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The impact of the war in Ukraine on the supply of selected raw materials to Poland and to the European Union

Introduction

The ongoing war in Ukraine has had substantial trade implications for the directly involved countries, as well as for neighboring ones such as Poland and other European Union members that have depended on raw material supplies from Russia, Ukraine, and

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Belarus (Redeker 2022). The research focuses on Poland, as the country's economy ranks sixth in the Union in terms of GDP value (Frączyk 2024) and is a significant participant in the European market for mineral raw materials. The conflict has primarily impacted the international supply chains of crude oil and natural gas, as well as metals, industrial minerals, and agricultural products. A growing literature investigates the economic consequences of the Russia–Ukraine war. Studies have examined a range of topics, including economy (Mahlstein et al. 2022), stock exchange performance (Boungou and Yatié 2022; Umar et al. 2023), commodity markets and prices (Fang and Shao 2022; Khurshid et al. 2023), critical raw materials supply disruptions (Moise 2022; Katser-Buchovska 2024), food security issues (Behnassi and El Haiba 2022; Carriquiry et al. 2022; Jagtap et al. 2022), and foreign relations (Masters 2023). More than three years from February 2022, when Russia invaded Ukraine, escalating a conflict that began in 2014, it is possible to assess the trade impact of the war on Polish industry, as well as the results of sanctions imposed by the EU on the import of certain mineral raw materials from Russia in light of that country's aggression against Ukraine (Timeline 2024). The war in Ukraine is being felt particularly in the eastern and southern parts of the country, especially in the Donetsk and Luhansk regions, where many of the mines and plants that produce the commodities imported into Poland and the EU are located (Muggah and Rohozinski 2025). Russian military attacks have undermined Ukrainian industry, devastated Ukrainian facilities, and led to the destruction of infrastructure. The conflict has also exacerbated the volatility of commodity prices, damaging global economic growth, which the COVID-19 pandemic has already hit.

The well-known problems of supplying the national and European economies with energy raw materials (especially crude oil and natural gas) due to the conflict between Russia and Ukraine have been, and continue to be, the subject of extensive debate at various levels (e.g. Chen et al. 2023; Cui et al. 2023; Muggah and Rohozinski 2025), while less attention has been paid to the equally important risks associated with disruptions to the supply of non-energy raw materials, which have become the subject of detailed analysis within this article. Industries whose proper functioning may be jeopardized by reduced supplies of selected mineral raw materials from Russia, Belarus, and Ukraine have also been identified, together with possible solutions and alternative sources of supply.

The three countries mentioned were significant exporters of commodities. In 2020, Russia, Ukraine, and Belarus accounted for 12.3% of the EU's total imports of non-food, non-energy raw materials (RMIS Newsletter 2022). Ukraine has been among the top 10 global producers of titanium (mainly titanium ore), iron ore, kaolinitic and refractory clays, steel, manganese and silicon (both as ferroalloys), graphite, zirconium, uranium, as well as raw materials essential for modern technologies such as beryllium, aluminium, nickel, and cobalt (Malyuk 2023). Furthermore, Ukraine holds resources for 21 out of the 34 minerals identified by the EU as critical (ZPP 2023). Belarus, in turn, has been the second-largest producer of potassium salts. At the same time, Russia has controlled a considerable share of a range of raw materials supply and trade, from base metals (steel, aluminium, copper, nickel), to critical raw materials (PGMs – especially palladium, titanium, vanadium, antimony) and

fertilizers (potash, phosphate rock) (RMIS Newsletter 2022). Ukraine shipped most of its products by sea (approximately 70%), and the conflict has significantly limited logistics due to the blocking or destruction of port facilities. The current performance of some Ukrainian companies exporting selected commodities to Poland is characterized in more detail in this article. Russia, in contrast, has faced economic sanctions that have limited its ability to participate in the EU and the world markets (Borin et al. 2022).

It is believed that one of the reasons for Russian aggression against Ukraine, in addition to the repeatedly announced ideological issues, has been Ukraine's natural resource potential. Since the beginning of the war, numerous metal ore (e.g., lithium, tantalum, cesium, strontium) deposits, as well as almost all kaolinitic clay mines in the Donetsk region, have been occupied or are on the frontline (ZPP 2023; EITI Report of Ukraine 2023; Muggah and Rohozinski 2025).

1. Materials and methods

To select the most important mineral raw materials imported to Poland from Russia, Ukraine, and Belarus, the Mineral Raw Materials Management Database, created and updated annually by the authors, was analyzed from 2013 to 2023. This database contains, among other things, production and foreign trade turnover statistics for approximately 140 non-energy mineral raw materials in Poland. The value and volume data were mainly obtained from the Central Statistical Office (GUS) and supplemented by company reports and direct information from producers. As a result of the analysis, a group of 30 non-energy raw materials, imported from at least one of the countries involved in the war during this period, was selected from approximately 140 non-energy raw materials. The assessment of the importance of the supplies of these raw materials for the Polish economy was based on the methodology used by Lewicka et al. (2022), according to modified criteria, taking into account data from 2023 and, for comparison, from 2020 – the year before the outbreak of full-scale war in Ukraine, i.e:

1. At least 20% share of imports of raw materials – cumulative from the three mentioned directions – in satisfying domestic demand in 2023 or 2020;
2. The total value of deliveries of raw materials from these countries in 2023, at least PLN 27 million (the criterion originally used in the above methodology was PLN 20 million; here it is modified by a cumulative inflation factor between 2020 and 2023 of approx. 38%, according to GUS).

In terms of the value of imports in 2023, the most important were (Table 1):

- iron ores and concentrates, ferroalloys, ball clays and refractory clays, imported mainly from Ukraine;
- Russian carbon black, unalloyed aluminium, potassium salts, metallic nickel, and lithium oxides and hydroxides;
- potassium salts from Belarus.

Table 1. Mineral raw materials, for which Russia and/or Belarus and/or Ukraine were principal suppliers to Poland in 2020 and 2023

Tabela 1. Surowce mineralne, których głównymi dostawcami do Polski w latach 2020 i 2023 były Rosja i/lub Białoruś i/lub Ukraina

Mineral raw material	CN	Volume of imports from three countries to Poland ('000 tons)		Value of imports from three countries to Poland ('000 PLN)		The share of total foreign supplies in covering the domestic demand (%)		Combined share of three countries in total imports to Poland (%)		Combined share of imports from three countries in covering the domestic demand (%)	
		2020	2023	2020	2023	2020	2023	2020	2023	2020	2023
1	2	3	4	5	6	7	8	9	10	11	12
Iron ores and concentrates	260111-12	4,149.3	3,385.1	1,631,423	1,746,815	100.0	100.0	80.5	85.0	80.5	85.0
Carbon black	2803	260.1	167.3	684,381	777,623	66.6	66.3	81.8	51.1	54.5	33.9
Ferroalloys	7202	49.6	196.7	202,813	725,668	44.8	54.1	26.8	57.0	12.0	30.8
Aluminium, unalloyed	760110	90.7	19.5	613,325	199,225	89.9	90.8	47.4	12.3	42.6	11.2
Potasium salts	3104	638.0	126.3	649,042	222,173	100.0	100.0	59.8	16.1	59.8	16.1
Nickel	750210	1.5	0.6	80,441	54,490	100.0	100.0	34.7	23.7	34.7	23.7
Ball clays and refractory clays	25070080, 250830	412.5	100.2	76,635	27,354	85.6	71.8	86.1	61.5	73.7	52.9
Lithium oxides and hydroxides	282520	0.1	0.3	3,369	48,364	100.0	100.0	75.0	33.7	75.0	33.7

Source: own calculations based on GUS

The eight raw materials selected for detailed analysis are critical to the following industries: iron and steel metallurgy (iron ores and concentrates, ferroalloys), non-ferrous metals metallurgy (aluminium, nickel), glass making (lithium raw materials), rubber (carbon black), fertilizers (potassium salts), ceramics (ball and refractory clays).

The characteristics of the management of selected mineral raw materials in Poland were compared with the changes resulting from Russia's invasion of the European Union's market for these raw materials, based on an analysis of statistics from the EUROSTAT database. Information on the volume and value of Ukrainian sales of the above-mentioned raw materials to Poland was obtained from the website of the Ministry of Internal Affairs of Ukraine. Data on production volumes and company performance were sourced from the companies' websites and reports from the GMK Center, as well as from the National Academy of Sciences of Ukraine.

2. Results of the analysis and discussion

2.1. Iron ores and concentrates

Domestic demand for iron ores and concentrates is met entirely by imports, the volume of which depends on the condition of the iron and steel industry. Imported iron ores and concentrates are entirely consumed by this sector for the production of pig iron using blast furnace technology (Lewicka and Burkowicz, eds. 2024). The steel industry in Poland is influenced by numerous factors that shape its dynamics and competitiveness. In recent years, the industry has been affected by economic, environmental, and political factors. The sole domestic user of iron ores and concentrates is ArcelorMittal Poland SA, which currently operates two active blast furnaces at its Dąbrowa Górnicza smelter, manufacturing pig iron for the production of crude steel. Another blast furnace at ArcelorMittal Poland's steelworks in Krakow was shut down in 2020 due to the poor macroeconomic situation, mainly related to the COVID-19 pandemic, as well as high energy costs and CO_2 emission charges (Nettg 2020). Demand for iron ores and concentrates peaked at almost 7.5 million tons in 2018 (Figure 1). Since then, this has been reduced markedly, falling below 4 million tons in 2023, primarily due to weak demand from blast furnace pig iron producers. Consequently, the production of pig iron decreased from 5.2 million tons in 2017 to 2.7 million tons in 2023 (Lewicka and Burkowicz, eds. 2024; World Steel 2024).

Between 2013 and 2023, Ukraine was the leading supplier of iron ores and concentrates to Poland, with a share exceeding 80% of the total supplies in 2019 and 2023 (Figure 1). The observed decrease in the import of these raw materials to Poland has been attributed to transportation difficulties and logistics disruptions resulting from military actions in Ukraine. As a result, the value of Ukrainian iron ore and concentrate sales to Poland diminished from almost 552 million USD in 2021 to ca. 482 million USD (–13%) in 2022, and then to around

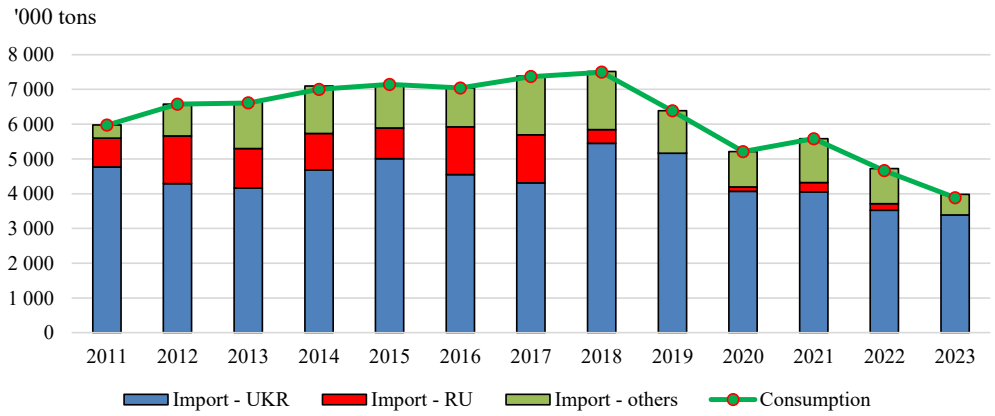

Fig. 1. The supply sources and consumption volume of iron ores and concentrates in Poland detailing deliveries from Ukraine and Russia (GUS, own calculations)

Rys. 1. Źródła podaży i wielkość zużycia rud i koncentratów żelaza w Polsce z wyszczególnieniem dostaw z Ukrainy i Rosji

203 million USD in 2023 (–58%) (Ministry of Internal Affairs of Ukraine). Possible ways to alleviate the drop in deliveries from Ukraine include increasing imports from Brazil, Sweden, and other countries by sea, as well as developing the recycling of scrap steel products. Given the situation of the iron and steel industry in Poland, resulting from high gas and energy prices, record levels of CO_2 emission allowance prices, and increasing steel imports from outside the European Union where EU standards do not apply, it is expected that demand for iron ores and concentrates in Poland may continue to decline.

Ukrainian iron ore deposits are located basically in the Zaporizhia, Dnipropetrovsk (Kryvyi Rih iron ore basin), and Poltava regions (Malyuk 2023). One of the largest enterprises of Ukraine's mining and metallurgical complex, the Zaporizhia Iron Ore Plant, operates in the Zaporizhia region. It exploits the South Bilozerske deposit, which is characterized by very rich ores. Its uniqueness is that the ore quality is better than the rich ores of Kryvyi Rih (60% Fe versus 57% Fe) (Novikov 2024; Bubnova 2019). The deposit has been mined underground (mining capacity of 4.5–4.7 million tons per year). Finished products have been exported to the Czechia, Slovakia, Poland, and Austria (Ministry of Internal Affairs of Ukraine), and partially utilized by the metallurgical plant Zaporizhstal, supplying the domestic market (Ilin 2019; Skipochka 2019). Unfortunately, this enterprise has been under the occupation of Russia since the first days of the war and continues to work for the benefit of the occupiers. In the Dnepropetrovsk region, there are large iron ore enterprises, such as ArcelorMittal Kryvyi Rih, Southern Mining and Processing Plant, Ingulets Mining and Processing Plant, Northern Mining and Processing Plant, Central Mining and Processing Plant, and Sukha Balka (Malyuk 2023; Babii 2022). As of August 2024, these facilities were located 50–60 km from the frontline. Iron ore companies in the Poltava region are considered the safest because they are closer to the country's center.

