23. POTASH

Key facts and figures

Material name and Formula	Potash, K_2O	World / EU production (tonnes)[1]	33,980,686/ 4,254,936
Parent group	n.a.	EU import reliance[1]	23%
Life cycle stage assessed	Extraction	Substitution index for supply risk [SI(SR)][1]	1.00
Economic importance (EI)(2017)	4.8	Substitution Index for economic importance [SI(EI)][1]	1.00
Supply risk (SR) (2017)	0.7	End of life recycling input rate (EOL-RIR)	0%
Abiotic or biotic	Abiotic	Major global end uses (2014)	Fertilisers (92%), Chemicals (8%)
Main product, co-product or by-product	Mainly primary production	Major world producers[1]	Canada (30%), Russia (17%), Belarus (15%)
Criticality results	2011	2014	2017
	Not assessed	Not Critical	Not critical

[1] average for 2010-2014, unless otherwise stated.

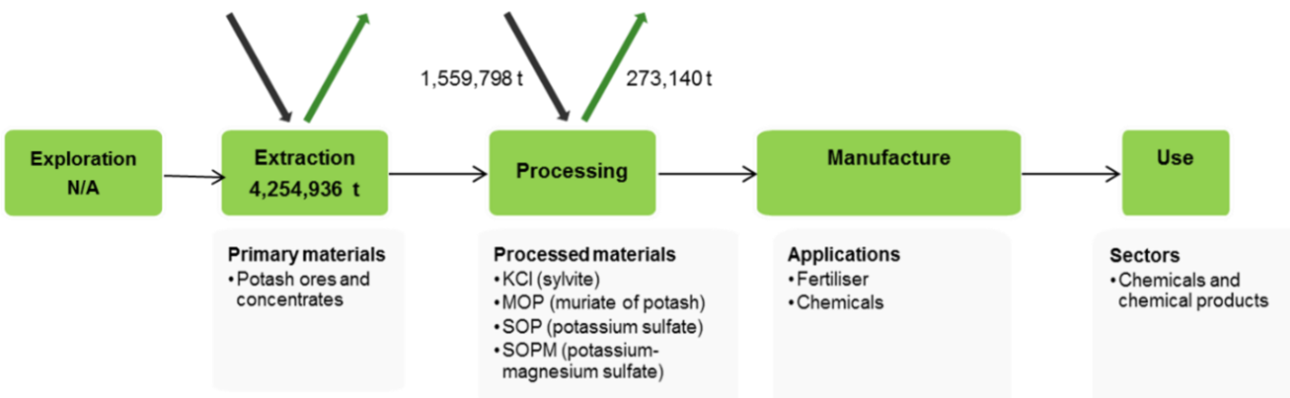

Figure 183: Simplified value chain for potash

The green boxes of the production and processing stages in the above figure suggest that activities are undertaken within the EU. The black arrows pointing towards the extraction and processing stages represent imports of material to the EU and the green arrows represent exports of materials from the EU. A quantitative figure on recycling is not included as the EOL-RIR is below 70%. EU reserves are displayed in the exploration box.

Figure 184: Economic importance and supply risk scores for potash

23.1 Introduction

The term potash (expressed as K2O content) is commonly use in agriculture and horticulture to describe the nutrient form of elemental potassium (K). Potassium is an abundant element in the Earth's uppercrust with an abundance of about 2.8 wt. % (Rudnick, 2003). Potash minerals occur in bedded-evaporite deposits. They are typically chloride (Cl) or sulphate (SO4) based compounds that contain varying amounts of K and/or Mg and Ca. Potash minerals are typically pinky-red in colour, soft and extremely water soluble. Economically important potash minerals include: Carnallite, Sylvite and Sylvinite. Potassium has many essential biological roles in animals, plants and humans, such as metabolism and growth. Hence the main application of potash is in the manufacture of fertilisers. Potash minerals are used in the manufacture of numerous potassium-based compounds such as potassium hydroxide (KOH), potassium nitrate (KNO3) and potassium carbonate (K2CO3). These compounds are used in a wide range of applications that include: medicine; glass; explosives; pyrotechnics; ink; bleaching agents; soaps; dyes; textiles, etc.

