2 BARYTE

2.1 Overview

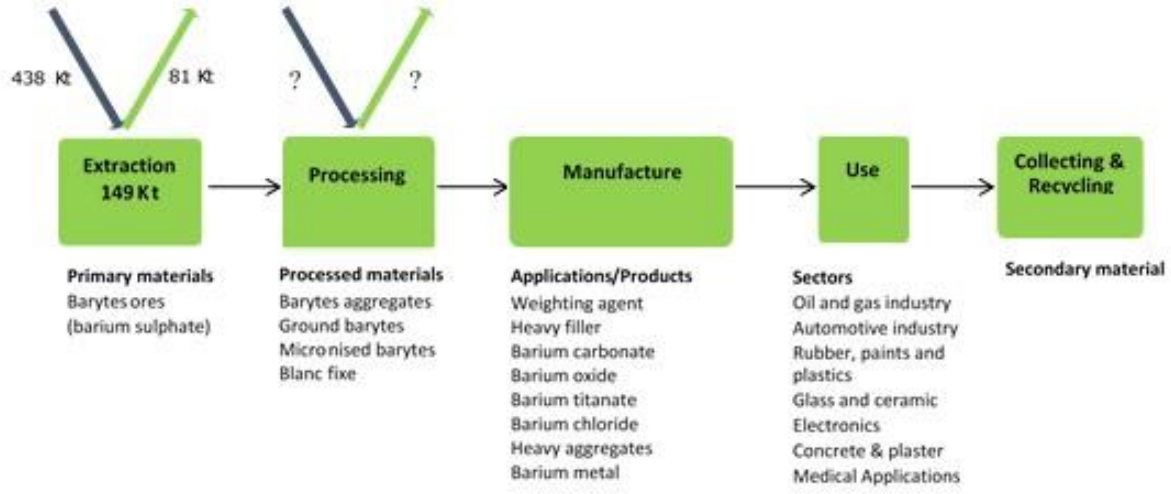

Figure 15: Simplified value chain for baryte for the EU, averaged over 2012-2016[7]

Baryte (or barite)(chemical symbol Ba) is a naturally occurring barium sulphate mineral ($BaSO_4$). It is inert, non-toxic and almost insoluble in water. Baryte has a high density, of 4.5 g/cm^3, a high fusion point (1,580°C) and brightness, and a low oil absorption. Baryte is commonly white, or colourless, but can appear in various colours, like grey or black, depending on the presence of impurities.

The assessment has been conducted at the extraction stage. We consider a $BaSO_4$ content of 98% in barytes ores and concentrates, based on the hypothesis of the minimum purity for industrial grade for export purpose. Data sources are WMD (2019) for production (in kg of $BaSO_4$) and COMEXT (CN 25111000) for trade.

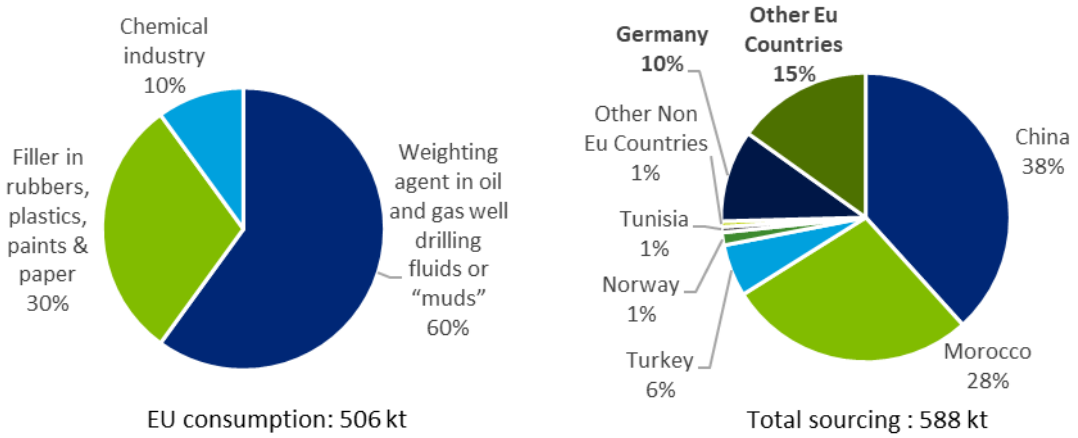

Figure 16: End uses and EU sourcing of barytes (Average 2012 to 2016)[8]

Over the 2012-2016 period, the global production of baryte decreased by about 14%. The leading global supplier is China, with an average share of 38% in the world production,

[7] JRC elaboration from multiple sources, see next sections.
[8] JRC elaboration from multiple sources

followed by India, with 12%. Export restrictions to barytes are applied by China and Vietnam (OECD, 2019).