Nevertheless, Russian troops regularly launch rocket attacks on these very companies and Ukraine's critical infrastructure (energy, transport, industrial plants). Operations are particularly complicated by sudden power cuts and logistical constraints due to the blockage or destruction of port facilities. As a result, the mining production of iron ore and concentrates in Ukraine has been reduced, in some cases by more than 50% compared to the pre-war period (GMK 2023). For example, in 2023, ArcelorMittal Kryvyi Rih could only utilize around 40% of its mining capacity (approximately 24.9 million tons of ore and 10.3 million tons of concentrate) and 25–30% of its metallurgical production capacity (ArcelorMittal 2023; Barich 2023). The decline in mining production has affected exports to Poland, as well as to other EU countries (Figures 1 and 3).

The second most important supplier of iron ores and concentrates to Poland was Russia, whose deliveries reached up to 20% of total imports until 2017. Between 2019 and 2022, this share decreased to less than 4%, and in 2023, it was withheld (Figure 1) due to sanctions imposed by the European Union on Russia. Between 2013 and 2023, Ukraine's average annual share of iron ore and concentrates imports to Poland accounted for 70%, while Russia's – for around 10%. Their combined supplies to Poland constituted 80.5% in 2020 and 85% in 2023 (Table 1).

Among EU countries, the leading importers of iron ore and concentrates from third countries were the Netherlands, Germany, France, and Italy. Poland, with a share of 5–7%, was the fifth largest importer in recent years (Figure 2, EUROSTAT 2024).

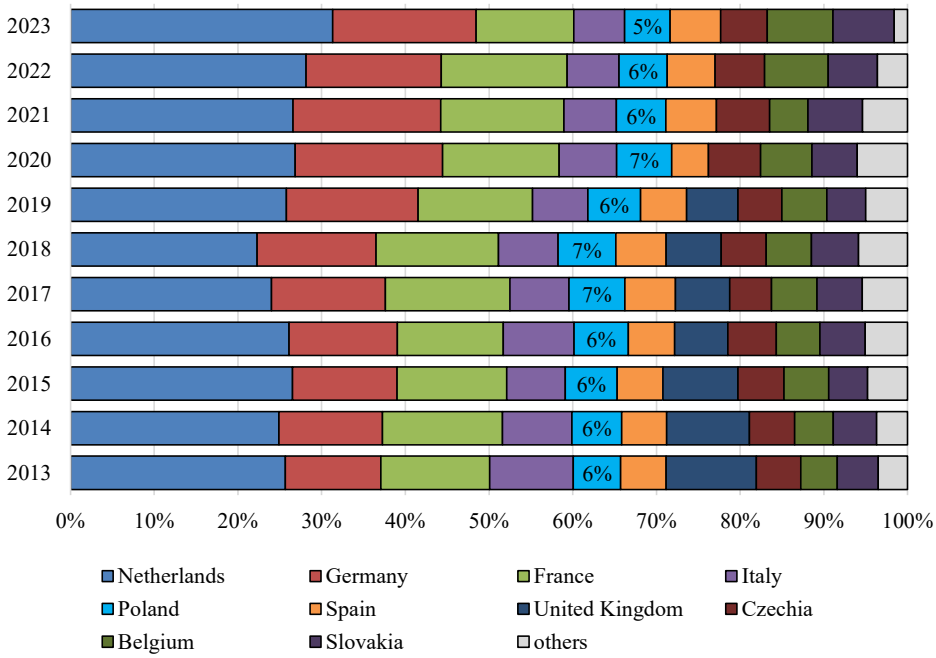

Fig. 2. The main importers of iron ores and concentrates in the EU (EUROSTAT 2024)

Rys. 2. Główni importerzy rud i koncentratów żelaza w UE

Before 2022, Ukraine exported 15–20 million tons of iron ore and concentrates annually to the EU markets (EUROSTAT 2024), ranking second (after Canada) among external suppliers. Shipments from Ukraine decreased to 12.9 million tons in 2022, improving slightly to 13.4 million tons in 2023 (GMK 2024a). Despite the Russian blockade of Ukrainian Black Sea ports, Ukraine maintained its second position among suppliers of iron ore and concentrates to the EU. However, its global sales fell by 26% compared to 2022 and by 60% compared to pre-war 2021. Russia supplied 12 million tons of these raw materials to the EU market in 2021. Following the aggression against Ukraine, imports from Russia fell to 2.8 million tons in 2022. As a result of the imposition of EU sanctions, these supplies decreased to just 300,000 tons in 2023 (Figure 3, EUROSTAT 2024). The combined share of deliveries from Ukraine and Russia to EU countries reached up to 28% between 2013 and 2021, but fell to less than 19% between 2022 and 2023 (Figure 3). The decline in supply was not only due to the hostilities in Ukraine and the imposition of sanctions on Russia, but also to the weakening demand from European steel producers, which led to a reduction in their steelmaking capacities. The EU's climate policy and restrictive environmental regulations contributed substantially to a decline in the use of iron ores and concentrates for the production of pig iron in blast furnaces. As a result, total imports of iron ore and concentrates into EU countries have decreased by 22% over the past few years (Figure 3). The leading suppliers to the EU market were Canada, Ukraine, Brazil, and South Africa (GMK 2023; EUROSTAT 2024).

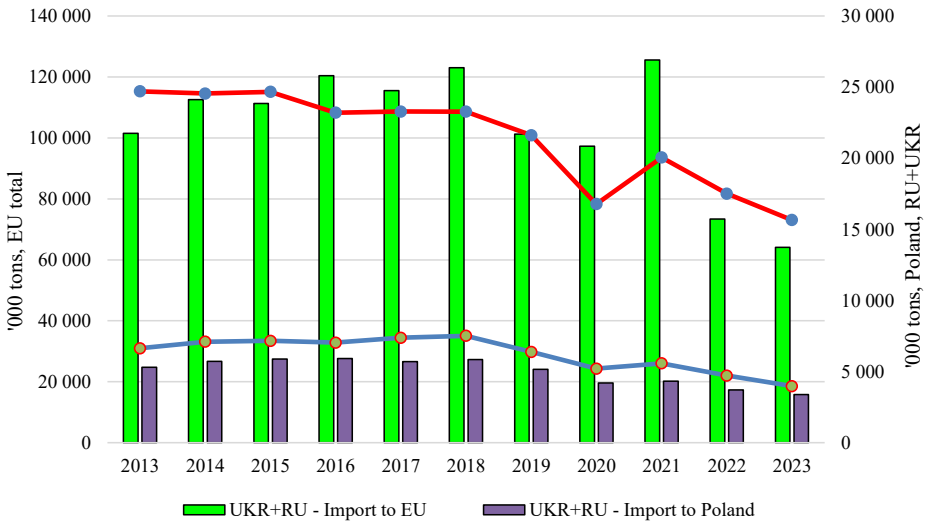

Fig. 3. Imports of iron ores and concentrates to the EU and to Poland detailing deliveries from Ukraine and Russia (EUROSTAT 2024; Lewicka and Burkowicz, eds. 2024; GUS)

Rys. 3. Import rud i koncentratów żelaza do UE i Polski z wyszczególnieniem dostaw z Ukrainy i Rosji

The reduced demand for iron ore and concentrates from customers in Europe between 2022 and 2023 is a result of the economic downturn caused by the COVID-19 pandemic, which contributed to disrupted supply chains and increased general economic uncertainty. In addition, Russia's unprovoked invasion of Ukraine in 2022 has further disrupted the overall economic cycle in European countries, with a knock-on effect on inflation across Europe. All these factors contributed to a reduction in demand for steel and steel products, with consumption in 2023 18% lower than in 2021 (World Steel 2024). Simultaneously, European producers have been developing steel production using less carbon-intensive electric furnace technology (with the use of steel scrap instead of iron ore and concentrates), accounting for 45% of the total steel output in 2023 (World Steel 2024). Future demand for iron ore and concentrates in EU Member States will depend on the pace at which steelmakers adapt to the decarbonisation processes of the EU economy in the coming years. The most likely scenario involves increasing the share of steel produced in electric furnaces in total steel production, as it significantly reduces CO_2 emissions compared to the blast furnace process. Such steps have been taken, for example, by ArcelorMittal, which is withdrawing from the use of blast furnace technology in its steel mills in Western Europe (GMK 2024b).

2.2. Carbon black

Carbon black is primarily used in Poland for the production of tyres (approximately 80% of total consumption), technical rubber products, such as gaskets (more than 10%), toner cartridges, inks, plastics, and other applications (less than 10%) (Lewicka and Burkowicz, eds. 2024). The development of the tyre industry had a decisive impact on the increase in the importation of carbon black to Poland and its domestic production. The growth in supply, from ca. 300,000 tons to over 400,000 tons per year, was halted by the COVID-19 pandemic in 2020, but it recovered in the following two years. In 2023, foreign deliveries of carbon black to Poland decreased by over 44% due to a decline in domestic tyre industry production following the rise in energy costs (Figure 4). The consumption of technical carbon black reached around 250,000 tons in 2022. During the period 2013–2023, about 30% of demand was covered from domestic sources (average 50,000 tons/year, with a maximum of 65,000 tons in 2017). The largest foreign supplier of carbon black to Poland was Russia. Smaller quantities were imported from Germany, the Czechia, Ukraine, and, most recently, from China and India. Russia's share of imports averaged 72% over the period analysed. In 2022, shipments of carbon black from that country remained at a similar level to 2021. However, as total imports to Poland increased significantly, Russia's share dropped from 72% to less than 57%, while in 2023, it was only about 46%. Purchases of carbon black from Russia and Ukraine accounted for approximately 55% of domestic demand in 2020. By 2023, their share fell to around 34% (Table 1).

Poland is one of the largest importers of carbon black in the European Union, with a share of 32–47% (Figure 5, EUROSTAT 2024). At the same time, large quantities of cheap carbon

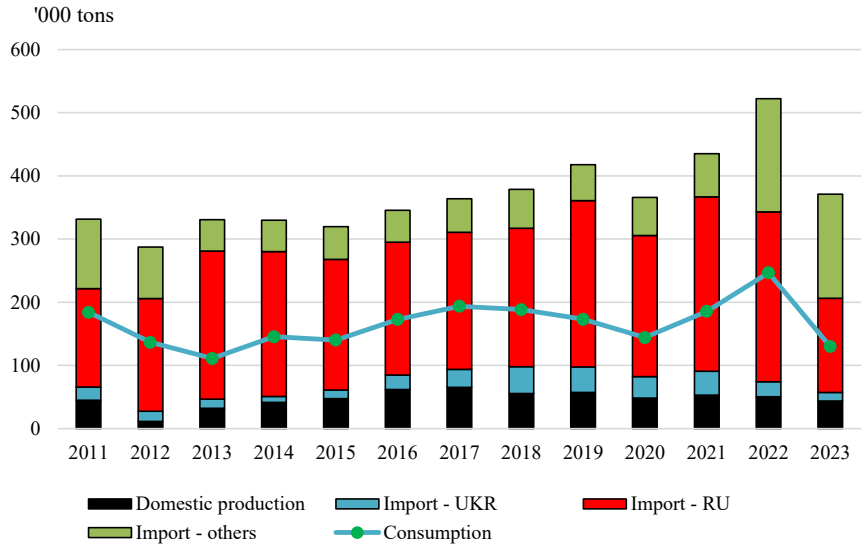

Fig. 4. The supply sources and consumption volume of carbon black in Poland, detailing deliveries from Russia and Ukraine (GUS, own calculations)

Rys. 4. Źródła podaży i wielkość zużycia sadzy w Polsce z wyszczególnieniem dostaw z Rosji i Ukrainy

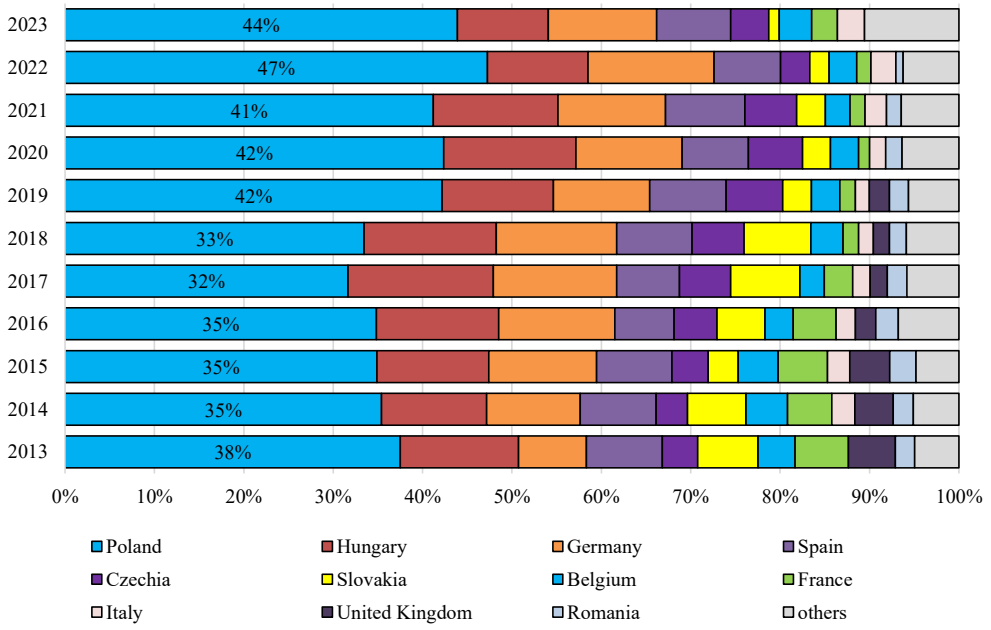

Fig. 5. The main importers of carbon black in the EU (EUROSTAT)

Rys. 5. Główni importerzy sadzy w UE

black (mainly of Russian origin), usually far exceeding the level of domestic demand, were re-exported from Poland. Of the other EU countries, Hungary, Germany, and Spain have also been large importers of carbon black (Figure 5).

