



Horizon 2020  
Programme

**SCRREEN2**

*This project has received funding from the European  
Union's Horizon 2020 research and innovation programme  
under grant agreement No 958211.*

Start date: 2020-11-01 Duration: 36 Months



---

FACTSHEETS UPDATES **BASED ON THE EU FACTSHEETS 2020**

**BENTONITE**

---

AUTHOR(S):

## TABLE OF CONTENT

BENTONITE .....	3
Overview .....	3
Market analysis, trade and prices.....	7
Global market.....	7
EU TRADE .....	8
Price and price volatility.....	9
Outlook for supply and demand .....	10
DEMAND .....	10
Global and EU demand and Consumption .....	10
EU uses and end-uses.....	11
substitution .....	14
SUPPLY .....	16
EU supply chain .....	16
Supply from primary materials .....	16
Supply from secondary materials/recycling.....	19
Other considerations .....	19
Health and safety issues related to bentonite or specific/relevant compounds at any stage of the life cycle .....	19
Environmental issues .....	19
Normative requirements related to the use and processing of bentonite.....	20
Socio-economic and ethical issues.....	20
Research and development trends .....	20
References .....	21

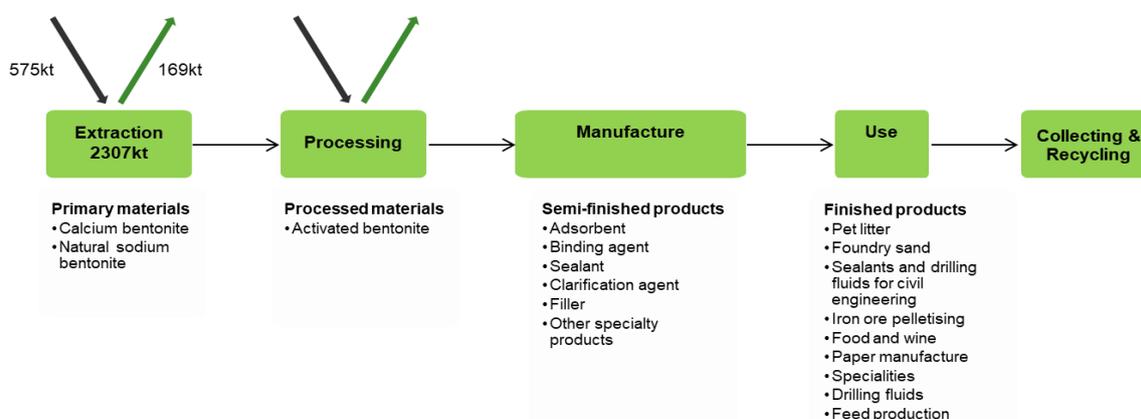
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 958211



**BENTONITE**

**OVERVIEW**

Bentonite is a smectite clay consisting mostly of the mineral montmorillonite, a silicate of hydrated sodium, calcium, magnesium and aluminium. Industrial bentonites are generally either the sodium or calcium variety. Depending on their genesis, bentonites contain a variety of accessory minerals, like quartz, feldspar, calcite or gypsum that can affect the industrial value of the deposit depending on the application. Bentonite deposits are usually exploited in open pit operations. Extracted bentonite is distinctly solid, even with a moisture content of approximately 30 %.



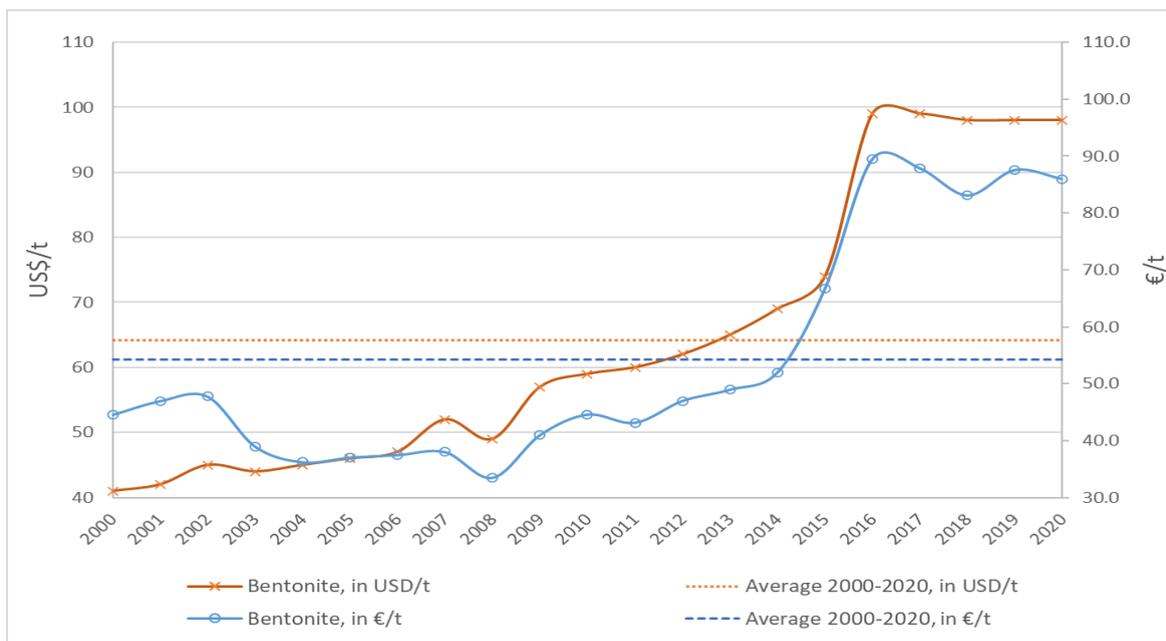
**Figure 1. Simplified value chain for bentonite in the EU<sup>1</sup>**

**Table 1. Bentonite supply and demand in metric tonnes, 2016-2020 average**

Global production	Global Producers	EU consumption	EU Share	EU Suppliers	Import reliance
<b>21 Mtonnes</b>	China 24%	3 Mtonnes	16%	Turkey 20%	23%
	USA 18%			Italy 12%	
	India 15%			Greece 12%	
	Turkey 7%			Netherlands 10%	
	Greece 5%			Slovakia 9%	