In the EU, the only mining activities are in Germany (primary) and Bulgaria (reworking tailings). The much cheaper imports from India and China make domestic mining a rather unattractive option. Over the 2012-2016 period, the EU imports of baryte diminished by 27%, while the exports only had small fluctuations. Import reliance for baryte is 70%.

Being baryte used extensively in the oil industry as a weighting agent for drilling muds, its worldwide market developments are strongly related with those of the oil industry, i.e. most likely a diminishing demand on the medium and long term, resulting in excess supply.

The price of baryte ores have a slightly decreasing trend in China, which is reflected also in the US price of the ground baryte, at around 180 US$ per tonne in 2018.

The EU annual average consumption of baryte is 506,410 tonnes per year, averaged over 2012-2016. Its sourcing is mainly from outside EU: China (38%) and Morocco (28%), but 25% comes from EU member states, out of which Germany is the major provider (10% of the total EU sourcing).

Baryte is mainly used as a weighting agent (about 60% of end uses) or to elevate hydrostatic pressure to counteract high-pressure zones during drilling activities. The high specific gravity of baryte makes it suitable for a wide range of industrial, medical, and manufacturing uses.

Several substitutes are available for these applications, but for the moment they are either economically less attractive (for drilling), or have inferior quality (for fillers) or they are not safe (for medical applications).

Various sources estimate the EU reserves of barytes to be around 13.1 million tonnes (in Ba content), while at the global level these are projected at 380 million tonnes.

According to SCREEN, baryte is present in small deposits in various EU countries (Belgium, Bulgaria, Croatia, Czech Republic, France, Germany, Ireland, Italy, Poland, Portugal, Romania, Spain and Sweden). In Portugal, a proved mineral reserve of 112,000 tonnes for baryte is found in the Serras da Mina Fe-Mn-baryte mine.

2.2 Market analysis, trade and prices

2.2.1 Global market analysis and outlook

The World Mining Data reveals a clear decreasing trend in the world production of baryte, more precisely a decline by 14% over the 2012-2016 period. The biggest global supplier is China (32%), followed by India (12%), Morrocco (10%), Iran (8%), Kazakhstan (7%), Turkey and Unites States, with 6% of the world production each.

The consumption in "drilling mud" - and therefore of baryte - fluctuates from year to year, as it is correlated with the amount of exploration drilling for oil and gas, which in turn depends, among others, on oil and gas prices.

Table 7: Qualitative forecast of supply and demand of barytes

Materials	Criticality of the material in 2020	Demand forecast	Supply forecast

	Yes	No	5 years	10 years	20 years	5 years	10 years	20 years
Baryte	X		+	+-	-+	+-	+-	?

We have found no reliable demand and supply forecasts for the next 5, 10 and 20 years from industry experts or from the literature. Nonetheless, we expect the baryte demand to follow global energy trends. In the medium term, the world demand for oil is likely to keep growing, although the rate of growth is slowing down (IEA, 2019). However, the implementation of climate change policies is likely to impact the demand of oil in the energy mix, substantially diminishing its share. From this perspective, on medium and longer term one could expect rather a moderation of demand for baryte, resulting eventually in excess supply.

For the moment, baryte continues to be the preferred commodity for usage in drilling. Nevertheless, the availability of a large number of substitutes might influence its future market developments.

2.2.2 EU trade

Over the 2012-2016 period, the EU imports of baryte diminished by 27% (almost 141,000 tonnes per year). Over the same time period, the exports only showed small fluctuations, remaining stable around 80,000 tonnes per year. These developments resulted in a decreasing trend of net imports.

The EU imports of baryters were mainly from China, Morocco, and Turkey. Free Trade Agreements between EU and Morocco, Turkey, Tunisia, Norway are in place.