The European Union's carbon black external supplies were dominated by Russia, which accounted for 70–75% (400,000–550,000 tons per year) of the Community's total imports in 2016–2021 (EUROSTAT 2024). In 2021, Russia supplied about 550,000 tons of carbon black and 240,000 tons of synthetic rubber to the European Union (EUROSTAT 2024). The war in Ukraine and the sanctions against Russia have significantly impacted the European rubber processing industries, exacerbating the pandemic-related shortage of raw materials. Over the last two years, Russia's share of the EU's carbon black market decreased significantly, from 55% to 47%, with a corresponding drop in its purchases, particularly in 2023 (by 37% compared to the previous year) (Figure 6). At the same time, raw materials from China and India have entered the European market.

Poland has been one of the leading tyre manufacturers in Europe. Their annual production ranged from 46 to 59 million units. The factories in Dębica (Goodyear), Olsztyn (Michelin), Poznań, and Stargard (both Bridgestone), belonging to the largest global tyre companies, produce mainly passenger car tyres (30–33 million units/year). Between 2018 and 2022, tyre production showed significant fluctuations. During the COVID-19 pandemic, specifically in 2020, there was a sharp decline (by more than 15% compared to the previous year, from 50 million units to around 42 million units). In 2021, tyre production recovered (by more than 40%) to more than 59 million units, but in the following two years it fell by 11% and 12% respectively (to around 47 million units in 2023) (GUS 2024).

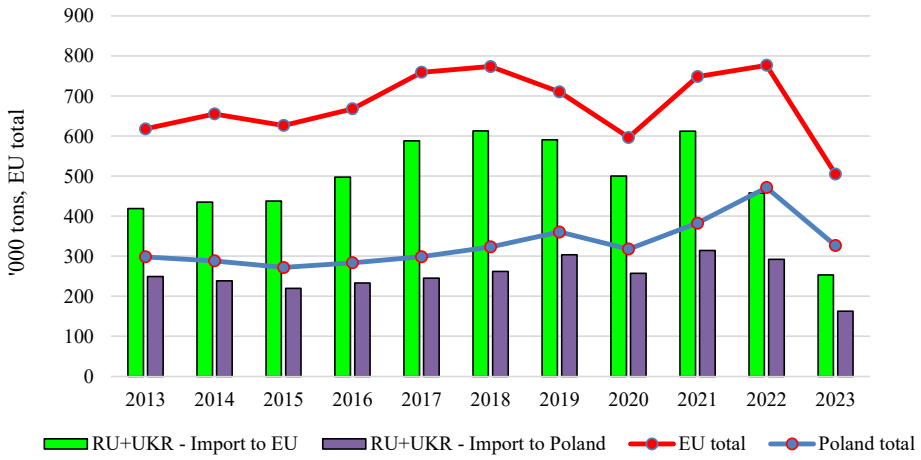

Fig. 6. Import of carbon black to the EU and to Poland detailing deliveries from Russia and Ukraine (EUROSTAT; Lewicka and Burkowicz, eds. 2024; GUS)

Rys. 6. Import sadzy do UE i Polski z wyszczególnieniem dostaw z Rosji i Ukrainy

In 2022, the international price of carbon black rose sharply. As a result, the unit value of imports of this raw material to Poland doubled compared to the previous year (Lewicka and Burkowicz, eds. 2024). The high price of carbon black and skyrocketing energy costs have reduced the competitiveness of domestic products on the European market, which has been fed by cheap products from the Far East. In 2024, Michelin decided to close the truck tyre plant in Olsztyn and transfer this production segment to Romania. Inflationary pressures on the industry and the economy as a whole, increased levels of market uncertainty, rising labor costs, and a forecast of further deterioration in consumer sentiment also contributed to the closure of the plant (Romania Journal 2024).

As the production of carbon black in a conventional process, as well as the tyres themselves, poses a significant environmental threat, the search is on for sustainable raw materials with a lower carbon footprint. The Szczecin-based company Contec, in collaboration with the Warsaw University of Technology and industrial partners, has developed a method for the pyrolysis of used tyres, from which carbon black is recovered (Lach 2023). It is a technology that reduces the carbon footprint by five times compared to traditional methods of producing carbon black. In light of emission standards and the EU's green policy, this technology offers the possibility of producing tyres in a more environmentally friendly manner. Contec plans to launch new production lines and additional plants in the near future. The domestic supply of carbon black is expected to increase between 2025 and 2030 due to the development of secondary (recycled) carbon black production.

2.3. Ferroalloys

Since 2015, ferroalloys in Poland have been produced exclusively by electric furnace technology. Their only producer is the Re Alloys Ltd in Łaziska Górne, producing mainly ferrosilicon (with 75% Si content, as well as 45%, 65% and 80% Si), ferrosilicon-chromium (with minimum 21%, 25%, and 33% Cr), ferrosilicon-aluminium (with 75% Si and maximum 4% Al), and occasionally some ferrosilicon-manganese. Total domestic ferroalloy production from 2013 to 2021 ranged from 78,000 to 105,000 tons, with an average of 88,200 tons per year, accounting for more than 50% of demand (Lewicka and Burkowicz, eds. 2024). In 2022–2023, the domestic supply of ferroalloys decreased to 55,000 tons per year, while its share of domestic consumption dropped to approximately 30% (Figure 7).

The steel industry consumes ferroalloys for the production of low- and high-alloy steels and, to a lesser extent, noble steels. The Polish steel industry's demand for ferroalloys increased gradually until 2018, when it reached nearly 200,000 tons (Figure 7). After a reduction to 140,000 tons/year over the following two years, it almost doubled to a record level of nearly 250,000 tons in 2022 (Figure 7; Lewicka and Burkowicz, eds. 2024). This was accompanied by a significant growth in supplies from Ukraine, which jumped by as much as 263% compared to 2021. In 2023, imports from Ukraine increased further, reaching a record 196,000 tons (EUROSTAT 2024), despite a 35% decrease in

demand for ferroalloys in Poland, to 160,000 tons (Figure 7). This was coupled with the growth of ferroalloys exports from Poland. The increase in supplies from Ukraine to the Polish market was linked to the blockage of transport routes across the Black Sea to other Ukrainian customers, such as China and other Asian countries. This, together with rising energy prices and production costs, has contributed to a decline in ferroalloy production in Poland over the past two years.

Between 2013 and 2021, Norway was the primary supplier of ferroalloys to Poland, followed by Ukraine. In 2022–2023, imports from Ukraine more than doubled, and Poland became the primary recipient (Lewicka and Burkowicz, eds. 2024; EUROSTAT 2024). The value of these deliveries increased from around USD 102 in 2021 to USD 352 million in 2022 (Ministry of Internal Affairs of Ukraine). In 2023, despite an increase in import volumes, the total value was only USD 150 million, due to a decline in international ferroalloy prices. Imports from Russia were of much less importance. Between 2013 and 2021, its share of total supplies did not exceed 5%, while in 2022–2023, it disappeared completely (Figure 7), despite not being affected by EU sanctions. Between 2013 and 2021, the share of ferroalloy supplies from Ukraine and Russia in Poland's imports was below 30%, whereas in 2022–2023, it exceeded 50% (Table 1). The level of coverage of domestic demand for ferroalloys by foreign supplies increased from around 45% in 2020 to over 54% in 2023, while the share of imports from Ukraine and Russia increased from 12% to 31% respectively (Table 1).

The Ukrainian ferroalloy industry consisted of three large enterprises: Nikopol, Zaporizhzhia, and Stakhanov, specializing in the production of ferrosilicon and

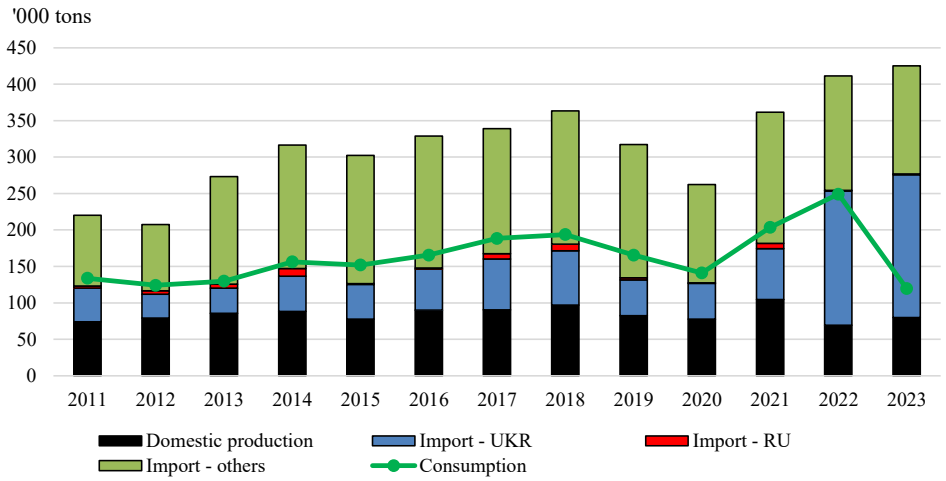

Fig. 7. The supply sources and consumption volume of ferroalloys in Poland detailing deliveries from Ukraine and Russia (GUS, own calculations)

Rys. 7. Źródła podaży i wielkość zużycia żelazostopów w Polsce z wyszczególnieniem dostaw z Ukrainy i Rosji

ferromanganese, with a total annual capacity of around 1.5 million tons, and the smaller Pobuzhsky Ferronickel Plant (100,000 tons per year). Nikopol – formerly the world's largest producer of manganese-based ferroalloys (950,000 t/y, 75–80% exported), and Zaporizhzhia – one of the Europe's largest producers of ferrosilicon, ferromanganese and metallic manganese (the capacity of 347,000 t/y), both adjacent to the war zone, have been under constant missile attack since 2022 (Kudryavtsev 2024; personal communication). During the first two years of the war, their total output was 538,000 and 210,000 tons per year, respectively. At the same time, Ukraine's ferroalloy exports (mainly to Poland) became one of the country's most significant sources of revenue for its economy. However, in early November 2023, these companies ceased operations due to increased hostilities, low ferroalloys prices, electricity shortages (following the bombing of power plants), high production costs (increased electricity transmission tariffs), and lack of domestic raw material supply (suspension of mining and processing of crude manganese ore). The Pobuzhsky plant – formerly the largest ferronickel producer in Europe – has been forced to suspend operations since November 2022 (personal communication; https://pfk.com.ua/?lang=en). The Stakhanov plant (the capacity of 200,000 t/year of ferrosilicon), located in the Luhansk region, has been taken over by the invaders. The military operations in Ukraine have had a devastating effect on the foreign sales of Ukrainian iron and steel companies.

Among the EU countries, the leading importers of ferroalloys from third countries were the Netherlands, Italy, Belgium, Spain, and Germany. Poland has been their sixth customer in recent years, with a share reaching a maximum of 11% in 2023 (Figure 8, EUROSTAT 2024).

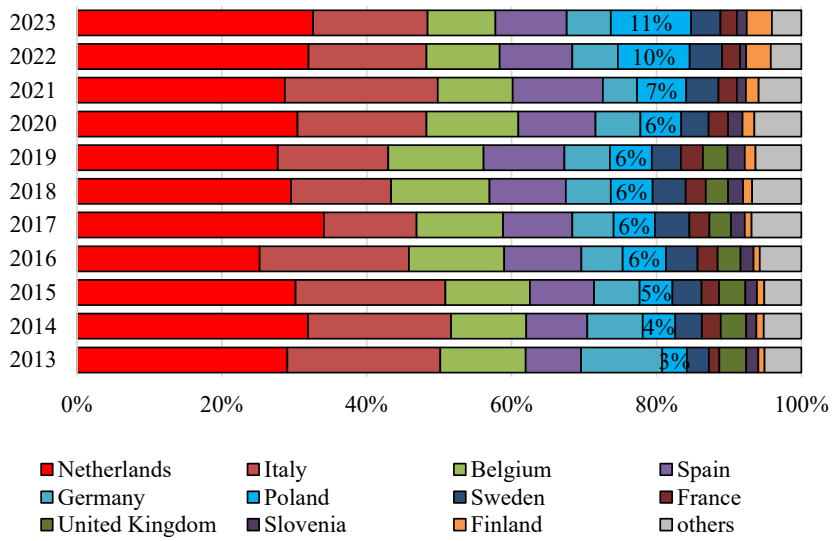

Fig. 8. The main importers of ferroalloys in the EU (EUROSTAT 2024)

Rys. 8. Główni importerzy żelazostopów w UE

In 2020, before the outbreak of the war, Ukraine exported around 330,000 tons of ferroalloys annually to the EU markets (EUROSTAT 2024), ranking third among external suppliers with a share of 16%. Although shipments from Ukraine decreased to 225,000 tons (10% of the total EU imports) in 2022, it retained its third position among the EU's ferroalloy suppliers (EUROSTAT 2024). In 2023, due to logistical and trade difficulties, exports of ferroalloys from Ukraine to the EU were almost 50% lower than before the war (GMK 2024c). Russia supplied 41,000 tons of ferroalloys to the Community in 2020. After the aggression against Ukraine, these exports increased to 128,000 tons in 2022, while Russia's share of total EU imports reached 5% (EUROSTAT 2024). The maximum combined share of supplies from Ukraine and Russia to EU countries was 19% in 2018, but it has recently fallen to less than 12% (Figure 9). The reduction in supply is not only the result of the war in Ukraine, but also of reduced demand from European steelmakers, resulting in a 5% decrease in total imports of ferroalloys into the EU over recent years (Figure 9). Norway and South Africa have become the leading suppliers to the EU market (EUROSTAT 2024).