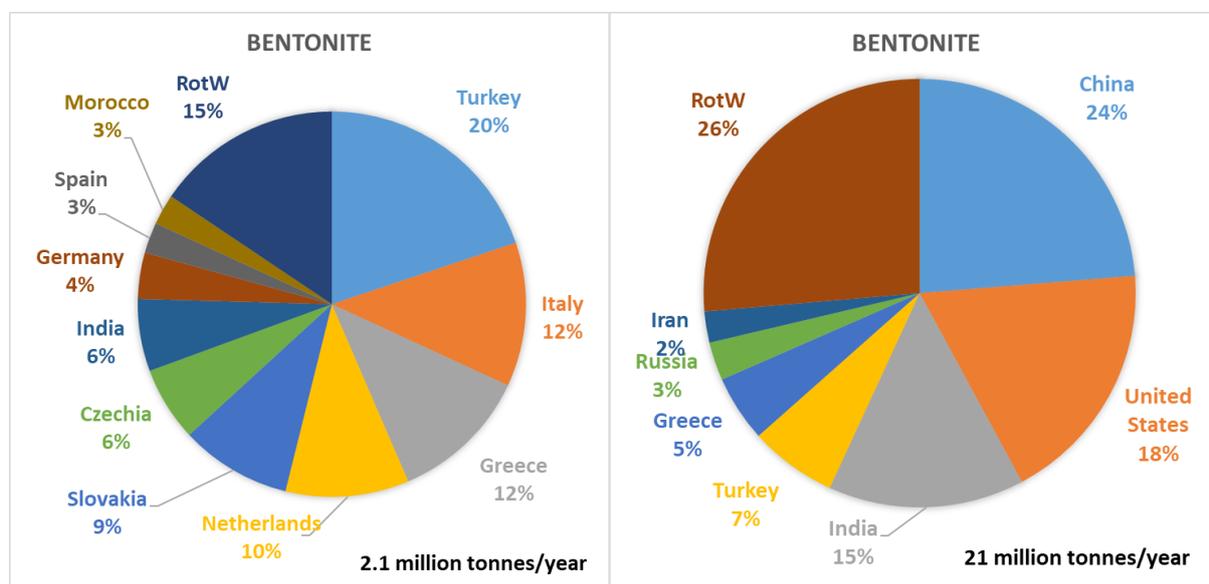
**Prices:** During COVID-2019 pandemic, the global production of clays (including bentonite) was reduced as a response to a decreasing demand (USGS, 2021). For bentonite, some of the main drivers are the changes in paper, wine, detergents, oil clarifications, and casting metal industries (Eynard et al., 2020). However, such changes in 2020 did not significantly affect bentonite prices, which are expected to remain steady by the end of 2021. The annual price fluctuated between € 47/t in 2012 and € 86/t in 2020 with the highest price at € 89/t in 2016 (USGS, 2021). Furthermore, the average price of bentonite in 2012-2020 was € 72/t, and prices showed an increasing trend until 2016. From 2016 to 2020, bentonite prices were stable, showing a price volatility of less than 1% during this period.

<sup>1</sup> JRC elaboration on multiple sources (2012-2016)



**Figure 2. Annual average price of bentonite between 2000 and 2020 ( USGS, 2021)<sup>2</sup>. Dash lines indicates average price for 2000-2020.**

**Primary supply:** Global reserves and resources figures are expected to be large, however there are no global reserves figures, or country-specific figures published. World mine production of bentonite in 2020 can be summarised: United States (4.2 Mt), China (5.6 Mt), Turkey (1.6 Mt), India (3.6 million tonnes) and Greece (1.1 Mt) are the major producing countries (WMD, since 1984).



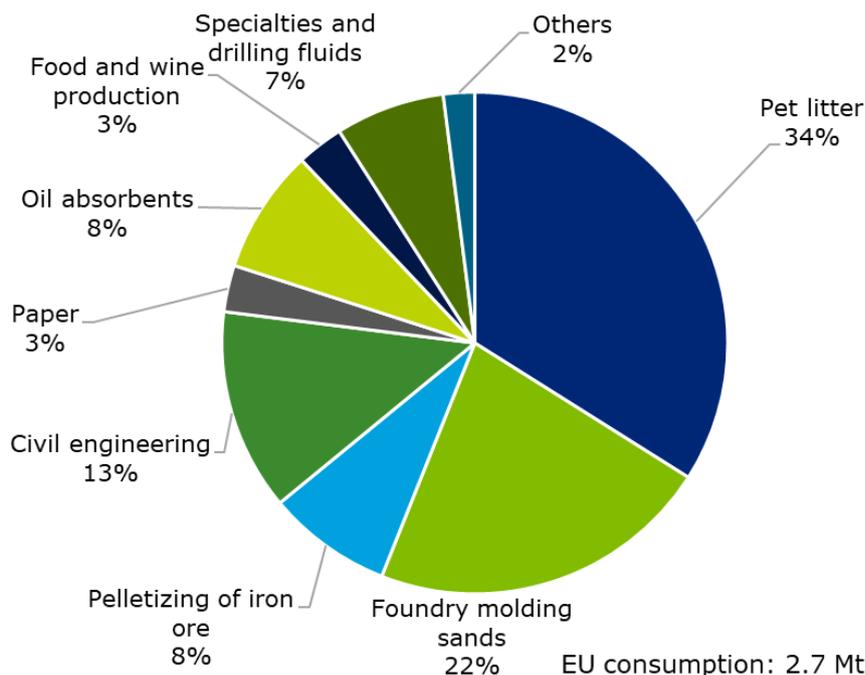
**Figure 3. EU sourcing of bentonite (Eurostat 2022) and global mine production (WMD 2022) (average 2016-2020)**

<sup>2</sup> Values in €/kg are converted from original data in US\$/kg by using the annual average Euro foreign exchange reference rates from the European Central Bank ([https://www.ecb.europa.eu/stats/policy\\_and\\_exchange\\_rates/euro\\_reference\\_exchange\\_rates/html/eurofxref-graph-usd.en.html](https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html))

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 958211

**Secondary supply:** According to IMA-EUROPE (2018), 50% of bentonite in products is recycled at end-of-life. However, only for some applications, in particular Foundry molding sands (22%) and Civil engineering (13%), and to some extent paper (3%), recycling can contribute to partially cover demand. This corresponds to a EoL-RIR (End-of-Life Recycling Input Rate) of 19%. Bentonite used in pet litter is not recovered.

**Uses:** Bentonite is often named as the ‘mineral of thousand uses’ and is used in a diverse range of markets including pet litter, foundry, construction and civil engineering, pelletising, paper, food and wine production, drilling fluids and many more.



**Figure 4: EU uses and end uses of bentonite. Average 2012-2016. (IMA Europe, 2018). No further update on use data available following SCRREEN Expert and Validation workshops (2021, 2022)**

**Substitution:** Substitutes have been identified for applications in pet litter, foundry moulding sands, pelletizing of iron ore and civil engineering uses.

**Other issues:** No health or safety issues could be found during the literature review. The use of bentonite is not restricted under REACH Regulation (EC) No 1907/2006 Annex XVII (Registration, Evaluation, Authorization and Restriction of Chemicals). Bentonite deposits are normally exploited by quarrying. Depending on the scale and technology used, quarrying can cause an environmental impact such as noise, dust, water pollution, solid erosion, and loss of biodiversity among others. Bentonite can be highly polluting to water and groundwater if it is released into the environment. Therefore, it is recommended to contain mining activities and avoid contact with the watercourse and/or surface water drains (‘Environmental Guidance for Your Business in Northern Ireland & Scotland’ 2021; ‘Bentonite | IMA Europe’ 2011). Globally the bentonite economy is small (less than 0.01% of the total world trade market). The market is also very limited for the main producing countries (India 0.03%, Turkey 0.07%, USA 0.01%, Italy 0.01%, Netherland 0.01%). In 2020, the bentonite export market represented about 0.16% of the total Cyprus exports, and 0.1% for Armenia (COMTRADE, 2020).