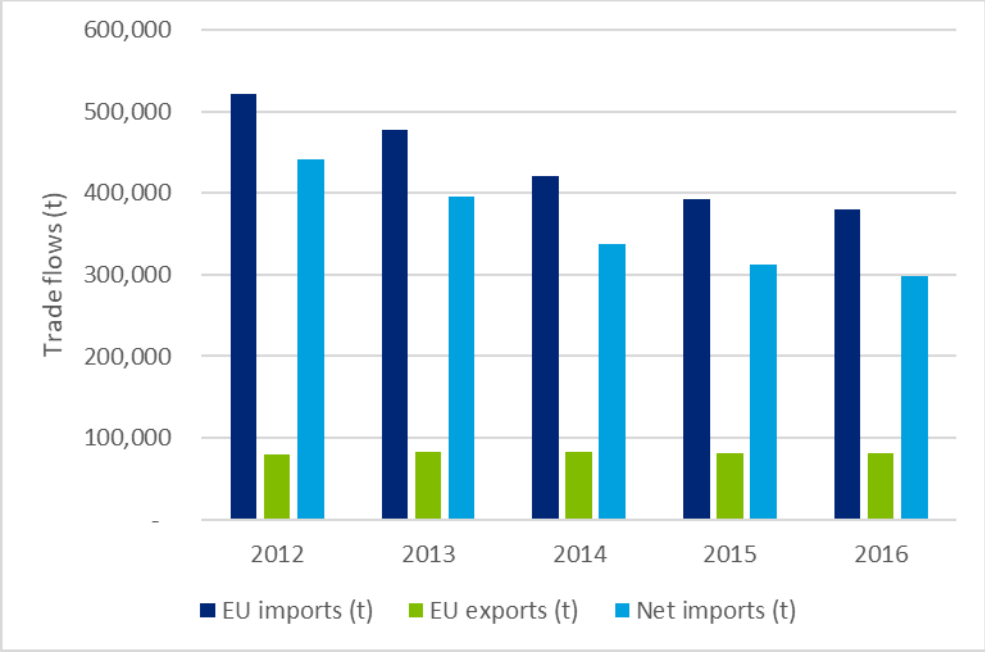

Figure 17: EU trade flows for barytes (Averaged over the 2012-2016)(Eurostat, 2019b)

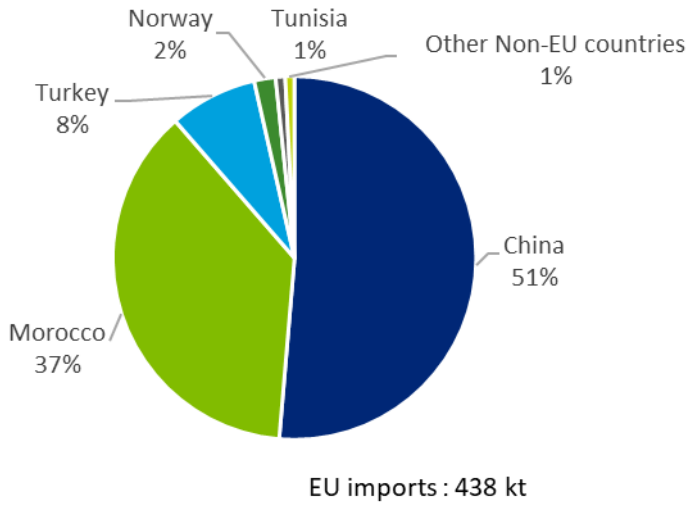

Figure 18: EU imports of barytes. Average 2012-2016 (Eurostat 2019b)

2.2.3 Prices and price volatility

Prices for Chinese drilling grade barytes have decreased over the past five years, from 131-135 USD per tonne FOB China in 2012 to 80-90 USD per tonne by the end of 2017.

Beyond the extraction stage, the price of baryte depends on the degree of processing, which is determined by use/end-use and its quality requirements. Drilling-grade baryte has typically the lowest price. Filler applications command higher prices due to the required physical processing (by grinding and micronising), and there are further premiums for whiteness and brightness and colour (The Barytes Association, 2016).

As estimated by USGS, for the year 2017 and 2018, the price for ground baryte is about 180 USD/tonne FOB, but over the 2012-2016 period has fluctuated, with an overall slightly decreasing trend (Figure 19).

