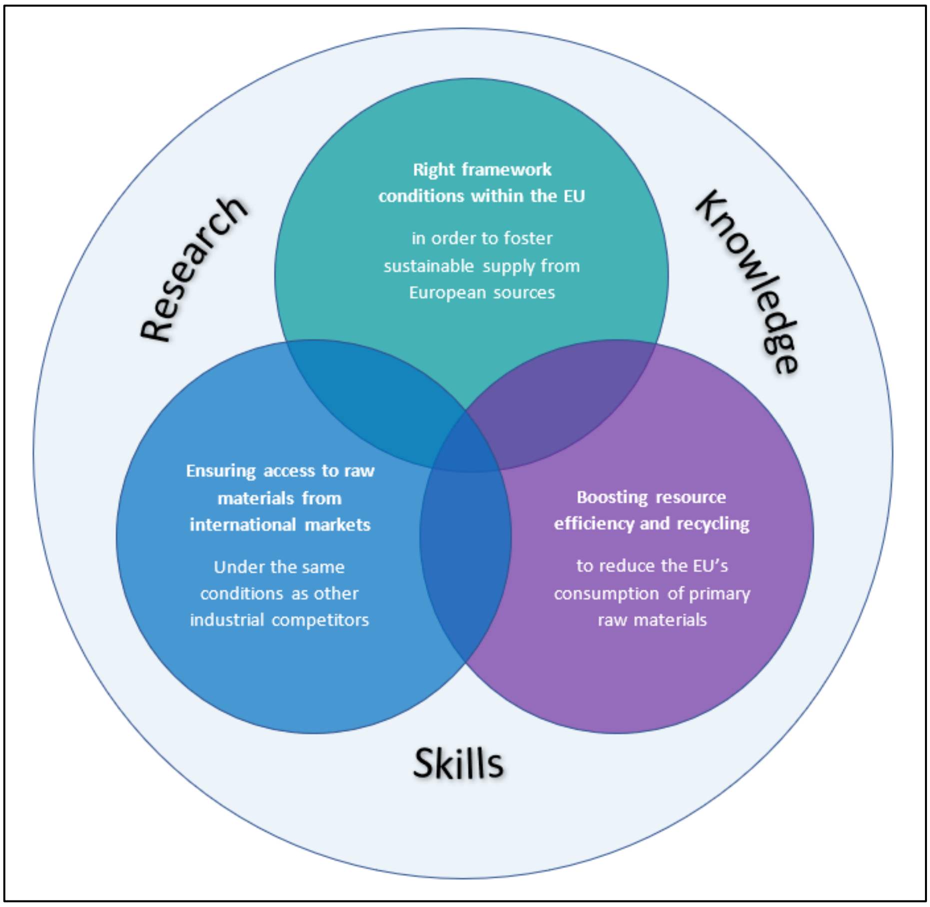


Figure 42 - Key elements of the EU's RawMaterials Initiative (Source: own illustration; [32])

In the *EIP-RM SIP Implementation document* (2016)[20] it was indicated that the level of implementation for "*Priority area II.A*" was "very limited". The situation has improved since 2016, but it is still far from the targets set in the EIP-RM SIP. Great potential for improvement lies in the accessibility and centralised collection of information. Thus, it is often difficult or even impossible to gain access to the appropriate information, which subsequently blocks the improvement of resource management, the streamlining of permitting procedures and public awareness work.
It is generally acknowledged that **B**est **A**vailable **T**echniques (BAT) **Ref**erence Documents (BREFs) contribute to increasing environmental protection and sustainable development of industrial sectors, while providing more predictability for the industry during the permitting process.

[20] https://ec.europa.eu/growth/sectors/raw-materials/eip/strategic-implementation-plan_en *(05.12.2022)*

The *Joint Research Centre* (JRC), in cooperation with DG GROW is carrying out an action on the *"Implementation of framework conditions for non-energy minerals"* for the project *"RM-EIP II - Support for raw materials policy"* in the framework of the *European Innovation Partnership* (EIP) *for Raw Materials* (RM). Part of this action is the study *"Collection of available techniques for the prevention or reduction of environmental impacts in Non-Energy Extractive Industries (NEEI)"* [31], which aims to provide an overview of existing documents and information on available techniques considered relevant by stakeholders and their categorisation. This study also includes an assessment of the key environmental issues.

Preliminary assessment of the KEI (Key Environmental Issues)

Table 3 gives an overview of the KEIs for NEEI. As can be seen, solid particle emissions to soil and water, various air emissions, noise, vibrations, the impact on biodiversity and land use, together with safety, which was also assessed, are considered of high importance for the extraction of construction materials. For the treatment phase, the number of high importance impacts reduces slightly, and transport and storage show none.

Table 3 - Summary of the KEI for extraction / treatment / transport & handling / storage [21]

Extractive activities	Extractive activity types	Sector	Safety			Em. to soil & gr.	Emissions to surface water					Emissions to air			Other emissions			Biodiversity & land use			Consumption			Haz. mat.
			Structural stability	Physical stability	Chemical stability	Diffuse and channelled emissions	Anion contaminants	Acidity and dissolved substances	Suspended particles	Organic contaminants	Metals and metalloids	Dust	VOCs and other potential air pollutants	GHG and other comb. em.	Noise	Vibrations	Odour	Habitats, plants, wildlife	Visual footprint and landscape impacts	Impacts on materials assets and cultural heritage	Energy consumption	Water consumption	Reagents and auxiliary materials	Lubricants, fuels, chemicals (incl. Cyanide)
Extraction	Surface	Construction minerals										A			A							A		A
Treatment	Comminution (size reduction, e.g.crushing &	Construction minerals	A COS			A COS			A COS			A COS									A	A COS		
Transport & handling	Loading & unloading	Construction minerals							A COS			COS												
Transport & handling	Hauling	Construction minerals							A COS															
Storage	Storing (temporary storage)	Construction minerals				A COS						A COS												

— Grey: *not covered*, i.e. there is no aggregated impact in relation to the specific environmental issue and parameter. The combinations falling under the grey coloured category are combinations of activities and mineral resources that in reality do not occur and/or activities for which the specific aggregated environmental impact in the EU is considered as not significant.

— Green: *low importance (1)*, i.e. the environmental issue is not relevant for the activity; although an aggregated impact could occur, this is considered as small or trivial for the activity in the EU extractive sub-sector.

— Amber: *medium importance (2)*, i.e. the environmental issue is relevant for the activity, the aggregated impact is considered as medium for the activity in the EU extractive sub-sector.

— Red: *high importance (3)*, i.e. the environmental issue is very relevant for the activity, the aggregated impact is considered as high for the activity in the EU extractive sub-sector

[21] *A = aggregates; COS = construction and ornamental stones*

Figure 43 shows a summary of the weighted scores for all phases for construction[22] minerals. They score highest (high and medium scores) on dust emissions, noise and vibrations, emissions to surface water (TSS[23]), structural stability and emissions to soil and groundwater.

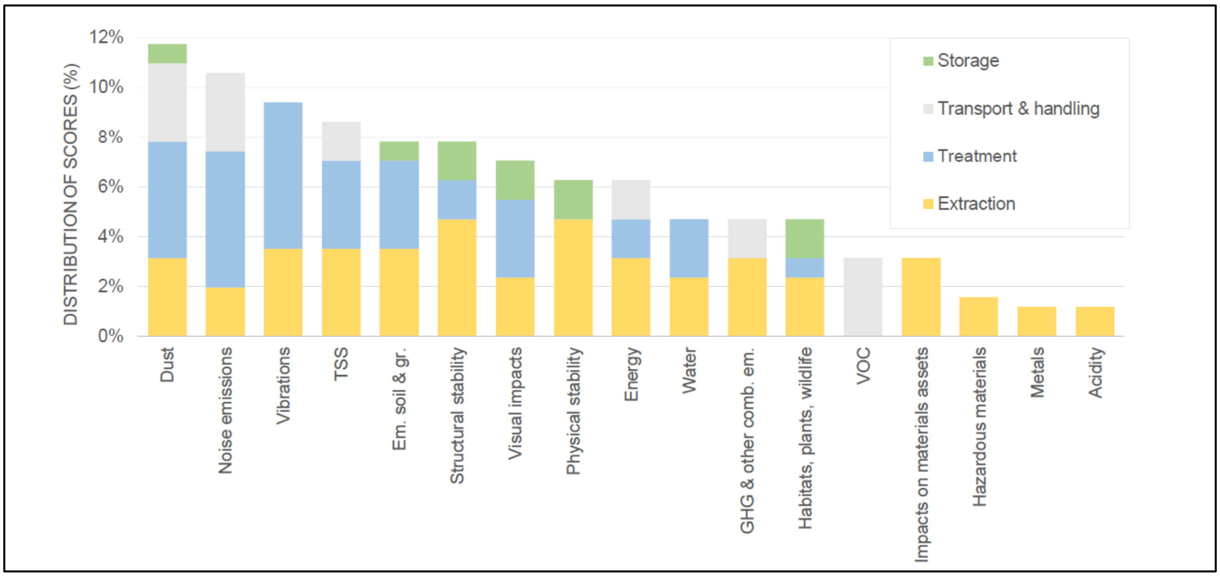


Figure 43 - Distribution of total weighted medium (2) and high (3) scores across the environmental issues for the extractive activities: Construction minerals (Source: [31])

- Especially during surface and subsurface extraction as well as during the comminution, size control and physical separation processes, the highest aggregated impact scores can be observed for both aggregates and construction and ornamental stones. The high and medium aggregated impacts during extraction are observed across a range of environmental issues, e.g. in decreasing order: stability issues (structural and physical), vibrations, emissions to groundwater and surface water (TSS), dust emissions, and energy consumption etc. The high and medium aggregated impacts during treatment processes relate to, in decreasing order of KEI scores, vibrations, noise emissions, dust emissions, emissions to surface water (TSS) and emissions to soil and groundwater.

- Though the extraction of aggregates and of construction and ornamental stones leads to similar levels of emissions to air and surface water, in general, it is considered that the treatment of aggregates could lead to higher levels of emissions to air (dust), noise and vibrations (comminution, size control and physical separation).

Table 4 gives a summary of the KEI and also lists prevention and reduction techniques on how to address them.

[22] Typical construction minerals are aggregates (sand, gravel, and crushed natural stone), various brick clays, gypsum, and natural ornamental or dimension stone. The demand for construction minerals is generally high (https://ec.europa.eu/growth/sectors/raw-materials/related-industries/minerals-and-non-energy-extractive-industries/construction-minerals_en) *(05.12.2022)*

[23] Total suspended solids (TSS) is the dry weight of suspended, undissolved particles in a water sample.

Table 4 - Overview of the Key Environmental Issues (KEI) in non-energy extractive industries and Prevention or Reduction Techniques (PRT) to address them (Source: [31])

KEI	PRT group	PRT No.	PRT title	Cross reference (secondary KEI)[24]
Generic PRT				
All KEI	Corporate management	PRT001	Organisational and Corporate Management System	
		PRT002	Environmental Management System	
	Information and data management	PRT003	Extractive site characterisation (incl. Baseline study)	
		PRT004	Extractive activities options	
		PRT005	Environmental Impact Assessment	
		PRT006	Public and community engagement	
		PRT007	Environmental monitoring programmes	
Risk-specific PRT ensure **SAFETY (STABILITY)**				
Structural stability, and related adaption to climate change	Design for closure	PRT008	Design for closure	
	Additional Organisational and Corporate Management tools	PRT009	Additional Organisational and Corporate Management tools	
	Ground investigation	PRT010	Ground investigation	
	Selection of extraction methods	PRT011	Selection of extraction methods to ensure structural stability, and related adaptation to climate change, in the long term	
	Developing blasting schedules	*PRT012*	*Developing blasting schedules*	*PRT107*
	Water management	PRT013	Water management	
		PRT014	Drainage systems	
	Geotechnical analysis and monitoring	PRT015	Geotechnical analysis	
		PRT016	Geotechnical monitoring	
		PRT017	Geotechnical conformance checks and audits	
Physical stability	Backfill stabilisation techniques	PRT018	Stabilisation of the backfill material	
	Backfilling	PRT019	Backfilling	
Chemical stability	Prevention or minimisation of pollutant leaching	PRT020	Automatic cyanide control	
		PRT021	Reduction of cyanide use	
		PRT022	Pre-aeration of the ore	
		PRT023	Monitoring cyanide concentrations	
	Prevention or minimisation of Acid Mne (or Rock) Drainage (AMD/ARD)	PRT024	AMD/ARD management strategy	
		PRT025	Conceptual site model of AMD processes	
		PRT026	Desulphurisation/sulphuric acids onsite production	
		PRT027	*Progressive rehabilitation*	*PRT043*
		PRT028	*Permanent dry covers*	*PRT045*
		PRT029	*Permanent free water and wet covers*	*PRT046*
Stability	Monitoring of physical and chemical stability	PRT030	Monitoring of physical and chemical stability	

[24] *Indication of cress references in italics*

KEI	PRT group	PRT No.	PRT title	Cross reference (secondary KEI)
Risk-specific PRT for the prevention or minimisation of **EMISSIONS TO SOIL AND GROUNDWATER**				
Diffused and channelled emissions to soil and groundwater	Soil management	PRT031	Soil management	
	Explosives management	PRT032	Nitrogen and explosives management	
	Basal structures and physical barriers	PRT033	Impermeable natural soil basal structure	
		PRT034	Impermeable artificial structure	
		PRT035	Secondary containment	
	Water management	PRT036	*Water management*	*PRT013*
		PRT037	*Hydrologic control*	*PRT061 (part of it)*
		PRT038	*Recycling of water*	*PRT060*
		PRT039	*Diversion of water run-off systems*	*PRT062 (part of it)*
		PRT040	*Drainage systems*	*PRT014*
		PRT041	*Landscaping and geomorphic reclamation*	*PRT119*
		PRT042	*Water treatment techniques*	*PRT063, 078*
	Covering	PRT043	Progressive rehabilitation	
		PRT044	Revegetation	
		PRT045	Permanent dry covers	
		PRT046	Permanent free water and wet covers	
	Heap bioleaching	PRT047	Heap bioleaching	
	Groundwater and soil pollution remediation	PRT048	Remediation of contaminated soil - Permeable Reactive Barriers (PRBs)	
		PRT049	Remediation of contaminated soil - phytoremediation	
		PRT050	Remediation of contaminated soil - stabilisation	
		PRT051	Remediation of contaminated soil - encapsulation	
		PRT052	Remediation of contaminated soil – soil washing	
		PRT053	Remediation of contaminated soil - thermal desorption	
		PRT054	Remediation of contaminated soil - (bio)venting	
		PRT055	Remediation of contaminated soil - natural attenuation or in-situ bioremediation	
		PRT056	Remediation of contaminated soil - composting	
	Monitoring of emissions to soil and groundwater	PRT057	Monitoring of emissions to soil and groundwater	
		PRT058	Leakage detection systems	
Risk-specific PRT for the prevention or minimisation of **EMISSIONS TO SURFACE WATER**				
Extractive Influenced Water (EIW) generation	EIW generation prevention or minimisation	*PRT059*	*Water management*	*PRT013*
		PRT060	Re-use or recycle the excess water	
		PRT061	Erosion and sediment control	
		PRT062	Stormwater management	
Suspended particles	Removal of suspended solids or suspended liquid particles	PRT063	Removal of suspended solids or suspended liquid particles	
Anions contaminants	Removal of anions contaminants	*PRT064*	*Oxidation based systems*	*PRT068*
		PRT065	*Reduction based systems*	*PRT069*
		PRT066	*Ion exchange*	*PRT073*
		PRT067	*Filtration of dissolved substances*	*PRT074*

KEI	PRT group	PRT No.	PRT title	Cross reference (secondary KEI)
Metals and metalloids	Removal of metals and metalloids	PRT068	Oxidation based systems	
		PRT069	Reduction based systems	
		PRT070	Chemical precipitation	
		PRT071	Co-precipitation with chloride or sulphate metal salts	
		PRT072	Adsorption	
		PRT073	Ion exchange	
		PRT074	Filtration of dissolved substances	
Organic contaminants	Removal of organic contaminants	*PRT075*	*Oxidation based systems*	*PRT068*
		PRT076	*Adsorption*	*PRT072*
Acidity and dissolved substances	Removal of acidity and dissolved substances	PRT077	Active neutralisation	
		PRT078	Passive neutralisation	
Emissions to surface water	Monitoring of emissions to surface water	PRT079	Monitoring of emissions to surface water	
Risk-specific PRT for the prevention or minimisation of **EMISSIONS TO AIR AND RELATED CLIMATE IMPACTS**				
Dust	Prevention or minimisation of dusting from blasting	PRT080	Planning and design of blasting	PRT105
	Prevention or minimisation of dusting from exposed surfaces	PRT081	Water or water-based solutions spraying of exposed surfaces	
		PRT082	Wind protection systems	
		PRT083	*Reduction and minimisation of exposed surfaces*	*PRT043, 044, 045, 046, 061, 119*
	Prevention or minimisation of dusting from equipment, roads and facilities	PRT084	Enclosing equipment and facilities	
		PRT085	Water or water-based solutions spraying of exposed surfaces	
		PRT086	Road and equipment maintenance	
		PRT087	Organisational techniques for transport and handling	
	Prevention or minimisation of dusting from channelled emissions	PRT088	Air collection - dust emissions	
		PRT089	Treatment of channelled dust emissions	
Volatile Organic Compounds (VOC) and other potential pollutants emissions	Prevention or minimisation of emissions of VOC and other potential air pollutants	*PRT090*	*Nitrogen and explosives management*	*PRT032*
		PRT091	Advanced explosive techniques and alternatives to blasting	
		PRT092	Treatment of channelled VOC and other potential air pollutants emissions	
Greenhous Gases (GHG) and other combustion emissions	Prevention or minimisation of GHG and other combustion emissions	PRT093	Decarbonisation	
		PRT094	Increased equipment efficiency	
Emissions toair	Monitoring of air emissions	PRT095	Monitoring of dust, VOC, GHG and other combustions emissions	

KEI	PRT group	PRT No.	PRT title	Cross reference (secondary KEI)
Risk-specific PRT for the prevention or minimisation of **OTHER EMISSIONS**				
Noise	Prevention or minimisation of noise emissions	PRT096	Noise and vibration management plan	
		PRT097	Noise protection systems	
		PRT098	*Planning and design of blasting*	*PRT105*
		PRT099	*Staging the charges and blasting quantity*	*PRT106*
		PRT100	*Developing blasting schedules*	*PRT107*
		PRT101	Organisational techniques for noise reduction	
		PRT102	Noise insulation of equipment and facilities	
	Monitoring of noise emissions	PRT103	Monitoring of noise emissions	
Vibrations	Prevention or minimisation of vibrations	PRT104	Ground vibrations and overpressure control with appropriate drilling grids	
		PRT105	Planning and design of blasting	
		PRT106	Staging the charges and blasting quantity	
		PRT107	Developing blasting schedules	
		PRT108	Advanced initiation techniques	
	Monitoring of vibrations	*PRT109*	*Vibration control techniques for equipment and facilities*	*PRT102 (part of it)*
	Monitoring of vibrations	PRT110	Monitoring of vibrations	
Odour	Prevention or minimisation of odour emissions	*PRT111*	*Odour treatment techniques*	*PRT043, 044, 092*
	Monitoring of odour emissions	PRT112	Monitoring of odour emissions	
Risk-specific PRT for the prevention or minimisation of **BIODIVERSITY AND LAND USE IMPACTS**				
Habitats; plants and wildlife	Prevention or minimisation of impacts on habitats, plants and wildlife	PRT113	Ecological survey	
		PRT114	Strategy for terrestrial habitat preservation	
		PRT115	Strategy for aquatic habitat preservation	
		PRT116	Soil conservation measures	
		PRT117	Other measures for minimisation of biodiversity and land use impacts	
		PRT118	Rehabilitation techniques	
		PRT119	Landscaping and geomorphic reclamation	
Visual, footprint and landscape impacts	Prevention or minimisation of visual, footprint and landscape impacts	PRT120	Topographical and land surveys	
		PRT121	Visual barriers	
		PRT122	*Visual impact optimisation*	*PRT043, 119 (part of it)*
Impacts on material assets and cultural heritage	Prevention or minimisation of material assets impacts	PRT123	Cultural heritage assessment	
		PRT124	Minimise adverse impacts and implement restoration measures	
		PRT125	Community consultation, engagement and protection	

KEI	PRT group	PRT No.	PRT title	Cross reference (secondary KEI)
Risk-specific PRT for the prevention or minimisation of **CONSUMPTION**				
Energy consumption and related contribution to climate change	Prevention or minimisation of energy consumption	PRT126	Energy use: balance, reporting and audit	
		PRT127	Benchmarking - Best Truck Ratio (BTR) assessment tool	
		PRT128	Generic energy consumption reduction techniques	
		PRT129	Operational energy consumption reduction techniques	
		PRT130	Optimisation of crushing and grinding processes	
		PRT131	Optimisation of material flow	
		PRT132	Friction reduction and wear protection	
		PRT133	Mine automation	
		PRT134	Digitalisation	
		PRT135	*Decarbonisation: Renewable energy - solar*	*PRT093*
Water consumption	Prevention or minimisation of water consumption	*PRT136*	*Water management*	*PRT013*
		PRT137	Water consumption reduction measures	
		PRT138	Water recovery techniques	
Reagents and auxiliary materials	Prevention or minimisation of reagents and auxiliary material consumption	PRT139	Auxiliary materials recovery techniques	
		PRT140	Design, inspection, maintenance of storage tanks	
Risk-specific PRT for the prevention or minimisation of **HAZARDOUS MATERIALS IMPACTS**				
Hazardous materials	Lubricants, fuels, chemical management	PRT141	Use minimisation of hazardous substances	
		PRT142	Elimination and substitution of hazardous substances	
		PRT143	*Nitrogen and explosives management*	*PRT032*
		PRT144	Mobile Manufacturing Units Explosives	
		PRT145	*Leakage detection systems*	*PRT058*
		PRT146	*Secondary containment*	*PRT034, 035*
		PRT147	Lubricants and fuel management	
	Cyanide management	PRT148	Cyanide management	
		PRT149	*Monitoring cyanide concentrations*	*PRT023*

Prevention or Reduction Techniques (PRT) and the European Green Deal commitments [31]

JRC's study *"Collection of available techniques for the prevention or reduction of environmental impacts in NEEI"* has already taken on board several European Green Deal commitments. More in detail, and in line with the proposed European climate law, the European Industrial Strategy and European Biodiversity Strategy for 2030, the following climate impact aspects have been considered:

1. Mitigation to climate change. This is covered under the following KEIs:
   - Emissions to air - GHG and other combustion emissions: *Examples of proposed PRT are decarbonisation (including electrification or fuel switching, including renewables) (PRT093) and increased equipment efficiency (PRT094).*
   - Energy consumption and related contribution to climate change: *Examples of proposed PRT are generic energy consumption reduction techniques (PRT128), operational energy consumption reduction techniques, optimisation of crushing and grinding processes (PRT130), optimisation of material flow (PRT131).*

2. Adaptation to climate change. This is covered under the following KEIs:
    - Structural stability, where more climate-resilient extractive activities, considering the risks of extreme floods, heavy rainstorms, landslides, during both the operational and the closure and after closure phases have been considered: *Examples of proposed PRT are selection of extraction methods (PRT011), water management (PRT013), drainage systems (PRT014), geotechnical analysis (PRT015) and geotechnical monitoring (PRT016).*

3. Achieving climate change mitigation benefits by helping to influence the carbon sink. This is covered under following KEIs:
    - Impacts on biodiversity and land: *Examples of proposed PRT are soil conservation measures (PRT116), rehabilitation techniques (PRT118) or landscaping and geomorphic reclamation (PRT119).*

Moreover, in line with the commitments of the *European Green Deal* and the new *Circular Economy Action Plan*, together with the indicative targets of the *Action Plan on Critical Raw Materials, resource efficiency and circular economy* aspects are considered in the JRC study. Extractive waste generation prevention and extractive waste reduction techniques, considering both waste and non-waste (by-products) materials were analysed in the following BATs:

- Prevention of solid extractive waste generation (BAT6):
    - *a) pre-sorting and selective handling of extractive by-products*
    - *b) placing extractive by-products back into excavation voids*
    - *c) using extractive by-products for internal or external purposes*
- Reduction of non-inert extractive waste and hazardous extractive waste generation (BAT7) by sorting and selective handling of extractive waste
- Recovery of extraction waste (BAT10).