In Europe an average 4.3 million tonnes of potash is extracted per annum in Germany, Spain and the United Kingdom, or about 13% of the global total. Apparent consumption of potash in the EU is about 5.5 million tonnes per annum, the majority of which was used in the production of fertiliser for the agriculture industry. According to the EC agricultural crop output was valued at €200 million in 2015 (EC, 2016).

23.2 Supply

23.2.1 Supply from primary materials

23.2.1.1 Geological occurrence

Potash mineral deposits are chemical sedimentary rocks that formed by the evaporation of saline waters (e.g. seawater) resulting in the precipitation of salt minerals (Dill, 2010). Salt deposits may be broadly split into two groups: (1) present day, or geologically young shallow-water salt deposits and (2) ancient deep-water salt deposits.

Shallow water deposits typically occur in semi-arid to arid coastal environments and are characterised by their limited thickness and restricted lateral extent. The low magnesium sulphate content of shallow water deposits indicates precipitation from nonmarine, or mixed marine-nonmarine waters. Whereas deep water deposits form thick, laterally extensive deposits enriched in magnesium sulphate; this enrichment in magnesium sulphate is indicative of formation by precipitation of seawater in a restricted marine basin. Deep water deposits are typically bedded, with carbonate minerals occurring at the base of the sequence followed by calcium sulphates, halite, magnesium sulphates and then magnesium and potassium chlorides. Mineable potash deposits are generally associated with thick halite deposits, where the potash occurs as thin seams near to the top of the halite beds (Prud'homme and Krukowski, 1994; Dill, 2010; Pohl, 2011).

European potash production is primarily from the Zechstein Formation, a large (c. 200,000 km^3) Permian evaporite sequence that outcrops in Germany, the United Kingdom, the Netherlands and Poland. A large proportion of the Zechstein formation is found beneath the North Sea, where it plays an important role a cap rock for the North Sea oilfield (Pohl, 2011).

23.2.1.2 Exploration

The Minerals4EU project identified that potash exploration in the EU, in 2013, was primarily taking place in Spain and the UK. However, exploration may have taken place in other EU countries where no information was provided during the survey (Minerals4EU, 2015).

Global exploration for potash is currently focused in Canada, parts of Africa (e.g. Ethiopia, Eritrea and Republic of Congo), Australia, the US and Brazil. Although, the current eight year low-price of potash may put some of these projects on hold for the foreseeable future (Mining Journal, 2016).

23.2.1.3 Mining, processing and extractive metallurgy

Potash is primarily extracted from deep underground deposits by conventional mining methods similar to those used for extracting coal (i.e. mechanised longwall mining). Potash may also be extracted by injecting a heated brine into the mine workings to dissolve the potash in-situ, the resulting solution is then pumped to the surface and the potash recrystallised by evaporation (PotashCorp, 2016). This process is known as solution mining.

The processing of potash ores comprises four stages: (1) potash ore is crushed and ground to release the potash minerals from the ore, at this stage clay minerals are also removed from the ore (i.e. desliming); (2) potash minerals are separated from unwanted salt minerals (e.g. halite) by froth-floatation; (3) the potash minerals are dried and size-graded; and finally (4) further purification takes places by dissolving the potash minerals in hot-brine to remove impurities. Upon cooling a high-purity precipitate is formed, which may be used in the production of fertilisers and potassium-chemicals (PotashCorp, 2016).

23.2.1.4 Resources and reserves

There is no single source of comprehensive evaluations for resources and reserves that apply the same criteria to deposits of potash 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 of reporting depending on the location of their operation, their corporate identity and stock market requirements. Translations between national reporting codes are possible by application of the CRIRSCO template[22], which is also consistent with the United Nations Framework Classification (UNFC) system. However, reserve and resource data are changing continuously as exploration and mining proceed and are thus influenced by market conditions and should be followed continuously.