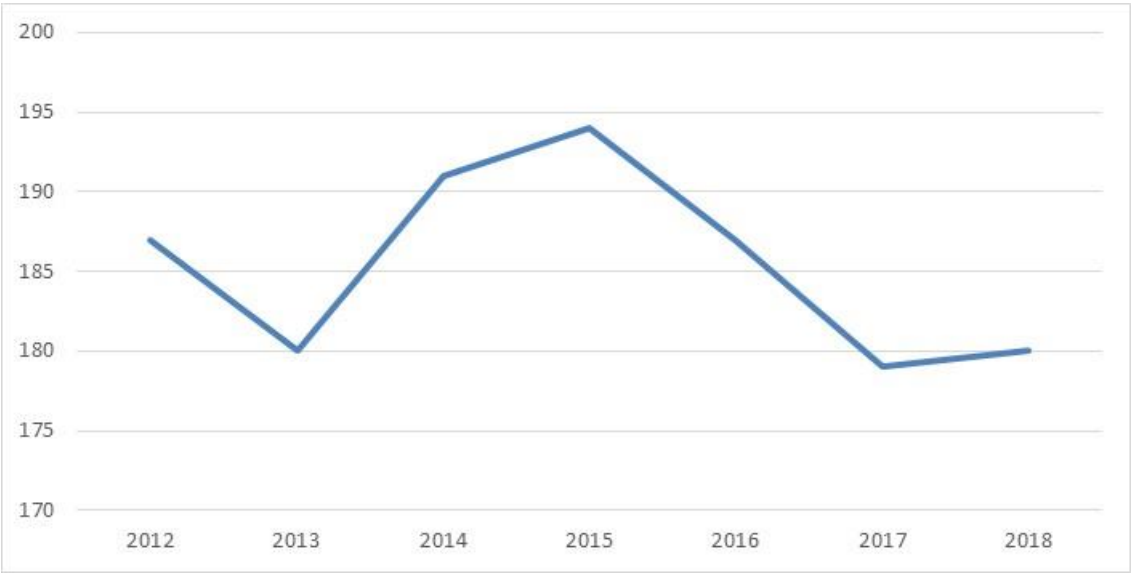

Figure 19. Prices of baryte, ground (USD per tonne) from 2012 to 2018 (Data from USGS)

Due to its main application for drilling, the key driver for the baryte market is the evolution of oil and gas exploration (following trends in the fossil fuel production, influenced by the

rise in global demand for energy, and its composition). Fast-growing economies like China and India are expected to be the main contributors to the increasing global demand of oil and gas, due to the increasing energy consumption accompanying their rapid industrialization and urbanization.

2.3 EU demand

2.3.1 EU demand and consumption

Over the period 2012-2016, the EU consumed on average about 506,000 tonnes per year of barium contained in baryte.

Net trade as a percentage of apparent consumption (i.e. the import reliance) for baryte is 70% on average for that period.

2.3.2 Uses and end-uses of barytes in the EU

Baryte is primarily used as a weighting agent in drilling fluids or "drilling muds" for oil and gas wells, where baryte's high specific gravity assists in containing pressures and preventing blowouts. Ground baryte is combined with bentonite, water, and other materials to manufacture "mud" which is pumped down the drill hole. Drilling muds remove cuttings up to the surface, while cooling and lubricating the drill bit (Schlumberger, 2013). In drilling muds, the current standard is the API (American Petroleum Institute) specification 13A 4.1 or 4.2. New standards are under discussion.

Baryte is also used as a heavy filler in rubber, paint and plastics applications. The automotive industry mostly uses baryte as a soundproofing material in moulded components, floor mats, and in friction products such as breaks and clutches pads. In the construction sector, baryte is used for the production of building materials or of special types of concrete having x-ray protection and sound insulation. Baryte is used as filler in asphalt, in high quality primers and anti-corrosion coatings, abrasion-resistant paint such as bituminous paints etc. (Mineralia, 2016).

In the chemical industry baryte is used for the preparation of barium compounds, notably barium carbonate ($BaCO_3$). The latter is used in the production of special glass, as an ingredient in high-fire glazes, and in the brick and tile industry (BRGM, 2014). $BaCO_3$ is increasingly used in electronic components, such as electronics ceramics and capacitors. Another barium compound, barium meal (barium sulphate), is used in radio-diagnosis.

In the EU, the oil and gas production accounted for more than half of the baryte consumption, while the remainder went to the chemicals and filler (The Barytes Association, 2016)(Figure 20).