Finally, resource efficiency and circularity were specifically tackled under the following KEIs:

- Physical stability: *An example of proposed PRT is backfilling (PRT019)*
- Emissions to soil and groundwater: *Examples of proposed PRT are soil management (PRT031) or progressive rehabilitation (PRT043)*
- Emissions to surface water – Extractive influenced water (EIW) generation: *Examples of proposed PRT are water management (PRT059, cross reference) or reuse or recycle the excess water (PRT60)*
- Water consumption: *Examples of proposed PRT are water management (PRT136, cross reference), water consumption reduction measures (PRT137) or water recovery techniques (PRT138)*

JRC's study *"Collection of available techniques for the prevention or reduction of environmental impacts in NEEI"* provides an in-depth overview of the currently available techniques for the prevention or reduction of environmental impacts in NEEI.[25]

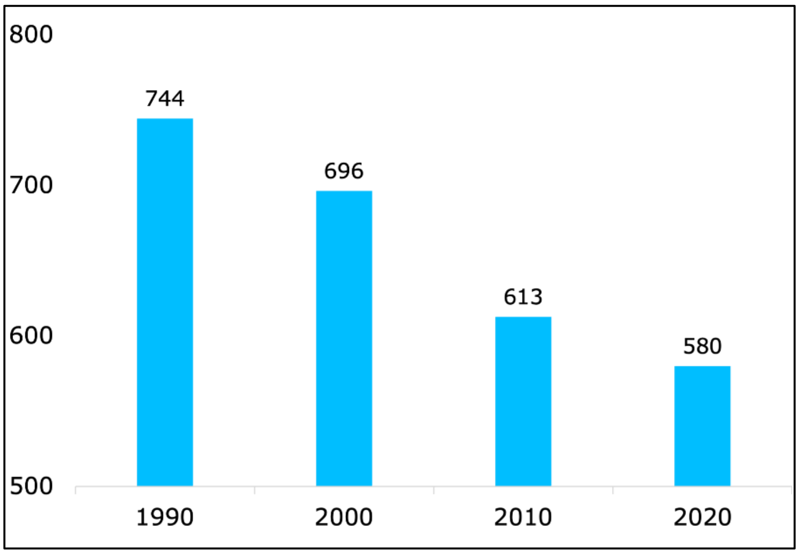
[25] *Note: The reported techniques in JRC's study have been collected and assigned into categories, without an evaluation of their actual contribution to the prevention or reduction of negative impacts on the environment from non-energy extractive activities. As stakeholders suggested, the study and particularly the Annexes, can be used as an interactive screening toolkit of PRT that may apply depending on the site-specific conditions.*

The aggregate industry and its downstream products

The energy use for the extraction processes of aggregates is comparatively low[26]. Most of the energy use and emissions result from transport within quarries, from quarries to local customers and to the location sites for further processing.

In contrast to this, the average water consumption for the production of aggregates is very water intensive. Energy and emission intensity rise with any further production step along the life cycle. As aggregates are raw materials for diverse production processes and application areas, their different production stages and application areas generate severe indirect environmental impacts. Two products are of particular importance in the context of energy and emission issues of the basis material aggregates: concrete and cement. Concrete is the most important building material in the world. [8]

The average production of concrete worldwide is about 1.8 m³ per capita/year (2020) and the average production of cement worldwide is about 0.5 t per capita/year (2020).[27] About 70–80% of concrete consists of aggregates. A further 10–15% of the concrete contains cement. The application of concrete, requires the input of cement, which is regarded as an important parameter in respect to energy use and CO_2 emissions for aggregates. [8] The production of one [kg] cement produces about 0,58 [kg] CO_2 emissions (= 580 [kg] CO_2 / [t] cement) *(Figure 44)*[28]. Therefore, the production processes of downstream products are decisive, not because they are under the responsibility of the aggregates industry but because of their relevance for the building sector and their indirect impact related to aggregates.



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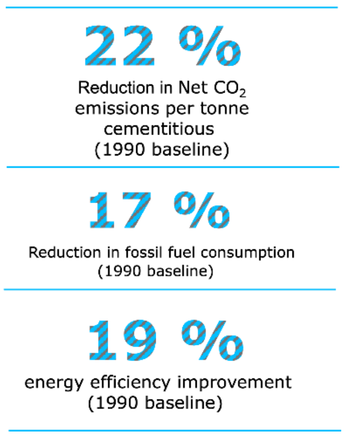


Figure 44 – Net [kg] CO_2 / [t] cement (2020) (Source: GCCA)*

Comparatively few CO_2 emissions are caused by the production of 1 [kg]] of aggregates. On average, these amount to 0.005 kg of CO_2 per kg of aggregates (= 5 [kg] CO_2 / [t] aggregates).

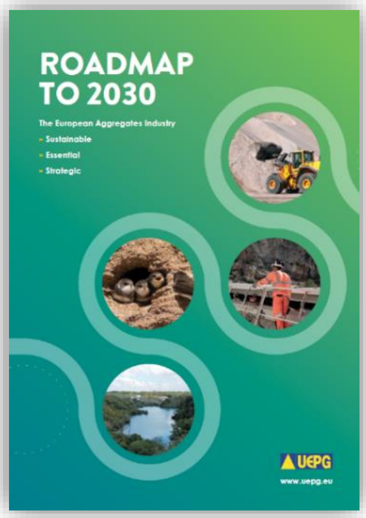
[26] *This statement applies to the extraction and production of construction raw materials, but not to the production of binders such as cement, as these require a much higher degree of grinding and are therefore very energy-intensive.*

[27] https://gccassociation.org/concretefuture/cement-concrete-around-the-world/ *(05.12.2022)*

[28] https://gccassociation.org/sustainability-innovation/gnr-gcca-in-numbers/ *(05.12.2022)*

[29] * https://gccassociation.org/sustainability-innovation/gnr-gcca-in-numbers/ *(05.12.2022)*

Aggregates Europe - UEPG ROADMAP TO 2030 [33] AND SUMEX PROJECT



In the Roadmap to 2030, published in September 2021, Aggregates Europe - UEPG shows the way for the European aggregate industry to respond to the challenges described above and to support the digital and green transition of the Euopean economy to climate neutrality by 2050.

Requirements/Needs:

- Sustainable access to local resources and optimising transport;
- Streamlined and efficient national land use planning and permitting policy;
- Regulations facilitating a Circular Economy, increasing resource efficiency;
- A level playing field through consistent implementation of EU law.

Targets:

- Responsible Sourcing and delivering high quality products;
- Improving public awareness for aggregates;
- Further expansion of the industry into a high-tech sector that offers attractive careers;
- Running a responsible environmental business policy;
- Supporting Biodiversity in both extraction and restoration;
- Prioritising the safety, health and well-being of employees and customers;
- Improving relations and communication with local communities to strengthen the "Social Licence to Operate";
- Expanding international exchange through the Global Aggregates Information Network (GAIN™) to support sustainability.

Aggregates Europe - UEPG is also a partner of the Horizon 2020 project SUMEX (*Sustainable Management of Extractive industries*), and as such played an active role in drawing up a sustainability framework for the European extractive industry, which should be implemented by 2050 (and as such going further than the Roadmap to 2030.

SUMEX sees legal compliance with all applicable legislation (local, regional, national and international) as the baseline and as a minimum requirement for companies in the extractive sector. But even in the EU, with member states with advanced economies, more or less well-developed democratic systems and strong governance of the extractive sector (i.e. through mining and environmental legislation), legal compliance does by no means equal sustainable management of the sector. In fact, governance systems are very diverse across Europe [34] and hence SUMEX suggests one common standard to describe what responsible extraction should mean in the EU: to use the *IRMA (Initiative for Responsible Mining Assurance) Standard* [35] to describe the criteria that a responsible extractive operation should fulfil today. In addition, SUMEX suggests for the industry to transition, aligned with the *European Green Deal*, from responsible extraction towards a future state of sustainable management, as expressed through the sustainability aspects described in *Figure 45* over a time period up to 2050, via the milestone of contributing towards achieving the Sustainable Development Goals (SDGs) in 2030. [36] Some of the goal descriptions contained in the aspects might be relevant earlier than in 2050 and there, action should not be pushed backwards.

These aspects describe key components of what sustainable management of the extractive industry should consider. They represent a set of topics (e.g. valuing social and natural capital, planning beyond the mine life) and goals (e.g. no bribes, zero greenhouse gas emissions), which have to be underlined with processes in order to get to such a state. The sustainability aspects consider the European Green Deal and its aspiration to transform the European economy to an inclusive, circular and carbon neutral economy in 2050. As already stated above they are a mixture of topics which should be considered as part of responsible mineral extraction in the present (e.g. emergency preparedness and risk management, diversity and anti-discrimination) and future aspirations (e.g. defining the role of extractives in a green economy, carbon neutrality) which the sector needs to move towards going forward. *Figure 45* gives an overview of the sustainability aspects in a temporal context.

[30]

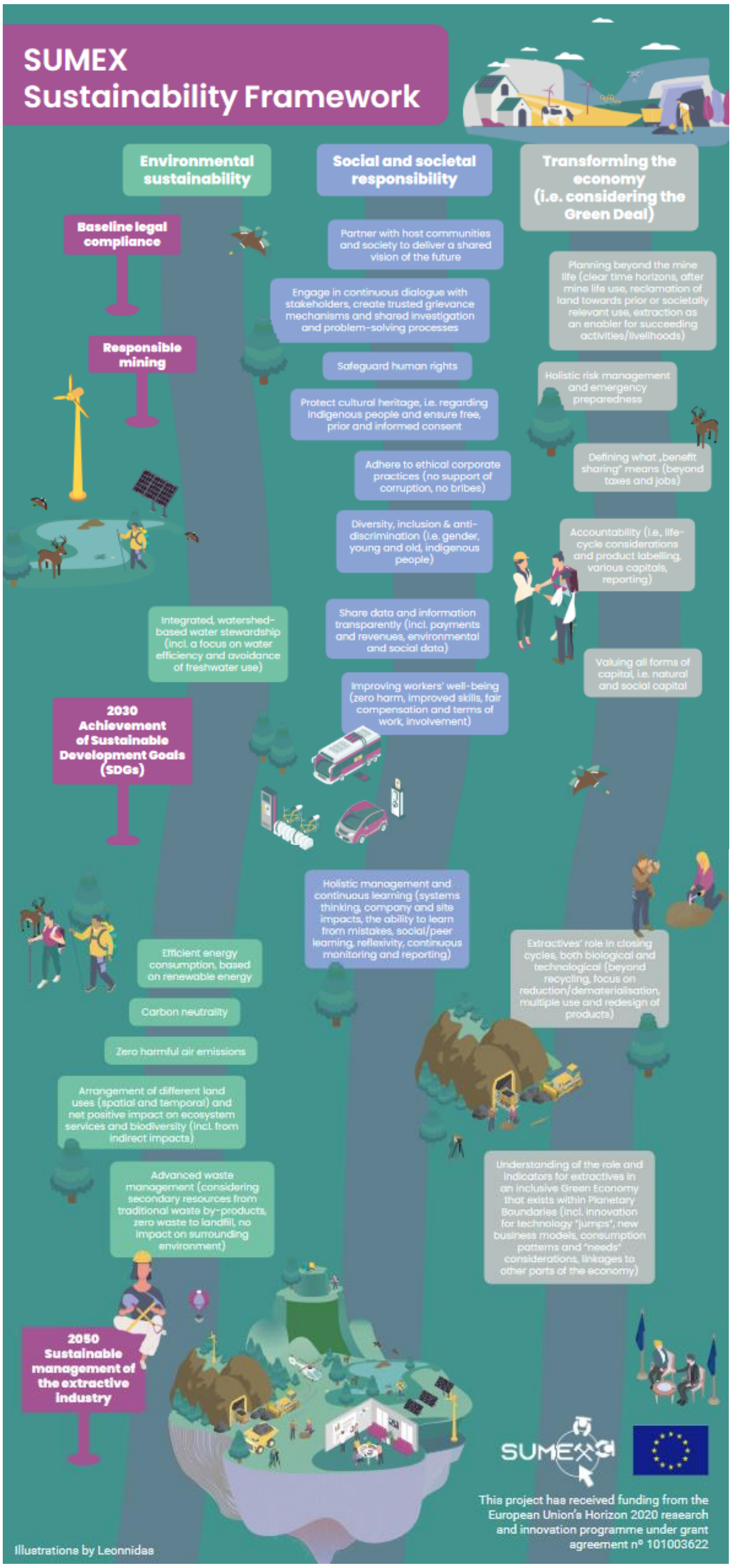


*Figure 45 – SUMEX Sustainability Framework (Source: SUMEX 2021 [36])**

[30] * https://www.sumexproject.eu/wp-content/uploads/2021/09/SUMEX_MUL_D_1.2_SD-criteria.pdf (05.12.2022)

Subsequently, the topics of transport, biodiversity, water and society/SLO are examined in more detail, as agreed in scope for this study. CO_2 and energy use are not dealt with in a separate chapter, although transport currently plays a strong role in CO_2 production (as does the aggregates downstream industry, i.e. cement).

6.1. TRANSPORT

Transport is a key element in the production and delivery of aggregates. Two main issues arise in this context: firstly, the environmental impacts of the supply of aggregates in the immediate vicinity of the quarry. Secondly, transport costs are a significant factor in the final delivery costs, as aggregates are generally low-value materials that are transported by road, rail and sea. [3]

The EU is largely self-sufficient in the supply of aggregates, but the production figures of the individual European countries vary strongly depending on the topography and geology. [8] Due to the wide distribution of aggregate minerals across the European Union, the high demand and their relatively low cost per tonne, the markets tend to be relatively close to the production sites. The economic transport radius by road is typically in the range of about 30-50 km[31]. In order to keep transport distances and the related transport costs as low as possible, a tight network of pits and quarries is necessary. However, it must be considered that even if transport distances are short, the frequency of journeys can still be very high. Some very large sites can also serve more distant markets, through a direct rail or port connection. [5] Sometimes smaller production sites also have larger transport distances, for example if there are no local/domestic sources of supply (e.g. in Poland or Romania > 100 km). [9]

International trade of aggregates is limited to local transactions across neighbouring countries, given the low value/weight ratio and relatively high transport costs. The total annual EU imports between 2012 and 2016 were on average 20.5 Mt, and the total annual exports between 2012 and 2016 on average amounted to 9.5 Mt. [9]

There is very little in the relevant literature on the impact of aggregate transport on the environment. [37] The survey used in this study also revealed that there are little to no records of aggregate transport in the countries, although all responses agree that 75-100% of aggregate transport is by road. The rest is split between rail and water (depending on the infrastructure available).

Furthermore, all respondents agree that there is currently no alternative to road transport, as the customers/destinations are far too dispersed and, in most cases, do not have a rail connection, and the rail network in general is far too poorly developed throughout Europe and often there are rail network capacity constraints (e.g. line capacity limitations, weight limits) [3] to offer an economically viable alternative. Transport by water is simply very limited by geographical conditions and economical only useful in a few countries like the Netherlands.

Transport issues are likely to increase in importance in the future: for example, communities will continue do ask for alternatives to road transport due to particulates and noise, CO_2 emissions will need to be cut due to climate change, rail borne traffic competes with passenger traffic on congested rail routes, and the port and wharf infrastructure should be able to take seaborne transports as well as have appropriate transport links to supply the markets. [3]

[31] Information based on data from UEPG (questionnaire)

The annual GHG emissions resulting from the use of aggregates (sand, gravel and crushed rocks) are estimated to be up to 1 billion tonnes of CO_2-equivalent per year *(considering 20 g of CO_2-equivalent per kg of sand, i.e. a value corresponding to the emissions of sand from open-pits and 100 km of delivery by truck)*. These represent between 0.3% and 2% of global annual GHG emissions, with the best estimate of 1%, which in turn represents half of the global emissions generated by the shipping industry. As aggregate consumption is projected to increase in the future due to population and income growth, it is even more important to consider in detail any measure to reduce GHG emissions. [2]

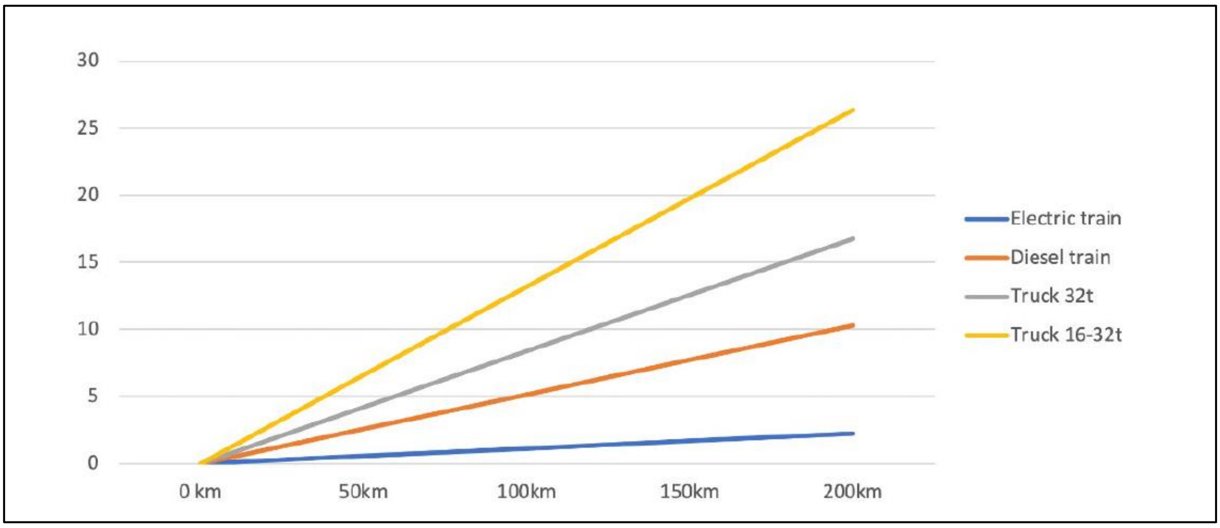


Figure 46 - GHG emissions from transportation in Brazil in [g] of CO2-equivalent / [kg] of freight (Source: [1])

Even though *Figure 46* refers to statistically recorded values from Brazil, these can certainly also be approximately applied to Europe, because according to the combustion reaction one litre of diesel produces about 2.65 [kg] of CO_2.

In terms of CO_2 emissions, the road transport sector is one of the main emitters. However, there are a number of possible options and technologies to reduce CO_2 emissions from road transport, such as electrification of vehicles, changes from road transport to railroad transport or other forms of transport such as belt conveyors or cableways, or the use of low-carbon fuels in vehicles such as natural gas, hydrogen, etc. [38]. Most of these solutions are not applicable to goods transport in the short term and the renewal of the current truck fleets will take time. As a result, the CO_2 emissions produced by goods transport will require some time to be reduced. [37]

6.2. BIODIVERSITY

Legal background [39]

The Birds[32] and the Habitats[33] Directives are the cornerstones of the EU biodiversity policy. These Directives have two main objectives:

- *protect rare and endangered habitat types and habitats of the species of European interest, including wild birds, in order to ensure their survival and restoration through designation of the Natura 2000 sites and appropriate management of the sites;*
- *protect species across the EU, both within and outside Natura 2000 network, through species protection provisions.*

The prohibitions by the Directives include the deliberate destruction of, damage to, having a significant negative effect on these species and their habitats. These cases classify as "*significant adverse effects*" in the meaning of the EIA Directive. Article 16(1) provides derogation clauses, which can be relevant for extractive projects:

> *"(b) to prevent serious damage, in particular to …. and water and other types of property;*
> *(c) in the interests of …. public safety, or for* ***other imperative reasons of overriding public interest****, including those of a social or economic nature and beneficial consequences of primary importance for the environment*".

Based on the directives, it is not explicitly forbidden to extract mineral raw materials in Natura 2000 areas (see also the relevant Guidance from the European Commission from 2012 on undertaking non-energy extractive activities in accordance with Natura 2000 requirements[34] [32]), it is the implementation of the directives in national legislation by the member states that currently often does so. The aggregates industry is well aware of this issue and has made biodiversity and land impact a priority, as described below.

Quarries: A positive contribution to biodiversity conservation

Non-energy extractive industries (NEEI) production sites and their activities can, if properly planned, actively contribute to biodiversity conservation. Especially when the extraction site is located in an already impoverished environment, the extraction industry can help to create new habitats for wildlife (e.g. new wetland areas for various amphibian species; cliffs as nesting opportunities for birds; habitat for insects and reptiles or disused shafts as shelter for bat populations). Some of these new habitats are located in areas of low nature conservation value and thus form important ecological corridors between core protected areas.
Species protected under the Birds and Habitats Directives are often found in former quarries which are therefore included in the Natura 2000 network:
The rehabilitation of quarries and mines is common practice in Europe today. Many of these renaturation projects aim to steadily increase wildlife habitats and biodiversity throughout the whole project cycle.

[32] Directive 2009/147/EC on the conservation of wild birds (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009L0147)
[33] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31992L0043) *(05.12.2022)*
[34] https://op.europa.eu/en/publication-detail/-/publication/69b6d6c1-bfc1-4fe5-9252-08af20a95cfe/language-en/format-PDF/source-search *(05.12.2022)*

In many companies, a biodiversity policy statement is already part of their overall strategies. Some also develop more detailed strategies and action plans to support biodiversity, evaluating in detail how individual measures can be implemented in practice at the sites. Numerous examples[35] of how resource extraction and nature conservation can go hand in hand exist (*Figure 47*). These projects are often supported by cooperation with nature conservation authorities as well as nature conservation organisations at national (e.g. in Germany and Austria) but also at international level. [32] [40]

Figure 47 - Numerous examples of how resource extraction and nature conservation can go hand in hand exist all over Europe (Source: Aggregates Europe UEPG)

[35] *See Appendix C for details*

Best Practice Case – BELGIUM

LIFE in Quarries [40]

For 6 years, from 2015 to 2021, the LIFE in Quarries project (LIFE14 NAT/BE/000364) has been demonstrating, developing and securing the potential for biodiversity in a regional network of 27 active extractive sites.

The main innovation of the project was to implement a «dynamic biodiversity management» strategy in 27 sites allowing the development of a quarries' network contributing to regional biodiversity conservation stakes while maximizing the extractive sector's contribution. This management model is based on an evolutionary system of creation and conservation of a network of temporary habitats, managed in parallel with the extractive activity, and aimed at maintaining environments suitable for the development of specific pioneer biodiversity. By enabling a better cohabitation between animal and plant species and the extractive activities, the LIFE in Quarries ensures the development of nature in active quarries.

Actions:

- *403 pioneer ponds set up*
- *30.75 hectares of pioneer grasslands under temporary protection*
- *403 shelters (Stones, stumps and sandpiles) were set up*
- *14 vertical faces and 18 sand banks (develop nesting sites) were managed*
- *143 permanent ponds*
- *682 metres of gently sloping banks lead to softening the slopes in order to facilitate reedbeds' installation*
- *30 floating platforms and an islet have been built*
- *108 hectares of open herbaceous habitats were restored on former spoil heaps and in sites' surrounding areas*
- *12 galleries have been secured for the long term*
- *created approximately 5 400 metres of linear screes (Raw material laid out in rows: dispersal corridors for reptiles) training of quarry staff*

Source: Aridós © nido-polluelo-buho-real

Rehabilitation and closure of extraction sites - Nothing ends without something new being born

Different stages of closure (not necessarily a time-wise sequence):
Rehabilitation during operation → decommissioning → closure → rehabilitation → monitoring and aftercare → re-use of the site.
The closure plan - in a broad sense, covering all the above activities - is an important element of the EIA showing the negative, as well as potential positive impacts of the project, especially the details on how the local society and economy can benefit from the re-instated land use capacities and ecosystem functions of the site. The closure plan increases the understanding of the long-term impacts and describes the measures to prevent and minimise these impacts. In addition, it facilitates the discussion on the objectives for the decommissioning process and how the area will be used after the quarry/mine is closed. [39]

EU Biodiversity Strategy for 2030 - Bringing nature back into our lives [41]

The EU Biodiversity Strategy for 2030 sets out a comprehensive package of commitments and actions to put Europe's biodiversity on the path to recovery by 2030 for the benefit of people, the planet, the climate and the economy, in line with the 2030 Agenda for Sustainable Development and with the objectives of the Paris Agreement on Climate Change. The Strategy aims to address the five main drivers of biodiversity loss and put in place an enhanced governance framework, as well as fill any policy gaps, while at the same time consolidating existing efforts and ensuring the full implementation of existing EU legislation.