For Europe, there is no complete and harmonised dataset that presents total EU resource and reserve estimates for potash. The Minerals4EU project is the only EU-level repository of some mineral resource and reserve data for potash, but this information does not provide a complete picture for Europe. It includes estimates based on a variety of reporting codes used by different countries, and different types of non-comparable datasets (e.g. historic estimates, inferred reserves figures only, etc.). In addition, translations of Minerals4EU data by application of the CRIRSCO template is not always possible, meaning that not all resource and reserve data for potash at the national/regional level is consistent with the United Nations Framework Classification (UNFC) system (Minerals4EU, 2015).Many documented resources in Europe are based on historic estimates and are of little current economic interest. Data for these may not always be presentable in accordance with the UNFC system. However a very solid estimation can be done by experts.

[22] www.crirsco.com

Global resources of potash are geographically widespread and very substantial. The USGS estimates that worldwide resources of potash are likely to be about 250 billion tonnes (USGS, 2016). In Europe three countries are known to have potash resources, namely Spain, Germany and the United Kingdom. However, data for these are not reported in accordance with the UNFC system of reporting. Data for Germany are not reported at all because data collection in that country is the responsibility of sub-national level authorities (Minerals4EU, 2015). Resource data for some countries in Europe are available in the Minerals4EU website (see Table 112) (Minerals4EU, 2014) but cannot be summed as they are partial and they do not use the same reporting code.

Table 112: Resource data for the EU compiled in the European Minerals Yearbook of the Minerals4EU website (Minerals4EU, 2014)

Country	Reporting code	Quantity	Unit	Grade	Code resource type
UK	JORC	11.5	Mt	K_2O content	Indicated and Inferred
Spain	None	117.5	Mt	Potash	Historic resource estimate

Global reserves of potash are also sizeable (Table 113) and widely distributed, but are notably concentrated in Canada, Belarus and Russia. Reserve data for some countries in Europe are available in the Minerals4EU website (see table 114) but cannot be summed as they are partial and they do not use the same reporting code.

Table 113: Global reserves of potash in 2016 (Data from USGS, 2016)

Country	Potash (K_2O equivalent) Reserves (tonnes)	Percentage of total (%)
Canada	1,000,000,000	27
Belarus	750,000,000	20
Russia	600,000,000	16
Israel	270,000,000	7
Jordan	270,000,000	7
China	210,000,000	6
Chile	150,000,000	4
Germany	150,000,000	4
United States	120,000,000	3
United Kingdom	70,000,000	2
Spain	20,000,000	<1
Brazil	13,000,000	<1
Other countries	90,000,000	2
World total (rounded)	*3,700,000,000*	*100*

Table 114: Reserve data for the EU compiled in the European Minerals Yearbook of the Minerals4EU website (Minerals4EU, 2014)

Country	Reporting code	Quantity	Unit	Grade	Code reserve type
UK	JORC	4	Mt	K_2O content	Proven & probable
Spain	-	2.6	Mt	Potash	Proven
Italy	None	500	Mt	Potash salts	Estimated
Ukraine	Russian classification	5,212	kt	Potassium salts, K_2O contained	A

23.2.1.5 World potash production

On average, almost 34 million tonnes (K2O content) of potash is extracted each year from 12 countries worldwide. However, a large proportion (c. 60 %) of production occurs in just three countries, Canada (30 %), Russia (17 %) and Belarus (15 %) (Figure 185). Other important global producers include, China, Israel, Jordan and Chile. European production, chiefly from Germany (9%), Spain (2%) and the United Kingdom (1%), accounts for about 13 % of total global supply, i.e. around 4.2 million tonnes (BGS, 2016).