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 958211

**Table 2. Uses and possible substitutes**

Use	Percentage*	Substitutes	Sub share	Cost	Performance
Pet litter	34%	Wood based pet litter	3%	Very high costs (more than 2 times)	Reduced
Pet litter	34%	Attapulgit	7%	Very high costs (more than 2 times)	Reduced
Foundry moulding sands	22%	Inorganic Substances	5%	Similar or lower costs	Similar
Foundry moulding sands	22%	Organic Substances	5%	Very high costs (more than 2 times)	Similar
Pelletizing of iron ore	8%	not assessed, below 10%			No substitute
Pelletizing of iron ore	8%	not assessed, below 10%			No substitute
Civil engineering	13%	polymer support fluids	10%	Similar or lower costs	Similar
Paper	3%	not assessed, below 10%			No substitute
Paper	3%	not assessed, below 10%			No substitute
Oil absorbents	8%	not assessed, below 10%			No substitute
Oil absorbents	8%	not assessed, below 10%			No substitute
Food and wine production	3%	not assessed, below 10%			No substitute
Food and wine production	3%	not assessed, below 10%			No substitute
Specialties and drilling fluids	7%	not assessed, below 10%			No substitute
Specialties and drilling fluids	7%	not assessed, below 10%			No substitute

\* EU end uses of bentonite. Average 2012-2016. (IMA Europe, 2018).; outputs of SCRREEN Experts Validation Workshop, 2022)

## MARKET ANALYSIS, TRADE AND PRICES

### GLOBAL MARKET

**Table 3. Bentonite supply and demand in metric tonnes, 2016-2020 average**

Global production	Global Producers	EU consumption	EU Share	EU Suppliers	Import reliance
<b>19 Mtonnes</b>	China 29%	3 Mtonnes	16%	Turkey 20%	23%
	USA 23%			Italy 12%	
	India 18%			Greece 12%	
	Turkey 8%			Netherlands 10%	
	Greece 6%			Slovakia 9%	

The USGS (USGS 2021) estimates the global bentonite production in to about 16 million t in 2021, with China, the USA and India being the largest producers. Greece is Europe’s major bentonite producing country (1.3 million t in 2021). In the USA bentonite is mainly used for pet waste absorbents (49%) and drilling mud (23%) (USGS 2021). Largest European producers in 2019 were Greece, Germany and the Czech Republic (source: BGR Database).

The USA is the leading global producer of sodium bentonite and is a significant producer of calcium bentonite. Elsewhere in locations such as Europe, China and India, calcium bentonite is the predominant mineral and is used either in its natural state or after sodium-exchange or acid activation.

Foundry sands, pet litter, iron ore pelletising, drilling mud and civil engineering account for about 80% of the global bentonite consumption (metal casting 30%, iron ore pelletising 20%, cat litter 15%, drilling mud 10%, civil engineering 10%) (IM 2016). Further appliances include paper industry, refining, animal feed, construction, ceramics etc.

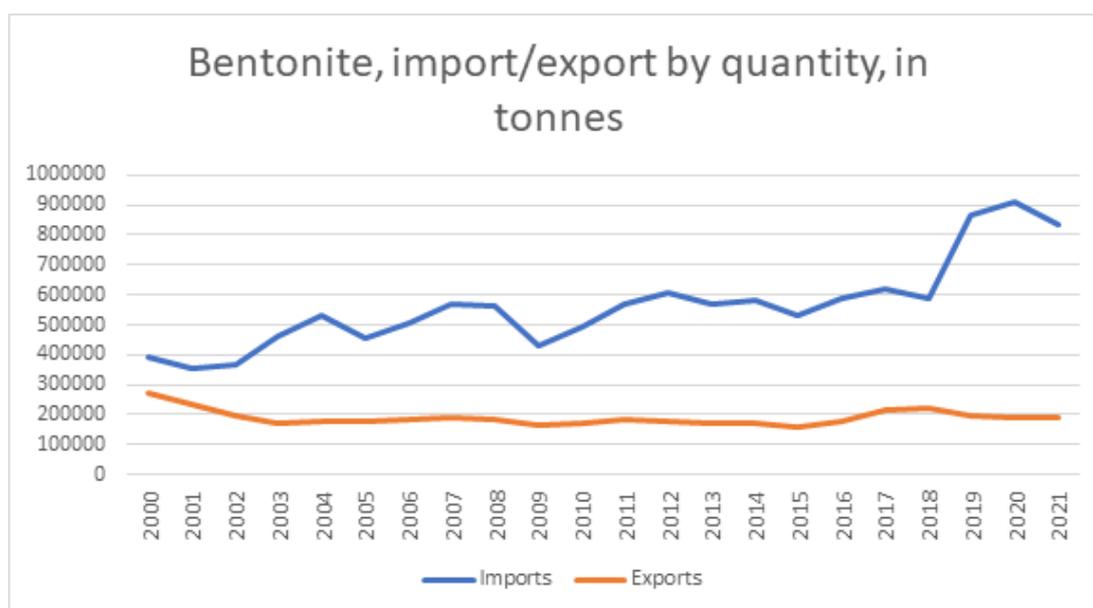
Consumption patterns of bentonite vary from region to region, depending on the industry composition, income situation and population demographics. For example, cat litter consumption is higher in wealthier economies; therefore, demand is concentrated in areas such as North America, Japan and Europe. Similarly, bentonite consumption for iron ore pelletising is greatest in countries that produce iron ore 'fines' that need to be agglomerated, such as in China, Russia and the US. Bentonite use in foundry sands is widely used, but demand shifted with castings production from high-cost locations such as Western Europe, to lower-cost production bases in Eastern Europe, India, S.E. Asia and China. The US remains a major producer of iron castings due mainly to its large automotive and heavy equipment manufacturing industry. (IM 2016)

Industrial-grade bentonite prices range from as low as 40 US\$ per tonne for cat litter dried crudes to 240 US\$ per tonne for higher grades used in oilfield services markets (IM 2018). Other specialised grades for e.g. the paper industry ask higher prices.

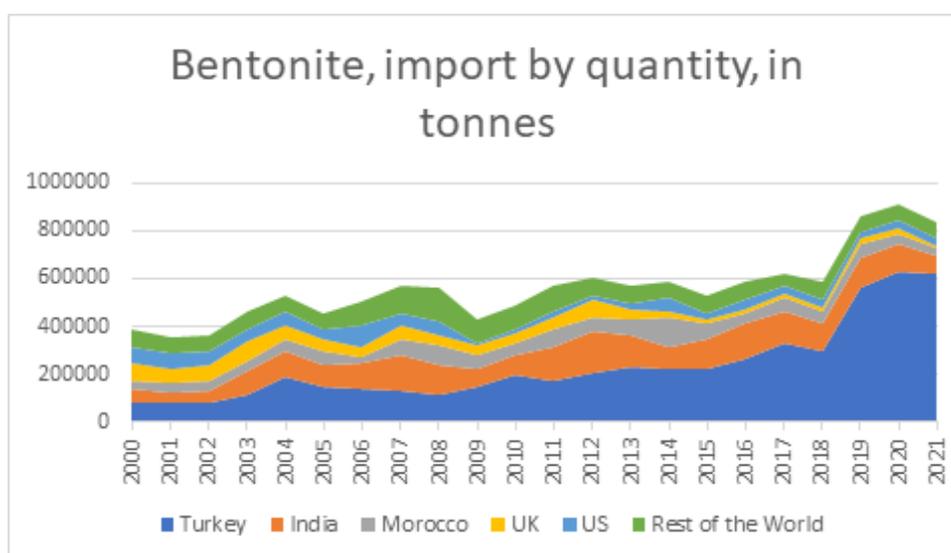
EU TRADE

**Table 4 Relevant Eurostat CN trade codes for Bentonite.**

CN trade code	title
<b>25081000</b>	Bentonite



**Figure 5. EU trade flows of Bentonite (CN 250810) from 2000 to 2021 (based on Eurostat, 2022)**



**Figure 6. EU imports of Bentonite (CN250810) by country on 2000-2021 period (based on Eurostat, 2022).**

Figure 5 shows the EU trade in bentonite in tonnes, between 2000 and 2021. The EU is a net importer of bentonite. The imports of bentonite (CN 25081000) varied from 390,479 t in 2000 to 837,396 t in 2021, while bentonite exports ranged between 269,853 t and 186,622 t per year. The EU is a net importer of bentonite.

