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Value chains in the high-tech raw materials industry – the example of the lithium value chain

Introduction

The strategic management concept of the 'value chain' is currently gaining popularity among both management theorists and practitioners, and it is widely examined in the literature (Porter 1985; Gereffi 1999; Staritz et al. 2011; Kano 2018; Sarc et al. 2019; Awan et al. 2022) in both internal and global perspectives. In general terms, the value chain represents the process of 'adding' value to the final product through successive processes, starting with

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the company's sourcing of raw materials, materials, semi-finished products, etc., through production, logistics and marketing activities and ending with the provision of additional services to the customer (Porter 1985). Value chain management is often associated with the process of improving the business model, aiming to increase value for the customer while simultaneously capturing financial benefits to the greatest extent possible. Currently, due to new challenges faced by businesses, such as sustainable development, the circular economy, determining changes in the approach of international corporations to strategic assumptions, and changes in the organization of modern business operations, the concept of the value chain and the business model is undergoing a revitalization and is gaining special importance, especially in the raw materials sector in Europe.

Raw materials are crucial to the global and European economy. They form a strong industrial base, producing a wide range of goods used in everyday life and modern technologies. They are the foundation for the development of industries such as automotive, aerospace, information technology, as well as sectors related to renewable energy (energy transformation). The observed rapid global economic growth has contributed to a sharp increase in the demand for raw materials. Forecasts from the World Bank and the OECD confirm the continued rapid growth in global demand for raw materials and that the global raw material consumption will more than double by 2060 (OECD 2019; World Bank Group 2017). This state of affairs is driven by the fact that all future technologies – such as electromobility, digitalisation, and energy transformation – shape and increase the demand for raw materials (CoR 2021). Additionally, when considering the European market, a strong dependence on imports from outside Europe provides reliable and uninterrupted access to certain raw materials an increasing issue in the EU. The need to ensure the competitiveness of the European industry, which requires efficient and secure access to raw materials, has led the European Commission to adopt the Raw Materials Initiative (COM 2008), outlining a strategy to reduce dependence on non-energy raw materials used in industrial value chains, strengthen domestic supply sources, and support the supply of secondary raw materials through resource efficiency and the circular economy (recovering already-used materials). In addition, the European Commission has established a continuously updated list of critical raw materials (CRMs) of high importance to the EU economy and with high supply risks (Grohol et al. 2023).

Lithium (Li), among others, is particularly important for the development of innovative strategies and has been identified as one of the most important metals of the energy revolution. In the European Commission's latest list of critical raw materials from 2023, lithium has been designated as a strategic raw material (SRM) (COM 2023). The strategic importance has been determined based on the material's significance for green transformation, digital technologies, defense and space applications (COM 2023). In recent years, lithium has become one of the most demanded commodities in the market due to its wide range of modern applications, especially in energy and nuclear reactors, the automotive industry (batteries for e-mobility), electronics, defense, space, as well as metallurgy and medicine (Grohol et al. 2023). The global demand for lithium is projected to increase by up to 89 times by 2050 (COM 2023). Furthermore, in the European context, lithium is the third most import-dependent raw material (import reliance: extraction – 81%, processing – 100%) (Grohol et al. 2023). Therefore, it is highly vulnerable to a range of supply chain-related threats, as its production and processing are geographically concentrated and often dominated by local regulatory systems (Hailes 2022).

Due to the increasing supply risks and the growing economic importance of lithium worldwide, the objective of this paper is to analyze the global value chains for lithium by mapping the global sources of its extraction, processing, value addition, and its applications in finished products. This article specifically focuses on the developing lithium market as of the second decade of the twenty-first century (as of September 2023).

1. Value chain as a strategic development concept

The literature concerning value chains identifies various definitions of the network of relationships provided by a value chain, and subjective solutions make it possible to speak of sectoral or technological value chains.

An analysis of theoretical sources identifies an industry value-added chain at the micro-level (Porter 1985), an industry value chain at the meso-level (Galbraith 1983; Galbraith 1985), a global value chain at the macro-level (Staritz et al. 2011) and a technological value chain (Pavitt 1984) that combines the micro and meso levels. Each of these interpretations presents a different perspective on value generation considerations.