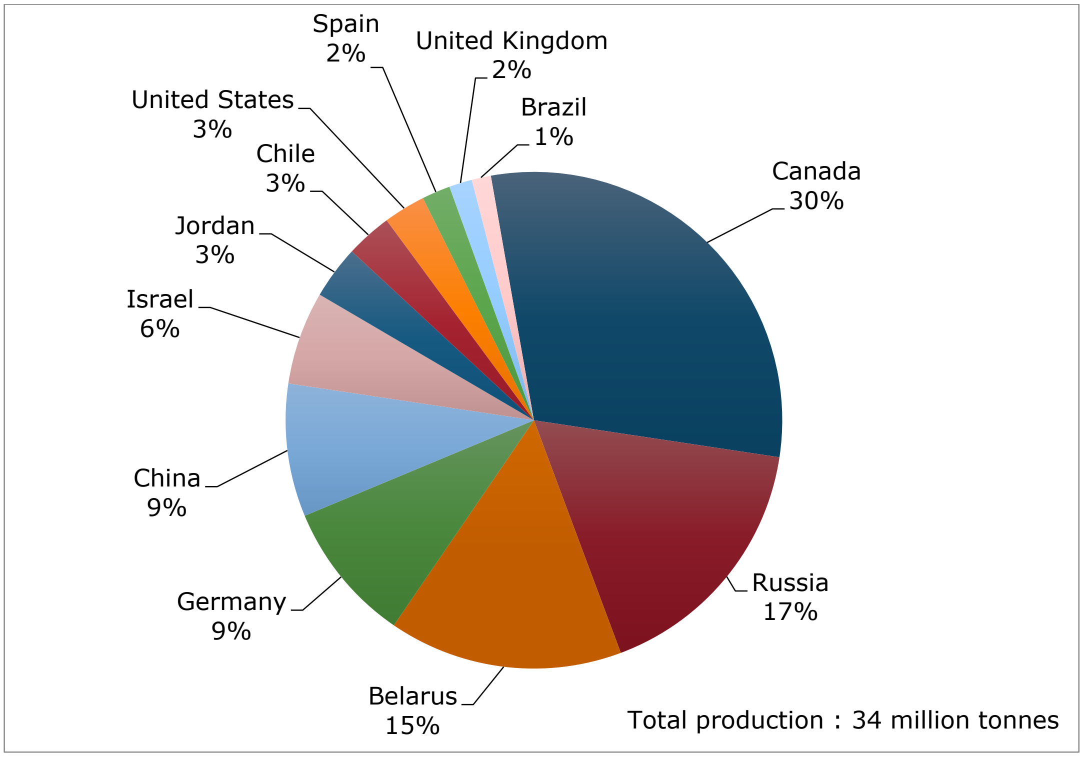

Figure 185: Global mine production of potash, average 2010–2014 (Data from BGS World Mineral Statistics database - BGS, 2016)

23.2.2 Supply from secondary materials

Potash minerals are highly-water soluble, which results in them becoming widely dispersed in the natural environment, they are thus irrecoverable and non-recyclable (Harben, 1999; EC, 2014). The End-of-life recycling input rate is thus 0%.

23.2.3 EU trade

Trade data for potash minerals (i.e. carnallite and sylvite) in the EU are not available from Eurostat. As a result it was only possible to calculate a global supply risk for potash ores and concentrates.

However, trade data for processed potassium chloride reveal that on average the EU imports just over 1.5 million tonnes of potassium chloride (as K2O) each year, but exports only about 300 thousand tonnes. The EU is therefore a net importer of potassium chloride, which may indicate that domestic production is not sufficient to meet current EU demand alone. The import reliance is 23%.

More than half (ca. 71 %) of EU imports come from just two countries, Russia and Belarus. The remainder comes from Chile, Canada, Israel and Jordan (Figure 186). Imports of potassium chloride into the EU have been relatively consistent during the same period, although notable exceptions are Chile and Israel, which have decreased their exports to the EU by 34 % and 55 % respectively. Spain is Europe's most significant exporter of potassium chloride, on average accounting for 77 % of all European exports during the period 2010–2014.