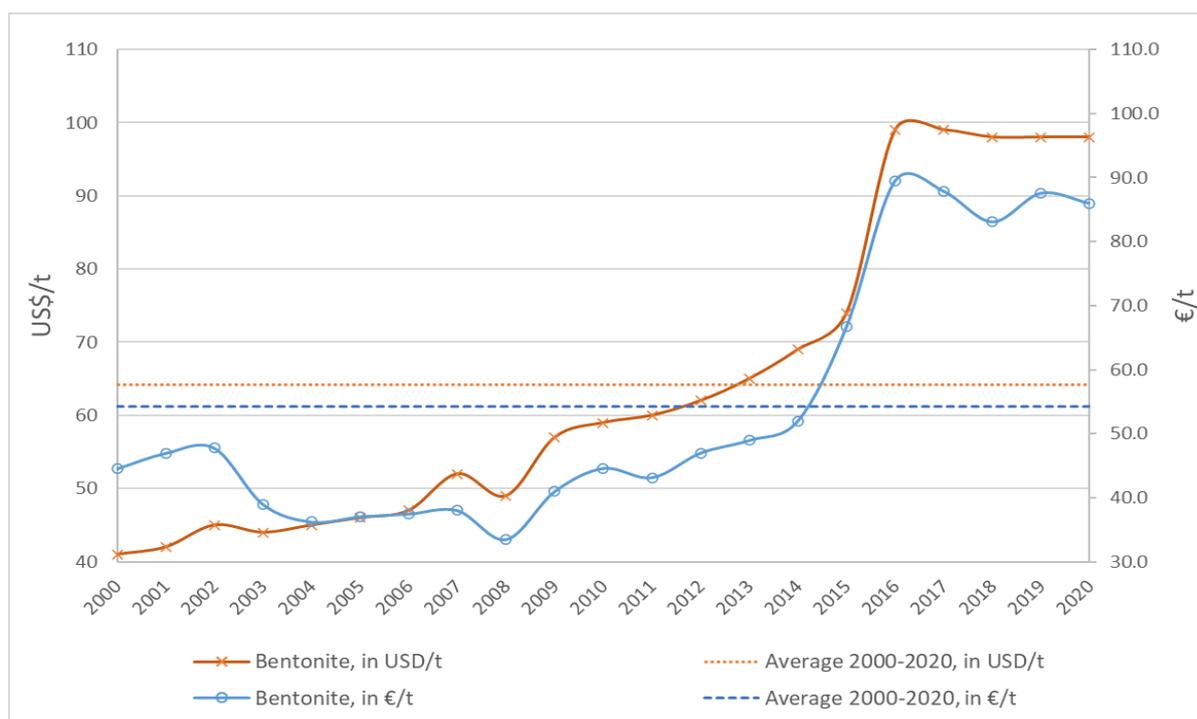
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 958211

The average import quantity for the period 2016-2020 was about 747 kt/y, an average for the period 2016-2020, which was a considerable increase from 500 kt over the last assessment for the period 2012-2016, according to Comext (Eurostat, 2022).

The main suppliers for the EU are Turkey (42%), India (19%), Morocco (10%), United States (7%) and United Kingdom (7%) in 2000-2021 period.

## PRICE AND PRICE VOLATILITY

During COVID-2019 pandemic, the global production of clays (including bentonite) was reduced as a response to a decreasing demand (USGS, 2021). For bentonite, some of the main drivers are the changes in paper, wine, detergents, oil clarifications, and casting metal industries (Eynard et al., 2020). However, such changes in 2020 did not significantly affect bentonite prices, which are expected to remain steady by the end of 2021. The annual price fluctuated between € 47/t in 2012 and € 86/t in 2020 with the highest price at € 89/t in 2016 (USGS, 2021). Furthermore, the average price of bentonite in 2012-2020 was € 72/t, and prices showed an increasing trend until 2016. From 2016 to 2020, bentonite prices were stable, showing a price volatility of less than 1% during this period.



**Figure 7. Annual average price of bentonite between 2000 and 2020, in US\$/t and €/t (based on USGS, 2021)<sup>3</sup>. Dash lines indicates average price for 2000-2020.**

<sup>3</sup> Values in €/kg are converted from original data in US\$/kg by using the annual average Euro foreign exchange reference rates from the European Central Bank ([https://www.ecb.europa.eu/stats/policy\\_and\\_exchange\\_rates/euro\\_reference\\_exchange\\_rates/html/eurofxref-graph-usd.en.html](https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html))

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

## OUTLOOK FOR SUPPLY AND DEMAND

Analysts generally see a growth in demand over the next 5 years, from which a large portion will be generated in Asia. For 2021 a growth of about 4 % is predicted (Technavio 2021). Whether this growth will be reached, will also depend on the economic impact of the pandemic crisis.

The future demand of bentonite is expected to vary for different end use sectors. The demand for bentonite used in oil drilling mainly depends on oil and gas exploration activities, and in the USA is especially dependent on fracking activities. Bentonite use in iron ore pelletizing depends on the demand for iron and steel. As China's steel production decreased in 2021, this is likely to have a negative impact on bentonite demand in the sector. The future of bentonite used in foundry sands will follow the trend of key sectors utilising iron ore castings such as the automotive and heavy equipment manufacturing sectors. The USA are a major iron casting producer and the future of this industry is expected to remain positive due to ongoing technological innovation (e.g. the smart car) and the uptake from emerging economies. The pet litter segment is expected to remain strong. An increase in civil construction activity in Asian countries and edible oil refining in Asia could boost bentonite consumption. Bentonite could improve its importance in the pharmaceutical industry with a growing interest in using nanoparticles as drug delivery mechanisms. For other end uses, it is difficult to speculate any future trends due to the variability of sales on bentonite seen from year to year and at regional level.