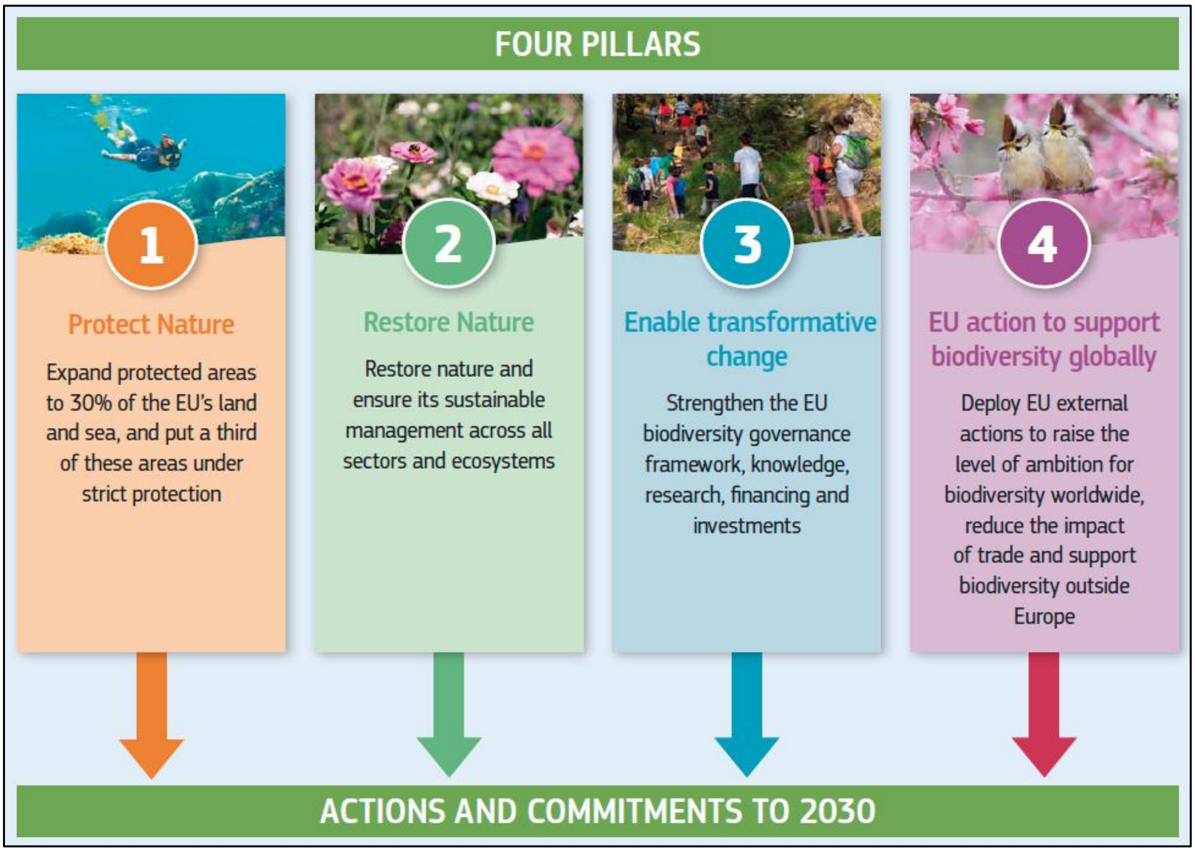


Figure 48 - The four pillars of the EU Biodiversity Strategy 2030 (Source: [41])

The EU Biodiversity Strategy 2030 will be another challenge for the extractive industry, i.e. given that protected areas are to be expanded to 30% of the EU's land and sea and that a third of these areas should be put under strict protection. Whilst extraction is currently not explicitly forbidden in Natura 2000 areas, it could again mean that various European countries will implement stricter rules in their national legislation, making it (next to) impossible to extract mineral raw materials in protected areas. It is therefore even more important for Aggregates Europe - UEPG and its members to continue its path towards biodiversity protection (i.e. making it an operational normality throughout all phases of a site, well beyond the current number of practise examples) and making the case that aggregate extraction and biodiversity can co-exist and that indeed the industry is making a significant contribution towards the second pillar of the Strategy, namely to restore nature and to ensure its sustainable management.

Source: Forum Mineralische Rohstoffe © Barbach

6.3. WATER

The summer of 2022 was (once again) one of the hottest on record in recent history – and was also one with exceptional drought conditions almost everywhere in Europe. Ongoing climate change will likely mean that water will become an ever increasingly scarce resource with competition for water increasing. Experience from other parts of the world, i.e. Southern America, shows that such competition for water is one of the main conflict sources related to the extractive industry.

In Europe, there are approximately 26.000 aggregates extraction sites, nearly 60% of which carry out the washing of materials for their production. The increasing demands on the purity of building materials require the washing of gravel, sand, crushed stone and construction material recycling. In their original state, these materials are contaminated with impurities such as clays, silts, fine particles, wood and coal. The water used for washing is contaminated with these impurities. In order to be able to use the gravel washing water or sand washing water several times, it must be cleaned *(Figure 49)*. [42]

Quarries using process water are subject to the application of national provisions:

- Discharge of process water from material processing facilities outside the approved site
- Recycling of the waters with specified quantitative and qualitative parameters
- Designing the recycling circuit in such a way that accidental pollution cannot occur

In quarries and material treatment plants, there are also other streams of water not included in the production process *(Figure 50)*:

- Water for maintenance of the site
- Water for the use of personnel (domestic water)
- Water of natural origin (rainwater and drainage water)

These waters should be accounted for and monitored.
Discharges (to the site) of waters other than those necessary for the production process are subject to qualitative controls, the thresholds for which are normally set by specific national or regional regulations.
Detailed consumption figures for water management are usually available on site at the individual companies, but are not collected centrally. [42]

EU Water Framework Directive

Whilst die EU's Directive 2000/60/EC establishing a framework for the Community action in the field of water policy or, for short, the EU Water Framework Directive (WFD) has been in force since 2000, it has in this year entered its third management cycle, which will last until 2027, at which time the "good status" (as defined in the WFD) for all waters, surface and groundwater, should finally be achieved.
As with other environmental legislation, the WFD had to be implemented in national legislation in the member states and once again there is significant differences in this implementation, meaning that in some countries the requirements are stricter than described in the WFD. This can have significant impacts on extractive companies, i.e. when it comes to the permitting of new operations.

The responsible stewardship of water, i.e. its consideration in the context of the local watershed, water efficiency and the minimisation of fresh water intake requirements will therefore be of the same importance for aggregates companies as their management of biodiversity aspects.

Source: Forum Mineralische Rohstoffe

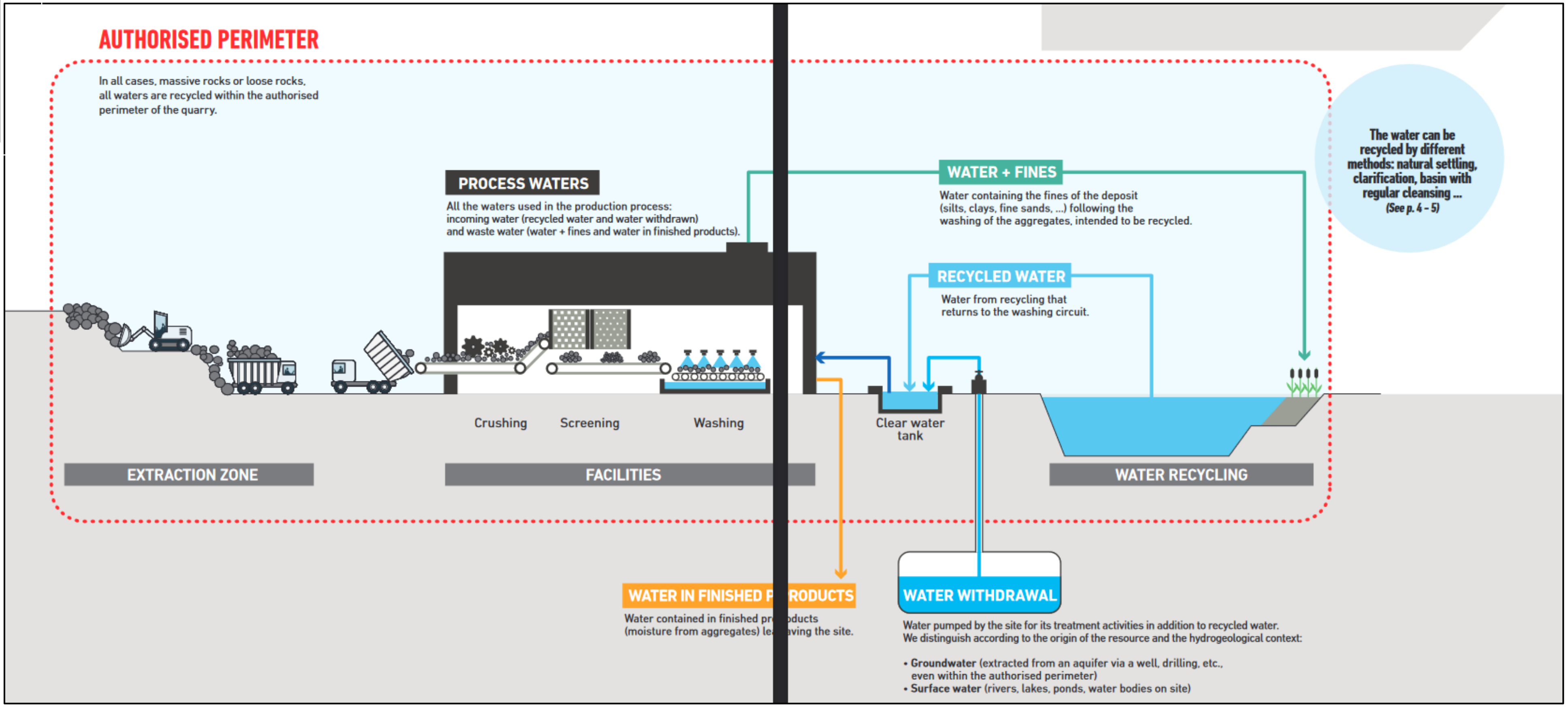


Figure 49 – The circuit of process water of aggregates treatement on a site (Source: UEPG – Water Management [42])

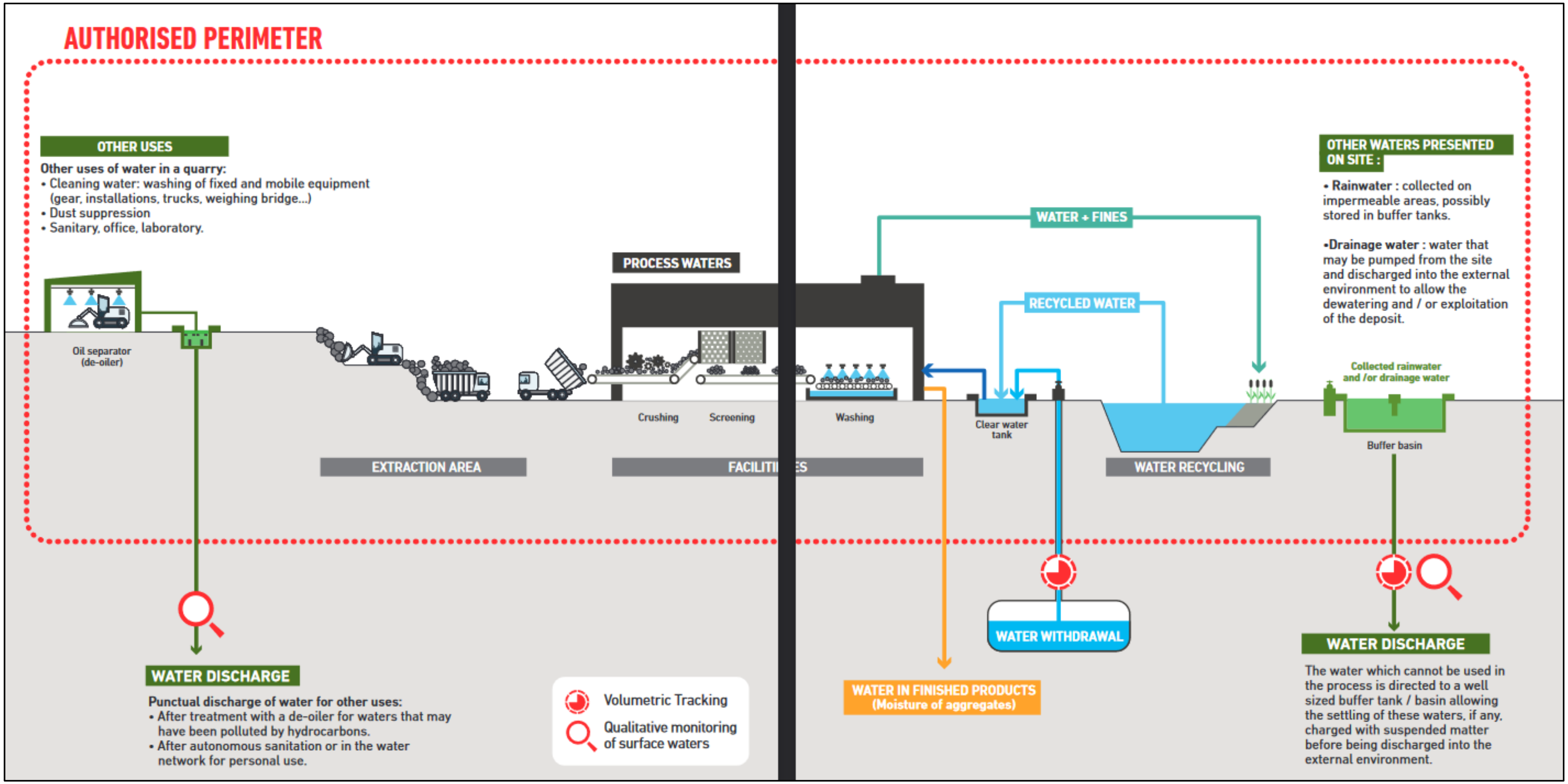


Figure 50 - Other waters on site (Source: UEPG – Water Management [42])

6.4. SOCIAL ASPECTS

Beyond the environment, extractive operations also have social (and socio-economic) impacts; they employ people, are part of local communities and, more broadly, are part of the economy and society. Skills and jobs, health and safety for both employees and community, security and human rights, but also the distribution of financial benefits (i.e. taxes and royalties, local recruitment and procurement), the impact on community and regional development (plans), transparency and reporting, grievance and dispute mechanisms and corruption are some of the key issues related to the extraction of minerals. Together with the environmental performance, all of these aspects are important for the social acceptance of an extractive operation. In recent years the expectations of communities and society (incl. NGOs) on the performance of extractive companies have increased significantly, while on the other hand the perception of this performance has decreased, leading to a trust gap and a “not in my backyard” feeling against the extractive industry.

Engaging the community and society, together with improved operational performance along Aggregates Europe - UEPGs Roadmap to 2030 and SUMEX’s sustainability framework will be crucial in order close this trust gap and to achieve a social license to operate (SLO). This chapter presents findings from the Horizon 2020 project MIREU that should be useful in this context.

From consultation to engagement

What is community consultation?

Community consultation is a form of community involvement, whereby the minerals extracting company seeks feedback, requests and suggestions from the community that may be useful in its decision-making. However, this does not mean that there is always a consensus to be achieved in every case, but rather that the company can make better decisions by incorporating the community's opinion and to get the social license to operate.
Community consultation also provides an opportunity for companies to get a more acute view of the attitudes and expectations of the affected community. [43]

What is community participation?

Participation includes all activities undertaken by the community to get involved in a subject/project in any way possible. This also includes direct meetings, writing emails, participating in events, making phone calls, etc. [44]

What is community engagement?

Engagement goes further than participation and consultation.

The term “community engagement” is defined in the ISO 26000 standard as *“stakeholder engagement”*. This International Standard is not a management system standard, but a guide that provides orientation and recommendations on how organisations of all types should behave in order to be considered socially responsible. [45]

Stakeholder engagement is defined in ISO 26000 [46] as follows:

> *"Activity undertaken to create opportunities for dialogue between an organisation and one or more of its stakeholders, with the aim of providing an informed basis for the organisation's decisions."*

Community engagement means that the community itself contributes actively in finding the best decision on various issues.

The value of practical and constructive discourse on an issue or an upcoming decision is that it gives the community the feeling of being heard and taken into account. A good dialogue between all parties concerned and the understanding of each other's concerns form the basis of a constructive engagement process and the most efficient decision-making possible.

Effective community engagement can be achieved through mutual trust, respect and open communication between industry, community and not to be forgotten authority.

A good relationship with the respective authorities, which monitor and enforce the local quarrying and nature conservation laws etc., and play an important role in permitting and licensing processes, on the part of the companies not only facilitates their daily work, but also enables a sustainable use of the post-quarrying landscape after the closure of a site that will be pleasing to all parties. If a company obeys the legal regulations and tries to work as well as possible in all areas, this will also have a positive effect on its SLO, as long as this is also properly communicated.

The way in which the community is involved is subject to constant change and can vary strongly within the course of a project. Flexibility, transparency and the necessary sensitivity by the company to respond to the needs of the population are essential. Thus, the degree of community engagement varies depending on the size of the project, its impact and the willingness of the community to get involved. [43]

It is essential to start involving stakeholders already before or at the latest during exploration activities, not only because it often requires the consent of landowners. And here again, first impressions count. If it is positive, it will also have a positive impact on the quality of community involvement and future relations. [47]

Source: Forum Mineralische Rohstoffe

The Social License to Operate (SLO) or "Better in Our Backyards"

The social license has many, at first sight invisible, but significant benefits not only for a company. This in turn affects the awareness of communities, NGOs and other stakeholders associated with existing or planned quarrying/mining activities. When the community is not involved and thus fails to support raw material extraction activities in most cases, resistance, confrontation and unrest often ensue. Ignorance, lack of understanding and imagined paternalism in turn often lead to fears in the local community towards a quarrying/mining project, which results in opposition, protests and riots. [47]
There are a variety of activities that communities use to oppose quarrying/mining activities in their neighbourhoods, such as marches, protests, road blockades, and in extreme situations, kidnappings of staff and robberies of installations, etc. Through global networking, opponents are increasingly challenging extractive companies. [48]
Misconceptions about the issue or project often lead to objections and difficulties that serve no constructive purpose and inflame discord, conflicts and hostility. All these dysfunctional interactions with communities make it difficult for the extractive company to operate efficiently, sustainably and economically. A positive SLO thus benefits both sides, the company and its residents. [47]

A new approach: SLO guidelines & SLO Toolbox for Europe [49]

Based on the classical pyramid of Thomson & Boutilier [50], a new adapted SLO model (*Figure 54*) was developed in the course of the MIREU project (2020), which captures both the community and societal dimensions and assumes that the drivers for achieving SLO and losing SLO are the same.

- The *yellow* levels show how SLO is built up:
    - The higher you go up the pyramid, the higher the level of SLO.
    - The level at which interaction takes place can be seen on the sides: acceptance, support, cooperation.
- The *purple* levels show how SLO is lost:
    - The further down the pyramid you go, the more resistance a project will experience.
    - The effects of SLO loss are shown on the side: No Acceptance, Resistance, Protests.

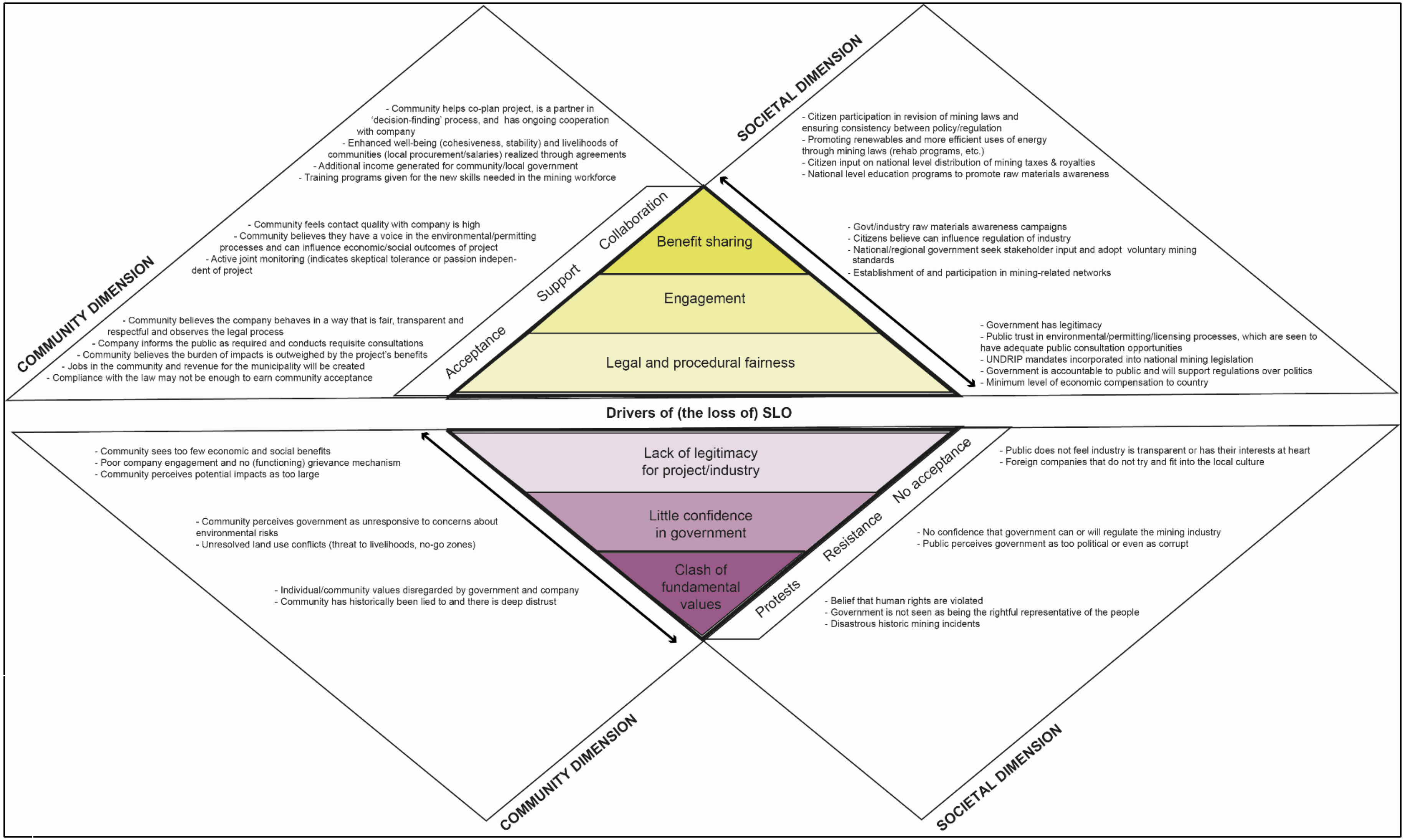


Figure 51 - Model of SLO (Source: Lesser, Gugerell, Poelzer, Hitch, & Tost, 2020 [49])

This model specifically developed for Europe and the idea of combining/contrasting both dimensions (community & societal) in one figure is based on the fundamental "composition" of Europe/the European Union.
There is no question that there is a broad consensus on what is meant by SLO all around the world: legitimacy, credibility and trust are the core components. However, Europe is not homogeneous (language, culture, worldview, etc.) and the different SLO debates currently taking place on the continent need to be understood as a manifestation of their specific local contexts.
While the community dimension is the most important determinate of whether a company has SLO or not, in the long term, the societal dimension will be useful to understand because it could be a bell weather of future policy directions and the broader public opinion around quarrying and mining. [51]

Community engagement – a balancing act for extractive companies
The main cause of social conflicts is not meeting the expectations of the community and this can easily escalate to social crisis and then everyone has lost: the company, which might have to stop their operations, the government, which might not receive taxes and even the communities themselves, which might paralyze their economic activities in this way. [52]
Stakeholders are parties (potentially) affected by extraction activities, their procedures, processes and outcomes. Opposite them are the parties that have an interest in the extraction activities and their results and outcomes. [44]
Through information and knowledge transfer, transparency and openness, a bridge can be built to the local community and a good basis for discussion can be created. Nevertheless, companies must always evaluate who should know how much and what? Often, less information is better than a flood of facts and figures. A society is made up of many individuals with different opinions, values and views. What is fulfilment for one is hell on earth for another, and so it can happen that despite transparency and openness by a company, resentment and resistance arise in the community, especially if people do not feel understood or heard. This then needs to be addressed specifically and individually in each situation and a creative solution found to the problem that has arisen. The great challenge for an extraction company is determining how to balance these diverse stakeholder interests and values and ensure that all stakeholders believe their interests are being met. A sure instinct and understanding of human nature are of advantage in most cases. [53]
In order to identify all stakeholders involved in a project, it is essential to make direct contact and thus establish a basis for discussion and connection with the individual community groups.
In the course of these conversations, the relationships and values of each stakeholder group will become clearer, as will the broader social and political dynamics in the community. [49]

The approach towards SLO as outlined in the MIREU project should be beneficial for aggregates companies, i.e. when they are planning for new operations in the context of the already discussed environmental issues, i.e. transport and biodiversity and, related to this, access to land and land use.