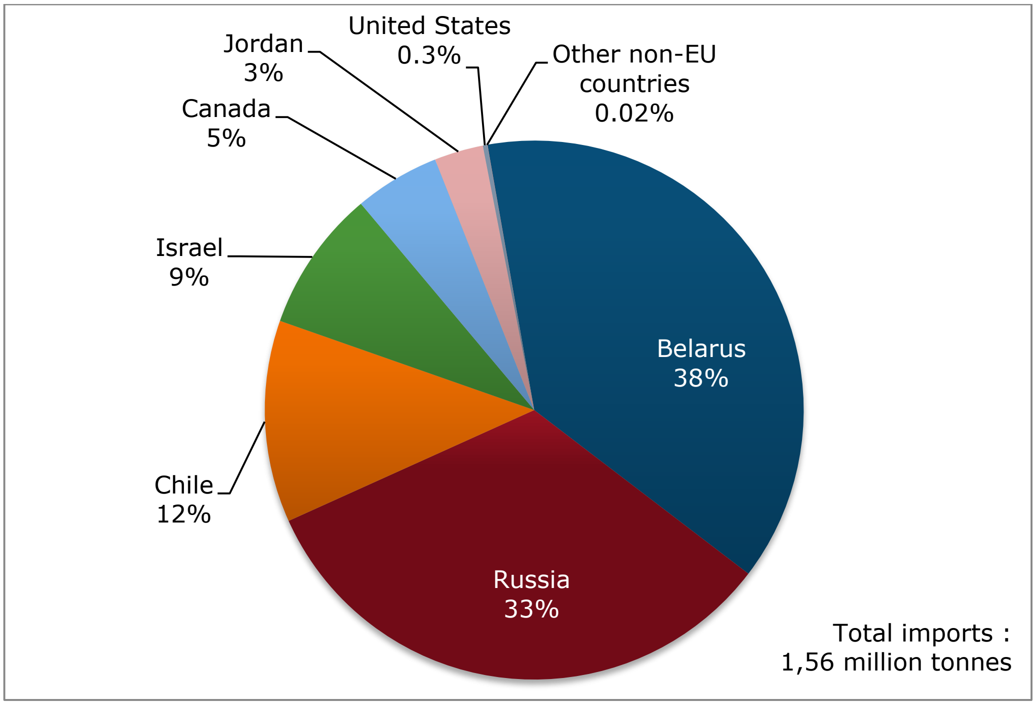

Figure 186: EU imports of processed potassium chloride (K_2O content), average 2010–2014 (Data from Comext database - Eurostat, 2016a)

According to the OECD there are currently no export quotas placed on potash exported to the EU; however, potash exports from Belarus, China and Jordan entering the EU are subject to an export tax of up to 25 % (OECD, 2016).

23.2.4 EU supply chain

Primary potash is extracted in only three EU countries, Germany, Spain and the United Kingdom. Combined production from these three countries accounts for about 13 % of the global total, or on average about 4.3 million tonnes (as K2O) per annum during the 2010–2014 period. This explains the relatively low import reliance of 23 % for potash in the EU. The EU sourcing (domestic production + imports) is shown in the Figure 187.

Based on averages during the period 2010–2014 just over 1.5 million tonnes (as K2O) per year of potassium chloride was imported into the EU, almost all of which went to only seven EU countries, namely Belgium, Germany, Spain, the United Kingdom, the Netherlands, France and Ireland. These countries account for a significant amount (ca. 70 %) of European agricultural output, and hence drive European demand for potassium chloride as a fertiliser (EC, 2016).