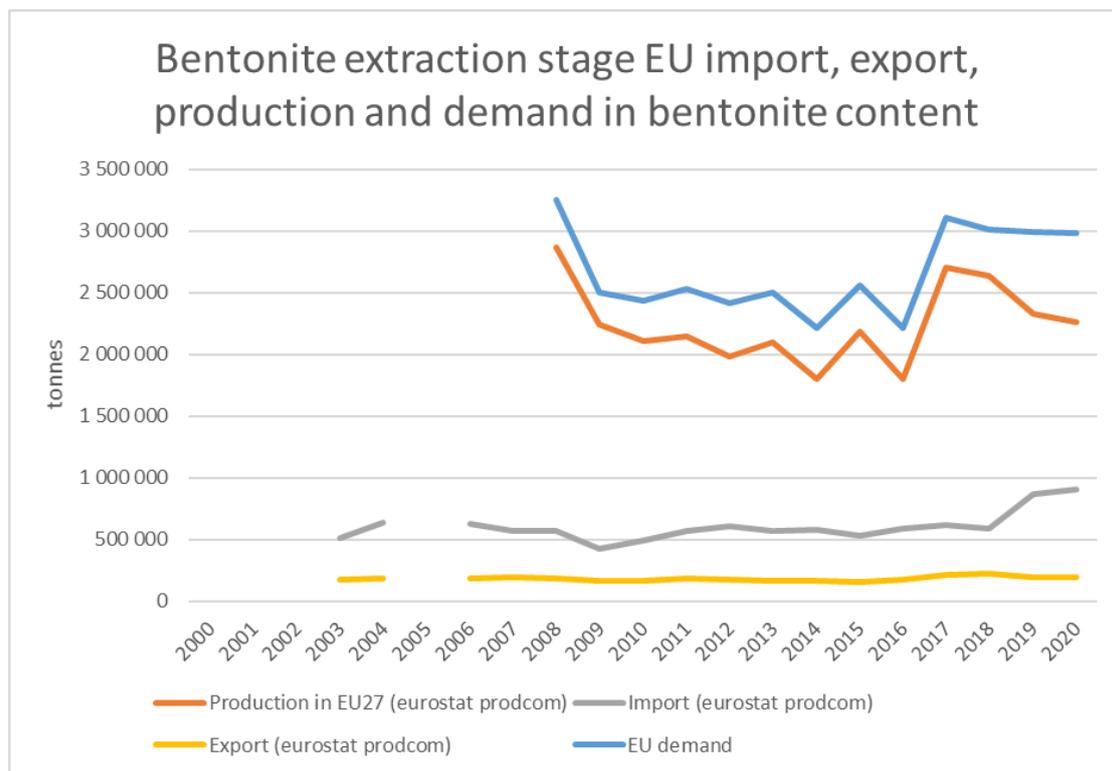
## DEMAND

### GLOBAL AND EU DEMAND AND CONSUMPTION

At global level, consumption patterns vary widely depending on the industry availability in a specific region and country demographics. For example, cat litter consumption is higher in wealthier economies, such as North America, Europe and Japan. Bentonite use in iron ore pelletizing is higher in countries that produce iron ore fines or have a strong steel industry, e.g. China, Russia and the United States (Scogings, 2016).

Bentonite processing stage EU consumption is presented by HS code CN 250810 bentonite. Production, import and export data is extracted from Eurostat Prodcom (2021a, 2021b) using PRCCODE 8122210.

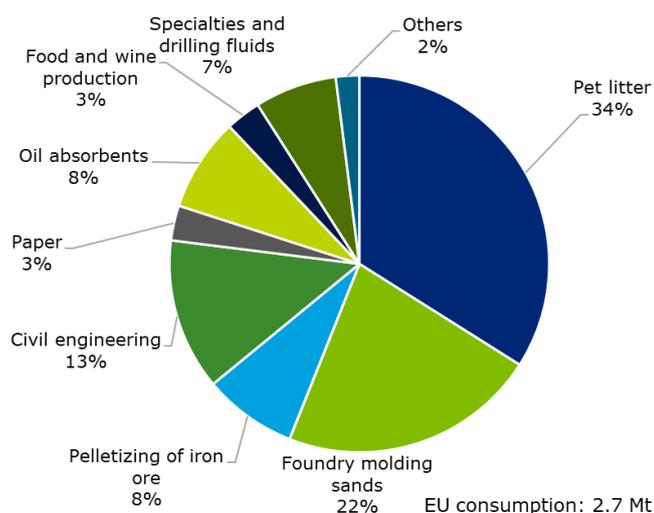
Based on UNComtrade (2021) average import reliance of bentonite at extraction stage is 16.0 % for 2008-2020.



**Figure 8. Bentonite (CN 250810) extraction stage apparent EU consumption. Production data from Eurostat Prodcom (2021a) for bentonite available for 2008-2020. Import and export data from Eurostat Prodcom (2021b) available for 2003-2004 and 2006-2020. Consumption is calculated in bentonite content (EU production+import-export).**

## EU USES AND END-USES

Bentonite is often named as the ‘mineral of thousand uses’ and is used in a diverse range of markets including pet litter, foundry, construction and civil engineering, pelletizing, paper, food and wine production, drilling fluids and many more.



**Figure 9. EU end uses of bentonite. Average 2012-2016. (IMA Europe, 2018). No further update on use data available following SCRREEN Expert and Validation workshops (2021, 2022)**

Relevant industry sectors are described using the NACE sector codes (Eurostat, 2022).

**Table 5. Bentonite applications (IMA-Europe, 2018), 2-digit and associated 4-digit NACE sectors, and value added per sector (Eurostat 2022).**

Applications	2-digit NACE sector	Value added of NACE 2 sector (millions€, 2019)	4-digit NACE sectors
Pet litter	C23 - Manufacture of other non-metallic mineral products	72,396	C2399 - Manufacture of other non-metallic mineral products n.e.c.
Foundry moulding sands	C24 - Manufacture of basic metals	63,700	C2452 - Casting of steel
Pelletizing iron ore	C24 - Manufacture of basic metals	63,700	C2451 - Casting of iron
Civil engineering	C23 - Manufacture of other non-metallic mineral products	72,396	B0990 - Support activities for other mining and quarrying
Paper	C17 - Manufacture of paper and paper products	47,452	C1712 - Manufacture of paper and paperboard
Oil adsorbent	C20 - Manufacture of chemicals and chemical products	117,150*	
Food and wine production	C11 - Manufacture of beverages	251,015 (inc C10 & C12)	C1102 Manufacture of wine from grapes
Specialties and drilling fluids	B09 - Mining support service activities	TBA	B0910 - Support activities for petroleum and natural gas extraction
Others	C20 - Manufacture of chemicals and chemical products	117,150* * Data to 2014 only	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

---

## APPLICATIONS OF BENTONITE IN THE EU

---

### PET LITTER

In Europe, the pet litter market presents the greatest share. Bentonite is used due to its absorbing properties. The formation of clumps helps the removal of impurities, allowing the remaining product to be used for longer.

---

### FOUNDRY MOULDING SANDS

Bentonite is used in foundry moulding sands as a bonding material to produce iron, steel and non-ferrous casting.

---

### PELLETISING IRON ORE

Bentonite finds use as a binding agent in the production of iron ore pellets, which comprises the feed material in blast furnaces for pig iron production or in the production of direct reduction iron (DRI).

---

### CIVIL ENGINEERING

In civil engineering, the bentonite thixotropic properties are important, and it finds application in foundations, tunnelling, pipe jacking, and in horizontal directional drilling. It is also used in the construction and sealing of landfills.

---

### PAPER

Bentonite is important in paper making where it is used in pitch control, in de-inking during paper recycling and in the manufacture of carbonless copy paper.

---

### FOOD AND WINE PRODUCTION

In food and wine, bentonite is used as a purification agent.

---

### SPECIALTIES AND DRILLING FLUIDS

In drilling fluids, bentonite comprises one of the key mud constituents for oil and water well drilling and it is used to seal the borehole walls, to lubricate the drill head and to remove drill cuttings.

Bentonite finds application in numerous other specialised end-uses, for example in the pharmaceutical and cosmetics markets, where it is used, for example, as a filler, in detergents, and in paints and dyes.

Bentonite also finds use in animal feed production, where it is used as a pelletizing agent (IMA Europe, 2018).

## SUBSTITUTION

Substitutes have been identified for applications in pet litter, foundry moulding sands, pelletizing of iron ore and civil engineering uses.

**Table 6. Uses and possible substitutes**

Use	Percentage*	Substitutes	Sub share	Cost	Performance
Pet litter	34%	Wood based pet litter	3%	Very high costs (more than 2 times)	Reduced
Pet litter	34%	Attapulgite	7%	Very high costs (more than 2 times)	Reduced
Foundry moulding sands	22%	Inorganic Substances	5%	Similar or lower costs	Similar
Foundry moulding sands	22%	Organic Substances	5%	Very high costs (more than 2 times)	Similar
Pelletizing of iron ore	8%	not assessed, below 10%			No substitute
Pelletizing of iron ore	8%	not assessed, below 10%			No substitute
Civil engineering	13%	polymer support fluids	10%	Similar or lower costs	Similar
Paper	3%	not assessed, below 10%			No substitute
Paper	3%	not assessed, below 10%			No substitute
Oil absorbents	8%	not assessed, below 10%			No substitute
Oil absorbents	8%	not assessed, below 10%			No substitute
Food and wine production	3%	not assessed, below 10%			No substitute
Food and wine production	3%	not assessed, below 10%			No substitute
Specialties and drilling fluids	7%	not assessed, below 10%			No substitute
Specialties and drilling fluids	7%	not assessed, below 10%			No substitute

\* EU end uses of bentonite. Average 2012-2016. (IMA Europe, 2018).; [outputs of SCRREEN Experts Validation Workshop, 2022](#))

## PET LITTER

Substitutes include sepiolite (SCRREEN Experts, 2021) and wood-based litter, comprising wood pellets (e.g. from pine) which are often produced from sawdust and recycled wood materials.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

Other alternative pet litters include paper based, plant based, and silica gel-based products (Hall, 2016; Michaels, 2005).