The technological value chain pertains to a perspective that combines both micro and meso levels. This combination involves building the value chain of specific technologies and their collaboration from a multi-sectoral point of view. This type of value chain has been described in the various works (Andersen et al. 2020; Mäkitie et al. 2022; Malhotra et al. 2019; Musiolik et al. 2011; Sandén et al. 2011; Stephan et al. 2017).

In order to analyze the occurrence of the value chain, its perception as a strategic action of companies, we examined the Scopus database, in which 'value chain' as article title, abstract or keywords appeared, as many as 29,042 times (data as of 29.09.2023). Taking a closer look at the keywords, it can be seen that in addition to the connections typically associated with the concept of added value between technologies or industries, a large connection is made with terms relating to the realization of functions and management at a specific stage in the life cycle of a technology, company or industry (innovation, supplies and production, commerce). There are also significant indications of a connection with sustainable development or sustainability policy in general (Fig. 1).

The 'Sustainability' policy in value chains emphasizes the pursuit of efficiency in economic, social, and environmental aspects. Balancing these areas and their mutual complementarity requires appropriate business models that will support the smooth operation of integrated functions, technologies, companies or industries (Lorenc et al. 2023).

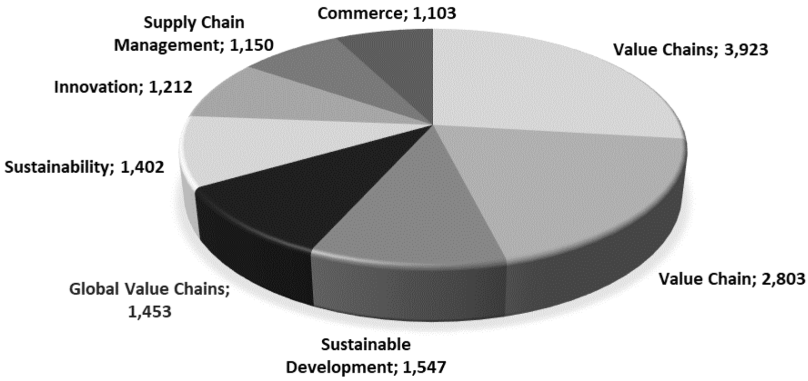

Fig. 1. The number of occurrences of the keywords related to the 'value chain' (own elaboration based on data from the Scopus database)

Rys. 1. Liczba wystąpień słów kluczowych związanych z terminem *value chain*

2. Raw materials value chain

Raw materials have been the strength of the economy and the basis of its development for centuries. Indeed, those countries that were and are rich in natural resources often dictate the direction of development and have a decisive voice in the arena of international relations. In today's world, it is important to manage available resources efficiently, considering the entire process of their acquisition, processing, utilization and disposal. In the era of the green economy and responsible business practices, environmental and social aspects are inseparable. In such a wide-ranging system, what values are generated, where they are created and who is the recipient of these values are all important factors. The blend of economic, environmental, and social interests strongly influences the processes related to exploration, mining, processing, and sales. This interconnection in the value chain, considering a circular economy, is illustrated in Figure 2.

The utilization of raw materials for various technologies forms the foundation of their development and simultaneously highlights the importance of raw materials in the context of the challenges of innovative corporate policies. The diversity of industries using raw materials is presented in Table 1 and is excerpted from the European Commission's report – Critical Raw Materials in Technologies and Sectors foresight.

The three key sectors presented in Table 1 – Renewables, E-mobility, Defence and Space – use innovative technologies, which in turn can be implemented using raw materials. Critical raw materials, in particular, play a significant role, as their acquisition becomes a crucial issue, especially in light of the demand for them in scenarios involving energy transition, vehicle autonomy, electromobility, space exploration, and the militarization of the world, considering recent events such as those in Ukraine.