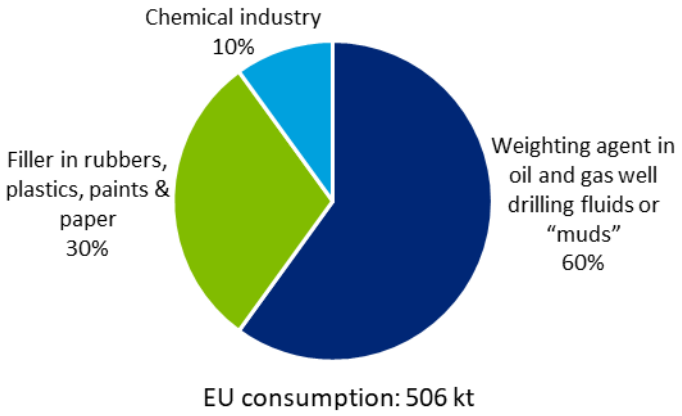

Figure 20: EU end uses of baryte. Average figures for 2012-2016 (SCRREEN, 2019).

The relevant industry sectors are described using the NACE sector codes in Table 8.

Table 8: Baryte applications, 2-digit and associated 4-digit NACE sectors, and value added per sector (Eurostat, 2019b)

Applications	2-digit NACE sectors	4-digit NACE sectors	Value added of sector (M €)
Weighting agent in oil and gas well drilling fluids	C23 - Manufacture of other non-metallic mineral products	C23.9.9 - Manufacture of other non-metallic mineral products n.e.c.	57,255
Filler in rubbers, plastics, paints	C22 - Manufacture of rubber and plastic products	C22.1.1 - Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres	75,980
		C22.2.1 - Manufacture of plastic plates, sheets, tubes and profiles	
Chemical industry	C20 - Manufacture of chemicals and chemical products	C20.1.3 - Manufacture of other inorganic basic chemicals	105,514

2.3.3 Substitution

Substitutes for baryte used as a weighting agent for the oil and gas industry include hematite (Fe_2O_3), ilmenite ($FeTiO_3$), calcium carbonate ($CaCO_3$), but they are economically less attractive than baryte. For this application, baryte has currently a market share over 99%. Hematite has a higher density and can be used to reduce the solids' percentage for rheology control, and ilmenite can be used when drilling activities take place close to a cheap supply source (Schlumberger, 2014; Huxtable, 2016).

For fillers, the main substitutes of baryte are calcium carbonate and clays (kaolin, talc), which are widely used for general purpose fillers where quality or technical considerations are less stringent. In fact, they do not match baryte quality in heaviness, sound proofing and radiation shielding.

There are various acceptable substitutes for barium carbonate in several applications in the chemical sector. Strontium carbonate is sometimes used as a substitute in ceramic glaze. There is no alternative to barium carbonate in dielectrics, and no safe substitute for medical applications.

2.4 Supply

2.4.1 EU supply chain

The EU production of baryte over the years 2012-2016 is around 149,000 tonnes per year ($BaSO_4$) (World Mining Data, 2019). The main EU producer is Germany (41% of total EU production), with an average of 60,500 tonnes per year for the same period.

2.4.2 Supply from primary materials

2.4.2.1 Geology, resources and reserves of baryte

Geological occurrence:

Baryte deposits are classified into three major types: stratiform, vein, and residual deposits. Stratiform (or bedded) deposits are the dominant source of industrial baryte. They are formed by the precipitation of baryte at or near the seafloor of sedimentary basins (sedimentary-exhalative or 'SEDEX' deposits). These deposits are often associated with volcanic-hosted massive sulphide mineralization (mainly zinc-lead). Individual beds can range from massive to laminated or fine-grained, and may have a baryte content between 50% and 95% which is often greyish to dark-grey in appearance. In vein deposits, baryte forms by precipitation from hydrothermal fluids or deep-seated brines in faults, fractures and cavities. This type of baryte varies in colour from white to yellowish and is often iron-stained. Residual deposits are formed by the dissolution of the host rock of the stratiform or vein deposits, leaving irregular masses of baryte in a clay matrix (BGS, 2005; NSW Department of Industry, 2009).

Global resources and reserves

There is no single source of comprehensive evaluations of resources and reserves of baryte in different geographic areas of the EU, or globally). The USGS collects information about the quantity and quality of mineral resources but does not directly measure reserves, and companies or governments do not directly report reserves to the USGS. Individual companies may publish regular mineral resource and reserve reports, but reporting is done using a variety of systems depending on the location of their operation, their corporate identity and stock market requirements. Translations between national reporting codes are possible by applying the CRIRSCO template[9]. which is also consistent with the United Nations Framework Classification (UNFC) system. In any case, reserve and resource data are updated continuously with the evolutions of exploration and mining, which are in turn influenced by market conditions.