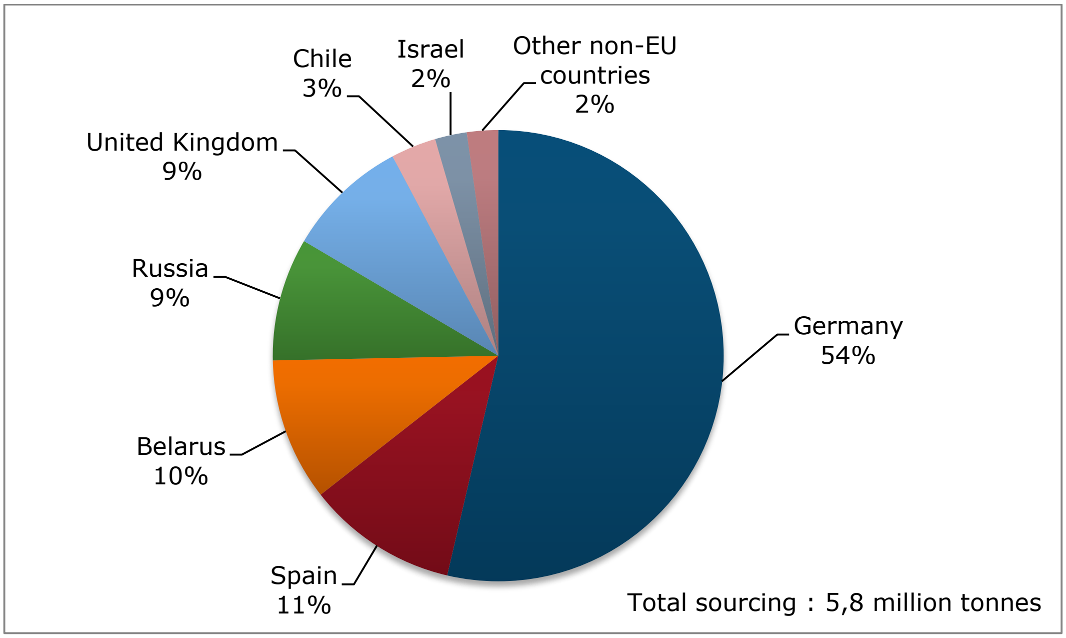

Figure 187: EU sourcing (domestic production + imports) of processed potassium chloride (K_2O content), average 2010–2014 (Data from Comext database - Eurostat, 2016a; BGS, 2016)

23.3 Demand

23.3.1 EU consumption

EU consumption of potash and concentrates in the EU was about 5.5 million tonnes (as K_2O) per year during the period 2010–2014. About 72 % of this (on average almost 4 million tonnes of K_2O per year) came from within the EU. The remainder was imported from outside the EU. This explains the relatively low estimated import reliance of 23 %.

23.3.2 Applications/end-uses

Global end-uses of potash in 2014 are shown in Figure 188 and relevant industry sectors are described using the NACE sector codes in Table 115.

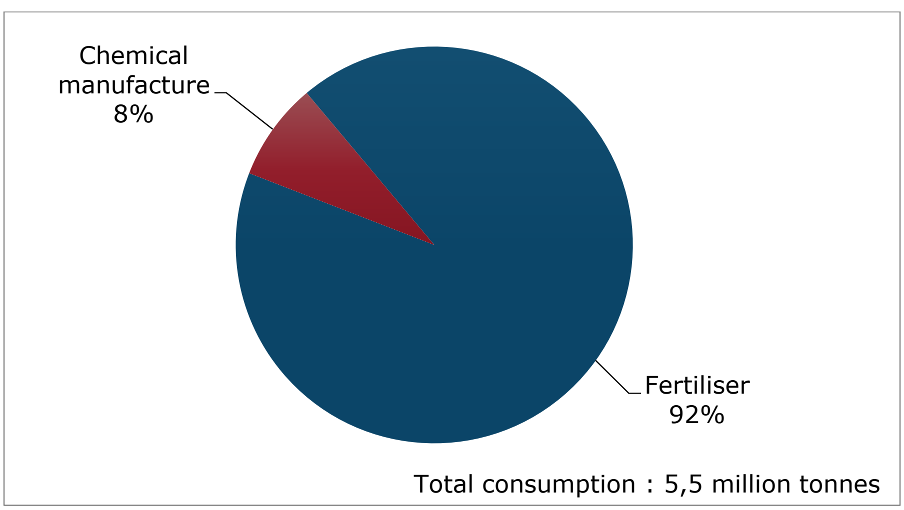

Figure 188: Global end uses of potash. Figures for 2014 (Data from USGS, 2014)