Fig. 2. The raw materials value chain (Hanghøj et al. 2018)

Rys. 2. Łańcuch wartości surowców

Table. 1. The representation of flows of raw materials and their current supply risks to the nine selected technologies and three sectors (based on 25 selected raw materials) (Bobba et al. 2020)

Tabela. 1. Reprezentacja przepływu surowców i ich obecnego ryzyka dostaw do dziewięciu wybranych technologii i trzech sektorów (na podstawie 25 wybranych surowców)

<table>
<tr><td colspan="6">Materials</td><td rowspan="9">Sectors</td></tr>
<tr><td rowspan="8">Supply risk</td><td>Very high</td><td>High</td><td>Moderate</td><td>Low</td><td>Very low</td></tr>
<tr><td>LREEs</td><td>Magnesium</td><td>Strontium</td><td>Indium</td><td>Manganese</td></tr>
<tr><td>HREEs</td><td>Niobium</td><td>Cobalt</td><td>Vanadium</td><td>Chromium</td></tr>
<tr><td></td><td>Germanium</td><td>PGMs</td><td>Lithium</td><td>Zirconium</td></tr>
<tr><td></td><td>Borates</td><td>Natural graphite</td><td>Tungsten</td><td>Tellurium</td></tr>
<tr><td></td><td>Scandium</td><td></td><td>Titanium</td><td>Nickel, Copper</td></tr>
<tr><td></td><td></td><td></td><td>Gallium, Hafnium</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Silicon metal</td><td></td></tr>
<tr><td rowspan="11">Technologies</td><td>Fuel cells</td><td>Batteries</td><td>Batteries</td><td>Batteries</td><td>Batteries</td><td rowspan="3">Renewables</td></tr>
<tr><td>Wind</td><td>Fuel cells</td><td>Fuel cells</td><td>Fuel cells</td><td>Fuel cells</td></tr>
<tr><td>Traction Motors</td><td>Wind</td><td>Robotics</td><td>Traction Motors</td><td>Wind</td></tr>
<tr><td>Robotics</td><td>Traction Motors</td><td>Drones</td><td>PV</td><td>Traction Motors</td><td rowspan="3">E-mobility</td></tr>
<tr><td>Drones</td><td>PV</td><td rowspan="3">Information & communication technology</td><td>Robotics</td><td>PV</td></tr>
<tr><td rowspan="3">Information & communication technology</td><td>Robotics</td><td>Drones</td><td>Robotics</td></tr>
<tr><td>Drones</td><td>3D printing</td><td>Drones</td><td rowspan="3">Defence & Space</td></tr>
<tr><td>3D printing</td><td></td><td rowspan="3">Information & communication technology</td><td>3D printing</td></tr>
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In Europe, the issue of resource acquisition is particularly important, as there is a large gap between the consumption of raw materials and their extraction on the continent. It turns out that while Europe, as a part of the world, controls the downstream areas of the value chains and profits from them, it does not have control of the upstream areas, such as exploration and extraction (in which Australia, Africa, and South America dominate). Additionally, Europe is less involved in resource processing (with China being dominant in this area). This dependency poses strategic threats to gaining competitive advantages for European companies and ultimately shifting higher margins to the upstream of raw material chains.

Europe, recognizing the threats, has identified strategic as well as critical raw materials from the perspective of future technologies and industries. The set of these raw materials is presented in Table 2.

Table 2. Critical and strategic raw materials in 2023 (Grohol et al. 2023)

Tabela 2. Surowce krytyczne i strategiczne w 2023 roku

2023 Critical Raw Materials (new CRMs in italics)			
Aluminium/bauxite	Cooking coal	Lithium	Phosphorus
Antimony	*Feldspar*	LRE	Scandium
Arsenic	Fluorspar	Magnesium	Silicon metal
Baryte	Gallium	*Manganese*	Strontium
Beryllium	Germanium	Natural graphite	Tantalum
Bismuth	Hafnium	Niobium	Titanium metal
Boron/borate	*Helium*	PGM	Tungsten
Cobalt	HREE	Phosphate rock	Vanadium
		*Copper**	*Nickel**
2023 Critical Raw Materials (Strategic Raw Materials in italics)			
Aluminium/bauxite	Cooking coal	*Lithium*	Phosphorus
Antimony	Feldspar	*LRE*	Scandium
Arsenic	Fluorspar	*Magnesium*	*Silicon metal*
Baryte	*Gallium*	*Manganese*	Strontium
Beryllium	*Germanium*	*Natural graphite*	Tantalum
Bismuth	Hafnium	Niobium	*Titanium metal*
Boron/borate	Helium	*PGM*	*Tungsten*
Cobalt	*HREE*	Phosphate rock	Vanadium
		*Copper**	*Nickel**

* Cooper and nickel do not meet the CRM thresholds, but are included as Strategic Raw Materials.