The MIREU SLO-Guidelines, SLO-Toolbox and individually adaptable SLO Tools can be found here: https://mireu.eu/slo (05.12.2022)

Appendix C provides further details on environment & sustainability at the country level.

APPENDIX C – ENVIRONMENT & SUSTAINABILITY – COUNTRY PROFILES

7. LAND-USE PLANNING

The amount of usable land on our planet is limited. A wide variety of land use interests are therefore often in conflict with each other. Private and public concerns must be balanced in order to optimise the impact on the environment, prosperity and the economical development. Land use planning is a balancing act between politically and socially defined goals and their spatial appropriation of limited land resources.
However, the problem of land scarcity is always a matter of perspective. Nevertheless, land use regulations and property rights always play a crucial role in the availability of land resources. The individual legal authorities regulate the zoning and delimitation of permissible land uses and thus regulate the correlation between supply and demand, which, however, is not always balanced. Different views and interests, as well as the scarcity of land, can lead to tensions and territorial ownership claims by different interest groups, private parties or organisations representing the political pillars.

Sustainable supply and access to raw materials are crucial for economic stability and prosperity and are addressed in numerous EU as well as Member State (MS) policies.
Various policies at EU level address the link between minerals policy and land use planning *(see Table 5 for a list of examples)*, but there are often major challenges [54]:

- Identification of safeguard measures to ensure domestic security of supply
- Insufficient effectiveness of minerals policy due to dispersed responsibilities in different policy areas and lack of coordination between different levels of government
- Potential sterilisation of extractable mineral deposits due to poor land use planning or competing land uses
- Weak horizontal coordination and cross-sectoral cooperation with other policy areas
- Conflicts of interest between land use for mineral extraction and other land uses such as urbanisation/residential development, nature conservation, agriculture, recreation, tourism, etc.

Domestic aggregate extraction requires a very small percentage of the total area of EU countries (*Figure 52*) compared to many other land uses. Domestic aggregate extraction requires a very small percentage of the total area of EU countries compared to many other land uses. Land use competitions with agriculture, recreation areas, residential areas, archaeology, etc. with quarries arise mainly in densely populated regions. An indirect effect of aggregate production and the use of aggregates is the material accumulation of a country, also referred to as " physical net addition to stock" (buildings and infrastructures), which is composed mainly of construction minerals such as aggregates and their downstream products, concrete and cement. Consequences of this ever-growing stock of buildings and infrastructure are additional soil sealing, rising maintenance and energy costs, and an increase in traffic congestion, etc. [8]

Not only safe access to domestic mineral resources is important for Europe's economic development, but also responsible and sustainable extraction of mineral raw materials. A major challenge lies in harmonising the interests of society (urban development, infrastructure expansion, agriculture, climate and environmental protection) with the exploration and extraction of mineral raw materials, within land use planning plays a crucial role in this. Therefore, the integration of mineral resources policies into land-use planning at different levels is a key factor for achieving responsibly sourced minerals. [55]

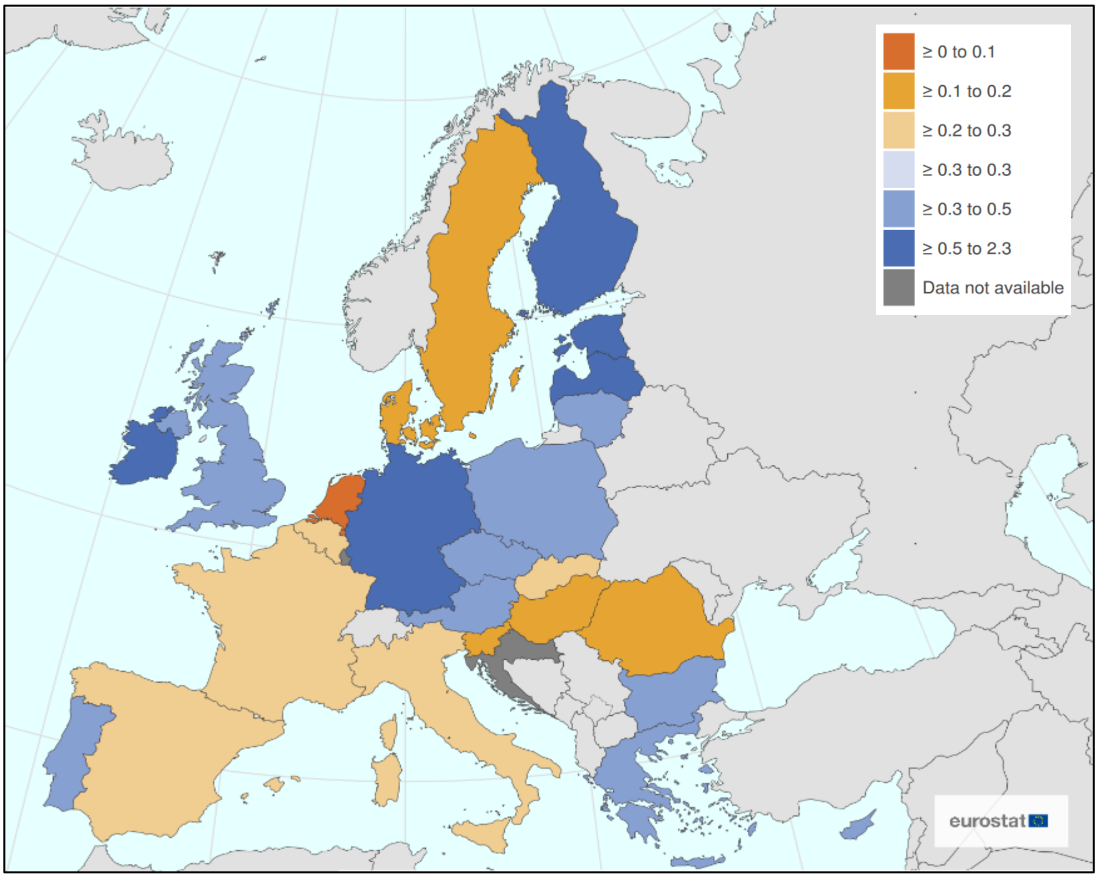


Figure 52 - Land use overview of mining and quarrying in Europe in [%] 2018 (Source: ©Eurostat)

Society's need for space (for settlements and infrastructure) as well as for natural resources is constantly increasing, which inevitably leads to conflicts with existing land capacities. Europe is a mosaic of landscapes, shaped by the evolving change of land uses of the past and present. Increasing land use is often accompanied by a loss of biodiversity, deterioration of habitat quality, increase in carbon dioxide emissions, soil sealing and landscape fragmentation, as well as urban heat island effects.

Land use planning and management are crucial to better reconcile land use with environmental concerns. This is a challenge that involves various policy levels and sectors and requires an integrated approach. Land use planning and land use management is usually carried out at local or regional level, e.g. as part of urban planning or agriculture and forestry. [36]

[36] https://www.eea.europa.eu/themes/landuse/intro *(05.12.2022)*

Table 5 - Consideration of "land-use" in EU mineral policy and vice versa (2019) (©Gugerell) (Source: [54])

EC 2011: Promoting sustainable development in the EU non-energy extractive industry	*"Land use and spatial planning policies directly affect sustainable development strategies for the industry"* (European Commission 2000a) *(p15)*
EC 2011: Tackling the challenges in Commodity Markets and on Raw Materials	*"(…) development is hindered by a heavy regulatory framework and competition with other land uses. Many regulatory issues in this area are the competence of Member States. The Commission therefore acts mainly as a facilitator for the exchange of best practices (…) setting up a land use planning policy for minerals that comprises a digital geological knowledge base, a transparent methodology for identifying mineral resources, long term estimates for regional and local demand and identifying and safeguarding mineral resources (taking into account other land uses) including their protection from the effects of natural disasters; "(European Commission 2011) (p17)*
Strategic Implementation Plan for the European Innovation Partnership on Raw Materials Part I. 2013	*"Minerals policies are not always clear and effective enough (e.g. dispersed among other policies, no public implementation support, uncoordinated between different levels (EU, Member States regional, local) and with other sectorial policies (land use planning policy, environment policy including biodiversity and waste management)). The permitting procedure for mining can be lengthy and sometimes lack transparency. While the overall potential for mining and quarrying in Europe is high, access to land is another key challenge for the extractive industry, where competing land uses may sterilise deposits for future use." (p8) "(…) objective is to foster access to known and still undiscovered mineral deposits, improve the conditions for sustainable access and supply of raw materials in the EU and safeguard the mineral wealth for future generations by classifying within a regulatory framework, the importance for society of certain mineral deposits. With regard to the land use planning or marine spatial plans, the aim is to ensure that NEEI are considered on equal terms as all other, often competing sectors such as agriculture, forestry, housing, industrial areas, etc" (p.18)"*
Strategic Implementation Plan for the European Innovation Partnership on Raw Materials, part II Priority areas, Action Areas and Actions	*"Minerals policies are sometimes not clear and effective enough because they are either dispersed among other policies or have no public and implementation support. Coordination and implementation of minerals policies at different levels (EU, MS regional, local) and horizontally with other sectorial policies is often not straightforward and therefore in some cases contradictory and time consuming. Even in the cases where Member States have recently issued a modern minerals policy strategy, adapted to the needs of society and the economy, this could prove to be ineffective if this policy is not strongly linked with other national policies such as an appropriate land use planning policy, environment policy including biodiversity and mine waste management and also with a common understanding and categorization of mineral deposits of local, regional, national and EU importance. (p.8) "Mineral policies must be developed integrating instruments and mechanisms for guaranteeing the accessibility of the raw materials for the industries and the society, public acceptance and transparency of EU market." (p24) "Land use planning policies at different levels (local, regional, national) should be better co-ordinated and linked with the general rules and guidelines for minerals land use planning issued at national level covering potential, current and past extractive areas. These rules and guidelines should include tools and mechanisms for forecasting long term supply of raw materials which are important at local, regional, national and EU level in view of the foreseen demand. Land use planning procedures are long and NEEI are mostly considered as an environmental degradation, not as an economic activity that is temporarily using land, therefore receiving a relatively low ranking compared to other land uses such as urbanization, nature conservation, agriculture, infrastructure, recreation etc." (p 27f)*
European Spatial Development Perspective	*"Efficient land protection, to preserve natural resources and soil functions is therefore necessary, mineral resources are widely missing"*
European Landscape Convention	*"Concerned to achieve sustainable development based on a balanced and harmonious relationship between social needs, economic activity and the environment; Noting that the landscape has an important public interest role in the cultural, ecological, environmental and social fields, and constitutes a resource favourable to economic activity and whose protection, management and planning can contribute to job creation"*
Thematic Strategy on the sustainable use of natural resources	*"Efforts will often need to be made in non-environmental policy areas. The approach advocated will strengthen policymaking at all levels (EU, national, regional and local). A better understanding of the environmental impacts of resources use throughout life cycles will allow policy makers to better prioritise and concentrate on areas where they can really make a difference"*

The Natura 2000 network

As already described in *Chapter 6*, "Natura 2000" is a coherent European ecological network *(Figure* 53) of protected areas, which is composed of sites hosting the natural habitats and the habitats of the species of European interest, including wild birds. The aim of the network is to protect, conserve and restore species and their habitats in their natural ranges. It is not a system of strict nature conservation in which all human activity is excluded, rather the two Directives provide a common legal framework to ensure that human activities are performed in such a way that the integrity of the Natura 2000 sites is not damaged. [39,56]

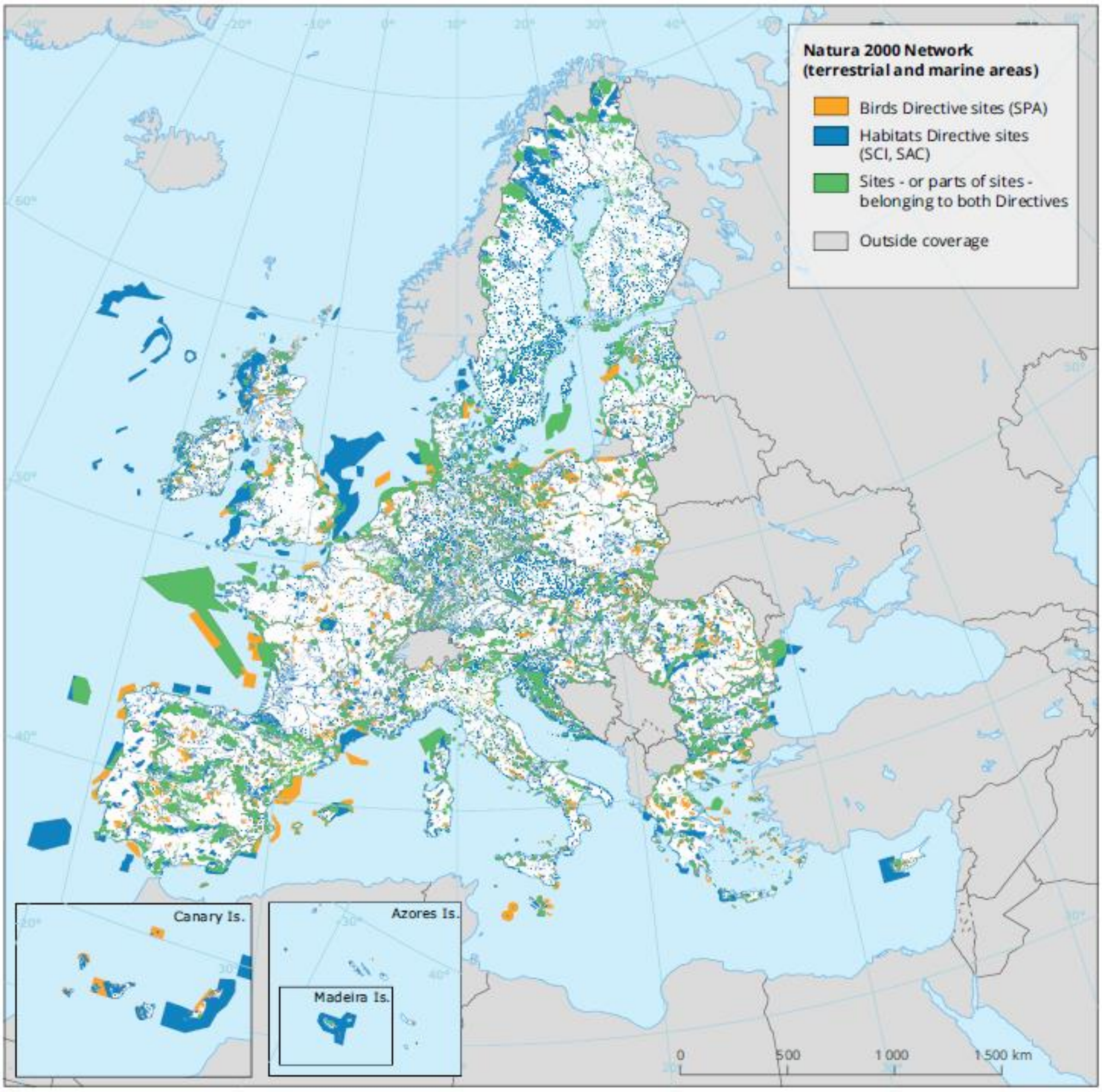


Figure 53 - Natura 2000 network (terrestrial and marine areas) (Source: EEA 2020 / Reference data: ©ESRI)

The *EU Biodiversity Strategy for 2030* sets the target of legally protecting a minimum of 30% of EU land and sea. *Figure 54* shows that in 2021, 26.4% of EU land was protected, with 18.5% of this area designated as Natura 2000 sites and 7.9% having other national designations, representing over 100,000 sites in total. [37] This means, that an additional 3.6% of land need to be protected in order to reach the overall target for land.

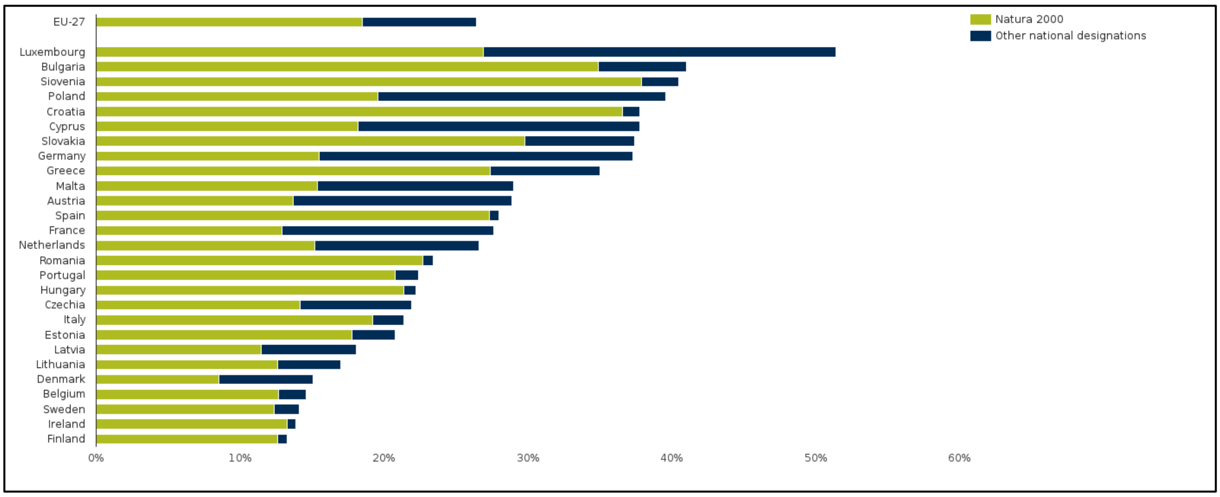


Figure 54 - Share of country designated as terrestrical protected area between Natura 2000 and national designations in 2021 (Source: ©European Environment Agency (EEA) / EuroGraphics)

As diverse as Europe is, so are the individual protected areas. Natura 2000 and other national designations have different patterns, reflecting the diversity of historical, geographical, administrative, political and cultural circumstances. However, the designation of a protected area is not enough to achieve the conservation aims. Rather, effective and coordinated management of the entire trans-European network of protected areas is needed, as outlined in the EU Biodiversity Strategy.[38]

As one of the most densely populated regions in the world, human activities in Europe have caused the decline and deterioration of many species and habitats. To identify critical pressures and threats, the Nature Directives require all Member States to report on the main causes of species loss and habitat degradation. Pressures are factors that have affected habitats and species in the current reporting period, while threats are factors that are likely to affect the two subsequent reporting periods. [57]
As shown in *Chapter 6.2* environmental protection and protection of endangered species do not necessarily exclude the extraction of domestic resources, especially in the area of aggregate extraction. *Figure 55* clearly shows that the extraction of mineral resources only has a minor impact on habitat and species diversity - quite the opposite of agricultural use. *(The size of the squares and their shade reflect the percentage of pressures for each group: bigger darker squares indicate higher percentages.)*

[37] https://www.eea.europa.eu *(05.12.2022)*
[38] https://www.eea.europa.eu *(05.12.2022)*

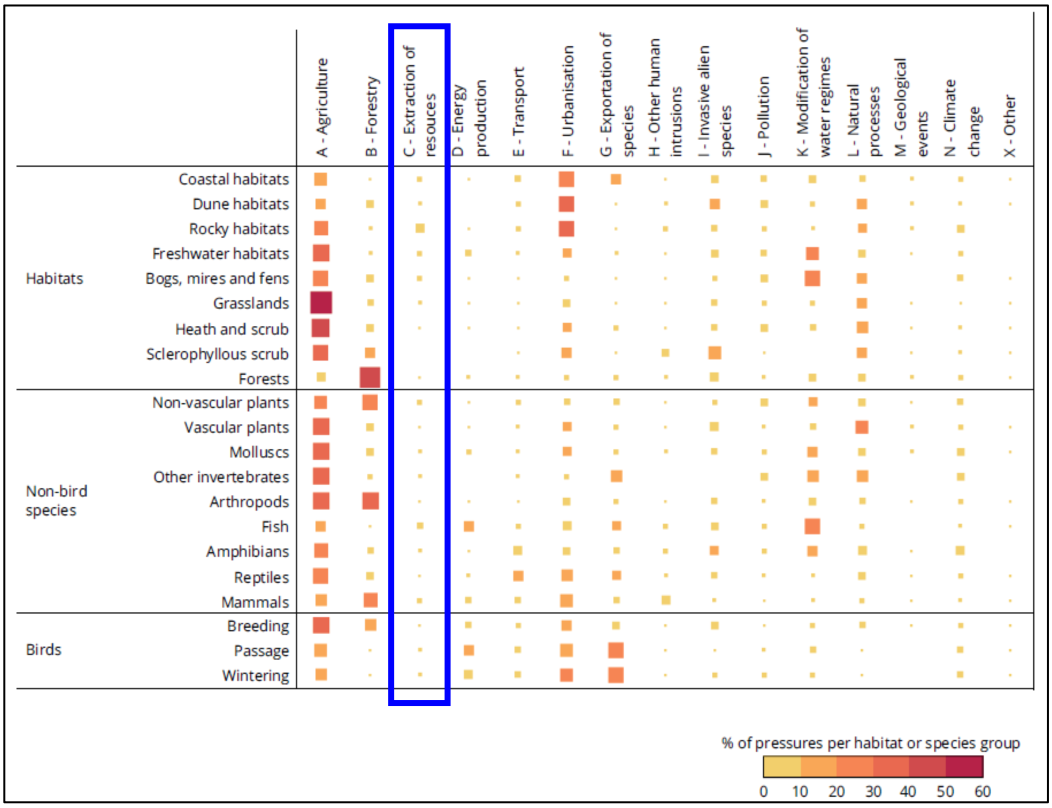


Figure 55 - Distribution of pressure categories among habitats and species (Results from reporting under the nature directives 2013-2018) (©EEA/ report: State of nature in the EU / data: Article 12 and Article 17 Member States' reports and assessments) (Source: [57])

Given the fact that the protected area coverage varies between EU Member States and also the fact that there has been an increase in designated *Natura 2000* areas in recent years *(Figure 56 & Figure* 57*)*, it is even more important to install a unified and far-sighted management of these protected areas, so that there is no shortage of domestic aggregates reserves due to prohibited aggregate permits, but this is the path Europe is currently on.