## FOUNDRY MOULDING SANDS

---

Bentonite in foundry moulding sands acts as a binder. Several alternative binders are available for use, but bentonite is the most popular and alternatives are used only to satisfy specific needs or functions.

Oils, such as linseed oil, other vegetable oils and marine oils may function as alternative binders.

Organic resins, such as phenolic resins are often used in resin shell sand casting, where good surface smoothness, fewer casting defects and good dimensional accuracy are a requirement.

Phenolic resins however are much more expensive than bentonite. Some inorganic resins may also substitute bentonite, for example sodium silicate and phosphate (Engineered Casting Solutions, 2006).

## PELLETISING IRON ORE

---

In the pelletizing of iron ore, bentonite is used as a binding agent and may be substituted by hydrated lime or organic binders. Bentonite is the most widely used binder in iron ore pelletizing. The use of bentonite is favourable in terms of physical, mechanical and metallurgical pellet qualities.

The use of hydrated lime as a binder finds application in the production of fluxed pellets. Hydrated lime was used as a binding agent for pellets in several plants as early as in the 1990s. Substitution of hydrated lime with bentonite, however, has significantly decreased the total energy requirements of the process, which provides direct cost savings (Kogel et al., 2006; Zhu et al., 2015).

Organic binders provide good wet pellet strength; however, they have found limited application in industry.

## FOOD AND WINE PRODUCTION

---

Instead of bentonite other locally available commodities, such as diatomite, could be used (although with criticality limitations itself).

## CIVIL ENGINEERING

---

Bentonite is used in civil engineering and related applications, for example in geosynthetics, in pilling, in the construction of cut-off walls (as a barrier), in excavation, boreholes and others.

Polymer support fluids are used as alternatives to bentonite, but it is believed that bentonite support fluids are much more popular (Jafferis and Lam 2013; Lam and Jefferis 2014).

Possible substitution for bentonite in construction sector (SCRREEN Experts, 2021), including common clays (with other clay mineral which are not part of the bentonite family) as substitution for materials used in embankments where impermeability is needed.

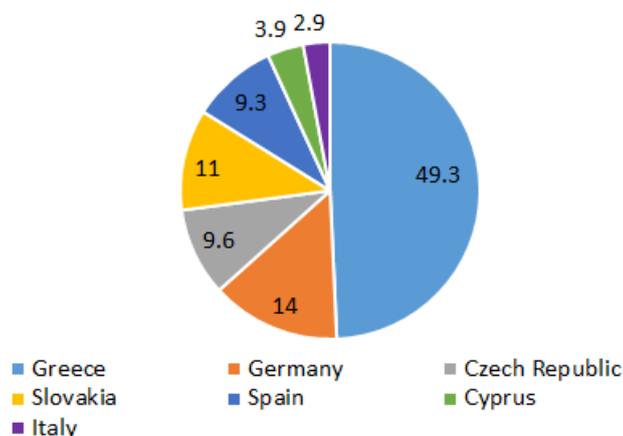
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

There are no quantified ‘market sub-shares’ for the identified substitutes of bentonite and the ones used are based on hypotheses made through expert consultation (SCRREEN workshops, 2019 and 2021) and literature searches.

## SUPPLY

### EU SUPPLY CHAIN

The yearly European production of bentonite over 2016-2020 ranged between 1.8 and 2.7 Mt (Eurostat, 2020), while the EU production mainly took place in Greece, Germany, Czechia and Slovakia (WMD, since 1984) (Figure 10). Europe is a net importer of bentonite and the main import countries are Turkey, India and Morocco. The import reliance of bentonite in EU-27 is estimated to be 30% (Eurostat, 2020).



**Figure 10: Bentonite production in EU by country (%) in 2020. Total production 2.3 mt (WMD, since 1984).**

### SUPPLY FROM PRIMARY MATERIALS

#### GEOLOGY, RESOURCES AND RESERVES OF BENTONITE

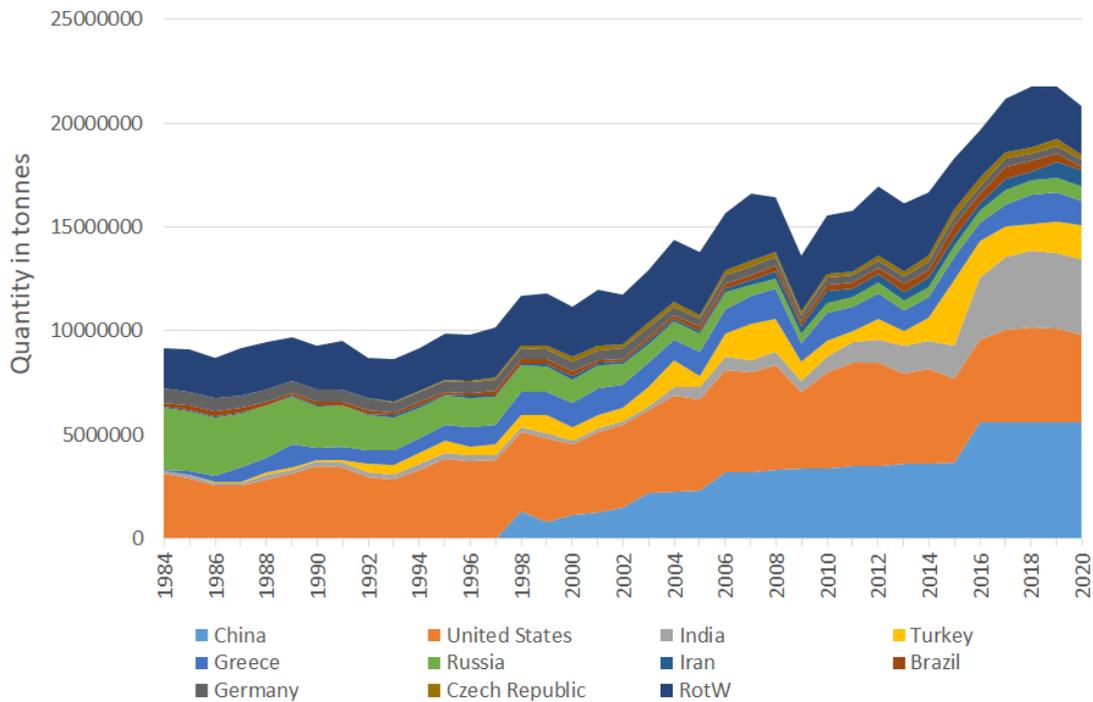
Global reserves and resources figures are expected to be large, however there are no global reserves figures, or country-specific figures published. The exact estimation of bentonite deposits is difficult as it is included roughly in the industrial minerals category of clays.