The USGS (2019) estimated around 740 million tonnes of (identified) resources and 320 million tonnes of reserves, of which half are located in China and Kazakhstan (Table 9).

[9] www.crirsco.com

Table 9: Global reserves of baryte in 2015 (Data from USGS, 2019)

Country	Estimated Baryte Reserves (tonnes)	Percentage of total (%)
China	36,000,000	11
Kazakhstan	85,000,000	27
Turkey	35,000,000	11
India	51,000,000	16
Iran	24,000,000	8
USA	NA	NA
Morocco	NA	NA
Mexico	NA	NA
Pakistan	30,000,000	9
Other countries	29,000,000	9
World Total (rounded)	**320,000,000**	**100**

EU resources and reserves

For Europe, there is no complete and harmonised dataset that presents total EU resource and reserve estimates for baryte. Many documented resources in Europe are based on historic estimates.

Table 10: Resource data for the EU compiled in the European Minerals Yearbook (Minerals4EU, 2019)

Country	Reporting code	Quantity	Unit	Code Resource Type
Czech Republic	National reporting code	0.57	Mt	Potentially economic
France	None	8.8 ($BaSO_4$)	Mt	Historic Resource Estimate
Hungary	Russian Classification	86	Mm^3	C2
Ireland	None	1.65	Mt	Historic Resource Estimate
Italy	None	3.5	Mt	Historic Resource Estimate
Poland	National reporting code	5.66	Mt	A+B+C1+C2
Serbia	JORC	1	Mt	Total
Slovakia	None	3.45	Mt	Verified (Z1)
Spain	None	9.99	Mt	Historic Resource Estimate
United Kingdom	None	22	Mt	Total

USGS (Mineral Commodity Summary, various editions) does not provide data on reserves in EU countries since 2014. Before 2014, reserves data were provided for Germany, the UK, France and Bulgaria (13.1 Mt of baryte for these four countries in 2005 – not expected to have evolved since). The Mineral Profile – Barytes from BGS (2005) provides the same data as USGS.

Resource and reserve data for some countries in Europe are available in the Minerals4EU (2019) website, but they cannot be summed up as they are partial and do not use the same reporting code (Table 10 and Table 11).

According to SCRREEN, baryte is present in small deposits in various EU countries (Belgium, Bulgaria, Croatia, Czech Republic, France, Germany, Ireland, Italy, Poland, Portugal, Romania, Spain, Sweden). In Portugal, a proved mineral reserve of 112,000 tonnes for baryte is present in the Serras da Mina Fe-Mn-baryte mine. In the other EU countries mentioned, no data on reserves is available: in these cases, reserves are considered null (SCRREEN, 2019).

Apart from the German (primary) and the Bulgarian (reworking tailings reworking) mines, no other mine is operating in the EU due to the competition with much cheaper imports from India and China.

Table 11: Reserve data for the EU compiled in the European Minerals Yearbook (Minerals4EU, 2019)

Country	Reporting code	Quantity	Unit	Code Reserve Type
Croatia	National reporting code	185.9	kt	No code
Slovakia	None	633	kt	Verified (Z1)
Spain	N/A	Reserves known to exist		N/A

2.4.2.2 World and EU mine production

World production of baryte is broadly linked to oil-well drilling activity and has increased from around 6 to 6.5 million tonnes per year in the early 2000s to 9.1 million tonnes per year in 2016. China is the largest baryte producer, contributing with an average of 3.7 million tonnes per year over the period 2012-2016 (see Figure 21).

Nevertheless, China's averaged share in the world production of barytes has decreased from 44% to 38% as compared to the average in 2010-2014 (CRM 2017). The second biggest supplier of baryte is India, which has also diminished its share in world production, from 18% to 12%. In return, several countries have increased their share in global baryte production over the period 2012-2016: Iran (from 4% to 8%), Kazakhstan (from 5% to 7%), Turkey (from 3% to 6%), and Russian Federation (from <1% to 2 %).

The EU accounts for almost 2% of the world production of barytes averaged over the 2012-2016 period. Within the EU27, besides Germany, baryte is mined in Bulgaria and Slovakia. Since 2016, Bulgaria became the major producer and in 2017 accounted for 56% of EU27 production of baryte.