In a subjective sense, realizing that value in the raw materials industry occurs through value chains, one can contemplate how production is distributed across various stages, and consequently, the migration of margins between countries. Matters related to exploration

Table 3. Indicative supply chains of oil and gas and selected clean energy technologies (IEA 2021)

Tabela 3. Przykładowe łańcuchy dostaw ropy i gazu oraz wybranych technologii czystej energii

Oil and gas													
	Upstream				Refining/midstream						Consumption		
Oil	US	Saudi Arabia	Russia		US		China		Russia		US	China	India
Natural gas	US	Russia	Iran		Russia		Qatar		Australia		US	Russia	China
Clean Technologies													
	Mining		Processing		Battery material			Battery cell/pack			EV deployment		
Copper	Chile	Peru	China	Chile	China	Korea	Japan	China	US	Korea	China	US	EU
Lithum	Australia	Chile	China	Chile									
					Polysillicon			Solar panel			PV installation		
Nickel	Indonesia	Phillippines	China	Indonesia	China	Korea	Germany	China	Korea	Canada	China	EU	US
					Wind turbine and components						Wind installation		
Cobalt	DRC		China		China	India	US	Spain	Germany		China	EU	US
Rare earths	China		China										

and extraction are typically linked to the presence of deposits in specific geographical areas, while subsequent stages of processing, metallurgy, production, and end-use are associated with countries with higher levels of economic development and innovation. Examples of raw material value chains are presented in Table 3 by country of implementation.

3. The nature of the lithium value chain

Lithium is one of the alkali metals, it has the highest heat capacity of all solid elements and is an excellent conductor of heat and electricity (Szlugaj and Radwanek-Bąk 2022). Therefore, as mentioned in the introduction, lithium is one of the metals most in demand in the world. This element finds a wide range of applications, with 80% being used in battery production, including batteries produced for electric vehicles (EVs) (about 62%), electronics (about 28%) and energy storage (about 10%). Lithium is also used in the production of ceramics and glass (7%), lubricants (4%), casting mould flux powders (2%), as well as in air treatment (1%) and medicine (1%) (Fig. 3).

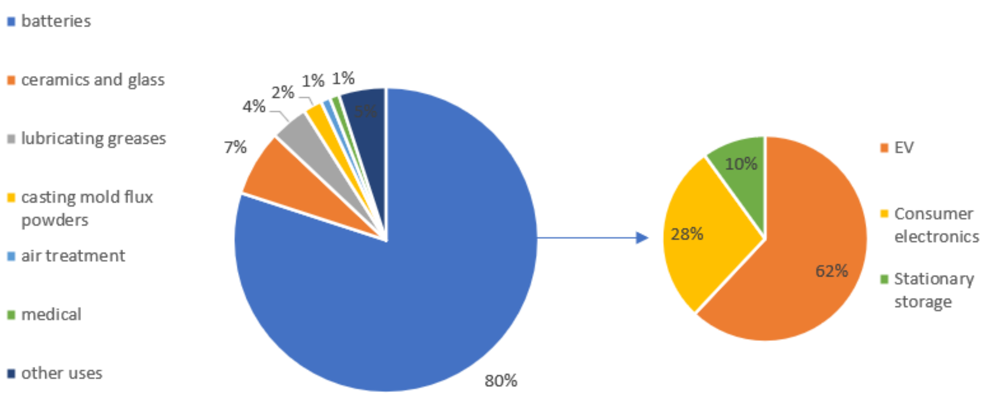

Fig. 3 Global trends in the use of lithium (own elaboration based on: Jaskula 2023; Bloomberg NEF 2023)

Rys. 3. Globalne kierunki wykorzystania litu

The utilization of lithium within the value chain alongside other resources in battery production is presented in Figure 4.

Analyzing the lithium value chains, it is possible to recognize some of the significant vertical integrations that work for the automotive sector. These chains consist of four main stages, namely extraction, processing, battery manufacturing and EV assembly (Fig. 5).