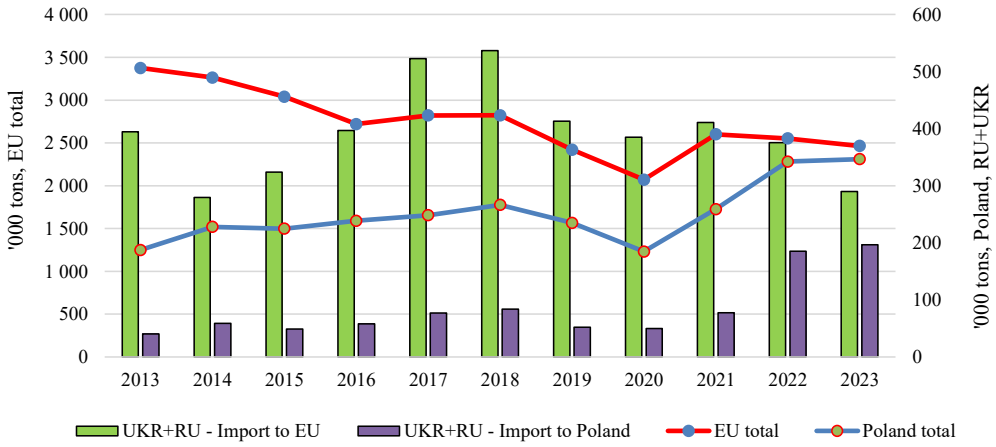

Fig. 9. Import of ferroalloys to the EU and to Poland detailing deliveries from Ukraine and Russia (EUROSTAT 2024; Lewicka and Burkowicz, eds. 2024; GUS)

Rys. 9. Import żelazostopów do UE i Polski z wyszczególnieniem dostaw z Ukrainy i Rosji

The EU authorities' policy of reducing CO_2 emissions is influencing steel production in EU countries and, consequently, demand for ferroalloys. World Steel forecasts that global demand for ferroalloys will increase by approximately 1–3% per year up to 2030 (Mining.com 2023). The projected growth reflects the expected expansion of steel production in China and India. Demand for ferroalloys in the EU countries will depend on the pace at which steelmakers adapt to the decarbonisation of the EU economy in the coming years.

2.4. Unalloyed aluminium

Aluminium is an essential metal in the automotive, construction, packaging, machinery, and consumer goods industries. Additionally, the properties of this metal make it an ideal material for the energy transition (Traczyk 2022). In Poland, there is no production of primary aluminium; the reported output concerns secondary, unalloyed aluminium. The volume of this production, which had declined to around 8,000 tons in 2016–2017, showed a slight upward trend (Figure 10). In 2022, it approached 24,000 tons. Domestic consumption, after reaching around 185,000 tons in 2018 (Lewicka and Burkowicz, eds. 2024), gradually decreased, except 2022, to approximately 140,000 tons in 2023 (Figure 10). The majority, i.e., almost 90%, of domestic demand for unalloyed aluminium in recent years has been met by supplies from other countries, including Russia. Imports from this country accounted for more than 47% of total supplies in 2020 and only around 12% in 2023 (Table 1) in favour of deliveries from other directions, including Iceland, the Netherlands, India, and Mozambique, the unit costs of which were comparable to imports from Russia (Lewicka and Burkowicz, eds. 2024). The reduction in Russia's supplies has been mainly the result of the diversification of purchases of this metal in connection with the invasion of Ukraine, but not of the EU sanctions, which have not yet been implemented. So far, only the US and the UK have imposed sanctions on aluminium imports from Russia (reuters.com).

Russia has been the major supplier of aluminium to the world market. In 2021, the country sold 4.3 million tons of the metal, representing 6% of total world production (RMG 2022).

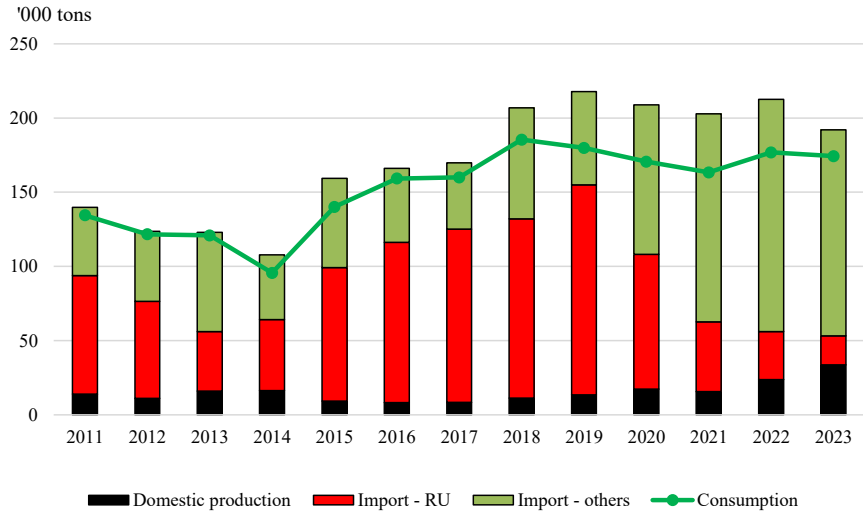

Fig. 10. The supply sources and consumption volume of unalloyed aluminium in Poland (GUS, own calculations)

Rys. 10. Źródła podaży i wielkość zużycia aluminium niestopowego w Polsce

However, more than 50% of Russia's aluminium production relied on imported alumina, mainly from Ukraine and Australia. As a result of the war, bauxite supplies to Ukrainian alumina plants were severely disrupted, while Australia stopped exporting bauxite and alumina to Russia. Furthermore, Rio Tinto suspended bauxite shipments to Rusal's alumina plant in Ireland, which probably also affected the deliveries of this raw material to Russia and other aluminium smelters in Europe (RMG 2022).

Poland has been the eighth largest importer of unalloyed aluminium in the European Union (Figure 11, EUROSTAT 2024). The volume of imports into the EU oscillated between 2.5 and 3.2 million tons/year, with a decrease of nearly 830,000 tons between 2018 and 2021 (Figure 12). Between 2014 and 2019, the EU's purchases of unalloyed aluminium were dominated by Russia, which accounted for 34–40% of the total external imports at that time. The decline in Russian supply volumes began in 2018, while a sharp reduction in its share occurred in 2020 (to around 20%). By 2023, this percentage had melted to around 10%. Declining supplies from Russia are compensated by increased imports from Mozambique, Iceland, Canada, India, Kazakhstan, the UAE, Saudi Arabia, and other countries.

The domestic aluminium industry produces a full range of aluminium products, mainly from aluminium alloys, i.e., cast, rolled, extruded, and drawn goods. Production and consumption of these commodities were on an upward trend until 2019, while in 2020 they

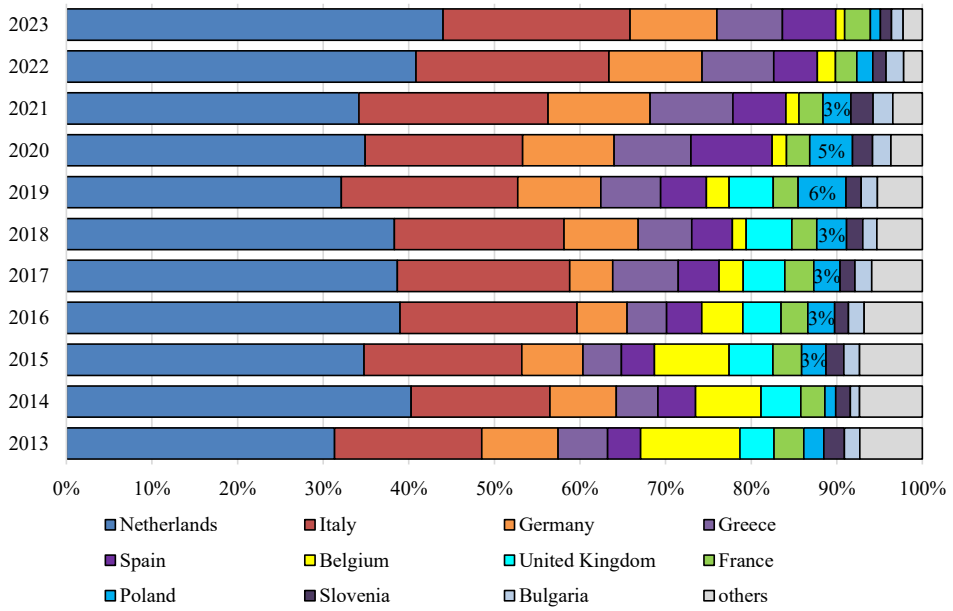

Fig. 11. The main importers of unalloyed aluminium in the EU (EUROSTAT 2024)

Rys. 11. Główni importerzy aluminium niestopowego w UE

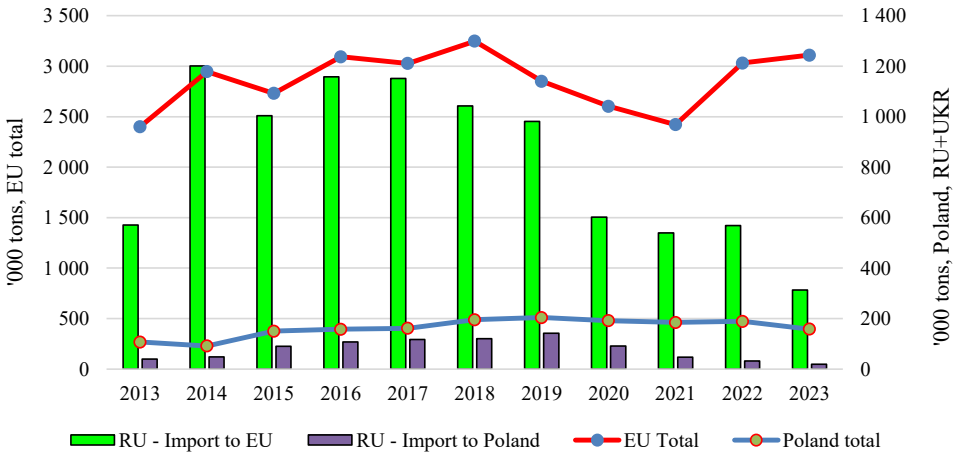

Fig. 12. Import of unalloyed aluminium to the EU and to Poland detailing deliveries from Russia (EUROSTAT 2024; Lewicka and Burkowicz, eds. 2024; GUS)

Rys. 12. Import aluminium niestopowego do UE i Polski z wyszczególnieniem dostaw z Rosji

declined, compared to 2018, due to the pandemic, i.e., production by about 9% (GUS) and consumption by about 5% (Aluminium Market in Poland 2021, 2022, 2023). In 2021, there was a rebound of around 17% for supply and 15% for demand, respectively. The boom in the aluminium market lasted until mid–2022, when rising costs, mainly of energy, triggered by Russia's aggression against Ukraine, led to a slowdown in all sectors of the economy and a rapid increase in product prices. This, in turn, resulted in a decline in supply and demand for aluminium and aluminium alloy products, which continued into 2023. Similar trends also occurred in the European market.

2.5. Potassium salts

Natural potassium salts are essential nutrients for agricultural production. For this reason, the demand for them is most influenced by the agricultural industry, both local and large-scale. Since 2013, domestic demand has been gradually increasing, stabilizing at around 960,000 tons/year in 2016–2019. In 2020–2021, it exceeded 1 million tons/year, reaching a maximum of 1,080,000 tons in 2021 (Lewicka and Burkowicz, eds. 2023). Between 2022 and 2023, the market collapsed and domestic demand for products made with potassium salts, i.e., mainly compound fertilizers NPK (containing, in addition to the two or three main components, such as nitrogen, phosphorus, and potassium, other nutrients and micronutrients), declined sharply. Thus, the consumption of potassium salts has reached its lowest level in the last decade (Figure 13).