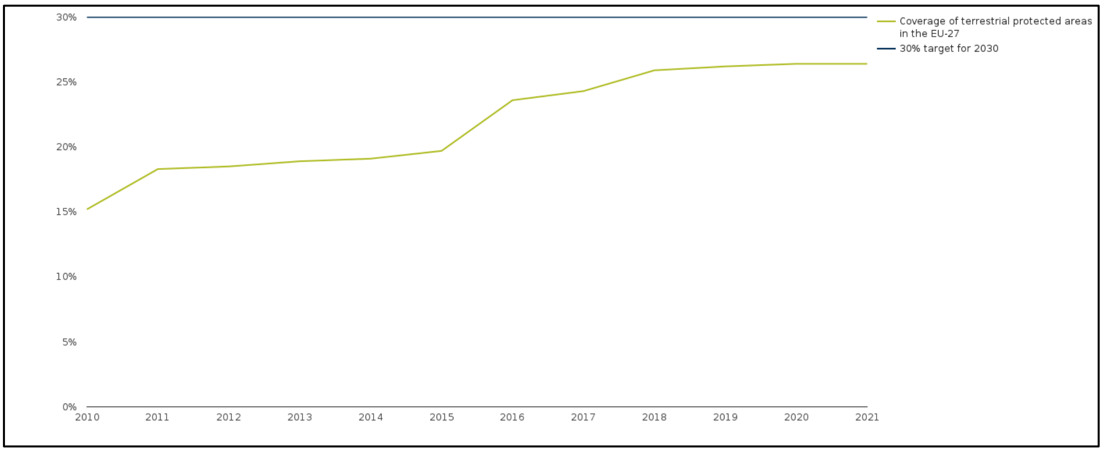


Figure 56 - Coverage of protected areas in the EU27 land are from 2010 until 2021 (Source: ©European Environment Agency (EEA) / EuroGraphics)

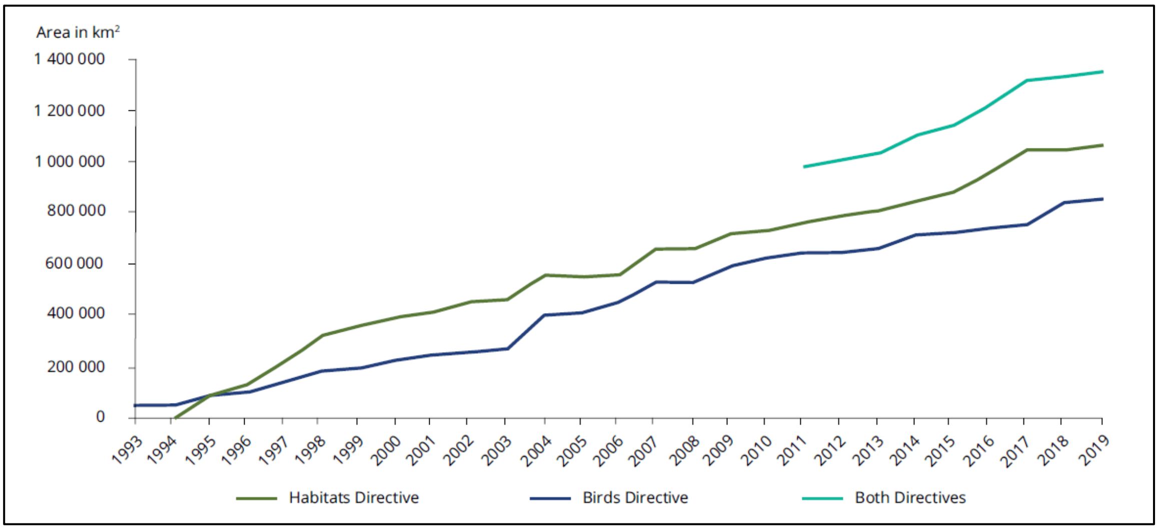


Figure 57 - Cumulative surface area of Natura 2000 network from 1993 to 2019 (Source: © EEA 2020 / Natura 2000 database)

Figure 58 shows that at the end of 2021, nine Member States had designated more than 30% of their land area as protected sites: Bulgaria, Croatia, Cyprus, Germany, Greece, Luxembourg, Poland, Slovakia and Slovenia.
The overlap for Norway and Switzerland relates to Emerald Network[39] sites. For all other countries the overlap relates to Natura 2000 sites.

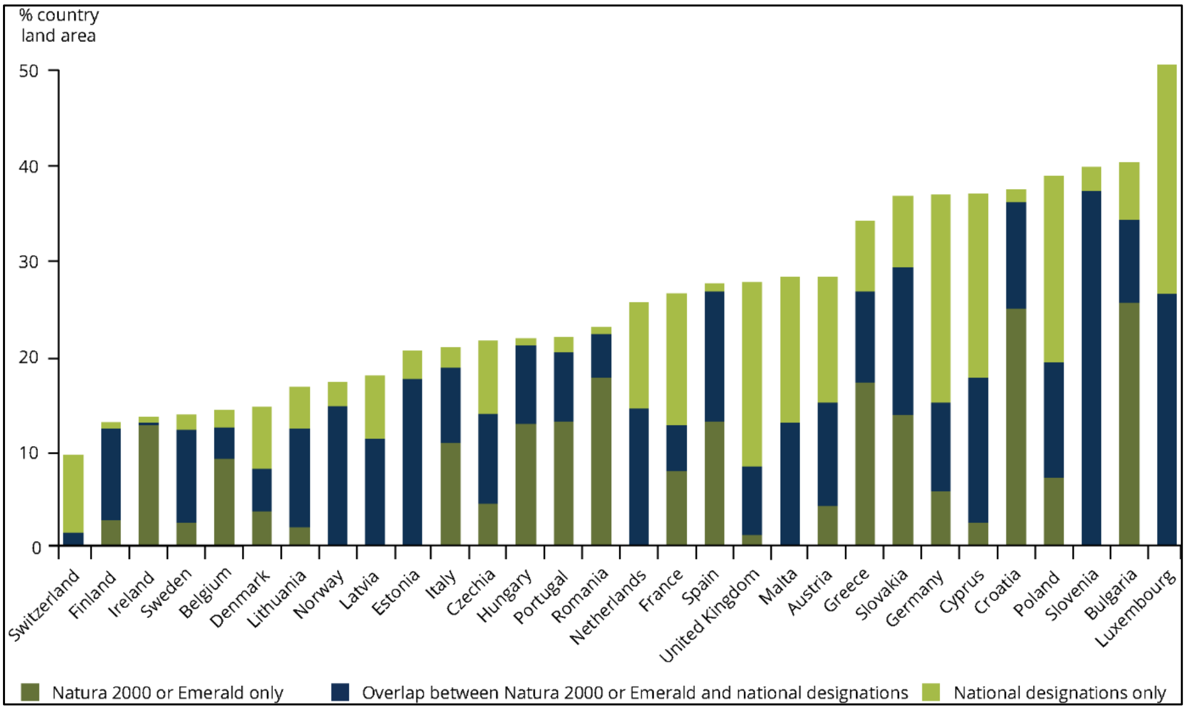


Figure 58 - Protected area coverage in EU member states 2021 (Source: ©European Environment Agency (EEA) / data: EEA & CDDA / EuroGraphics)

[39] *The Emerald Network is an ecological network made up of Areas of Special Conservation Interest. Its implementation was launched by the Council of Europe as part of its work under the Bern Convention, with the adoption of Recommendation No. 16 (1989) of the Standing Committee to the Bern Convention.*

Aggregates extraction in *Natura 2000*: it always needs a case by case approach

By its very nature, the extraction of minerals invariably has an impact on the land upon which it operates. Most mines and quarries require the removal of surface features during the extraction process and will need space for storage mounds, spoil tips and lagoons as well as for associated infrastructures, buildings and access roads. Such activities can also, on occasion, cause significant disturbance to wildlife and lead to the loss or deterioration of valuable natural habitats.
However, this is by no means systematic. There are cases where new extraction sites have been found to cause only a limited or temporary impact on the biodiversity and the natural environment. There are also a growing number of examples *(see Chapter 6.2 and Appendix C)* of where an extraction site has, over the course of its entire life cycle, delivered an overall net benefit for biodiversity. This is because more and more quarries, pits and mines are being/must be (i.e. in Europe) rehabilitated at the end of their life, with biodiversity in mind. Where this occurs in an already impoverished natural environment, such rehabilitated sites have the potential to make a significant positive contribution to biodiversity by providing new habitats for wildlife.
Nevertheless, this does not remove the obligation to ensure that individual extraction projects do not cause significant damage or disturbance to areas that are already of high nature value, especially when this could affect rare and threatened species of habitats of Community interest. Such risks need to be assessed on a case-by-case basis, and this must be done by skilled and far-sighted professionals.

Safeguarding future mineral resources [58]

There is a slowly rising awareness among people, but also among policy makers at the European level, that a reliable and sustainable supply with mineral resources is indispensable for Europe. One of the first impulses for this was the Commission Communication "Promoting the sustainable development of the EU's non-energy extractive industries" (COM (2000) 265 final)[40], which confirmed that land-use planning is one of the key factors for the competitiveness of the extractive industries.
In 2008, with the *Raw Materials Initiative* (RMI)[41] [59], which has the *European Innovation Partnership* (EIP) on Raw Materials[42] as the major EU commitment for its implementation, this issue was addressed politically through the awareness that EU is rich in mineral deposits, but their exploration and extraction are facing increased competition from different land uses and a highly regulated environment. Simultaneously it highlights the importance of ensuring the access to domestic sources through developing strategies to safeguard access to mineral raw materials for future use.

The findings of the MINLAND (2019) project show that the current practice of safeguarding access to mineral resources in Europe through the existing legislative framework is effective, but not efficient.
The legislative framework is effective because:

- Permits are (with a few exceptions) successfully integrated into land use plans (protection of existing mineral resources)
- In a few countries, areas with well-documented resources are taken into account in legislation to safeguard minerals (integration in Land Use Plan)

The legislative framework is inefficient because only a small part of the known mineral resources can be secured (well-documented resources in conflict-free areas) and the safeguarding of hypothetical mineral resources is only addressed in a few countries.

[40] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52000DC0265&from=DA *(05.12.2022)*
[41] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52008DC0699&from=EN *(05.12.2022)*
[42] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012SC0027&from=EN *(05.12.2022)*

Figure 59 - Countries having a main national/regional mining law.
(Source: MINLAND 2019, D 2.3 [60])

Green: mining law addresses minerals safeguarding, mining permits and areas with well documented resources are appointed to land use planning authorities.
Blue: mining law does not address safeguarding; mining permits are appointed to land use planning authorities.
Grey: EU non-surveyed countries by the MINLAND project

Figure 60 - Countries (Emilia Romagna region in Italy) with land use planning legislation
(Source: MINLAND 2019, D 2.3 [60])

Green: land use planning legislation addressing safeguarding of mineral resources
Blue: land use planning legislation not addressing safeguarding of mineral resources
Grey: EU non-surveyed countries by the MINLAND project

Appendix D presents more details of the situation at the country level.

APPENDIX D – LAND-USE PLANNING – COUNTRY PROFILES

8. POLICIES & LEGISLATION

This chapter presents key findings of the EU projects MIN-GUIDE (2016-2019) [60–63] and MINLEX (2018) [34], which looked in detail at policies and legislation impacting mineral extraction in Europe.

The EU's Raw Materials Initiative (RMI) *(see therefor Chapter 6)* has been the cornerstone of the EU's approach to raw materials in the last decade. In addition, MIN-GUIDE [64] identified a number of key directives and initiatives effecting the aggregates sector, as shown (updated) in *Table 6*.

Table 6 - "Key EU Directives and Initiatives Affecting the Aggregates Industry"

Title	Status/ source/ Year	Overall purpose	Notes
Conservation of natural habitats and of wild fauna and flora	Council Directive 92/43/EEC of 21 May 1992 Current consolidated version: 01/07/2013	To contribute towards ensuring biodiversity through the conservation of natural habitats or wild flora and fauna	Affects exploitation of new extraction sites and their transportation infrastructure
Strategic Environmental Assessment (SEA) Directive	Directive 2001/42/EC of 27 June 2001	Ensure that the environmental consequences of certain plans and programmes are identified, assessed and taken into account during their preparation and before their adoption.	Had to be complied by member states in July 2004
Groundwater Directive (Protection of groundwater against pollution)	Directive 2006/118/EC of 12 December 2006 Current consolidated version: 11/07/2014	This Directive lays down measures to prevent and control groundwater pollution, including: (a) criteria for the assessment of good groundwater chemical status; and (b) criteria for the identification and reversal of significant and sustained upward trends and for the definition of starting points for trend reversals. Moreover, the Directive complements the provisions preventing or limiting inputs of pollutants into groundwater contained in Directive 2000/60/EC, and aims to prevent the deterioration of the status of all bodies of groundwater.	
Water Framework Directive – *establishing a framework for Community action in the field of water policy*	Directive 2000/60/EC of 23 October 2000 Current consolidated version: 20/11/2014	The Directive aims for 'good status' for all ground and surface waters (rivers, lakes, transitional waters, and coastal waters) in the EU.	

Promoting sustainable development in the EU non-energy extractive industry	Communication COM (2000) 265 final	Risks are: air pollution, noise, soil and water pollution, effects on groundwater levels, destruction or disturbance of natural habitats, visual impacts on surrounding landscapes.	Mining and quarrying are increasingly influenced by other competing land uses, such as urban development, agriculture, nature conservation Issues of resource productivity are covered only implicitly
Thematic Strategy on the sustainable use of natural resources	Communication COM (2005) 670 final	The objective of the strategy is to reduce the environmental impacts associated with resource use and to do so in a growing economy. Focusing on the environmental impacts of resource use will be a decisive factor in helping the EU achieve sustainable development.	
Communication from the Commission on the precautionary principle	Communication COM (2000) 0001 final	- It explains the precautionary principle which enables a rapid response to be given in the face of a possible danger to human, animal or plant health, or to protect the environment. - In particular, where scientific data do not permit a complete evaluation of the risk, recourse to this principle may, for example, be used to stop distribution or order withdrawal from the market of products likely to be hazardous. - It establishes common guidelines on the application of the precautionary principle.	
Action Plan on Critical Raw Materials (CRM) - *Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability recognises*	Communication COM (2020) 474 final	The CRM recognises that the access to resources and sustainability is key for the EU's resilience in relation to raw materials. It points out the role of raw and advanced materials in the transition to the Green and Digital Economy where a main building block is about strengthening the sustainable and responsible domestic sourcing and processing of raw materials in the European Union.	

The European Green Deal	Communication COM (2019) 640 final	The European Green Deal, approved 2020, is a set of policy initiatives by the European Commission with the overarching aim of making the European Union (EU) climate neutral in 2050.	An impact assessed plan will also be presented to increase the EU's greenhouse gas emission reductions target for 2030 to at least 50% and towards 55% compared with 1990 levels. The plan is to review each existing law on its climate merits, and also introduce new legislation on the circular economy, building renovation, biodiversity, farming and innovation.
EU Biodiversity Strategy for 2030 - *Bringing nature back into our lives*	Communication COM (2020) 380 final	The biodiversity strategy aims to put Europe's biodiversity on the path to recovery by 2030 for the benefit of people, climate and the planet.	The strategy contains specific commitments and actions to be delivered by 2030: - Establishing a larger EU-wide network of protected areas on land and at sea - Launching an EU nature restoration plan - Introducing measures to enable the necessary transformative change - Introducing measures to tackle the global biodiversity challenge
Construction Products Regulation (CPR) - *Laying down harmonised conditions for the marketing of construction products (repealing Council Directive 89/106/EEC)*	Regulation (EU) No 305/2011 of 9 March 2011 Current consolidated version: 16/07/2021	This EU regulation is designed to simplify and clarify the existing framework for the placing on the market of construction products.	'construction product' means any product or kit which is produced and placed on the market for incorporation in a permanent manner in construction works or parts thereof and the performance of which has an effect on the performance of the construction works with respect to the basic requirements for construction works;
Energy Taxation Directive (ETD) - *Restructuring the Community framework for the taxation of energy products and electricity*	Council Directive 2003/96/EC of 27 October 2003 Current consolidated version: 15/09/2018	The directive is intended to ensure the functionality of the EU internal energy market and to avoid distortions of competition through different tax systems. In addition, it should also contribute to a low-carbon, energy-efficient economy, that is, to exert a steering effect with the aim of protecting the environment and the climate.	Energy taxation heavily influences markets for aggregates, in particular cement industry

Emissions Trading Directive - *Establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC*	Directive 2003/87/EC of 13 October 2003 Current consolidated version: 01/01/2021	The aim of the directive is to work towards reducing greenhouse gas emissions in the most cost-effective and economically acceptable way possible through an emissions trading system.	Concrete & cement industry
Mining Waste Directive (MWD) - *management of waste from extractive industries and amending Directive 2004/35/EC*	Directive 2006/21/EC of 15 March 2006 Current consolidated version: 07/08/2009	Introduction of measures for safe management of waste resulting from the extraction, treatment and storage of mineral resources and the working of quarries.	
Environmental Impact Assessment (EIA) – assessment of the effects of certain public and private projects on the environment	Directive 2014/52/EU of 16 April 2014 amending Directive 2011/92/EU	Aims of the EIA: - to avoid environmental damage from the outset in accordance with the precautionary principle - to consider the environmental impacts holistically and comprehensively, not only sectorally and in sections - to achieve a better preparation of projects and of the approval procedures - to give environmental concerns the same weight as other concerns in the consideration and decision-making process - to make the approval procedures for projects involving the public more transparent and comprehensible.	Concentrated permitting approach
Environmental Liability Directive (ELD) – *Directive on environmental liability with regard to the prevention and remedying of environmental damage*	Directive 2004/35/CE of 21 April 2004 Current consolidated version: 26/06/2019	Its objective is to create "a more uniform regime for the prevention and remediation of environmental damage" across the EU.	

Waste Framework Directive (WFD) – *Directive on waste and repealing certain Directives*	Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 Current consolidated version: 05/07/2018	This Directive lays down measures to protect the environment and human health by preventing or reducing the generation of waste, the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use, which are crucial for the transition to a circular economy and for guaranteeing the Union's long-term competitiveness.	**Article 3(1): 'waste' means any substance or object which the holder discards or intends or is required to discard;** Article 2(2)d: waste resulting from prospecting, extraction, treatment and storage of mineral resources and the working of quarries covered by Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries Article 5(1): "By products" substance or object, resulting from a production process, the primary aim of which is not the production of that item, may be regarded as not being waste referred to in point (1) of Article 3 but as being a by-product only if the following conditions are met: (a) further use of the substance or object is certain (b) the substance or object can be used directly without any further processing other than normal industrial practice; (c) the substance or object is produced as an integral part of a production process; and (d) further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.

Landfill Directive - *Directive on the landfill of waste*	Council Directive 1999/31/EC of 26 April 1999 Current consolidated version: 04/07/2018	The Directive's overall aim is "to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from the landfilling of waste, during the whole life-cycle of the landfill". This legislation also has important implications for waste handling and waste disposal.	
Marine Strategy Framework Directive -*Directive establishing a framework for community action in the field of marine environmental policy*	Directive 2008/56/EC of 17 June 2008 Current consolidated version: 07/06/2017	The MSFD is aimed at achieving or maintaining Good Environmental Status in European seas	
Air Quality Directive (AQD) - *Directive on ambient air quality and cleaner air for Europe*	Directive 2008/50 of 21 May 2008 Current consolidated version: 18/09/2015	EU directive which limits sulphur dioxide, NO_2 and other oxides of nitrogen, particulate matter (PM10, PM2,5), lead, benzene and carbon monoxide emissions from 2010. Hourly average emissions of NO_2 are limited 200 µg/m³ and yearly to 40 µg/m³.	
Industrial Emissions Directive (IED) - *Directive on industrial emissions (integrated pollution prevention and control)*	Directive 2010/75/EU of the Council of 24 November 2010 Current consolidated version: 06/01/2011	The directive aims to lower emissions from industrial production through an integrated approach.	

Monitoring Mechanism Regulation (MMR) – *Regulation on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change*	Regulation (EU) 2018/1999 repealing Regulation (EU) No 525/2013 (=MMR) Current consolidated version: 29/07/2021	his Regulation applies to the five dimensions of the Energy Union, which are closely related and mutually reinforcing: (a) energy security; (b) internal energy market; (c) energy efficiency; (d) decarbonisation; and (e) research, innovation and competitiveness	
Directive on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors	Directive 2000/14/EC of 8 May 2000 Current consolidated version: 26/07/2019	The objective of this Directive is to improve the control of noise emission in the environment by equipment for use outdoors. It contributes to the smooth functioning of the internal market, while protecting human health and well-being.	
Environmental noise directive (END) – *Directive relating to the assessment and management of environmental noise*	Directive 2002/49/EC of 25 June 2002 Current consolidated version: 29/07/2021	The END gives a common approach intended to avoid, prevent or reduce the harmful effects of environmental noise. The main target is an integrated noise management.	
Commission Directive establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council	Commission Directive (EU) 2015/996 of 19 May 2015	Common noise assessment methods, Input data, Measurement methods	

Occupational Health and Safety Framework Directive – *Directive on the introduction of measures to encourage improvements in the safety and health of workers at work*	Council Directive 89/391/EEC of 12 June 1989 Current consolidated version: 11/12/2008	measures to improve workers' safety and health at work are defined. The defined obligations for both employers and employees are intended to reduce the number of occupational accidents and work-related illnesses.	Many additional supplementary individual directives, e.g. for the areas of work equipment, personal safety equipment, etc.
Guidance document on non-energy mineral extraction and Natura 2000	2012	This leaflet represents a summary of the "Non-energy mineral extraction and Natura 2000" guide, designed to provide guidance on how best to ensure that NEEI developments are compatible with the provisions of the two EU Directives. It focuses in particular on the procedures to follow under Article 6 of the Habitats directive and provides clarifications on certain key aspects of this approval process in the context of NEEI developments in particular.	The guide is addressed to competent authorities and developers, as well as consultants, Natura 2000 site managers and other practitioners involved in the planning, design, implementation or approval of mineral plans or NEEI projects. It can be of interest also for NGOs, international bodies, and the general public.
Elaboration of guidelines for best risk management approaches in the extractive sector	2022	The risk management guidelines foster the sustainable supply of raw materials within the EU by identifying key activities most relevant to ensure the sustainability of extractive operations; support social acceptance of mining projects by identifying the most relevant risks and by providing approaches to avoid or mitigate them; encourage resource efficiency and the recovery of secondary raw materials. Conclusions drawn from the information exchange have no legally binding effect on EU Member States.	

EU principles for sustainable raw materials	2021	The objective of the EU principles for sustainable raw materials, is to align the understanding of sustainable raw materials extraction (from exploration to post-closure) and processing operations in the EU amongst Member States and define the general direction towards the SDGs. The principles should enable to better communicate with the public on the conditions under which sustainable raw materials extraction and processing takes place in Europe and increase public acceptance for this activity. The principles will build upon existing EU legislation concerning sustainability, and refer to internationally agreed sustainable raw materials extraction and processing initiatives.	The principles do not impose any obligations on the Member States or the industry. Development of indicators and certification is outside the scope of this action.
A review of European Union legal provisions on the environmental impact assessment of non-energy minerals extraction projects	Publications Office of the European Union, JRC 2021	This study may assist the sector in achieving a fluent approval of the EIA report and a streamlined environmental permitting. It is a concise document for developers, competent authorities, the public, and the "public concerned" encompassing with all the relevant Community legislation. It provides a review of the key environmental factors and some impact assessment elements along the mining life cycle phases, in addition to a few good practice cases. It also reviews the risk assessment methodologies, environmental monitoring, mitigation measures and assessment of alternatives, as well as environmental liability and information management issues.	

Aggregates Europe - UEPG, in its Roadmap 2030 [33] has layed out a policy compass to aggregates in which they describe the policy areas most relevant to the sector, ranging from the circular economy to technical standards (*Figure 61*), covering the main areas described in the table above and in this report.