In 2021, the global lithium production amounted to 107,000 tones (Jaskula 2023). Approximately 90% of lithium is obtained from Australia (52%), Chile (23%), and China (13%). The remaining approximately 10% is supplied by Argentina, Brazil, Portugal, the USA, and

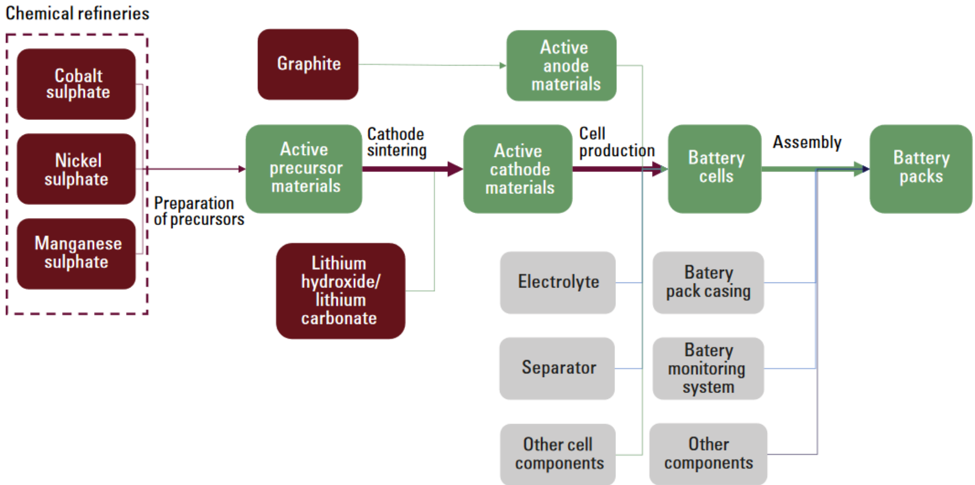

Fig. 4. The lithium-ion battery value chain (ECLAC 2023)

Rys. 4. Łańcuch wartości akumulatorów litowo-jonowych

Fig. 5. Lithium value chains for EV needs (own elaboration based on: CME 2023; Jaskula 2023)

Rys. 5. Litowe łańcuchy wartości na potrzeby pojazdów elektrycznych

Zimbabwe. In the case of the six considered value chains, the primary suppliers of lithium for the EV industry are Australia and Chile. Lithium does not occur in nature in metallic form, but instead occurs in chemical compounds with an ionic structure (e.g. salts, oxides, hydroxides) (Bolewski et al. 1976), thus lithium is extracted from brine or in the form of spodumene (hard rock). Australian lithium is extracted in the form of spodumene at six mines, while in Chile, there are two plants sourcing lithium from brine.

Lithium in the form of brine or spodumene must undergo processing to become a pure intermediate product that can be used in battery production, mainly as lithium carbonate or lithium hydroxide. In the figure above (Fig. 5), it can be observed that in the case of all four supply chains where lithium is mined in Australia, it is exported to China, where it undergoes processing. In contrast, lithium mined in Chile is also processed there. The second chart from the left shows the percentage of involvement of the two countries mentioned, which are relevant at the processing stage: China (89%), Chile (11%).

In the next stage of the value chain, following the extraction processes, battery processing takes place. When looking at the six main lithium supply chains, China (36%), Japan (33%) and the Republic of Korea (17%) play major roles at this stage (cf. Fig. 5, third chart from the left). Cathodes, anodes and electrolyte, which constitute the battery cells, are produced in these countries. These cells are further integrated into battery packs consisting of modules and protective systems, forming the final battery. Cathodes for lithium-ion batteries typically consist of a mixture of lithium and other minerals, including nickel (N), manganese (M), cobalt (C), or iron (Fe). For example, NMC111 batteries use a mixture of lithium and an equal mix of N, M, and C (CME 2023). Table 4 shows the types of lithium-ion batteries. Data from the International Energy Agency's Global EV Outlook 2023 shows that in 2022, around 60% of batteries produced for EVs consist of NMC-type batteries, followed by LFP-type batteries with a share of just under 30% and NCA-type batteries with a share of around 8%. Additionally, LMO-type batteries are used to a minimal extent. The fifth chemical compound on the horizon is LTO (Hill et al. 2019).