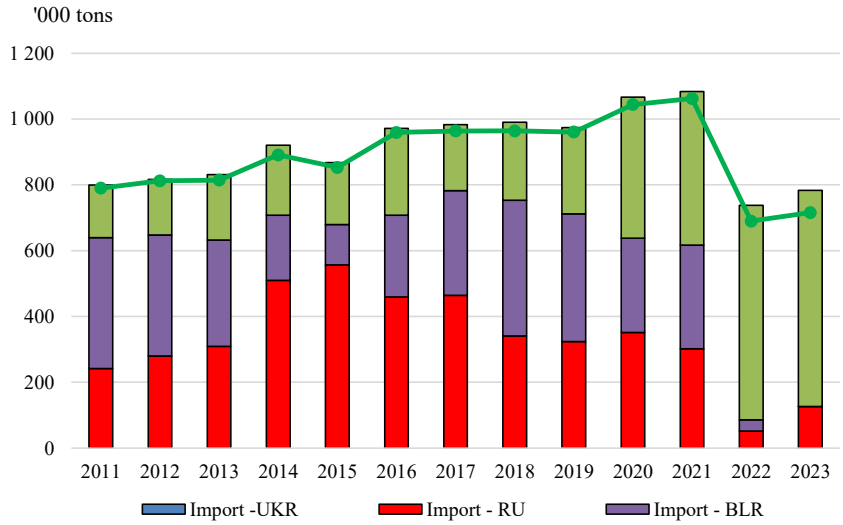

Fig. 13. The supply sources and consumption volume of potassium salts in Poland (GUS, own calculations)

Rys. 13. Źródła podaży i wielkość zużycia soli potasowych w Polsce

Natural potassium salts are not mined in Poland, even though their deposits have been preliminarily documented (BZZKP 2024). The entire domestic demand for potassium raw materials has been covered by imports from many countries, including Russia and Belarus, which accounted for 60% of the total foreign deliveries in 2020, but barely 16% in 2023 (Table 1). The decrease in potassium salts importation was mainly due to their rising prices, which peaked at over PLN 3,000/ton in 2022 from around PLN 1,250/ton in 2021 (GUS), following the increase in gas and energy prices. The sanctions imposed from 2020 onwards, first on Belarus and then on Russia, following the outbreak of the war in Ukraine, raised fears of a reduction in the supply of potassium salts. Another reason was the worsening macroeconomic situation of agricultural products on the Polish market, which was a consequence of the opening of the European market to supplies of agricultural products, mainly cereals, from Ukraine (Report… 2021, 2022, 2023).

The largest importer of potassium salts in the European Union has been Belgium, while Poland had ranked second, accounting for 19–30% of the external deliveries to the EU until 2021. In 2022, this share decreased to 9%, while in 2023, Poland became the third importer in the Community (Figure 14, EUROSTAT 2024). By 2021, imports of potassium salts into the EU had generally increased, reaching 3,440,000 tons, so unlike other commodities, their market has not been disrupted by the COVID-19 pandemic restrictions. In 2022, there was a 43% decline in the EU potassium salts imports, to around 1,960,000 tons (Figure 15, EUROSTAT 2024), which was due to supply constraints (especially from Belarus

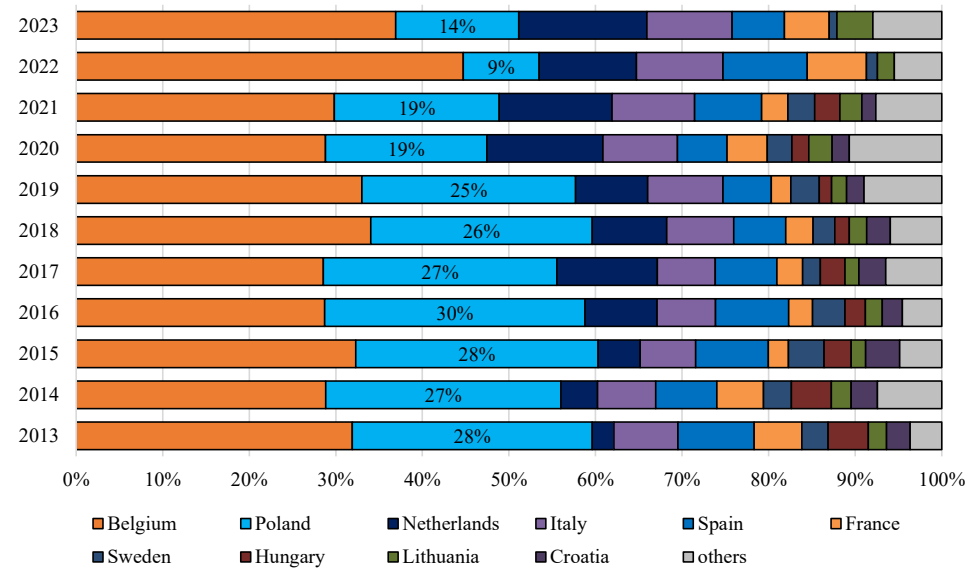

Fig. 14. The main importers of potassium salts in the EU (EUROSTAT 2024)

Rys. 14. Główni importerzy soli potasowych w UE

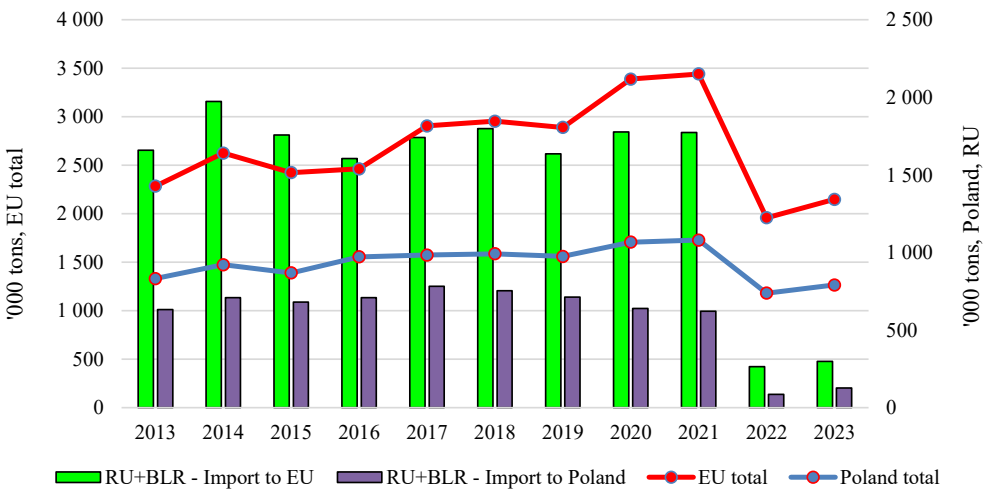

Fig. 15. Import of potassium salts to the EU and to Poland detailing deliveries from Belarus, Russia and Ukraine (EUROSTAT 2024; Lewicka and Burkowicz, eds. 2024; GUS)

Rys. 15. Import soli potasowych do UE i Polski z wyszczególnieniem dostaw z Białorusi, Rosji i Ukrainy

and Russia), drastic growth of these raw materials prices as well as uncertainty and refraining from purchases by customers, mainly of compound fertilisers (Report… 2023). A significant share of potassium salts destined for the EU came from Russia and Belarus (52% in 2020–2021), supplying 1,600–1,800 thousand tons/year. In 2022, the volume of these imports there decreased significantly, mainly a result of the outbreak of war in Ukraine and the introduction of economic sanctions by the EU against these two countries, including a total ban on imports of potassium salts from Belarus and a ban on imports from Russia, with deliveries of 838,000 tons of potassium salts and 1,578,000 tons of NPK fertilisers from Russia allowed in the period from 10.07.2022 to 09.07.2023 (Report… 2022). Accordingly, approximately 260,000 tons and approximately 300,000 tons, respectively, were sourced from these countries between 2022 and 2023, reducing the combined share of Russia and Belarus in supplies to the EU to 13% in 2022, while in 2023, Russia alone accounted for 14% (EUROSTAT 2024). Meanwhile, the EU has shifted its imports to other countries, mainly Canada, the UK, and Israel. It is expected that by 2030, EU domestic supply from ongoing mining projects (e.g., in Spain – Muga Vipasca, Sierra del Perdon, Pintano; Germany – South Harz, Zinnvald; Czechia – Cinovec) will contribute to further reducing the EU's dependence on imports of potassium salts from Belarus and Russia (JRC129105 2022).

2.6. Nickel

By far the most extensive domestic use of nickel is in the production of stainless steels (around 65–70% of consumption), which are used in the building construction, automotive, manufacturing, transportation, and architecture sectors, medical equipment, and domestic appliances. Stainless steel production in Poland fell from around 6,500 tons in 2018 to around 500 tons in 2021–2022 and around 330 tons in 2023 (GUS), due to the crisis in the domestic metallurgical sector. Other uses of nickel include: alloy steels, nickel-base alloys and superalloys (e.g., the chemical, petrochemical, energy, electrical and electronics industries, coinage and marine engineering), electroplating, casting, as well as nickel catalysts (for oil refining). Nickel serves as an active material in batteries, especially in lithium-ion chemistry for the expanding electric vehicle (EV) industry. In July 2022, the first cathode active materials (CAM) factory in Europe was commissioned by Belgian Umicore in Radzikowice near Nysa in SW Poland. The plant's annual production capacity was expected to reach 40 GWh in 2024, with the potential to grow to even more than 200 GWh, or 3 million electric cars, in the second half of the decade (Umicore 2024). Recently, the apparent domestic consumption for nickel has ranged 2,000–3,000 tons per year (Figure 16), showing a downward trend due to a decrease in the production of crude steel (Lewicka and Burkowicz, eds. 2024; GUS). Imports have entirely met demand for nickel. Until 2020, Russia was the leading supplier of this metal to Poland, accounting for approximately 35% of total foreign deliveries (Table 1). Most recently, this share has fallen to around 24% (Figure 16), while

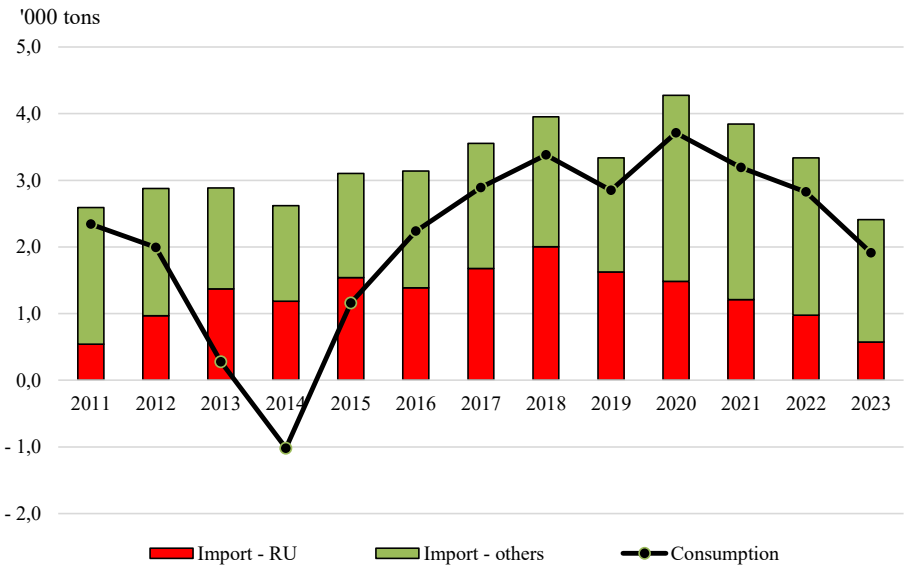

Fig. 16. The supply sources and consumption volume of nickel in Poland (GUS, own calculations)

Rys. 16. Źródła podaży i wielkość zużycia niklu w Polsce

the number of other nickel exporters to Poland increased (including the Netherlands, Japan, Norway, and Germany), which made foreign delivery sources more diversified (Lewicka and Burkowicz, eds. 2024).

The importance of Poland as a nickel customer is negligible compared to other EU countries. The largest EU importers of nickel were the Netherlands, Belgium, Germany, and Sweden (Figure 17). Russia supplied at least 22–30% of the EU's needs for nickel (EUROSTAT 2024). This share could be even larger as there are refineries in Europe operated by Russian companies, such as Nornickel – the world's largest producer of the high-grade nickel needed for electric vehicles – in Finland (Harjavalta refinery). By 2022, Russia provided 30–36% of the total external imports of the EU (Figure 18). Last year, this share fell to around 20% in favor of an increase in deliveries from other countries, especially Norway (EUROSTAT 2024).