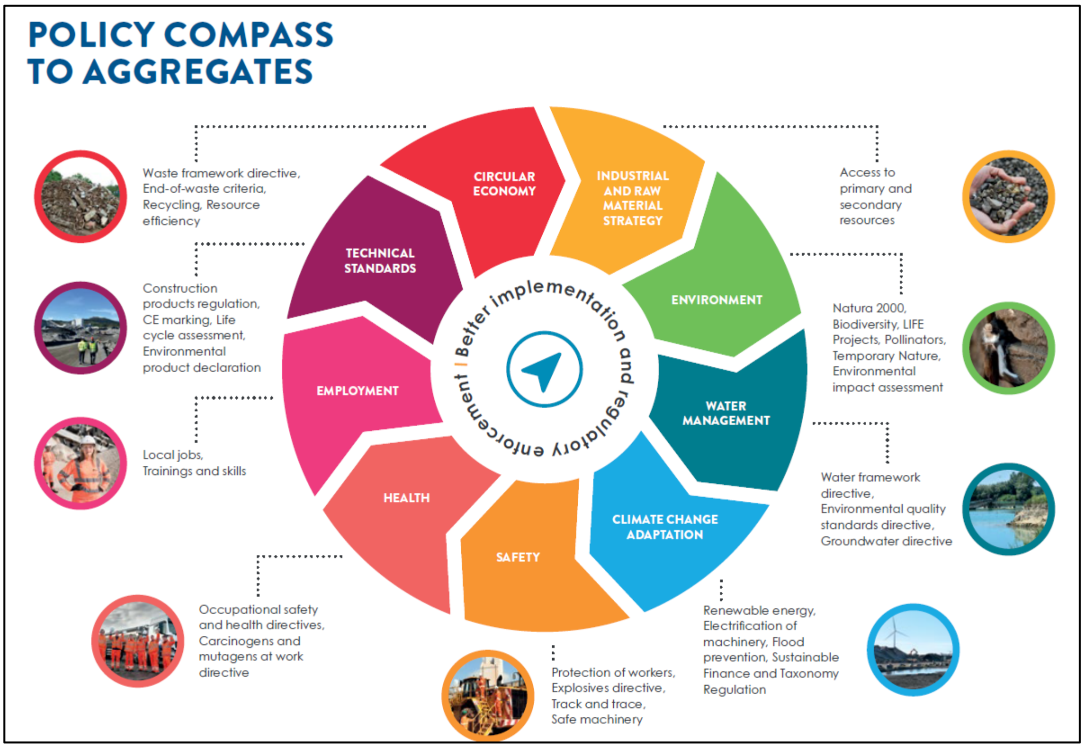


Figure 61 - Policy Compass to aggregates from UEPG's Roadmap 2030 (©UEPG Roadmap 2030 - Source: [33])

One aspect not explicitly mentioned in the policy compass, but springing from the RMI is the concept of "critical raw materials", which since received significant political backing and funding (e.g. as part of Horizon Europe or the EIT Raw Materials). In 2011, the EU has first published a list of critical raw materials[43] [65], that are crucial to the economy and which are a concern from a supply perspective. This list is currently undergoing its 4th re-assessment and it is expected that the number of raw materials included in this list will grow again.

Absent from this list are the aggregates, mainly due to the fact that, as shown in *Chapter 3*, their supply is from domestic sources from within Europe. Given the current political focus on critical raw materials, aggregates, which are equally important for the transformation needed as part of the Green Deal *(see Chapter 6)*, are at risk of being seen as a given and of losing out, i.e. in the context of land use planning, as described in the previous chapter, but also in the context of minerals policy governance.

The sector needs to continue making policy makers aware of the importance of aggregates in the context of the Green Deal and energy transformation - despite the fact of not being included in the critical raw materials list.

[43] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0025&from=EN *(05.12.2022)*

The following subchapters describe findings from MIN-GUIDE on approaches for effective mineral policy governance and findings from the project, which could be seen as suggestions for potential policy improvements.

Approaches for effective minerals policy governance

The concept of governance refers to the process of governing, the managing, steering and guiding of public affairs by governing procedures and institutions (e.g. public authorities or other stakeholders), especially in relation to public policy decision-making. It includes processes that go beyond, for example, formal planning and permitting procedures, but are in place to achieve general coordination of policy decision-making or involvement of stakeholders. [60]

Challenges pertaining to mineral policy [61]:

- *The need for **policy mixes** (e.g. financial incentives for investments in addition to regulatory instruments).*
- *A call for clear legislation to **avoid policy duplication** (as this makes e.g. permitting processes lengthy).*
- *The need for **effective strategic policy planning frameworks** and long-term orientation (sought after, for instance, by industry to establish security of investment, and include resource-related sustainability considerations more strongly).*
- *The requirement of **coordination between 'linked' policy areas and sectors** (e.g. influencing extraction and minerals policy).*
- *The need for stakeholder involvement (e.g. addresses low levels of **public acceptance** and **NIMBY**-attitudes towards mining and quarrying).*

The argument for a more integrated and comprehensive approach to mineral policy extends past environmental impacts of mineral exploitation to the recognition of socio-economic, political and cultural impacts on all levels of society [66]. *In order for EU MS to address the interconnected challenge of minerals policy, a holistic approach to 'good governance' is needed (Figure 62).*
Good governance, as a concept for guiding public policy decision-making, is an important prerequisite for achieving legitimacy, coherence and integration of policy. [60]

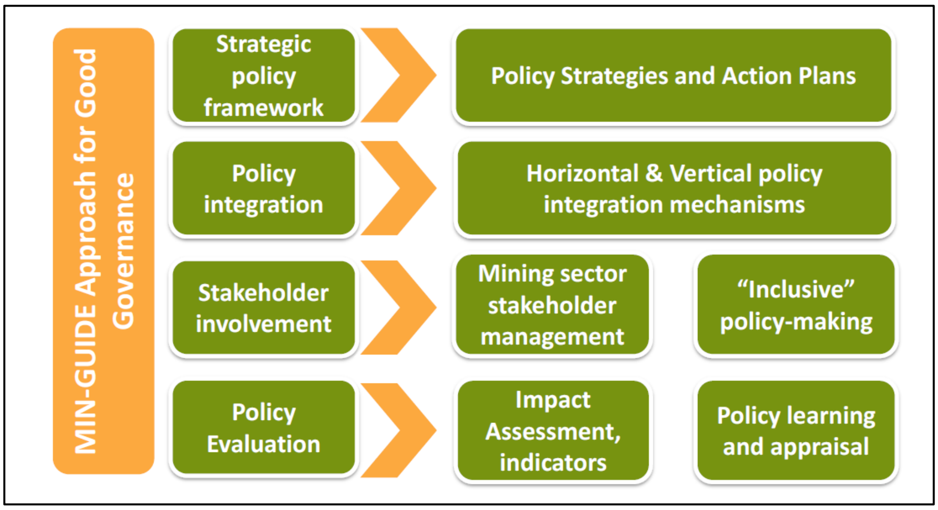


Figure 62 - MIN-GUIDE approach for Good Governance (Source: [60])

Particularly relevant aspects in the context of minerals policy are horizontal- and vertical policy integration, participation, long-term visioning and short-term action, as well as reflexivity and learning (evaluation and adaptation).[44]

Strategic Policy Framework
The challenges of public policy makers are mainly:
- the streamlining of policy instruments and objectives
- the coordination of the work of different authorities
- the commitment to the mineral sector in response to external pressures (e.g. SLO, market fluctuations, etc.).

The primary extractive sector calls for harmonisation of mineral policies and clear mineral policy strategies in the individual EU Member States (MS).

> *In an effort to address these challenges, 15 out of 28 EU MS (Table 7) have designed and implemented National Minerals Strategies (NMS). A NMS is a guiding document devising responsibilities and mandates for involved authorities along with a set of objectives, targets and clear timeframes for implementation [67]. The presence of a NMS can indicate the importance attributed to the minerals sector and a government's commitment to strategically address the challenges of a stable and sustainable supply of minerals. Thus, a NMS can provide guidance to public institutions and stakeholders on the direction and expectation of the national (or sub-national) level with regard to regulating the sector. A NMS should set out to create the "right framework conditions for quarrying and mining"; by ensuring coherence between regional and local strategies and other relevant policies, and, when appropriate, integrating a mix of different policy instruments. [60]*

a) National Minerals Strategy *[60]*

- ***Relevance***
  The presence of a National Minerals Strategy (NMS) can be an <u>indication of a government's commitment to establishing a coherent and long-term oriented minerals policy framework</u>.

- ***Potential Impact***
  The presence of a NMS can indicate the importance attributed to the minerals sector and commitment by the government to strategically address the challenges of a stable and sustainable supply of minerals in the respective country. An NMS typically also contains relevant commitment to <u>objectives, targets and a timeframe.</u> Moreover, a NMS can be a guiding document in terms of <u>giving clarity to responsibilities and mandates</u> of involved actors/ministries [67]. It may, furthermore, indicate a government's attempt to "resolve shortcomings of previous, more ad hoc, policy regimes" [68].

b) Central authority responsible for mineral policy *[60]*

- ***Relevance***
  A determinant of an effective minerals policy framework is the <u>presence of an authority with the responsibility and mandate to monitor, supervise and coordinate relevant ministries/departments/actors.</u>

[44] *European Commission and Directorate-General for Internal Market, Raw Materials Scoreboard European Innovation Partnership on Raw Materials*

- *Central authorities were identified for all 28 EU MS*

- ***Potential Impact***
  The presence of an authority with a clear mandate to coordinate and supervise governance mechanisms and strategies helps facilitate a streamlined process [69]. Hence, having transparency, in terms of responsibility and mandates (being centralised or regional), can foster consistency of a minerals policy framework.

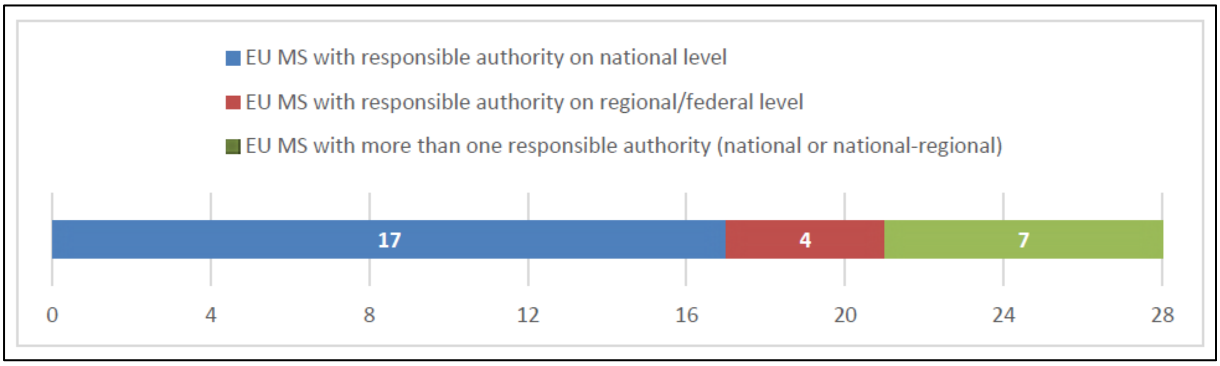


Figure 63 - Responsible Authority Mineral Policy in EU27+UK (2018) (Source: MIN-GUIDE [60])

Table 7 - EU MS and National Mineral Strategies (Source: MIN-GUIDE (updated))

Country	Mineral Strategy	Responsible Authority	
		Design	Implementation
Austria	Austrian Mineral Resources Plan (Österreichischer Rohstoffplan) (2012)	Federal Ministry of Science, Research and Economy	Federal Ministry of Finance
	Master Plan Raw Materials 2030 (Masterplan Rohstoffe 2030) (2021)	Federal Ministry of Agriculture, Regions and Tourism	Federal Ministry of Finance
Belgium (Flanders)	Mineral Resources in Flanders - The Flemish Policy (2010)	Environment, Nature and Energy Department	Environment, Nature and Energy Department
Croatia	Mineral Resource Management Strategy of Croatia (2008)	Ministry of the Economy	Ministry of the Economy
Czech Republic	The Raw Material Policy of the Czech Republic in the Field of Materials and Their Resources (1999/2017)	Ministry of Industry and Trade	Ministry of Industry and Trade
Estonia	National Development Plan for the Use of Construction Minerals (2011-2020)	Ministry of the Environment	Ministry of the Environment
Finland	Finland's Minerals Strategy (2010)	Ministry of Employment and the Economy , Finnish Geological Survey	Ministry of Employment and the Economy
France	Policy E1-E4 Strategy and Governance (2011)	Ministère de l'Economie, de l'Industrie et du Numérique	Ministère de l'Economie, de l'Industrie et du Numérique
Germany	Raw materials strategy of the federal government (2010)	Ministry of Economy and Technology	Ministry of Economy and Technology

Greece	National Policy for the Strategic Planning and Exploitation of Mineral Resources (2012)	Ministry of Environment, Energy and Climate	Ministry of Environment and Energy, Regional and local authorities (decentralised administrations, prefectures, municipalities)
Poland	Action Plan for Poland's Security in the Field of Non-Energy Raw Materials (p rogress)	Ministry of Economic Development	All ministries and public bodies involved in aspects of mineral resource policy
	National Raw Materials Policy (polityka surowcow panstwa) (2022)	Council of Ministers	Council of Ministers
Portugal	National Strategy for Geological Resources - Mineral Resources (2013-2030)	Ministry of Economic	DGEG
Romania	Mineral Industry Strategy (2012-2035)	Ministry of Economic	Ministry of Economic
Slovenia	National Mineral Resource Management Programme (2009)	Ministry of Infrastructure	Ministry of Infrastructure
	Slovenia Development Strategy 2030 (2017)	Government Office for Development and European Cohesion Policy	Government Office for Development and European Cohesion Policy
Spain	Road Map for the sustainable management of mineral raw materials (Hoja de ruta para la gestión sostenible de las materias primas minerales) (2022)	Ministry for the Ecological Transition and the Demographic Challenge (MITECO)	Ministry for the Ecological Transition and the Demographic Challenge (MITECO)
Sweden	Sweden's Minerals Strategy (2013)	Government Offices of Sweden	Munustry of Entreprise and Innovation

Policy Integration *[61]*

> *One of the main challenges of minerals policy is its interconnectedness with other policy areas. Hence, mechanisms of policy integration should address 'the lack of coordination' between relevant policy areas and, consequently, avoid policy duplication or inconsistencies.*
> *There is a need for cross-sectoral collaboration of different public authorities, which can be achieved through Horizontal Policy Integration (HPI) (ministerial and cross departmental collaboration).*
> *Thus, a good governance approach to minerals policy also calls for mechanisms of Vertical Policy Integration (VPI) (collaboration between different levels of government).*

Both VPI and HPI are highly relevant concerning the integration and implementation of EU policies in the member states, i.e. related to minerals (domain of MS) and environmental policies (EU domain). Relevant examples are the lack of implementation of mineral strategies in MS *(Table 7, above)* the different interpretation of whether or not extraction of minerals is allowed in Natura 2000 areas or differences in the implementation of the Water Framework Directive and what impacts on water bodies are possible, for example concerning the storage of tailings.

Policy integration hence requires both vertical and horizontal mechanisms to achieve effective integration of policies with cross-sectoral importance and impacts [70,71].

8.1. OVERVIEW OF EUROPEAN AGGREGATES TAXES, FEES AND ROYALTIES

In the course of this study, an attempt was made to ascertain the current situation regarding taxes, fees and royalties in the aggregates sector.
The feedback received from some countries can be found in *Appendix E2*. However, the feedback received was too little and too imprecise to provide much of an overall picture.

The following are the results of the literature research, which, however, date from 2005-2008 and have not been updated/published to date. The scattered feedback from the countries has already been incorporated here *(in Detail see Appendix E2)*

There is still a considerable need for data collection and update in the sector.

Taxes[45]
Taxes are payments that must be made on revenue that is generated from normal business activities. While taxes are also based on rates, they do not depend on particular land leases or activities. Anytime revenue is produced, including through typical income or through investment, taxes must be taken out.

Royalties[46]
Royalties to the government are payments in return for the permission to engage in certain activities on government lands.

Fee
A fee is a fixed price charged for a specific service.[47]
Obligatory payment to the Government or another organisation.[48]

Table 8 - "Taxes and Charges on Aggregates at National Level" (2005)[49]

Country	Name of tax, charge or fee	Purpose of instrument	Year of introduction
Austria	Landscape protection levy / Nature conservation levy	Support of nature conservation and landscape development (provincial/regional level – Bundesländerebene)	1990 and following
Bulgaria	Mining charge	No purpose stated	1997
Cyprus	Quarrying charge	No purpose stated	N/A
Czech Republic	Payments for mineral extraction	No purpose stated	1993
Denmark	Duty on raw materials	Efficient use of natural resources	1978
Estonia	Mineral extraction tax	Efficient use of natural resources/ cost coverage	1991
France	Tax générale sur les activités pollutants Matérieaux d'extraction (granulats)	Cost coverage	1999
Germany	Mining charge (regional level)	No purpose stated	1980

[45] https://smallbusiness.chron.com/differences-royalties-taxes-10001.html *(05.12.2022)*
[46] https://smallbusiness.chron.com/differences-royalties-taxes-10001.html *(05.12.2022)*
[47] https://www.investopedia.com/terms/f/fee.asp *(05.12.2022)*
[48] https://www.floodre.co.uk/faq/what-is-the-difference-between-tax-levy-and-duty/ *(05.12.2022)*
[49] *Source: [8] , [5] , OECD/EEA database/ETC/RWM, 2005*

Hungary	Mining charge	Fundraising for mine redemption	N/A
Italy	Quarrying activities (regional)	Compensation for environmental costs	N/A
Latvia	Natural resources charge Materials extraction charge	Efficient use of natural resources/ cost coverage No purpose stated	1996 N/A
Lithuania	Mineral extraction charges	Efficient use of natural resources/ cost coverage	1991
Poland	Mineral extraction charge	Cost coverage	N/A
Romania	Mining royalty Corporate tax		N/A
Slovakia	Mining charge	Revenue rising	N/A
Sweden	Mineral act charge Natural gravel tax Excavation charge	Cost coverage Efficient use of natural resources/ cost coverage	1992 1996 1999
UK	Aggregates levy Landfill Tax	Reduce demand of primary materials discourage landfill and encourage waste minimisation	2002 1996

Environmental taxes are applied in all European countries as a source of government revenues [72]. *Table 8* shows taxes and charges related to aggregates extraction that were/are in force in Europe (2008).

Pure aggregates taxes (including sand, gravel and/ or crushed rock) are implemented in Denmark, Sweden ("natural gravel tax"), the United Kingdom ("aggregates tax"), and in Belgium (Flanders) and Italy — on a regional level. Other countries raise mining or extraction charges. Two forms of taxes have to be distinguished in general: ad valorem taxes (monetary tax base) and ad quantum taxes (physical tax base). Denmark and Sweden are examples for ad quantum taxes. Other countries, which rate the extraction of mineral raw materials ad valorem, are the Czech Republic and Poland. [5,72]

APPENDIX E1 & E2 – MINERAL POLICIES & MINERAL EXTRACTION LEGISLATION – COUNTRY PROFILES

9. PERMITTING

This study was primarily aimed at identifying and pointing out gaps, problems but also possible solutions in the permitting procedures for aggregates in the individual countries.

All information is based on the results of the MIN-GUIDE[50] (2016-2019), MINLAND[51] (2017-2019) and MINLEX[52] (2017) projects, as well as on the questionnaire survey and the interviews with Aggregates Europe - UEPG members from the countries. As all three projects are EU-funded projects, "only" the EU28 are covered (without EFTA, sometimes some information about Norway is noted). *Table 9* shows the main legislation governing mineral resources and as such also the permitting process for new extractive sites. Other legislation, such as EIA requirements or site-specific situations concerning water, air emissions, Natura 2000, etc have not been analysed in any detail as part of this study.

Such a detailed description of the permitting processes would go beyond the scope of this study. There is still a need for further research in this regard. It would be advisable to discuss in-depth with the authorities responsible in the respective country about procedures, duration of procedures, reasons for delays, etc. in order to find possible solutions. EIA have become an important part of the permitting process.

Table 9 - EU MS main governing minerals legislation and responsible ministries (Source: MIN-GUIDE updated)

		Responsible Ministries	
Country	**Minerals Legislation**	**Design**	**Implementation**
Austria	Mineral Raw Materials Act (2016)	Department of mineral policy / Energy & Mining, Ministry of Science, Research and Economy	Ministry of Finance
Belgium (Flanders)	Flemish Parliament Act on Surface Mineral Resources (2014)	Environment, Nature and Energy Department	Environment, Nature and Energy Department
Belgium (Wallonia)	Mines Degree (1988/2009)	Regional Council of Wallonia	Regional Council of Wallonia
Belgium (National)	Law on Exploration and the Exploitation of non-living resources of the territorial sea and the continental shelf (2008)	Federal Public Service (FPS) Economy, SMEs, Self-emplyed and Energy	FPS Economy, SMEs, Self-employed and Energy, DG Quality and Safety, DG Energy (hydrocarbons), FPS Health, food chain safety and Environment, DG Environment (EIA)
Bulgaria	Subsurface Resources Act (2011)	Ministry of Energy	Council of Ministers
Croatia	The Mining Law (2009)	Ministry of the Economy (the mining directorate)	Department of the Mining Inspectorate, ministry of the economy (the mining directorate)
Cyprus	Mines and Quarries Regulations (1958) (law chapter 270)	Mines Service of Ministry of Agricultural, Rural Development and Environment	Mines Service of Ministry of Agricultural, Rural Development and Environment
Czech Republic	Mining Act no. 44 (1988/2006)	State Mining Authority	Czech Mining Office/District Mining Office
Denmark	Danish Raw Material Act (2013)	Ministry of Environment and Food	Ministry of Environment and Food
Estonia	Mining Act (2013)	Ministry of the Environment	Ministry of the Environment

[50] https://cordis.europa.eu/project/id/689527/results/de *(05.12.2022)*

[51] https://cordis.europa.eu/project/id/776679/results/de *(05.12.2022)*

[52] https://op.europa.eu/en/publication-detail/-/publication/18c19395-6dbf-11e7-b2f2-01aa75ed71a1/language-en *(05.12.2022)*

Finland	Mining Act (2011)	Ministry of Employment and the Economy	Finnish Safety and Chemicals Agency (TUKES)
France	Mineral Code (new) (2018)	Ministry for the Ecological and Inclusive Transition of France	Ministry for the Ecological and Inclusive Transition of France
Germany	Federal Mining Law (2016)	Landesamt für Geologie und Bergwesen (LAGB); Landesanstalt für Umwelt und Geologie (TLUG), Bundesministerium der Justiz und für Verbraucherschutz	Federal responsible authorities
Greece	The Mining Code (1973/1976/2014)	Ministry of Environment and Energy: Department of Mineral Resources	Ministry of Environment and Energy: Department of Mineral Resources, Regional and local authorities (decentralised administration, prefectures, municipalities)
Hungary	Mining Law (1993/2015)	Ministry of National Development (Hungarian office of Geology and Mining)	Ministry of National Development (Hungarian office of Geology and Mining)
Ireland	Minerals Development Bill	Department of Communications, Energy and Natural Resources	Department of Communications, Energy and Natural Resources
Italy	Regional Laws	Regional Authorithies	Regional Authorithies
Latvia	Law on Subterranean Depths (1999/2006)	Ministry of the Environment, Ministry of Economics	Ministry of the Environment, Ministry of Economics, local governments, the Lavian Environment, Geology and Meteorology Agency
Lithuania	Underground Law (1995)	Ministry of Environment	Ministry of Environment
Luxembourg	Law about mines, shallowopen-pit mines and quarries (1810)	National Authorities	Ministry of Labour, Employment and Social Solidarity, Economy, Ministyr of Sustainable Development and Infrastructure
Malta	Malta Resources Authority (2015)	The Malta Environment and Plannng Authority	Malta Resources Authority
Poland	Geological and Mining Law (2015)	Ministry of the Environment	(State treasury can assign mineral rights/central administration) Ministry of Environment, Ministry of Energy, Ministry of Economic Development
Portugal	General Legal Framework for the Discovery and Use of Geological Resources (2015)	Ministry of the Economy	Ministry of the Economy
Romania	Mining Law (2003)	The National Agency of Mineral Resources (NAMR)	The National Agency of Mineral Resources (NAMR)
Slovakia	Mining Act (1988/2010)	Slovak National Council	Slovak Geological Institutr, Ministry of Environment, Ministry of Economy (national and regional mining offices)
Spain	Spanish Mining Law 22/1973	Ministry of Industry, Energy and Tourism	Ministry of Industry, Energy and Tourism (national); Department of Industry of the Autonomous Government (Regional)
Sweden	Minerals Act (1991/2006)	Ministry of Enterprise and Innovation	Swedish Mining Inspectorate/Ministry of Enterprise and Innovation
The Netherlands	Minig Act (2002)	Ministry of Economic Affairs and Climate Policy	Ministry of Economic Affairs and Climate Policy
United Kingdom	Town and Country Plannung Legislations	Town and Country Plannung Legislations	Mineral Planing Authorities (MPAs)

***Barriers, Challenges and drivers** [60]:*

The extractive industry's capital-intensive investments, long start-up times, or complex commodity market developments require stable legal framework conditions and efficient public administration. In this regard, permitting procedures for licensing of mineral raw materials exploration and extraction are of significant importance for the sector.
According to the EIP SIP19[53] and the MINLEX Study[54], there are a number of challenges the permitting systems of EU Member States are confronted with:

1. ***Involving different authorities:** the permit procedure involves many authorities; in many permitting procedure segments, especially at the local / regional level, qualified personnel may be missing or be insufficiently trained;*
2. ***Long time frames**: start of authorisation to permit times are characterised by long or unknown time frames for the permit application;*
3. ***Multiple and/or conflicting legal provisions**: the whole permitting chain sometimes does not have a clear course, since various and sometimes repetitive requirements are requested based on different regulatory policy instruments; and*
4. ***Non-transparent or unavailable information:** available information and support to applicants or investors (i.e. nature and time frame of the process, as well as the level of permitting fees, royalties, etc.) is not sufficient at the time of permit application.*

Integrating the different permits required in such a way that they are issued by one competent authority (a "one-stop shop") and with only one environmental impact assessment (EIA) or by parallel assessment[55] might be one approach to overcome the abovementioned challenges.
Table 10 provide an overview of the MINLEX study results: EU MS permitting regimes and one-stop shops, as well as background information on the effectiveness of permitting regimes (time frames and permitting success rates).