#### WORLD MINE PRODUCTION

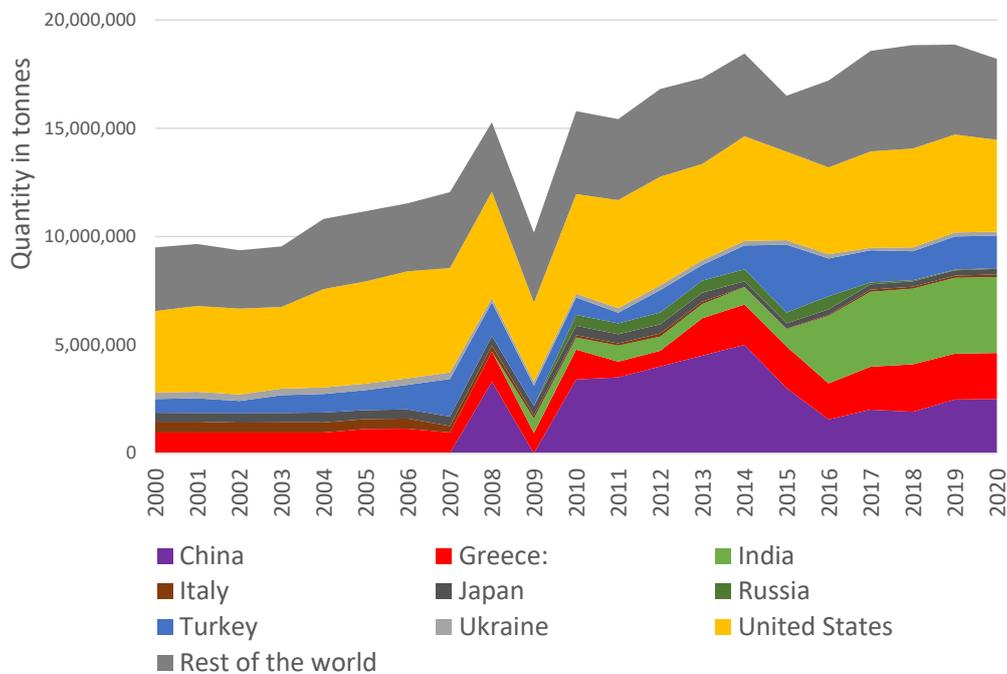
World mine production of bentonite in 2020 can be summarised as following: United States (4.2 Mt), China (5.6 Mt), Turkey (1.6 Mt), India (3.6 million tonnes) and Greece (1.1 Mt) are the major producing countries (WMD, since 1984). Production of bentonite takes place in several other countries at a much smaller scale. In Europe, Greece is the largest producer but Germany (2% of global production), Czechia (2%), and Slovakia (1%) are also important producers.. World bentonite production by country since 1984 according to WMD and

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 958211

since 2000 according to USGS can be seen in Figure 11 and Figure 12 respectively (WMD, since 1984; USGS, since 2000). United States, India, China and Greece consist are the major producers.



**Figure 11. Global bentonite production by country since 1984 (WMD, since 1984).**



**Figure 12. Global bentonite production by country since 2000 (USGS, since 2000).**

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 958211

Minerals Technologies Inc. (MTI) is the leading producer accounting for an estimated 15% of global bentonite production. MTI operates primarily in the United States (Wyoming and Alabama), but owns mines and plants in Australia, China, Mexico, Turkey and elsewhere. Imerys is considered the second largest producer in the world with an estimated market share of 10-12%. Imerys owns mines and plants in Greece, Bulgaria, Hungary, Georgia, Morocco, South Africa and numerous other places. Clariant AG is an important producer of industrial grade bentonites, catalysts and specialised bentonite products. Finally, the Taiko Group is reported as the largest producer of acid activated bentonites after Clariant (Scogings, 2016).

## EU MINE PRODUCTION

As it was previously shown, a significant production of bentonite is taking place in Europe. Overall, 13 countries are recorded as bentonite producers in EU.

Table 7 presents in detail the EU production per country of bentonite and related products (attapulgite and sepiolite) for the 2015-2019 period (BGS 2021).

**Table 7. EU production of bentonite and related products (in thousand tonnes) between 2015 and 2019 (BGS 2021).**

Country	Sub-commodity	2015	2016	2017	2018	2019
<i>Bulgaria</i>	Bentonite	61	47	54	54	54
<i>Cyprus</i>	Bentonite	127	117	96	99	83
<i>Czech Republic</i>	Bentonite	369	374	254	277	357
<i>Denmark</i>	Bentonite	54	66	70	56	48.2
<i>France</i>	Bentonite	36.4	42.6	25	35.7	30
<i>Greece</i>	Attapulgite	108	44.5	54.28	53.3	36.7
<i>Greece</i>	Bentonite	1123	883	1088	1355	1300
<i>Hungary</i>	Bentonite	11.3	16	9.9	35.1	35
<i>Poland</i>	Bentonite	0.45	1	0	0.56	0.5
<i>Romania</i>	Bentonite	19.3	27	37.7	35	42
<i>Slovakia</i>	Bentonite	205	158	226	270	251
<i>Slovenia</i>	Bentonite	0.2	0.182	0.15	0.12	0.1
<i>Spain</i>	Attapulgite	26.2	28.8	59	28	30.4
<i>Spain</i>	Bentonite	100.6	115	178	179	160
<i>Spain</i>	Sepiolite	525	519	483	698	595
<i>Germany</i>	Bentonite	393	393	416	379	366
<i>Italy</i>	Bentonite	12.8	46	86	100	82.7
<i>Total</i>	All materials	3173.5	2908	3130	3654	3472

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

## OUTLOOK FOR SUPPLY

---

Bentonite demand in 2027 is expected to increase by 8% compared to 2020 due to rising environmental concerns related to wastewater treatment and also due to expected large-scale drilling activities in the U.S (gminsights.com, 2020). There are several reports concerning the bentonite mining expansion in U.S (blm.gov, 2021; blm.gov, 2022), however, there are not respective data for other countries worldwide.

## SUPPLY FROM SECONDARY MATERIALS/RECYCLING

According to IMA-EUROPE (2018), 50% of bentonite in products is recycled at end-of-life. However, only for some applications, in particular Foundry melting sands (22%) and Civil engineering (13%), and to some extent paper (3%), recycling can contribute to partially cover demand. This corresponds to an EoL-RIR (End-of-Life Recycling Input Rate) of 19%. Bentonite used in pet litter is not recovered. Pet litter commonly ends in the incinerated municipal waste stream and fly ash from that stream is often reused in various industries, for example the wall board industry. Bentonite used in the pelletizing of iron ore is not recoverable and the majority of it ends up in the slag. Slag however often finds use in the cement industry and therefore part of the bentonite trapped in slag is used there. Bentonite is used in construction projects and often ends up in construction and demolition waste, which is widely recycled (IMA Europe, 2019).

## OTHER CONSIDERATIONS

### HEALTH AND SAFETY ISSUES RELATED TO BENTONITE OR SPECIFIC/RELEVANT COMPOUNDS AT ANY STAGE OF THE LIFE CYCLE

No health or safety issues could be found during the literature review. The use of bentonite is not restricted under REACH Regulation (EC) No 1907/2006 Annex XVII (Registration, Evaluation, Authorization and Restriction of Chemicals).

### ENVIRONMENTAL ISSUES

Bentonite deposits are normally exploited by quarrying. Depending on the scale and technology used, quarrying can cause an environmental impact such as noise, dust, water pollution, solid erosion, and loss of biodiversity among others. Bentonite can be highly polluting to water and groundwater if it is released into the environment. Therefore, it is recommended to contain mining activities and avoid contact with the watercourse and/or surface water drains ('Environmental Guidance for Your Business in Northern Ireland & Scotland' 2021; 'Bentonite | IMA Europe' 2011).