Nevertheless, from 2020, Russia has become the sole supplier of nickel mattes to the EU (mainly to Finland) (EUROSTAT 2024; European Union 2022). Nevertheless, it should be emphasized that alternatives for locally sourced nickel in Europe are minimal. Before the war, Ukraine exported the nickel produced in the form of ferronickel (70,000–80,000 tons/year in 2016–2021). These shipments fell to 50,000 tons in 2022 and to only 4,000 tons in 2023 (EUROSTAT 2024). Any specific sanctions have not formally targeted nickel from Russia. However, the invasion of Ukraine has had a major impact on the markets of this metal, leading to a significant temporary increase in its price, mainly due to supply concerns. On 8 March 2022, the price of nickel on the London Metal Exchange reached its all-time high,

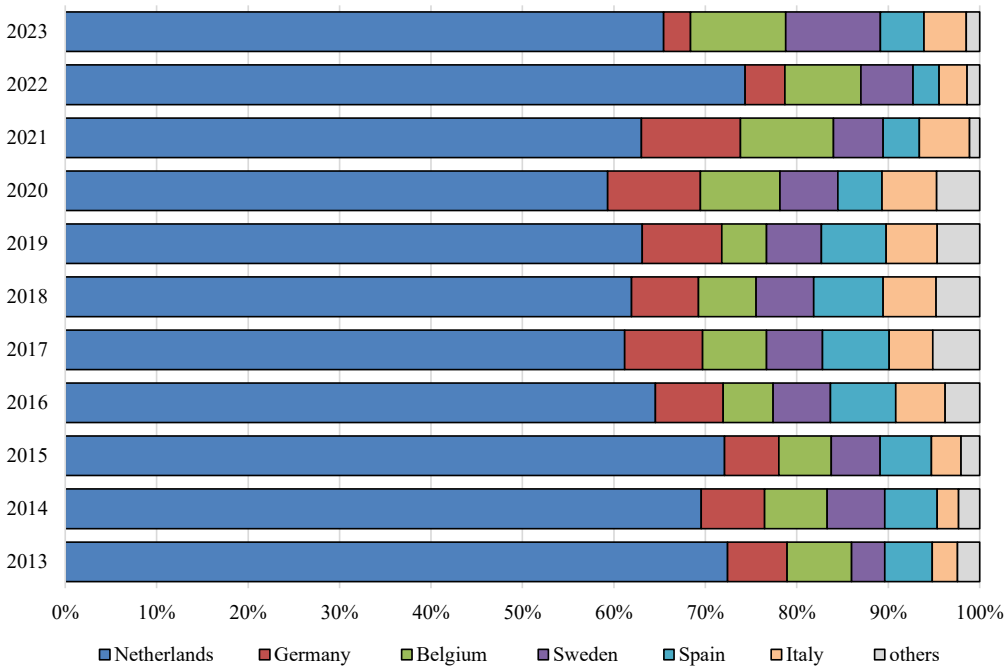

Fig. 17. Main importers of nickel in the EU (EUROSTAT)

Rys. 17. Główni importerzy niklu w UE

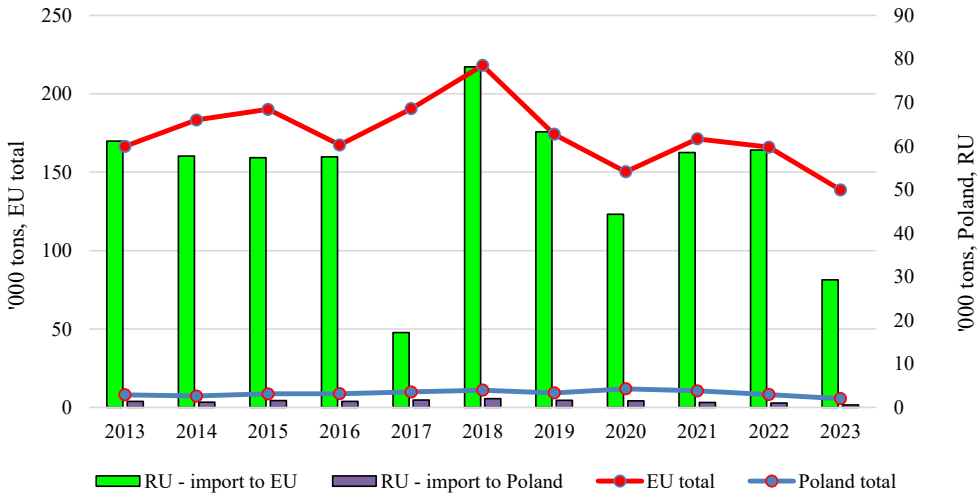

Fig. 18. Import of nickel to the EU and to Poland detailing deliveries from Russia (EUROSTAT; Lewicka and Burkowicz, eds. 2024; GUS)

Rys. 18. Import niklu do UE i Polski z wyszczególnieniem dostaw z Rosji

leading to the suspension of trading in this metal. In the following months of the year, the exchange price of nickel has fluctuated considerably, with a notable decline in 2023 that brought it back to pre-war levels and then led to a sharp decrease. Another consequence of the Russia's invasion of Ukraine has been the loss of access to capital and key logistical supply chains by Nornickel's largest shareholder (Vladimir Potanin), as the US, Canada and the UK imposed sanctions on him and on PJSC Rosbank, which he controls, as well as on other Russian entities (Silva 2023).

In 2022, nickel supply across Europe was flat as a response to high energy prices and lower demand from stainless steel mills (Ferreira and Pinto 2023). In 2023, nickel production in the region fell by around 3%, mainly due to furnace refurbishment at the Russian Nornickel. However, the outlook for the European nickel market is relatively good. The development of new applications, especially in clean energy and power generation sectors, the deployment of electric vehicles (EV batteries), and the expected increase in infrastructure development projects should be the key factors driving the market (Nickel Institute).

2.7. Ball and refractory clays

Kaolinitic clays (ball and refractory clays) are mainly used in Poland for the production of ceramic tiles (more than 60% of consumption), aluminosilicate refractory products (more than 20%), and ceramic sanitary goods (around 10%) (Lewicka and Burkowicz, eds. 2024). In 2018, demand for these raw materials peaked at around 700,000 tons (Figure 19). In recent years, it has declined significantly, mainly due to the unfavourable economic climate in the domestic ceramic tile industry (reduced profitability due to high gas and energy prices). Kaolinitic clays production in Poland ranged from 160,000 to 170,000 t/y until 2018. After falling to around 100,000 t/y in 2020–2021, it later increased to 130,000–140,000 t/y, only slightly offsetting the reduced clay imports from Ukraine (Figure 19). Supplies from this country have recently accounted for 62–86% of Poland's total foreign deliveries of ceramic clays, covering almost 74% of demand in 2020, while this share fell to around 53% in 2023 (Table 1). The volume of kaolinitic clays exports from Ukraine to Poland ranged from 320,000–480,000 t/y in 2015–2021 to around 260,000 tons in 2022 and to around 100,000 tons in 2023, while their value decreased from USD 15,000–20,000 in 2022 to USD 3,500 in 2023 (Ministry of Internal Affairs of Ukraine).

Poland is the third largest recipient of kaolinitic clays imported from outside the EU, after Spain and Italy, with a share of 12–19% (Figure 20, EUROSTAT 2024). The hostilities in Ukraine have severely restricted access to raw materials, which until 2021 were mined mainly in the Donetsk region (99% of clay production, remaining 1% – in the Zaporizhzhia region) (Szepel 2008; Galos 2008), located in the middle of the Donbass region in the eastern part of the country, which has been embattled since 2014. This has significantly reduced the supply of these high-quality ceramic clays not only to Poland, but also to other EU countries. Some Ukrainian clay mining companies operated until 2022, others until 2023.

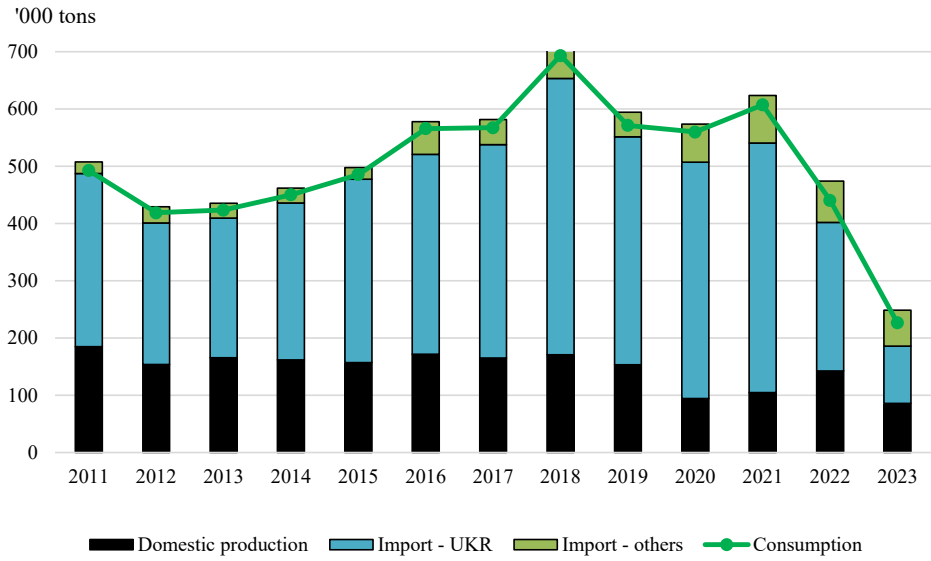

Fig. 19. The supply sources and consumption volume of ball and refractory clays in Poland detailing deliveries form Ukraine (GUS, own calculations)

Rys. 19. Źródła podaży i wielkość zużycia iłów biało wypalających się i ogniotrwałych w Polsce z wyszczególnieniem dostaw z Ukrainy

At the time of writing, almost all the enterprises, the most important of which were Vesco (operating the Novoandrieyevskoe deposit), Donbas Clays (Yuzhnooktiabrskoe, Kutzerovyarskoe deposits), Druzhkovkoe Rudouprvlenye (Novorajskoe and Oktiabrskoe deposits), and Donkerampromsyryo (Toreckoe deposit), were under occupation or on the frontline (EITI Report of Ukraine 2023). Before the outbreak of the war, Ukraine produced up to 6.5 million tons of kaolinitic clays and exported 4–6 million tons annually (79–93% of global trade), of which 38–54% went to the EU markets (EUROSTAT 2024). In 2022, the volume of Ukrainian exports of these raw materials fell to 1.2 million tons, and in 2023 to less than 0.5 million tons, while the EU countries purchased 964,000 tons and 277,000 tons, respectively. Ukraine's share in the EU's deliveries decreased from 79% in 2020 to 41% in 2022 and approximately 28% in 2023 (Figure 21).

The main consumer of kaolinitic clays in Poland, i.e., the ceramic tile sector, has recently experienced a significant deterioration in its performance. As a result of lower exports to eastern markets and rising production costs, the domestic supply of ceramic tiles fell from 110–120 million m^2/year in 2013–2022 to 97 million m^2 in 2023 (GUS 2024). A massive increase in gas prices, among other things, led to the shutdown of three of the seven production lines at one of the leading tile manufacturers, the Cerrad factory in Starachowice (central Poland). In addition, the EU restrictions on Russia resulted in the sale of Russian assets, i.e., three large production plants by another significant Polish producer − Cersanit

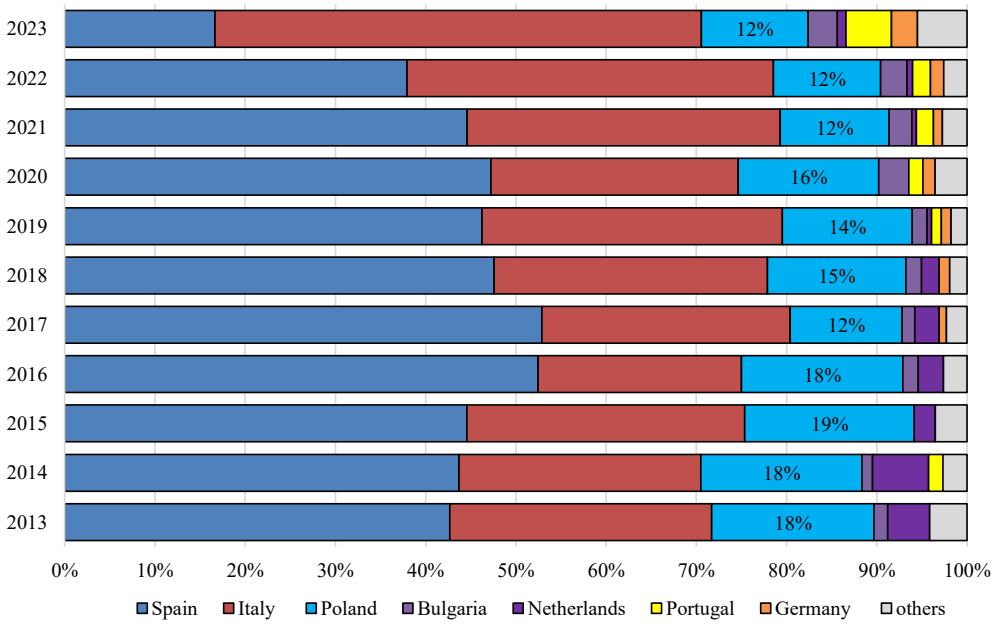

Fig. 20. The main importers of ball and refractory clays in the EU (EUROSTAT 2024)

Rys. 20. Główni importerzy iłów biało wypalających się i ogniotrwałych w UE

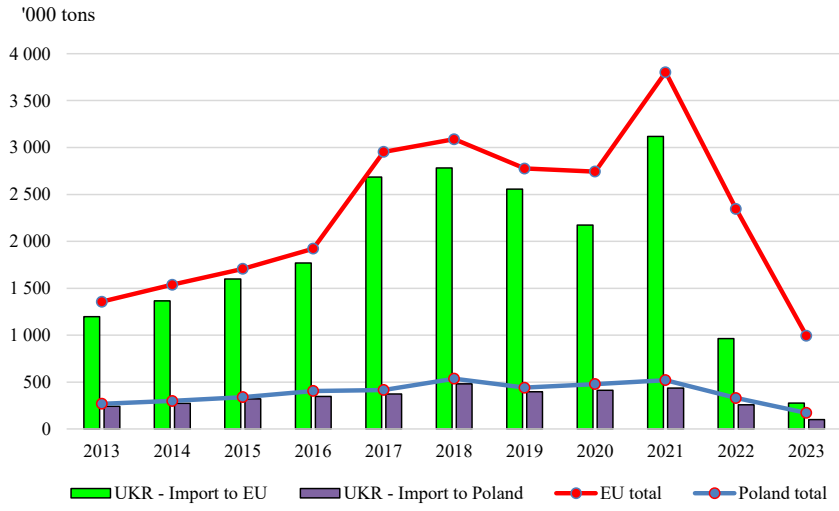

Fig. 21. Imports of ceramic clays to the EU and to Poland detailing deliveries from Ukraine (EUROSTAT 2024; Lewicka and Burkowicz, eds. 2024; GUS)

Rys. 21. Import iłów biało wypalających się i ogniotrwałych do UE i Polski z wyszczególnieniem dostaw z Ukrainy

(Elżbieciak 2023). The current domestic demand for ceramic tiles is 63–65 million m^2/year (Kowalski et al. 2024). The loss of physical and economic security (e.g., due to rising inflation) among Poles and citizens of other Central European countries, which were shaken by Russia's aggression against Ukraine, has resulted in a downward trend in the consumption of ceramic tiles (Miros 2024).