- ***Permitting Regimes**: According to MINLEX, permitting procedures for the NEEI in EU MS revolve around a principal national or regional authority and other collaborating authorities at all levels that issue an exploration or an extraction permit. MINLEX differentiates permitting procedures according to three different permitting regimes: centralised, decentralised or mixed (combination of centralised and decentralised). Centralised regimes are those where permitting procedures are managed by national level authorities, whereas in decentralised regimes, permits are granted by regional (provincial) or municipal authorities.*

- ***One-stop shops:** As a solution to more complex permitting regimes, a "one-stop" shop per region or country can act as a "single point of contact' for a potential investor. Such a regime facilitates the coordination and parallel work of co-authorities, reducing the time for decisions to be made and facilitates potential investor´s perspectives on how to deal with all necessary legislation and permits. Some EU MS, such as Austria, Denmark, Germany, Hungary, Ireland, and Portugal have already introduced such a system which has led to lower timeframes for permitting.*

[53] EIP SIP part II Action area n° II.1: Minerals Policy Framework
[54] MINLEX Study – Legal framework for mineral extraction and permitting procedures for exploration and exploitation in the EU, 2017.
[55] European Commission, 2014. Evaluation and exchange of good practice for the sustainable supply of raw materials within the EU; EIP SIP part II Action area n° II.1: Minerals Policy Framework; MINLEX Study – Legal framework for mineral extraction and permitting procedures for exploration and exploitation in the EU, 2017.

- ***Permitting time frames:*** *As regards the time for acquiring an extraction permit, there is a vast variation among different EU MS: Some EU MS share relatively short time frames, ranging from 2 months in Slovakia, to others that cover longer time frames, such as France (e.g. 10 to 16 months for quarried substances) or Spain (3 to 7 years, this number includes the EIA procedure).*

Table 10 - MINLEX Study EU MS Permitting Systems: overview of selected indicators[56] (updated) (Country Profiles in detail: see APPENDIX F)

Country	Permitting regime type	One-stop shop	EXPLORATION permit success rates [%]	EXTRACTION permit success rates [%]	Legal timeframe for permit [month]	Time to extraction permit [months]	Time to environmental permit [months]
Austria	decentralised/ regional	YES[57]	95	80	extraction: 6 environ.: 4-9	12 to 24	up to 36 months
Belgium	mixed (Wallonia) centralised (Flanders)	-	N/A	92	N/A	4 to 6	4 to 6
Bulgaria	centralised	-	50	N/A	extraction: 7-8 environ.: n.d.[58]	up to years	from months to over one year
Croatia	centralised	-	85	85	extraction: 36-54 environ.: 26-36	36 to 52	26 to 36
Cyprus	centralised	-	95	92	extraction: n.d. environ.: n.d.	12 to 60	6 to 12
Czech Republic	mixed	-	43	92	N/A	N/A	N/A
Denmark	decentralised	YES	N/A	100	extraction: n.d. environ.: n.d.	9 to 12	12
Estonia	centralised	-	86	89	N/A	7 to 12	7 to 12
Finland	mixed	-	68	100	extraction: n.d. environ.: 2	3	6 to 12
France	decentralised/ regional	-	82	25	extraction: 12 environ.: n.d.	10 to 16	N/A
Germany	decentralised	YES	N/A	N/A	N/A	N/A	N/A
Greece	mixed	-	42	N/A	extraction: 2 environ.: 2	3 to 4	6 to 8
Hungary	Decentralised/ regional	YES	87	74	extraction: 3-15 environ.: 2+	4+	2 to 36
Ireland	mixed	YES[59]	97	100	extraction: n.d. environ.: 7	6 to 10	7
Italy	decentralised	-	100	100	extraction: 4 environ.: 4.4	N/A	4.4
Latvia	centralised	-	98	87	extraction: 1-4 (12) environ.: 2-6	1 to 12	2 to 6
Lithuania	centralised	-	85	84	extraction: 11-39 environ.: 2-24	11 to 39	N/A
Luxembourg	mixed	-	N/A	N/A	extraction: 6.5-18 environ.: 6.5-18	N/A	N/A
Malta	centralised	-	N/A	N/A	extraction: n.d. environ.: n.d.	3.3	N/A
Netherlands	centralised	-	100	100	extraction: 3 environ.: 1.5	3	1.5

[56] *ONLY concerning construction material (aggregates)*
[57] only for EIA
[58] n.d. = not defined by law
[59] Only for exploration permits

Poland	mixed	-	80	80	extraction: 3.9 environ.: 2.7	1.5 to 3	N/A
Portugal	mixed	YES	100	32	extraction: n.d. environ.: 1.7	11	N/A
Romania	centralised	-	100	0	extraction: n.d. environ.: 1.7	1 to 24	1 to 12+
Slovakia	mixed	-	78	N/A	extraction: 2 environ.: 3-5	2	2 to 12+
Slovenia	centralised	-	N/A	75	extraction: n.d. environ.: N/A	12+	N/A
Spain	decentralised	-	90	10	extraction: n.d. environ.: 6	36 to 120	12 to 36
Sweden	mixed	-	86	57	extraction: n.d. environ.: N/A	31	N/A
Switzerland	no Mining Act	-	N/A	N/A	extraction: n.d. environ.: n.d.	120 to 240	120 to 240
United Kingdom	decentralised	-	N/A	80	extraction: 3.3-7.5 environ.: n.d.	3 to 6	N/A

Since the "time to permit" frames differ quite widely, careful attention needs to be paid to the underlying reasons. There are a wide variety of reasons that can be considered for improving the permitting process and, consequently, shortening the actual "time to permit":

- *the specificities of the designated area for exploitation (e.g. prior established designation in land use planning, proximity to protected areas);*
- *the quality of the permitting process (e.g. insufficient resources of permitting authorities, un-skilled personnel, insufficient quality of guiding instructions, inefficient management processes); and*
- *the quality of the submitted permit (e.g. insufficient description of new extraction methods or missing supplementary information).*

Making permitting processes more effective may be achieved through integrating the different permits required in such a way that they are issued by one competent authority (a one -stop-shop) and with only one environmental impact assessment or by parallel assessment[60].

Currently, 7 EU MS[61] have introduced a "one-stop" shop per region or on the national level that already account for significantly lower permitting timeframes. Furthermore, guidance documents or translations may facilitate an understanding and legal certainty of what needs to be provided in order to obtain authorisation for mineral exploration or extraction. [55]

[60] *European Commission, 2014. Evaluation and exchange of good practice for the sustainable supply of raw materials within the EU; EIP SIP part II Action area n° II.1: Minerals Policy Framework*

[61] AT, DK, DE, HU, IE, and PT

In the following paragraphs, three good practice cases for Permitting Procedures are presented *(Source: MIN-GUIDE project)*. Their final selection was based on the preliminary results on the identification of good practice regarding exploration and extraction permitting procedures in the MIN-LEX Second Interim Report.

Case 1 - A one-stop-shop and greater transparency: Licensing system for exploration (IE): The Irish system for exploration licensing is a good practice case due to its administrative procedures organised as a one-stop shop, as well as publically available exploration data.

Case 2 - Environmental impact assessment and remediation plan are key to permitting procedures: Parallel processing of permit applications for extraction (DK): The Danish permit application system for extraction is a good practice example, because of its approach towards Environmental Impact Assessments, as well as inclusive remediation plans and payment guarantees during the permitting process.

Case 3 - Integrating geological information and mineral safeguarding in land use planning: One-stop-shop for permitting procedures (BE-Flanders): The Flemish system for extraction licensing is characterised as a good practice case due to its integrated land use planning approach and administrative procedures organised as a one-stop shop.

APPENDIX F – PERMITTING SYSTEMS – COUNTRY PROFILES

10. FUTURE TRENDS

By 2030, there will be strong economic growth, particularly in Asia, India, Africa and Latin America. According to estimates by the *Global Aggregates Information Network* (GAIN), global demand for aggregates will increase to 60 billion tonnes per year by 2030, driven by increasing population, urbanisation and economic growth. [23]

Aggregates Europe - UEPG Roadmap2030 – Future Challenges [33]

In its Roadmap 2030 Aggregates Europe - UEPG lists the following challenges for the aggregates sector:

1. ***CLIMATE NEUTRALITY***
   - *The decarbonisation of the electricity generation and its distribution will take time and require significant investment. Today, electrified or hydrogen-powered equipment for our sector is not mature enough to be widely available and affordable to SMEs. Supporting development and getting the incentives right to roll out such technology when ready will be decisive.*
   - *Permitting and land-use planning should be adapted to allow different activities (mineral extraction, recycling, production of renewable energy) on site.*
   - *Access to domestic resources, land-use planning and permitting is a national competence, while sustainable and responsible access to protected areas (Natura 2000) is decided in Brussels.*
   - *The NIMBY effect could block local access to resources and result in longer transport distances with a significant negative impact.*

2. ***EU CLIMATE CHANGE ADAPTATION STRATEGY***
   - *While quarries and sand/gravel extraction sites are going to be an essential partner in climate change adaptation, the industry is often still wrongly perceived as harmful to environment and climate.*

3. ***EU GREEN DEAL***
   - *There is a widespread misconception that biomass products (timber) and recycled materials could cover the total demand for construction materials and that such products would always be the most sustainable choice. There needs to be a more transparent and consistent way to demonstrate the sustainability credentials of different sources of construction materials, rather than relying upon perception.*
   - *The lack of progress on technical standards linked with the Construction Products Regulation prevents a better adaptation of the quality criteria for aggregates to requirements of constructions works and a more sustainable use of aggregates.*

4. ***NEW EU INDUSTRIAL STRATEGY***
   - *The fact that land-use planning and permitting for domestic raw materials is a national or regional competence while access to resources in protected areas (at least 30% by 2030) and environmental management (Environmental Impact Assessment) are covered by European legislation. What makes this policy area even more challenging, is the fact that public attention*

and the focus of decision makers lies mainly with critical raw materials and battery raw materials. Shortages on the supply of aggregates can lead to broken supply chains, delays or even closure of construction sites and impacts negatively on transport distances and the related CO_2 footprint.

5. *CIRCULAR EU ACTION PLAN*

- *The potential contribution of recycling and related figures should be realistic and not raise false expectations to which extent primary aggregates could be substituted. Even with the highest recycling rates, around 80% of natural aggregates will be needed to meet the total demand for construction across Europe.*
- *The availability of recycled materials is uneven between metropolitan and rural areas, and legally binding minimal recycled content, irrespective of the location, could lead to major CO_2 impacts.*
- *EU and national policies are promoting a European Recycling Society and call for fixed EU-wide targets, while indicators are not yet fully developed nor accurate / representative.*
- *The range of policy tools reaches from innovative products, new technologies, recycling targets, resource taxation and further restrictions to landfill. A better understanding of what is happening in the field is required to track the cause an effect of policy and regulatory interventions.*

6. *EU BIODIVERSITY STRATEGY*

- *It is essential to reconcile socio-economic and nature conservation objectives, to engage with stakeholders (particularly landowners and users) and create partnerships between local authorities, businesses, and NGOs to deliver practical results on the ground.*
- *Despite the EU Guidance on non-energy extractive activities in Natura 2000, proving in many cases the compatibility with biodiversity, aggregates extraction is often inappropriately excluded from protected areas or its surroundings. This is based on an outdated misperception that aggregates extraction harms the environment, leading to unsuitable local decisions against the letter and spirit of EU Directives.*

7. *SAFETY & HEALTH*

- *As many other industries in Europe, aggregate producers face the issue of an ageing workforce and the challenge of attracting young people towards the industry. The digital transition of SMEs (small and medium sized enterprises) and the need for new green jobs may also be challenging at times.*

8. *IMPLEMENTATION & ENFORCEMENT OF EU LEGISLATION*

- *In a highly competitive Industry, restrictive access to resources, unnecessarily costly impact assessments and lengthy permitting procedures make it difficult for companies to invest and continue to operate.*
- *Limited access to finance further weakens the competitiveness of a sector which consists mainly of SMEs.*
- *In some countries, illegal activities and occasional dumping of waste create an unbearable distortion of what should be a fair level playing-field.*
- *Existing artificial barriers due to different interpretations of EU legislation by the Member States fragments the single market and distorts competition.*

9. UN SUSTAINABLE DEVELOPMENT GOALS (SDGS)

- *The lack of knowledge and recognition by society and governments on the essential nature and use of aggregates for the daily needs of citizens – supply is assumed.*
- *In other regions of the world a very high demand for aggregates might trigger unsustainable and irresponsible extraction.*

A survey conducted by the Federación de Áridos (FdA, Spain) revealed that the four main problems for aggregates companies are, in this order [20]:

- trade margins
- obtaining operating permits and licences
- relations with politicians and unfair competition.

On a second level are:

- the environment
- oversupply
- low profitability
- the NIMBY phenomenon.

On the third level are:

- low sales
- poor image
- climate change
- lack of qualified staff

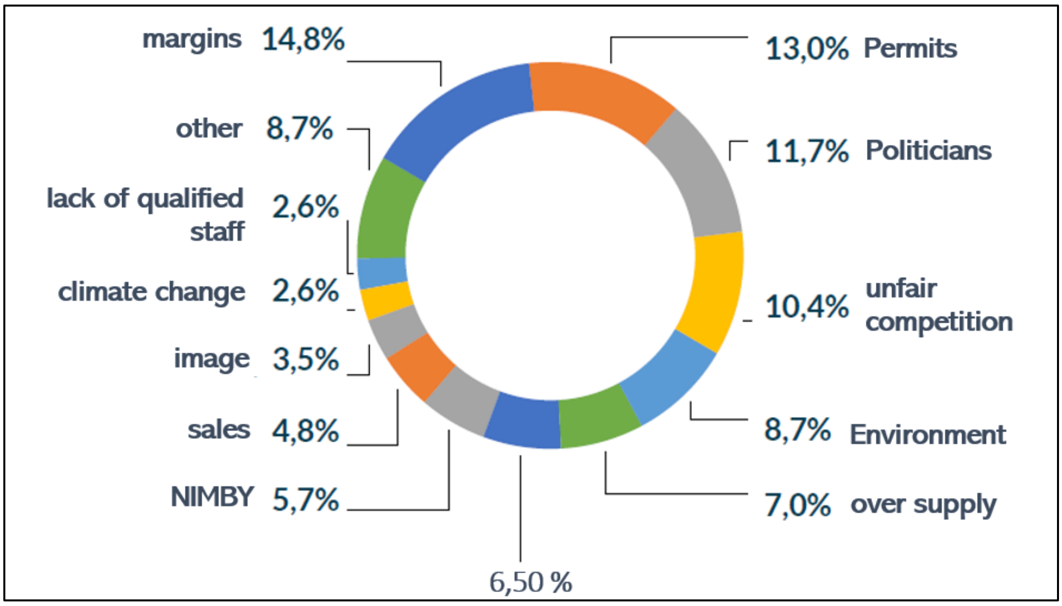


Figure 64 - Company's key challenges in 2022 (Spain) (Source: [20])

The results of FdA's company survey on the probability level of the possible scenarios for the year 2030 are shown in the following table:

Table 11 – Survey rsults on the probability level of possible scenarios for 2030

High consensus that this will happen	High consensus that this will not happen
• European, national and regional legislation will strengthen the protection of the natural environment and biodiversity. • Obtaining concessions and authorisations will require greater technical and economic capacities in companies (legal requirements, complexity of projects, processing of dossiers, etc.). • Local communities (municipalities, neighbours, NGOs, etc.) will increasingly fight against the approval of new aggregate extraction projects. • Increasing environmental constraints will accentuate the difficulties of access to resources. • Local communities (municipalities, neighbours, NGOs, etc.) and environmental organisations will be increasingly involved in the decision-making process for the approval of new aggregate projects. • Companies will need to substantially increase the technical and environmental capacity of their staff. • Taxation related to environmental protection (exploitation taxes, landfill taxes, CO_2 emission taxes, restoration guarantees, etc.) will have an increasing impact on extractive activity. • The weight of compensatory measures for environmental impacts will be increasingly important for aggregates companies. • The role of business associations will be more relevant in the defence of the sector's interests. • The environmental impacts of industrial activities will be valued economically.	• Spatial and local planning will address the need for aggregates supply. • Aggregate imports shall reach at least 10% of consumption. • Aggregates transport by rail will be developed significantly. • The demand for aggregates for civil works will be much higher than at present. • The reduction in the economic resources of the administrations, as well as other factors, will reduce the levels of control and demands on companies. • The rate of housing construction will increase.

Weakness	Threats
• Permissiveness of administrations to unfair competition • Low profitability • Bad image of the extractive industry • oversupply • Small size of enterprises, mostly SMEs and micro-SMEs. Atomisation of the sector.	• Lack of coordination between the substantive extractive industry administration and the rest of the administrations. • Administrative obstacles in obtaining permits and licences. • Downward pressure on prices • Increasingly restrictive, abundant and contradictory legislation • Excessive influence of political conditioning factors, to the detriment of regulated procedures. • Lack of objective and precise criteria in some administrations. • Inadequate land use planning, which hinders access to resources. • Permissive administration with non-compliers • Weakness of the extractive industry administration in relation to other administrations. • Protectionist legislation towards companies that originate non-payments

Strengths	Opportunities
• Strategic importance of the sector, as a supplier of essential and essential raw materials • Strategic position of the sector for the circular economy • Resilience: ability to adapt to a tougher and more competitive environment • Proximity to consumption centres (minimisation of traffic impacts and emissions) • Highly controlled process, due to the obligation to have a general exploitation project + rehabilitation plan + mining waste management plan. • High barriers to entry into the sector	• Circular economy: Valorisation of by-products (waste) • Circular economy: Management/production of recycled aggregates • New strategies to improve the image of the sector • Innovation in restoration and biodiversity management • Circular economy: Management of mining waste • Circular economy: Management of waste from other extractive or other industries • Introduction of Information and Communication Technologies - ICT. Digitalisation of Industry 4.0

Future demand

With increasing population density, the demand for aggregates is growing on the one hand for the construction of new buildings and infrastructure and on the other hand for the construction of renewable energies and thus to secure the increasing energy demand, especially in view of the phase-out of fossil fuels and the currently stressed security of supply with energy raw materials.

Therefore, Aggregates Europe - UEPG emphasises in its position paper of April 2022 [73]:

- *A wind turbine base of 1-2 MW needs up to 2,400 t concrete and according to WindEurope, wind energy capacity is supposed to rise from 220 GW today to up to 1,300 GW in 2050.*
- *Aggregates are needed for ensuring that Europe has a modern transport and military infrastructure, including roads/bridges/rail-tracks, airfields, and ports.*
- *The annually demanded 3 billion tonnes of primary and secondary aggregates are essential and strategic and contribute to Europe's resilience, climate-neutrality and biodiversity.*

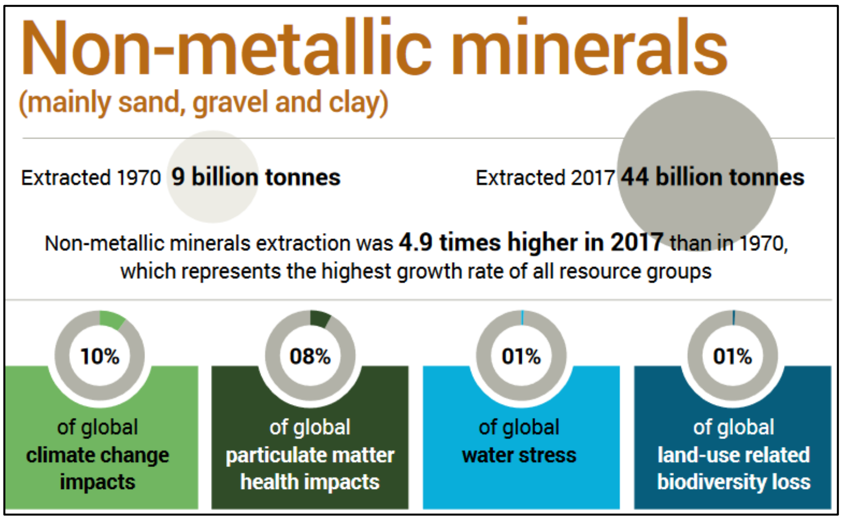


Figure 65 - Use of non-metallic minerals 1970 and 2017 and the impacts of extraction and primary processing in 2017 (Source: [74] JRC: Global Resources Outlook 2019 - Natural Resources for the future we want)

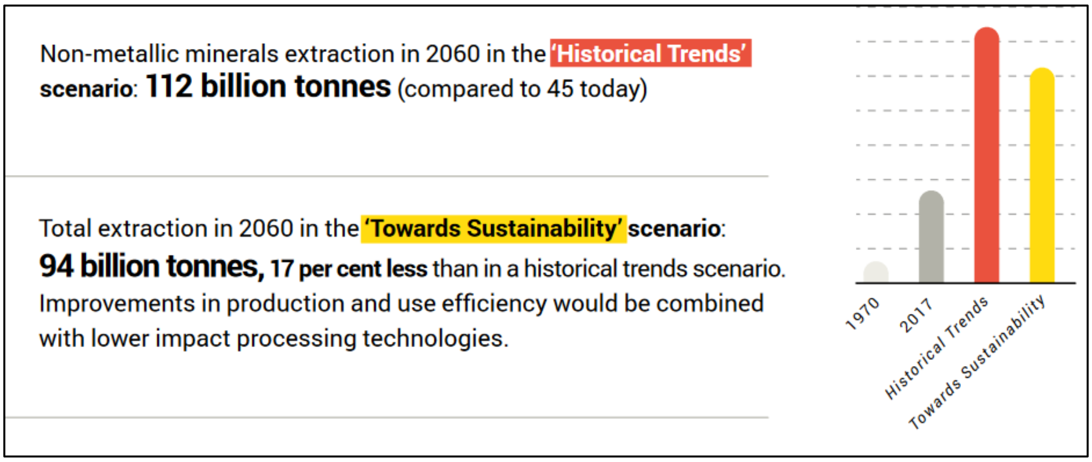


Figure 66 - Projected extraction in 2060 by continuing histroical trends and by adoping sustainable measures today (Source: [74] JRC: Global Resources Outlook 2019 - Natural Resources for the future we want)

Historical Trends Scenario

The *"Historical Trends scenario"* shows that "business as usual" is not an option for the future. Global non-metallic mineral use will more than double from 2017 levels, reaching a total of 112 billion tonnes by 2060, which in turn will cause a tremendous strain on resource supply systems and the environment. [74]

Towards Sustainability Scenario [74]

The second scenario shows that there are effective and feasible measures for resource efficiency and sustainable consumption and production.