Table 115: Potash applications, 2-digit and associated 4-digit NACE sectors, and value added per sector (Eurostat, 2016c)

Application	2-digit NACE sector	Value added of NACE 2 sector (millions €)	4-digit NACE sector
Fertiliser	C20 - Manufacture of chemicals and chemical products	110,000	C2015 – Manufacture of fertilisers and nitrogen compounds
Chemicals	C20 - Manufacture of chemicals and chemical products	110,000	C2013 – Manufacture of other inorganic basic chemicals

About 92 % of potash is used in the production of fertilisers. Potassium is one of three key macro-nutrients required for plant growth, the other two being phosphorous and nitrogen. It has a number of key biological roles in plants, including enzyme activation, water usage, photosynthesis and transport of sugars, starch formation and improved resistance to diseases (Harben, 1999).

Only a small amount (ca. 8 %) of potash is used in the production of potassium-bearing chemicals; however, they are used in a wide array of applications, a few of which are shown in Table 116. Many of these chemicals are strong oxidising agents (e.g. potassium persulphate, potassium permanganate and potassium nitrate) that are used for bleaching, water treatment and in the production of explosives.

Table 116: A selection of potassium-based chemicals and their applications and uses (Harben, 1999)

Chemical	Formula	Applications and uses
Potassium sulphate	K_2SO_4	Fertiliser; medicines; glass; accelerator in gypsum products
Potassium bisulphate	$KHSO_4$	Fertiliser; food preservative
Potassium persulphate	$K_2S_2O_8$	Bleaching agent; photography
Potassium nitrate	KNO_3	Fertiliser; explosives; glass; ceramics; plastics; medicines
Potassium oxide	K_2O	Fertiliser; explosives; glass; ceramics; medicines
Caustic potash	KOH	Synthetic rubber; batteries; soap; bleaching agent; water treatment
Potassium permanganate	$KMnO_4$	Bleaching agent; catalyst; water treatment; pigment
Potassium carbonate	K_2CO_3	Optical glass; ceramics; dehydrating agent
Potassium cyanide	KCN	Gold and silver recovery; fumigant; insecticide; photography

23.3.3 Prices and markets

United States potash prices rose sharply from almost US$200 per metric ton in 2004 to a high of over US$800 per metric ton in 2009. Since then they have been generally declining to just over US$600 per metric ton tonne in 2015 (Figure 189). The general decline in potash price is related to weak demand and increased competition, which has led to oversupply in some markets (Mining Journal, 2016).

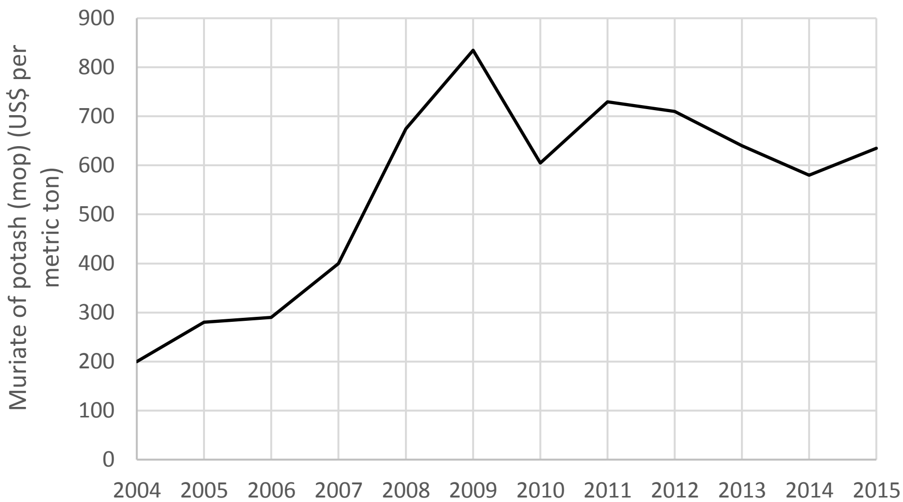

Figure 189: United States potash (muriate of potash – mop) price trend. (Data from USGS, 2015; 2016)

23.4 Substitution

Potash is one of three essential macronutrients required for plant growth and currently has no cost-effective substitutes. Alternatives, such as manure and glauconite (i.e. green sand) are available. However, they typically have much lower potassium contents and cost more per tonne of nutrient to transport (Harben, 1999; USGS, 2016).