Similar phenomena have also been observed in Italy and Spain, the leading European producers and exporters of ceramic tiles (Baraldi 2023). In Italy, total tile sales declined from 449 to 362 million m^2 (–19.3%) in 2022, exports from 356 to 277 million m^2 (–22.1%), and production from 431 million m^2 to 341 million m^2 (more than 20%, ceramicworldweb 2024). In Spain, in 2022, the production decreased to 500 million m^2 from 587 million m^2 the year before, while foreign sales declined from 544 million m^2 in 2021 to 353.5 million m^2 in 2023 (Baraldi 2023). The reason was a more than 10-fold growth in gas prices.

2.8. Lithium oxides and hydroxides

Domestic demand for lithium raw materials, including lithium oxides and hydroxides, has been met entirely by imports. Between 2013 and 2020, foreign supplies of the mentioned compounds fluctuated in the range of 100–206 tons/year (Figure 22) (Lewicka and Burkowicz, eds. 2024). In 2021–2022, purchases increased significantly, more than eightfold, to a record 1,420 tons. In 2023, they fell by 26%, but remained at a high level of more than 1,000 tons. Between 2013 and 2021, the demand for lithium oxides and hydroxides ranged from 70 to 325 tons/year (Lewicka and Burkowicz, eds. 2024). In 2022, as a result of a surge in imports (by 385%), apparent consumption more than quadrupled to a record high of 1,335 tons. In 2023, however, there was a more than 15-fold increase in foreign sales, which exceeded the volume of imports by 25% resulting in a negative volume of lithium raw materials consumption in Poland (Figure 22). This appears to have been related to the sell-off of stockpiles accumulated in 2022, the recipient of which was mainly South Korea (about 91% of exports). Lithium oxides and hydroxides imported to Poland are mainly used in the glass, ceramic, and electronic industries (Szlugaj and Radwanek-Bąk 2022). This could change with the start of the production of lithium-ion materials, which are used as an intermediate in the manufacturing of lithium-ion batteries (cells). Poland has recently become one of the leading global suppliers of batteries and accumulators (including lithium-ion batteries). There are currently more than 60 companies operating in this industry in Poland, among them global giants. So far, however, they have been using an imported intermediate product – the aforementioned lithium-ion material.

In 2013–2023, Russia was the leading supplier of lithium oxides and hydroxides to Poland, ranking first until 2021 and second (after the USA) in the last two years (Lewicka and Burkowicz, eds. 2024; EUROSTAT 2024). The share of Russia in total imports of lithium oxides and hydroxides to Poland until 2019 did not exceed 42%; in the following two years it reached 75% and 95% respectively, while recently it has stabilized at around 30%, while maintaining supply levels at 300,000–400,000 t/y (Table 1, Figure 22).

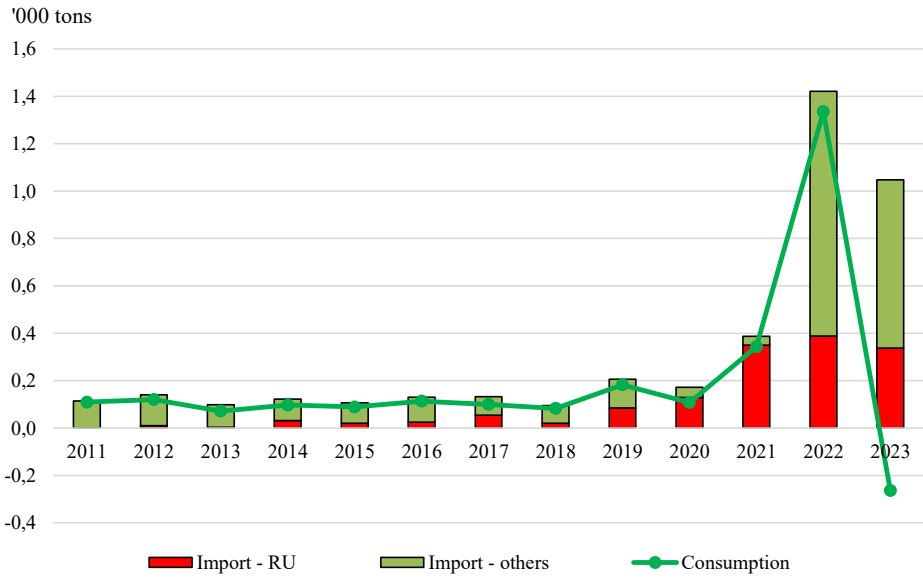

Fig. 22. The supply sources and consumption volume of lithium oxides and hydroxides in Poland (GUS, own calculations)

Rys. 22. Źródła podaży i wielkość zużycia tlenków i wodorotlenków litu w Polsce

Among the EU's countries, Belgium, Spain, the Netherlands, and Sweden were the top importers of lithium oxides and hydroxides from outside the Community (Figure 23). Until 2021, Poland imported small quantities of lithium compounds, and its share in the purchases of the EU was only a few percent. In contrast, in 2022–2023, a surge in supplies of lithium oxides and hydroxides to Poland resulted in it becoming the third purchaser among EU countries, with shares reaching 21% and 17% respectively (Figure 23, EUROSTAT 2024).

By 2020, Russia was the largest supplier of lithium oxides and hydroxides to the EU. In 2020, its market share was 46%, with exports to the Community reaching 2,400 tons (Figure 24, EUROSTAT 2024). In 2022, the EU's purchases of lithium raw materials from Russia decreased to 1,560 tons and their share to 16%, making Russia the third supplier to the EU (EUROSTAT 2024). By 2023, deliveries of lithium compounds from this country dropped to 370 tons, representing only 6% of the total Community imports (Figure 24). At the same time, the volume of the total EU's external imports of lithium oxides and hydroxides has been rising steadily, reaching a record 6,000 tons in 2022. Over the period 2016–2023, these supplies increased by as much as 88%. In recent years, the EU market has been supplied mainly by China, Chile, and the USA (EUROSTAT 2024).

The EU's CO_2 reduction policies, which include increasing the share of electric cars in the automotive market, are leading to an increase in the importation of lithium oxides and hydroxides into the Community. These compounds are used in the production of

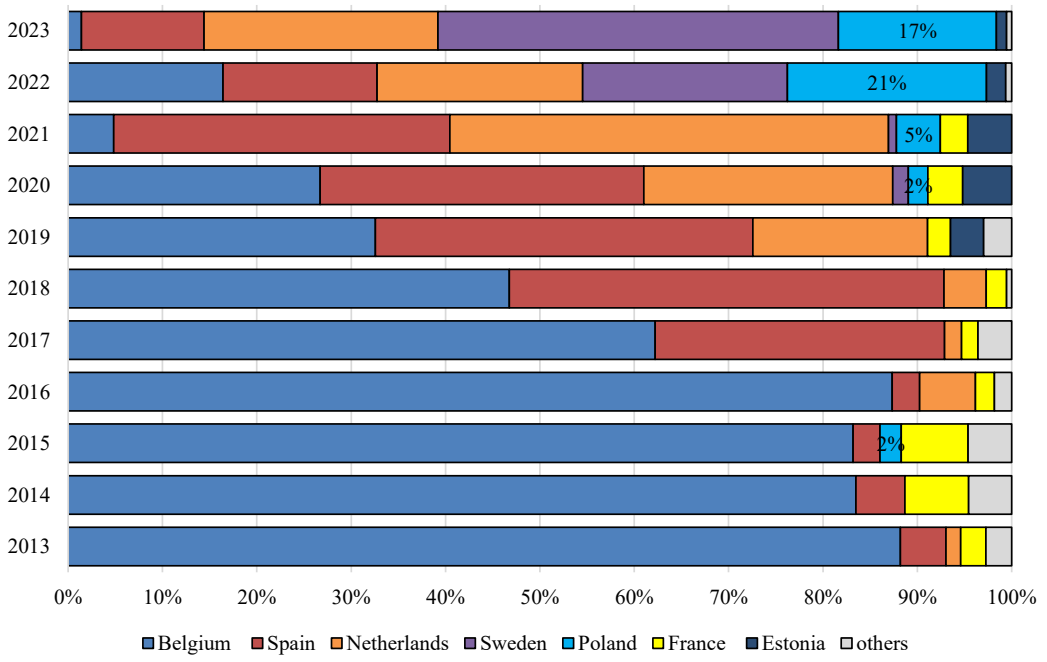

Fig. 23. The main importers of lithium oxides and hydroxides in the EU (EUROSTAT 2024)

Rys. 23. Główni importerzy tlenków i wodorotlenków litu w UE

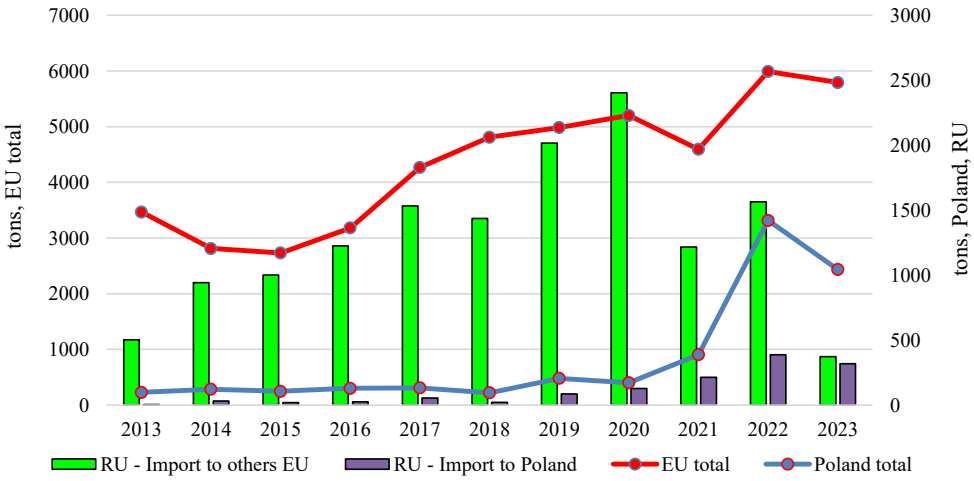

Fig. 24. Import of lithium oxides and hydroxides to the EU and to Poland detailing deliveries from Russia (EUROSTAT 2024; Lewicka and Burkowicz, eds. 2024; GUS)

Fig. 24. Import tlenków i wodorotlenków litu do UE i Polski z wyszczególnieniem dostaw z Rosji

lithium-ion batteries, which are widely used in electric cars, other motor vehicles, and consumer electronics (Bruno and Fiore 2024). In Poland, the production of lithium-ion batteries is carried out on a large scale. Between 2015 and 2020, world leaders such as LG, Exide, Panasonic, and others built their production facilities in Poland, while the export value of batteries and accumulators in 2020 reached PLN 17.8 billion (Szlugaj and Radwanek-Bąk 2022). In recent years, other companies' production facilities have been established, including Umicore, SK hi-tech battery materials, Capchem, Guotai Huarong, Mercedes-Benz, BMZ, and Johnson Matthey. The value of battery exports in 2022 achieved PLN 38.8 billion (PAIH 2023; PSPA 2023). The production capacity of lithium-ion battery cells in Poland is estimated at 73 GWh, which is approximately 6% of the global production potential, estimated at 1,163 GWh (PSPA 2023).

Concluding remarks

This study examined the effect of the Russia-Ukraine war on eight raw materials selected on the basis of their importance in trade (in terms of value and volume) between Poland and three countries involved in the conflict, i.e., the two mentioned above and Belarus. The analysed raw materials are essential for various key industries and technologies that determine the state and stable development of the domestic economy.

The outbreak of the full-scale war in Ukraine in 2022 exacerbated the problems with raw material supply chains in the European Union that had emerged during the COVID-19 pandemic. The conflict has caused uncertainty and interruptions in the global supply chain for essential raw materials, potentially slowing the transition to renewable energy (Nygaard 2022). It led to price increases and supply shortages for some raw materials, particularly in Member States that relied on imports from Ukraine, Russia, and Belarus (Khurshid et al. 2023). This is the case of Poland, which before the war covered 80% of its iron ore and concentrates needs and 90% of its kaolinitic clays needs by imports from Ukraine, 70% of its carbon black needs, 75% of its lithium oxides and hydroxides, almost 50% of its aluminium, and 35% of its nickel needs – by supplies from Russia, and almost 60% of its potassium salts needs by imports from Russia and Belarus together. In 2023 the deliveries of these raw materials from Russia in particular were significantly reduced (carbon black to 51% of the total imports, lithium oxides and hydroxides – to 34%, nickel – to 24%, unalloyed aluminium – to 12%, potassium salts – to 16%) or even disappeared (iron ores and concentrates, ferroalloys). The same trends were observed on the EU market.