- Reducing materials use in manufacturing and construction through a consistent mix of measures to increase innovation, increase demand for resource efficient products and increase recycling.
- Capturing emissions through bio-sequestration and carbon dioxide removal technologies
- Protecting landscapes and life on land through biodiversity conditions
- Changing societal behaviours

The *"Towards Sustainability scenario"* projects the following outcome in 2060:

- Net economic benefits would be visible by 2030, and increase more up to 2060. Sustainability measures boost economic growth by 8 per cent over *Historical Trends*.
- Annual global non-metallic mineral extraction is 17 per cent lower than under Historical Trends, reaching 94 billion tons in 2060.
- Well-being indicators grow faster than resource use
- Negative environmental impacts decouple from economic growth and resource use by 2060.

As discussed above, there are some future trends/scenarios at global level. At the European level, no dedicated literature was found in course of this study. However, at the national level, there are trend surveys by the Mineral Products Association (MPA) for the UK, which are briefly outlined below.

Long-term aggregates demand & supply scenarios, 2016-2030[62] [75]

The Mineral Products Association (MPA) has set out long-term aggregate demand and supply trends at a national (GB) level for the next 15 years, based on a scenario analysis. It aims to provide industry and industry stakeholders with indications of the volumes of aggregates that may be needed to satisfy future demand, reflecting the UK's needs for construction, including housebuilding and infrastructure.

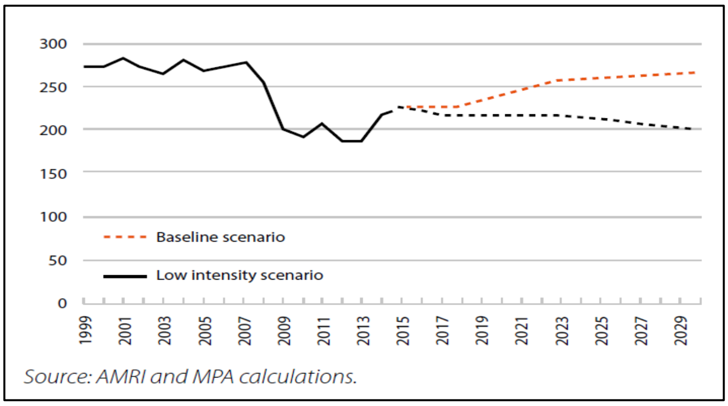


Figure 67 - Total GB aggregates demand to 2030 in [Mt], baseline and low intensity secenarios (Source: [75])

1. **Aggregates supply scenario 1**
   No change in the current supply mix of aggregates, i.e. the split between primary aggregates reflects the 2014 shares for marine sand & gravel in total sand & gravel (20%), and for total sand & gravel in total primary aggregates (36%).

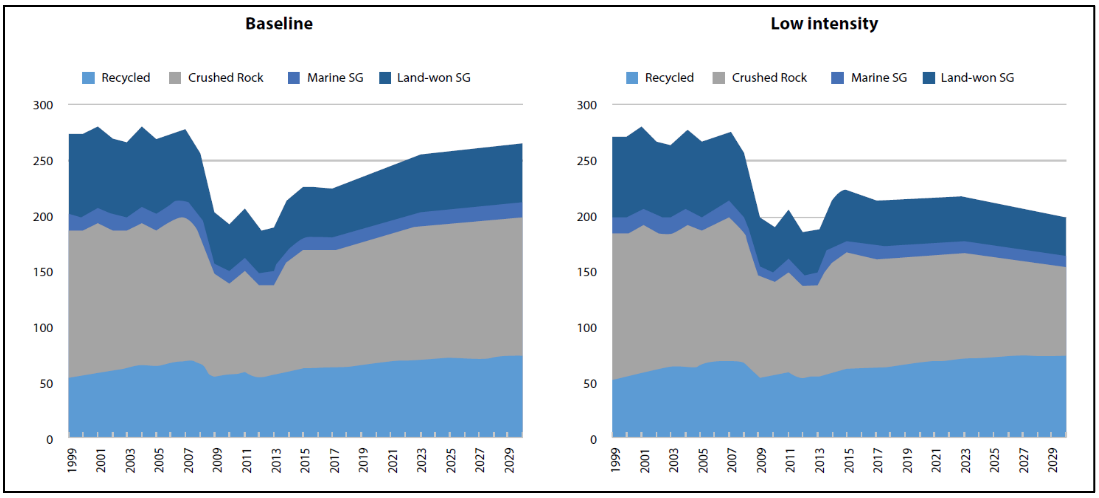


Figure 68 - Supply scenario 1: Low intensity (Source: [75])

[62] After the data acquisition deadline for this study, an update was published for the report "Long-Term Aggregates Demand & Supply Scenarios" (from mpa - Mineral Products Association) with scenarios up to 2035. (https://mineralproducts.org/MPA/media/root/Publications/2022/Aggregates_demand_and_supply_in_GB_Scenarios_for_2035.pdf) (https://mineralproducts.org/News-CEO-Blog/2022/release31.aspx) *(05.12.2022)*

2. Aggregates supply scenario 2

The availability of land-based sand & gravel becomes constrained over time, but there is sufficient marine sand & gravel to replace it.

In this scenario, we maintain the volume for total aggregates, and the share of total sand & gravel in the total aggregates as per scenario 1. However, land-won sand & gravel is gradually being replaced by marine resources, so that the share of marine sand & gravel increases to 50% of the total sand & gravel supply by 2030. Projections for crushed rock and recycled materials are as in scenario 1.

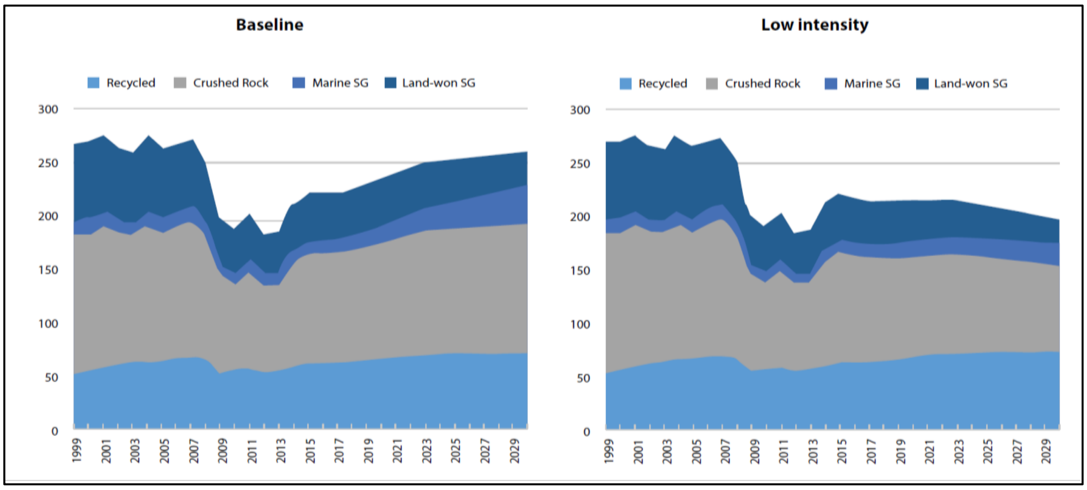


Figure 69 - Aggregates supply scenario 2 (Source: [75])

3. Aggregates supply scenario 3

Declining availability in land-won sand & gravel is fully made up by crushed rock substitution, as marine supplies are limited by wharf and dredger capacity. The total sand & gravel volume is assumed to decline, reflecting a 5% per year fall in land-won sand & gravel (to 21 [Mt per year] by 2030), which is entirely compensated by a rise in crushed rock supplies. Meanwhile, marine sand & gravel volumes continue to grow as per scenario 1.

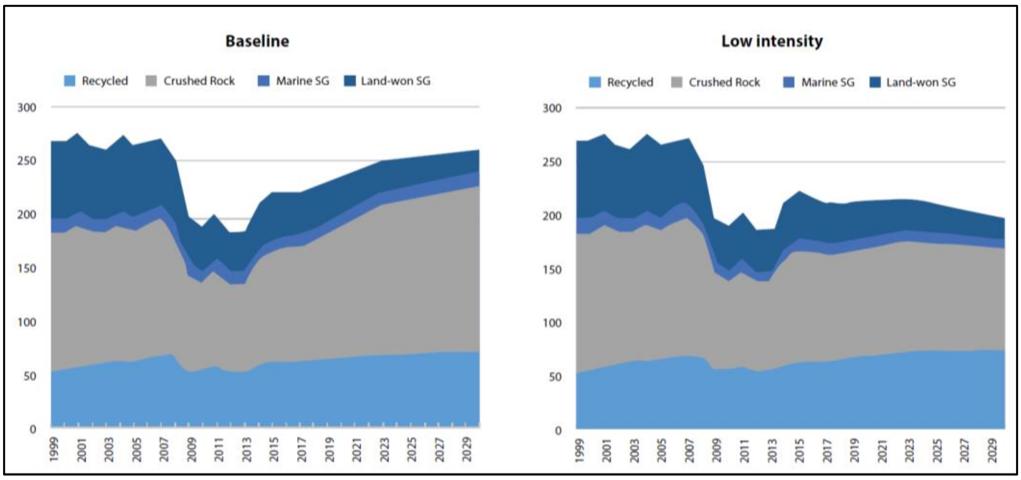


Figure 70 - Aggregates supply scenario 3 (Source: [75])

4. Aggregates supply scenario 4

Declining availability of land-won sand & gravel is made up by a combination of increases in both marine sand & gravel and substitution with crushed rock supplies. This scenario also relies on other elements, such as the associated infrastructure (rail/river) to enable the material to access the markets where it is required. Overall, the total sand & gravel volume is assumed to decline, reflecting a 5% per year fall in land-won sand & gravel (to 21 [Mt per year] by 2030). The decline is then compensated by a combination of increases in marine sand & gravel (by 5% per year, to 24 [Mt per year] by 2030) and crushed rock (to make up the difference with total aggregate demand). Our marine supply assumption can be compared with that of The Crown Estate, which has previously assumed a potential demand for marine aggregates of 29 [Mt per year] by 2030. Note that in this scenario, whilst crushed rock supplies need to increase by about 2.7% per annum to meet baseline demand, a fall in material intensity combined with increases in marine sand & gravel would, by contrast, reduce the total tonnage that would actually be required.

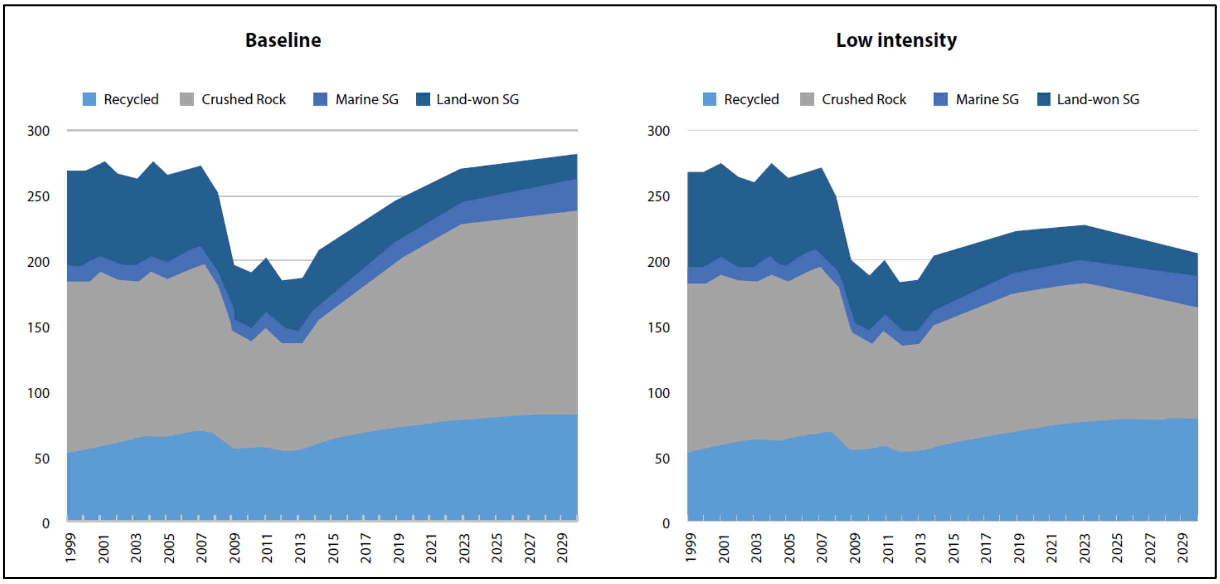


Figure 71 - Aggregates supply scenario 4 (Source: [75])

Scenarios Summary & Conclusion:

- *By 2030, about 267 [Mt] of aggregates might be needed each year to respond to construction needs.*
- *Even after projecting further reductions in material intensity to an unrealistic level, this would still mean a total demand for aggregates of 201 [Mt/year], the majority of which (more than 60%) would still need to come from primary sources.*
- *This means that the industry faces a cumulative demand for aggregates of between 3.2 - 3.8 billion tonnes over the next 15 years.*
- *There are uncertainties around the mix of primary aggregate sources. Trends suggest that the contribution made by traditional land-won sand & gravel sources are likely to continue to decline, being replaced by a combination of marine sand & gravel and crushed rock substitution. Replenishment rates for sand & gravel will need to increase if the decline is to slow. This will rely upon the industry bringing forward more applications and the mineral*

planning system responding accordingly. Secondary and recycled sources of material are expected to continue to make a major contribution to supply.

- *Whilst demand for aggregates will be determined ultimately by factors such as the rate and shape of economic growth, population changes and associated construction needs, there will also be a significant challenge for industry relating to future investment in operational and transport facilities, and skills and training. The scenarios have been produced at GB level, based on national data and forecasts. These should provide a helpful indication of how aggregates demand and supplies are anticipated to change over the next 15 years. They should also provide a national overview and context for local planning, including in preparation of LAAs. MPA will be considering the extent to which the methodology applied at the GB scale could be applied to a regional analysis.*

Outlook for supply and demand

The demand of aggregates is driven by activity in the construction industry, and it is closely linked to economic growth, urbanisation and increasing population (Aggregates Europe - UEPG 2018[63]) [23].
Foresights of the global trends in economic development predicts a GDP growth up to 2035, especially in the emerging economies [76]; thus, the outlook for aggregates demand growth in the coming years is positive, depending on the level of economic growth [23]. According to a recent study published by the OECD, the use of construction materials is projected to almost double between 2017 and 2060 with the largest growth in aggregates (sand, gravel and crushed rock), while construction materials use per capita is projected to rise in most countries [77]. For the EU, the increase is projected to be stronger in the 2030-2060 period than the 2017-2030 period. [9]
Depending on the success of the Green Deal and especially its circular economy requirements, these numbers might be smaller, but as the detailed study from the UK has shown above, 60% of supply would still need to come from primary sources.

APPENDIX G – Assessment of the overall situation and future development of the NEEI by the countries

[63] https://uepg.eu/mediatheque/media/AR_2017-2018.pdf *(05.12.2022)*

11. RECOMMENDATIONS & CONCLUSION

Green Deal and energy transition will continue to drive demand for aggregates; same situation globally

Even with Europe transforming towards an inclusive, low carbon and circular economy, there will be increasing demand for aggregates as otherwise this transformation will not be feasible. This is in addition to base-load demand (driven by private investment in construction).

Globally, the needs and expectations of societies are also driving the demand for aggregates, but a continued responsible supply cannot be assumed without improved governance of global raw material resources. The scale of the challenge inherent in sand and gravel extraction makes it one of the major sustainability challenges of the 21st century. These materials are one of the largest resources extracted and traded by volume, yet it is one of the least regulated activities in many regions. [23]

Essential – but uncritical?

European policymakers need to ensure that we keep the high level of European independence in aggregates supply. But this means that they should not be seen as a given by policy makers at all levels, as otherwise we might end up in a situation where they do become critical. Aggregates Europe - UEPG (and others) need to keep pushing policy makers to have aggregates on their radar besides CRMs, as they are essential for the transformations needed in the coming decades.

This also includes the national and regional level, i.e. have strategic, long-term, and clear raw material plans developed that include aggregates supply and demand scenarios given their geographic market limitations and have these requirements included / considered in land use and spatial planning in order to safeguard future deposits from potential sterilisation through other land uses. Aggregates Europe - UEPG and its members could also support this by developing a European database of easily accessible aggregates reserves and resources.

Manufactured aggregates - coming to stay?

Based on circular economy requirements, more stringent environmental legislation and, at least in some parts of the world, supply shortages, there is increasing interest in manufactured aggregates, i.e. from tunnelling and mining waste. There is still a considerable need for research in this area, but given that the sustainability benefits are enormous and societal pressure is increasing, solutions will be found. The European aggregates sector should have the potential of tunnelling and mining waste on its radar and should proactively find ways to make this part of their business solutions (and see it as an easy to access raw materials source) in the coming decades for and within a circular economy.

Make sustainability happen in operations

The sector needs to continue its drive towards sustainable operations, as for example described in the SUMEX sustainability framework. Focus areas should be carbon neutrality, low water (quality and quantity) impacts, significant reductions in dust emissions, transport solutions and a continued push for a positive impact on biodiversity (which is also a big opportunity regarding land use!). This means that commitments need to be delivered upon by all operational sites as this will be crucial to achieve continued social acceptance (SLO) and will help support access to new deposits (i.e. deposits in Natura 2000 areas).

This implies also best in class rehabilitation and site closure. The development of the rehabilitation requirements will involve local residents and take into account regional development plans, the trends specified in the spatial plans and biodiversity considerations. Rehabilitation should already take place during extraction. [78]

Continue engaging with society

Both the involvement of stakeholders, such as academia, industry and civil society organisations (e.g. environmental NGOs), as well as the public are of vital importance to a good governance approach of aggregates resources. Stakeholder mechanisms at all levels can be a way to increase public acceptance and establish a sense of 'ownership', but it can also be an opportunity to create legitimacy or include expertise from e.g. academia and industry.
The following characteristics are considered for effective stakeholder involvement [49]:

- consider what the 'right mix' of stakeholders is according to the context (integration of stakeholder expertise or creating legitimacy);
- go beyond mechanisms of just 'consultation' or 'compliant submission', but seek active participation and engagement to establish long-term fora for trust and legitimacy;
- set up mechanisms that allow for continuous feedback of stakeholders into the policy process e.g. committees or working groups. Respective mechanisms for stakeholder involvement contribute both to increased awareness (in public processes) and integration of external expertise (in mechanisms involving e.g. academia).
- include issues of mitigation and compensation of impacts relevant for stakeholders in the discussion (e.g. contributions include greening, mitigating local nuisance, or contributing to a general development fund to support local communities).

Societal intensions and legal requirements have changed significantly, yet permitting systems and land use planning have not changed accordingly

Societal intensions concerning a wide range of issues ranging from climate change, the Green Deal and a circular economy all the way to increased demands for security and defence, have found their way into European legislation in the last decade. In order to fullfill these intensions and requirements, aggregates (and other mineral raw materials) will have to play a crucial role. Yet, land use planning and permitting systems have not yet changed accordingly in order to enable the required extraction of mineral raw materials.

Not much has changed in the permitting systems of the European countries since the original study was undertaken over a decade ago. Hence there is still a requirement for these national or even regional systems to consider European intensions and requirements and to make the systems more efficient and timelier.

Since the "time to permit" frames differ quite widely, careful attention needs to be paid to the underlying reasons. The following can be considered for improving the permitting process and, consequently, shortening the actual "time to permit":

- the specificities of the designated area for exploitation (e.g. prior established designation in land use planning, proximity to protected areas);
- the quality of the permitting process (e.g. insufficient resources of permitting authorities, unskilled personnel, insufficient quality of guiding instructions, inefficient management processes); and
- the quality of the submitted permit (e.g. insufficient description of new extraction methods or missing supplementary information).

Therefore, making permitting processes more effective may be achieved through integrating the different permits required in such a way that they are issued by one competent authority (a one -stop-shop) and with only one environmental impact assessment or by parallel assessment[64].

Be transparent about your performance

Societal expectations on and public perceptions of the extractive industry have changed significantly in recent decades. Sustainable operations and engagement of society will be crucial for the sector going forward in order to continue achieving SLO and therefore being able to run operations smoothly and to get access to the new deposits required for delivering the Green Deal. Another crucial part of this puzzle is transparency, i.e. the collection and publication of environmental and social performance data. Gapless data collection, in all areas discussed in this study and well beyond current mainly socio-economic data, as far as possible based on common definitions and methodologies (in order to obtain comparable results), and the publication of this data should be considered as an opportunity and is also indispensable for achieving SLO and the continued access to new deposits.

[64] European Commission, 2014. Evaluation and exchange of good practice for the sustainable supply of raw materials within the EU; EIP SIP part II Action area n° II.1: Minerals Policy Framework

Finally, the following textbox lists the main needs and gaps in existing policies for the non-energy extractive industries and other relevant legislation and governance of aggregates as identified in the questionnaire and the interviews done as part of this study [33,63]:

- Provide accessibility and secure supply of aggregates. The national regulations/governance for the non-energy extractive industry (and other regulations affecting extraction) should be updated in such a way to make better access to mineral deposits possible. A gap in mineral policy concerning mineral deposit protection is noted:
    - Quarrying/Mining is not a political priority,
    - only a political decision could probably improve the situation in national mineral policies,
    - integration of the state and regional (county and municipality) physical planning system,
    - protection of aggregates and raw material resources in general (from other land uses),
    - determine the areas suitable for exploration and extraction in spatial plans,
    - often there is no legislative mechanism for dispute resolution between holders of mineral licences and landowners within the licensing regime,
    - extraction and other relevant legislations should provide juridical security to quarrying/mining rights and to access to mineral resources,
    - local communities have too many tools to “stop” extraction projects – often there is no legislative mechanism for dispute resolution
    - the banning of extraction operations by regional governance authority (autonomic county and municipalities)
- Optimisation of transport logistics is required
- Social unacceptance of extraction activities and public perception of mining and quarrying - find a way to achieve a better public perception and better social acceptance of extraction activity:
    - Prolongation of approval procedures for exploration and extraction is often caused by negative public opinion,
    - Negative standpoint is reflected through arguing of local authorities that land use of the property concerned is intended for other uses and that such justification is grounded on public interest,
    - Social unacceptance of mining and quarrying activities (NYMBY syndrome),
    - Public perception of extraction activities as nature and environmental devastators,
    - Extraction governance authorities and extraction companies should improve transparency and engagement with the local public,
    - Possible changes and improvements in national mineral policy to improve implementation of innovations in exploration and extraction should also address education of the society since the early age,

    - promotive actions to improve the knowledge base and level of trust of society in mining and quarrying (companies, regulators, authorities),
    - innovations in social engagement may be required for future mine/quarry developments,
    - the public is quite unaware of the extraction industry,
    - Future mineral policies must make raw materials extraction more attractive to public
- Streamlined/efficient national land-use planning and permitting policy
- Regulations facilitating Circular Economy and not Regulations and definitions (e.g. definition of waste) that prevent/hamper this
- Increasing of resource efficiency
- A level playing-field for all through consistent implementation of EU law
- Development of a national strategy for the management of aggregates for every EU MS
- Research activity/financing:
    - Mineral extraction authorities are incentivised to drive innovation and provide tools for academia to work more and better with companies
    - there are no specific tax incentives for RDI (research, development & innovation) programmes for innovation in exploration and extraction,
    - collaboration between government institutions, research companies and the quarrying industry on international research projects with the goal of improving mineral extraction technologies,
    - state owned extraction companies should be obliged to contribute to research, with a kind of percentage of their expenditures

- Simplification of permitting procedure (one-stop-shop) and time reduction of approval procedures for exploration and extraction of raw materials (most mentioned needs). There is a gap regarding the legal and the real time it takes for getting permits for exploration and extraction. The long-lasting and time-consuming permitting procedures - with uncertain outcomes - are addressed by different, often not well integrated and coordinated, governance bodies. In the scope of this matter the experts also identify needs/gaps as:
    - reconstruction and reorganisation of minerals governance bodies
    - better coordination between state authorities (different ministries) involved in the process of permitting
    - staff in extraction and other governance bodies is not experienced and skilled enough
    - establish single Mineral extraction authorities responsible for mineral extraction governance and permitting procedures (one stop shop),
    - the conflicts among governance authorities should be resolved internally,
    - respect the deadlines for the permitting, environmental, spatial planning and other governance procedures,
    - the establishment of responsibility and consequences for quarrying and other governance authorities in the case of not respecting deadlines for different governance procedures.

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