23.5 Discussion of the criticality assessment

23.5.1 Data sources

Production data for potash ores and concentrates was taken from the British Geological Survey's World Mineral Statistics dataset (BGS, 2016). Trade data for crude (raw) potash minerals were unavailable from Eurostat. As such potassium chloride (as K2O) trade data were taken from the Eurostat COMEXT online database instead (Eurostat, 2016) using the Combined Nomenclature (CN) code 310 420 (potassium chloride for use as fertiliser). Data were averaged over the five-year period 2010–2014 inclusive. Other data sources have been used in the assessment and are listed in section 23.7.

23.5.2 Calculation of economic importance and supply risk indicators

The calculation of Economic Importance (EI) was based on the 2-digit NACE sectors shown in Table 115. For information about the application share of each sector see section on applications and end-uses. Figures for value added were the most recently available at the time of the assessment (i.e. 2013) and are expressed in thousands of Euros.

The calculation of Supply Risk (SR) was calculated at the ores and concentrates stage of the life cycle using the global HHI calculation due to the unavailability of EU trade data on potash ores and concentrates.

23.5.3 Comparison with previous EU criticality assessments

A revised methodology was introduced in the 2017 assessment of critical raw materials in Europe and both the calculations of economic importance and supply risk are now different hence the results with previous assessments are not directly comparable.

The results of this review and earlier assessments are shown in Table 117.

Table 117: Economic importance and supply risk results for potash in the assessments of 2011, 2014 (European Commission, 2011; European Commission, 2014) and 2017

Assessment	2011			2014			2017	
Indicator	EI	SR		EI	SR		EI	SR
Potash	n.a.	n.a.		8.61	0.21		4.8	0.7

Although it appears that the economic importance of potash has reduced between 2014 and 2017 this is a false impression created by the change in methodology. The value added used in the 2017 criticality assessment corresponds to a 2-digit NACE sector rather than a 'megasector' used in the previous assessments and the economic importance figure is therefore reduced. The supply risk indicator is higher than in the previous years, which is due to the methodological modification and the way the supply risk is calculated. Hence differences between the assessment results are largely due to changes in methodology (as outlined above).

23.6 Other considerations

Potash (K_2O) is one of three key macro-nutrients required for plant growth, as such it is hard to imagine that future demand for potash will cease altogether. In fact, according to the Food and Agricultural Organisation of the United Nations (FAO) fertiliser demand is forecast to increase in the short term. This increase is largely driven by demand in China, India and Indonesia (FAO, 2015).

Polyhalite (K2Ca2Mg(SO4)4·2H2O) is an important evaporite mineral that is ustilised as a multi-nutrient (i.e. K2O, Mg, S, Ca) fertiliser, particularly for chloride sensitive crops. The world's largest polyhalite deposit (containing almost 2.7 billion tonnes of polyhalite resource) is currently being developed below the North Sea, off the North Yorkshire coast, in the United Kingdom by Sirius Minerals Plc (Sirius Minerals Plc, 2016). If successfully developed there is potential for the United Kingdom to become a globally important supplier of polyhalite.

The future demand and supply for potash is presented in Table 118.

Table 118: Qualitative forecast of supply and demand of potash

Material	Criticality of the material in 2017		Demand forecast			Supply forecast		
	Yes	No	5 years	10 years	20 years	5 years	10 years	20 years
Potash		x	+	+	?	+	+	+

23.7 Data sources

23.7.1 Data sources used in the factsheet

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23.8 Acknowledgments

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