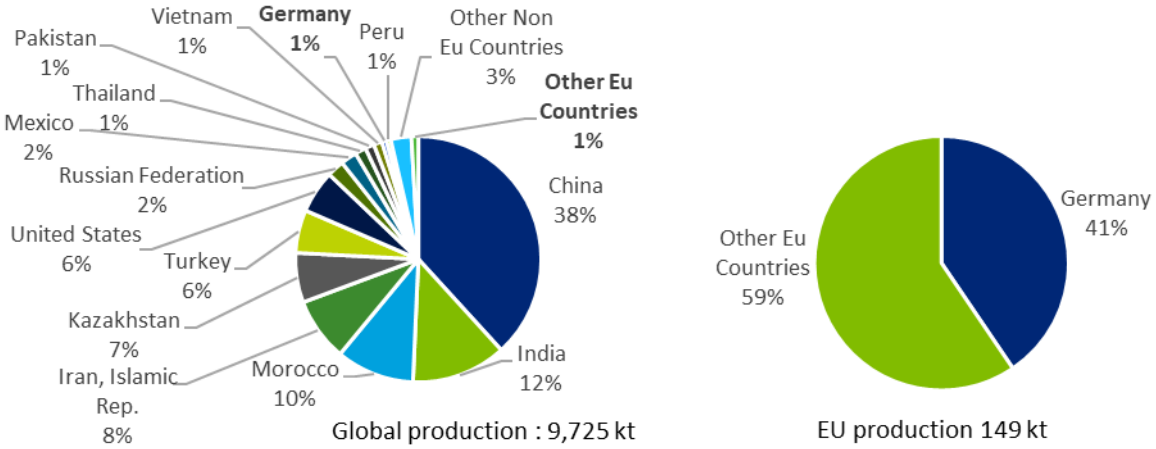

Figure 21: Global and EU mine production of baryte, average 2012–2016 (WMD, 2019)

The EU sourcing relies mainly on two extra-EU countries - China (38%) and Morocco (28%). Nevertheless, one quarter of the EU sourcing comes from domestic supply, out of which Germany is the major provider (10% of the total EU sourcing) (Figure 21).

2.4.3 Supply from secondary materials/recycling

Baryte is barely re-used. As baryte only constitutes a small percentage of the total cost of any drilling project, only a very small quantity is recycled for re-use beyond the amount recovered at drill sites (U.S. Department of the Interior & USGS, 2014). In most other applications, baryte is not recovered at all (as in fillers, etc.) and cannot be recycled. An exception is the use of baryte in glass during glass recycling.

In the current assement, the end-of-life recycling input rat for baryte is considered 1%, as in the previous assessment and confirmed by SCRREEN experts (2019).

2.4.4 Processing of baryte

After natural barytes are extracted they are usually sorted through physical separation from other compounds (e.g. gravity separation or flotation methods) and crushed, on or near the mining site, to get ground barytes, micronized barytes, baryte aggregates, etc. In a few cases, additional processing may be conducted to obtain the quality and colour required by the specific applications.

2.5 Other considerations

2.5.1 Environmental, health and safety issues

The naturally occurring mineral baryte is not subject to EU REACH regulations (ECHA, 2017). However, the re-precipitated blanc-fixe (barium sulphate) and also the barium salts are subject to REACH.

The barium content of drinking water, food, and soils is rarely high enough to present a human health concern and no adverse toxicological effects of barium on plants or wildlife have been reported near baryte mines or elsewhere (USGS, 2017)[10].

2.5.2 Socio-economic issues

We find no specific information about socio-economic issues related to barytes. Nevertheless, we suspect that for the major world producers - China and India - economic implications of baryte production might be relevant, especially in terms of jobs at the local and regional levels.

2.6 Comparison with previous EU assessments

The assessment has been conducted at the extraction stage, using the same methodology as for the 2017 list.

The results of this and of earlier assessments are shown in Table 12.

Table 12: Economic importance and supply risk for baryte in the assessments of 2011, 2014, 2017, 2020 (European Commission, 2011-2014-2017)..

	2011		2014		2017		2020	
Indicator	EI	SR	EI	SR	EI	SR	EI	SR

[10] https://pubs.usgs.gov/pp/1802/d/pp1802d.pdf

Baryte	3.7	1.7		2.8	1.7		2.9	1.6		3.3	1.26

Compared to the previous assessment, the economic importance has increased, while the supply risk is lower.

2.7 Data sources

2.7.1 Data sources used in the factsheet

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