No LCAs studies could be found related to any life cycle stage or specific use of the material during the scientific literature review.

## NORMATIVE REQUIREMENTS RELATED TO THE USE AND PROCESSING OF BENTONITE

Technical rules for the use of Bentonite can be found in the GESTIS Substance database<sup>4</sup>. In addition, Bentonite is included under the German regulation of accident insurers<sup>5</sup> for the use of respiratory protective equipment published in November 2021. Japan's (JSOH)<sup>6</sup> respirable dust maximum limit value for 8-hour exposure is 0.5 mg/m<sup>3</sup> and a total dust exposure of 2 mg/m<sup>3</sup>. The People's Republic of China, on the other hand, has a respirable dust maximum limit value for 8-hour exposure of 6 mg/m<sup>3</sup>.

## SOCIO-ECONOMIC AND ETHICAL ISSUES

### ECONOMIC IMPORTANCE OF BENTONITE FOR EXPORTING COUNTRIES

Globally the bentonite economy is small (less than 0.01% of the total world trade market). The market is also very limited for the main producing countries (India 0.03%, Turkey 0.07%, USA 0.01%, Italy 0.01%, Netherland 0.01%). In 2020, the bentonite export market represented about 0.16% of the total Cyprus exports, and 0.1% for Armenia (COMTRADE, 2020).

### SOCIAL AND ETHICAL ASPECTS

No specific issues were identified during data collection and stakeholders' consultation.

## RESEARCH AND DEVELOPMENT TRENDS

### RESEARCH AND DEVELOPMENT TRENDS FOR LOW-CARBON AND GREEN TECHNOLOGIES

#### *a. R&D trends in terms of emerging LCGT*

No research and development trends could be identified in the context of Bentonite use in emerging LCGT.

#### *b. R&D trends in terms of emerging application of RM in already existing LCGT*

No research and development projects could be identified in the context of emerging applications of Bentonite in already existing LCGT.

### OTHER RESEARCH AND DEVELOPMENT TRENDS

- Bentonite mechanical evolution (H2020 Euratom Programme)<sup>7</sup>

<sup>4</sup> <https://gestis-database.dguv.de/data?name=109332>

<sup>5</sup> See <https://publikationen.dguv.de/regelwerk/dguv-regeln/1011/benutzung-von-atemschutzgeraeten>

<sup>6</sup> <https://www.dguv.de/ifa/gestis/gestis-internationale-grenzwerte-fuer-chemische-substanzen-limit-values-for-chemical-agents/limit-values-japan-jsoh/index.jsp>

<sup>7</sup> See <https://cordis.europa.eu/project/id/745942>

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

The overall objective of the project is to develop and test the tools necessary for the assessment of the hydro-mechanical evolution of an installed bentonite barrier and its resulting performance. This will be achieved by cooperation between design and engineering, science, and performance assessment.

## REFERENCES

Gilg, H.A.; Kaufhold, S., Ufer, K. (2021): Smectite and Bentonite Terminology, Classification, and Genesis. In: Bentonites. Characterization, Geology, Mineralogy, Analysis, Mining, Processing and Uses. Ed.: Stephan Kaufhold, Geologisches Jahrbuch Reihe B, Band B 107, ISBN 978-3-510-96859-6 (unpublished)

IM (2016): Soaking it up: Bentonite's global reach. Industrial Minerals, <https://www.indmin.com/Article/3556884/Soaking-it-up-Bentonites-global-reach.html>

IM (2018): A growth trajectory - ceramics markets look to Asia. In: Industrial Minerals. Nr. 601, (2018) S. 33-35.

IM (2019): Clay time - Should pharmaceuticals take a closer look at bentonite. In: Industrial Minerals. Nr. 4, (2019) S. 38-40

IMA (2021): Factsheet Bentonite. IMA Europe, [https://ima-europe.eu/wp-content/uploads/2020/06/Bentonite\\_An-WEB-2011.pdf](https://ima-europe.eu/wp-content/uploads/2020/06/Bentonite_An-WEB-2011.pdf)

IMERYS: <https://www.imerys.com/minerals/bentonite>

Coutelle, H., Decher, A., Kaufhold, S., Karidakis, T., Kesore, K., Koch, D., Krause, A., Rickertsen, N., Stützer, A. (2021): Applications. In: Bentonites. Characterization, Geology, Mineralogy, Analysis, Mining, Processing and Uses. Ed.: Stephan Kaufhold, Geologisches Jahrbuch Reihe B, Band B 107, ISBN 978-3-510-96859-6 (unpublished)

Technavio (2021): <https://www.prnewswire.com/news-releases/bentonite-market-size-to-increase-by-over-400-mn-during-2021-2025--technavio-301357802.html>

USGS (2021): Clays. U.S. Geological Survey, Mineral Commodity Summaries, January 2021 <https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-clays.pdf>

Eurostat. (2021). Comext Database. <http://epp.eurostat.ec.europa.eu/newxtweb/>

Eynard, U., Georgitzikis, K., Wittmer, D., Latunussa, C. EL, Torres de Matos, C., Mancini, L., Unguru, M., Blagoeva, D., Bobba, S., Pavel, C., Carrara, S., Mathieux, F., Pennington, D., & Blengini, G. A. (2020). European Commission, Study on the EU's list of Critical Raw Materials (2020), Factsheets on Non-critical Raw Materials. doi: 10.2873/587825

USGS. (2021). Clays Statistics and Information. <https://www.usgs.gov/centers/nmic/clays-statistics-and-information>

BGS (2021). World Mineral Production 2015–19, Keyworth, Nottingham, UK. 89p. Available at: [https://www2.bgs.ac.uk/mineralsuk/download/world\\_statistics/2010s/WMP\\_2015\\_2019.pdf](https://www2.bgs.ac.uk/mineralsuk/download/world_statistics/2010s/WMP_2015_2019.pdf)

blm. gov, 2021, available at: <https://www.blm.gov/press-release/bureau-land-management-releases-analysis-bentonite-mining-project-hot-springs-county>

blm. gov, 2022, available at: <https://www.blm.gov/press-release/blm-releases-analysis-bentonite-mining-expansion-big-horn-county-0>

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

Eurostat (2020). Comext International Trade [Online]. Available at: <https://ec.europa.eu/eurostat/web/international-trade-in-goods/data/database>

gminsights.com, 2020, available at: <https://www.gminsights.com/industry-analysis/bentonite-market#:~:text=Industry%20Overview,of%20radioactive%20and%20toxic%20chemicals>.

OECD (2019). OECD Export restrictions on Industrial Raw Materials database. [online] Available at: [http://qdd.oecd.org/subject.aspx?Subject=ExportRestrictions\\_IndustrialRawMaterials](http://qdd.oecd.org/subject.aspx?Subject=ExportRestrictions_IndustrialRawMaterials)

Industrial Minerals Association (IMA-Europe) (2018). Recycling Industrial Minerals

Industrial Minerals Association (IMA-Europe) (2019). Data and information on bentonite provided by IMA-Europe and the European Bentonite Association during stakeholder workshops and expert consultation within the 'Study on the review of the list of critical raw materials'.

Scogings, A. (2016). Soaking it up: Bentonite's global reach Industrial Minerals, (June), 37-42.

USGS (since 2000), Mineral Commodity Summaries, U.S. Department of the Interior, U.S. Geological Survey

WMD (2022) World Mining Data, Austrian Federal Ministry of Sustainability and Tourism.