A shortage or disruption in the continuity of supply of the selected raw materials means a threat to the functioning of key sectors of the economy in Poland and the EU. The industries most at risk by reduced supplies of minerals from three countries involved in the war are the iron and steel and non-ferrous metals industries, and hence the construction, transport, engineering, and other industries. The withholding of supplies of potassium salts from Russia and Belarus for the fertiliser industry and kaolinitic clays from Ukraine for the ceramics

industry could also cause serious disruptions. Reduced imports of raw materials from these directions will be much less important for the rubber industry, as there is potential to develop domestic supplies of carbon black from tyre recycling. A stable, uninterrupted supply of lithium oxides and hydroxides would be essential if production of lithium-ion materials – an important component of lithium-ion batteries – is undertaken in Poland. Possible measures to mitigate the supply deficit of the analysed raw materials include finding new sources (diversification of import directions, substitution, supporting local production, technology developments), creating strategic stockpiles, and improving the efficiency of recycling and the use of secondary raw materials.

Despite logistical difficulties (closure of the main sea export corridor) and energy shortages, Ukraine has maintained its dominance in the supply of iron ore and concentrates to Poland. It also has remained the second largest supplier of these commodities to the EU (after Canada, Figure 25). Ukraine still belongs to the world's top five exporters of iron ore and concentrates, after Australia, Brazil, South Africa, and Canada, supplying around 39–45 million tons annually. This country has been also an important source for Poland and the EU of other raw materials, such as manganese and silicon (both as ferroalloys), and of various products in the iron and steel value chain (e.g. pig iron, non-alloy steel, stainless steel, other alloys), as well as clays (kaolin, ball and refractory clays). However, their share in the total EU imports dropped significantly in 2022 and 2023 (Figure 25) as a result of the hostilities in eastern Ukraine, where most of the production facilities and mines are located.

Another reason for the decrease in kaolinitic clays imports was the lower demand from the ceramic tile sector due to the increase in gas prices. Ukraine was the most important foreign supplier of these raw materials to Poland: its share ranged from 80–90% of the total imports until 2021, falling to 78% and 62% respectively in 2022–2023. Supplementary imports of raw materials of comparable quality will be complicated. Alternative solutions include: importing expensive, high-purity raw materials from the UK and the US, and lower-quality raw materials from Germany, Italy, and Spain, as well as developing the use of domestic clay minerals. To this end, attempts are being made to modify ceramic body recipes to include a higher proportion of domestic raw materials (to around 32% and 46% in 2022–2023, respectively). Unlike most commodities imported into Poland from Ukraine, deliveries of ferroalloys almost quadrupled in 2022–2023 compared to 2020, rising from 26% to 56% of total deliveries. This was a consequence of the blockade of ferroalloys trade routes from Ukraine to the east.

Russia has been the EU's leading supplier of nickel and aluminium, accounting for 30–36% and 19–23% respectively of the EU's total external imports until 2022. Specific EU sanctions have not formally targeted these supplies. Nevertheless, imports of these metals from Russia to the EU have fallen significantly from previous levels, while the volume of supplies from other countries has increased. Generally, this was mainly the result of the negative attitudes to Russian aggression, but also of a decline in industrial demand for aluminium and nickel (stainless steel) products due to rising production costs and energy prices. Diversification of supply sources, improved recycling rates, coupled with a ban on

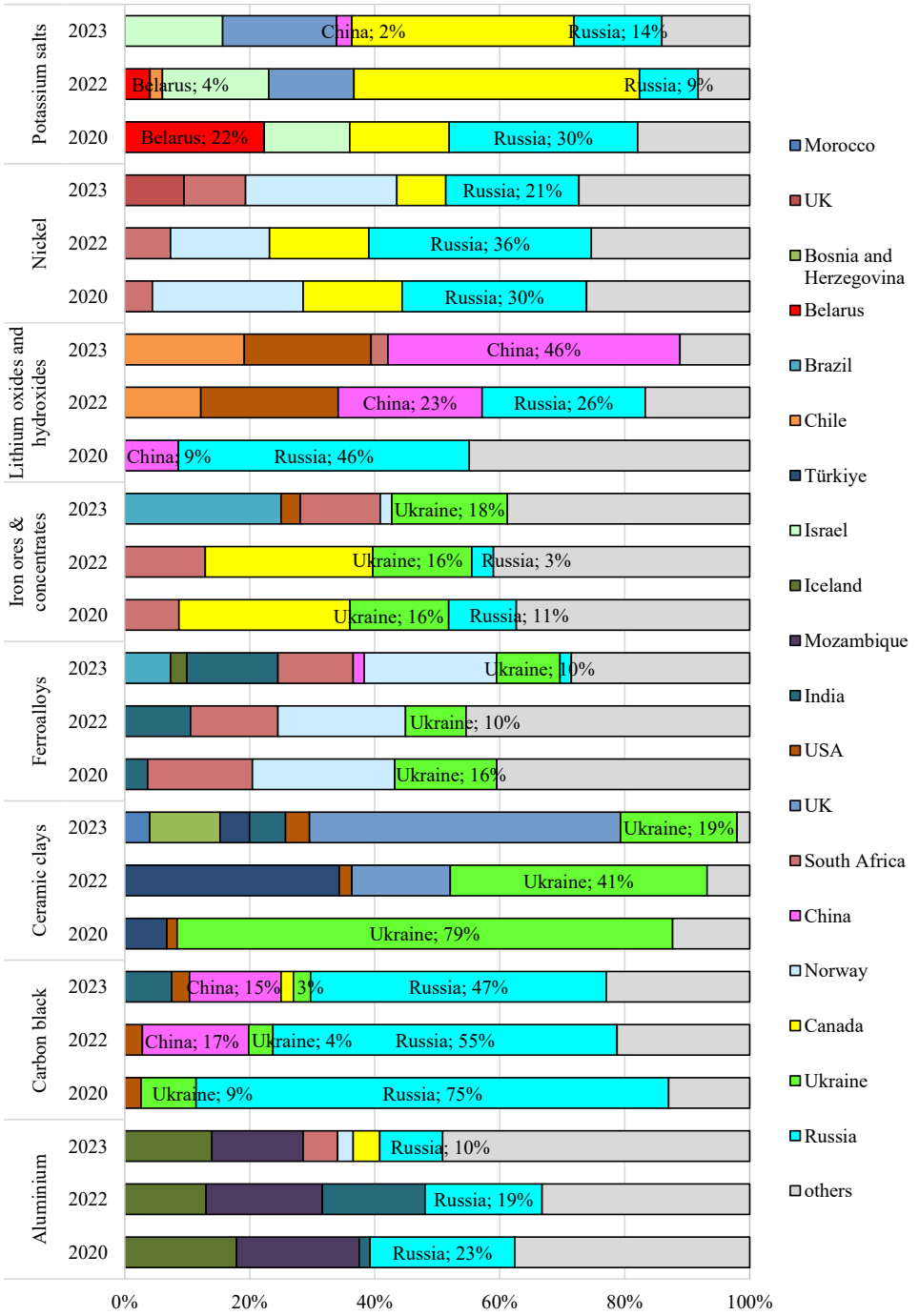

Fig. 25. Main suppliers of selected raw materials to the EU in 2020, 2022 and 2023

Rys. 25. Główni dostawcy wybranych surowców mineralnych do UE w latach 2020, 2022 i 2023

the export of their scrap from the EU, seem to be the right solutions to reduce dependence on supplies of these metals from Russia. Until 2020, Russia was also the leading supplier of lithium oxides and hydroxides to the EU. More recently, these supplies have declined significantly in favor of other countries such as China, Chile, and the USA. At the same time, the volume of external imports into the EU has risen to record levels and is expected to increase further. Deliveries of other selected commodities from Russia to the EU also decreased, partly as a result of the sanctions imposed, but also due to weakening demand. The exceptions were nickel and ferroalloys, whose share in total external imports to the EU increased relatively in 2022 compared to 2020, but decreased significantly in 2023 (Figure 25) and is expected to fall further in the following years.

One of the most important phenomena to emerge since the beginning of full-scale war is the need to rebuild raw material supply chains. Supply disruptions and sharp rises in gas prices from Russia have led to an increase in the production costs in Europe's most energy-intensive sectors, such as steel and non-ferrous metals metallurgy, as well as ceramic and fertilizers manufacturing. The Union's climate policy (high prices of CO_2 allowances, ETS, increasingly restrictive environmental regulations) also contributed to higher production costs. Other challenges included shortages of raw materials from Ukraine due to damage to transport routes, energy infrastructure (transmission lines and power stations), and production facilities. High energy costs and uncertain geopolitical situation resulted in reduced demand for raw materials in the EU, which in turn led to overstocking and falling prices of some raw materials below the break-even point (ferroalloys, aluminium, agricultural products) as well as to decrease of the production in the EU (Reboredo and Ugolini 2024). This situation has been exacerbated by the inflow of cheap competing products from third countries to Europe (steel, lithium oxides and hydroxides, tyres, ceramic tiles).

At the time of writing, the conflict in Ukraine is showing little sign of abating. It is therefore impossible to assess the overall impact of the invasion on the economy of Poland and other European Union countries in the longer term. This is all the more difficult as the geopolitical situation is becoming increasingly complex (wars in the Middle East, US-Chinese trade relations, US involvement in the truce in Ukraine). However, hope for possible post-war recovery comes from the Strategic Partnership Agreement on the Supply of Critical Raw Materials (Memorandum 2021) signed by the EU and Ukraine in 2021. The Ukrainian government has adopted an open-door policy for foreign investment and prepared a list of 100 regions for licensing and acquisition of exploration and production concessions (Ukraine's investment opportunities 2021).

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THE IMPACT OF THE WAR IN UKRAINE ON THE SUPPLY OF SELECTED RAW MATERIALS TO POLAND AND TO THE EUROPEAN UNION

Keywords

Russian-Ukrainian war, the EU, trade, raw materials, supply chain disruptions

Abstract

This article provides an up-to-date picture of the consequences of Russia's armed aggression (supported by Belarus) against Ukraine for the economy of selected non-energy mineral raw materials in Poland and the European Union. Three years from February 2022, when Russia invaded Ukraine, escalating a conflict that began in 2014, it is possible to assess the implications of the war for the Polish industry, as well as its impact on the EU due to the disruption of supplies of certain mineral raw materials from Russia, Belarus and Ukraine. The article also highlights the current challenges facing the Ukrainian mining and processing industry due to limited logistics and war damage, particularly in the eastern part of the country. One of the most significant phenomena to emerge following the outbreak of full-scale conflict is the need to rebuild raw material supply chains in European Union countries. Among the non-energy commodities imported from countries involved in the war, the most significant in terms of value of supply and actual share in satisfying demand in Poland were selected: iron ores and concentrates, carbon black, ferroalloys, nickel, kaolinitic clays (ball and refractory clays), aluminium, potassium salts, lithium oxides and hydroxides. The sectors most at risk from reduced supplies of these minerals have also been identified. These are mainly the iron and steel, and non-ferrous metals industries, and consequently the construction, transport, machinery, engineering, and other related industries, as well as the ceramics industry. Possible measures to reduce supply disruptions for the raw materials analysed include finding new sources (diversification of imports, substitution, growth of domestic production) and improving the efficiency of recycling and the use of secondary raw materials.

WPŁYW WOJNY W UKRAINIE NA DOSTAWY WYBRANYCH SUROWCÓW DO POLSKI I UNII EUROPEJSKIEJ

Słowa kluczowe

wojna rosyjsko-ukraińska, UE, handel, surowce, zakłócenia w łańcuchu dostaw

Streszczenie

W artykule przedstawiono konsekwencje agresji zbrojnej Rosji (wspieranej przez Białoruś) na Ukrainę dla gospodarki wybranymi nieenergetycznymi surowcami mineralnymi w Polsce i Unii Europejskiej. Po trzech latach od inwazji można ocenić implikacje wojny dla polskiego przemysłu, a także jej wpływ na UE w związku z zakłóceniami dostaw niektórych surowców mineralnych z Rosji, Białorusi i Ukrainy. W artykule podkreślono również obecne wyzwania stojące przed ukraińskim

przemysłem wydobywczym i przetwórczym ze względu na ograniczoną logistykę i zniszczenia wojenne, szczególnie we wschodniej części kraju. Jednym z najważniejszych skutków wybuchu konfliktu na pełną skalę stała się konieczność odbudowy łańcuchów dostaw surowców w krajach Unii Europejskiej. Spośród surowców nieenergetycznych importowanych do Polski z krajów objętych działaniami wojennymi jako najistotniejsze pod względem wartości podaży i faktycznego udziału w zaspokojeniu krajowego zapotrzebowania wytypowano: rudy i koncentraty żelaza, sadzę, żelazostopy, nikiel, iły kaolinitowe (biało wypalające się i ogniotrwałe), aluminium, sole potasowe, tlenki i wodorotlenki litu. Jako sektory najbardziej zagrożone zmniejszonymi dostawami tych surowców zidentyfikowano: hutnictwo żelaza i stali oraz metali nieżelaznych, a co za tym idzie budownictwo, transport, przemysł maszynowy, inżynieryjny i inne, a także przemysł ceramiczny. Wśród działań mających na celu ograniczenie zakłóceń w dostawach analizowanych surowców wskazano poszukiwanie ich nowych źródeł (dywersyfikacja kierunków dostaw, substytucja, rozwój produkcji krajowej) oraz poprawę efektywności recyklingu i wykorzystania surowców wtórnych.