Table 4. Types of lithium-ion batteries (JRC 2020)

Tabela 4. Rodzaje baterii litowo-jonowych

Full name	Abbr.	Chemistry
Rechargeable batteries		
Lithium Cobalt Oxide	LCO	$LiCoO_2$
Lithium Iron Phosphate	LFP	$LiFePO_4$
Lithium Manganese Oxide	LMO	$LiMn_2O_4$
Lithium Nickel Cobalt Aluminium Oxide	NCA	$LiNiCoAlO_2$
Lithium Nickel Manganese Cobalt Oxide	NMC	$LiNiMnCoO_2$
Lithium Titanate	LTO	$Li_4Ti_5O_{12}$

In the case of the first primary supply chain, where extraction takes place in Australia and the remaining stages (processing – battery manufacturing – EV assembly) occur in China, the main type of batteries produced and assembled in vehicles are LFP batteries. It is worth noting that approximately 95% of LFP batteries for electric commercial vehicles were used in vehicles manufactured in China (IEA 2023). In the next two supply chains Australia-China-China-Germany and Australia-China-Republic of Korea-Republic of Korea, the batteries manufactured and used in EVs are NMC811 batteries. In the next two supply chains, where the first two stages (extraction – processing) take place in Chile and the next two (battery manufacturing – EV assembly) occur either in Japan or in the Republic of Korea, the main type of battery is NMC622. In the case of the longest supply chain, Australia-China-Japan-USA, batteries of the NCA type are produced for EVs. Last year (2022), the demand for automotive lithium batteries increased by approximately 65% to 550 GWh from around 330 GWh in 2021 (IEA 2023).

When considering the recipients of the value of the entire chain in the form of the electric automotive industry, China (50%), Germany (18%), and Japan (8%) are the most important in the final stage, i.e. EV assembly (cf. Fig. 5, first chart from the right). Figure 6

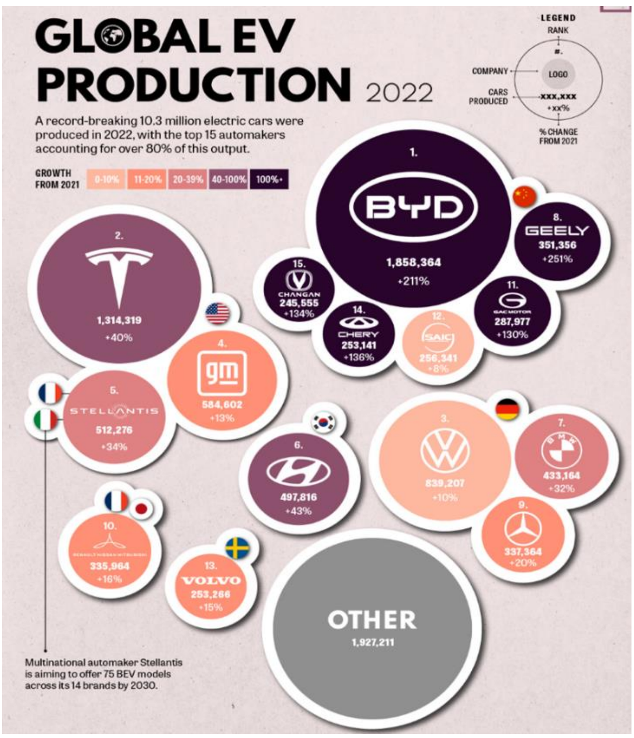

Fig. 6. Global EV production in 2022 (Lu 2023)

Rys. 6. Globalna produkcja pojazdów elektrycznych w 2022 roku shows fifteen companies accounting for 80% of global EV production. In 2022, the Chinese brand BYD ranked first in terms of electric car production. In addition to the BYD brand, five other Chinese brands were among the top fifteen EV manufacturers. Tesla, a US brand, ranked second. However, it is important to note that brands are assigned to the countries where their headquarters are located. This scheme does not provide information about how many Tesla cars are actually produced in the USA and how many in Shanghai (where even up to 50% of Tesla's total production takes place) or Berlin (about 13% of the total production).

If one examines the aforementioned most popular value chains, it becomes apparent that there is a bottleneck problem in China. In the processing stage, China is responsible for processing 89% of lithium and is also in the first place in battery manufacturing (36%) and EV assembly (50%). This problem was felt worldwide when Chinese factories halted production during the COVID-19 pandemic, and at that time, primarily Europe suffered from a shortage of lithium-ion battery cell components. Europe is highly dependent (99.8%) on external supplies.

4. Prospective changes in the lithium value chain

Prospectively, forecasts indicate that China's share in the global lithium value chain will continue growing until 2030. If we express this growth in terms of revenue, then the generation of revenue at each stage is presented in Figure 7.

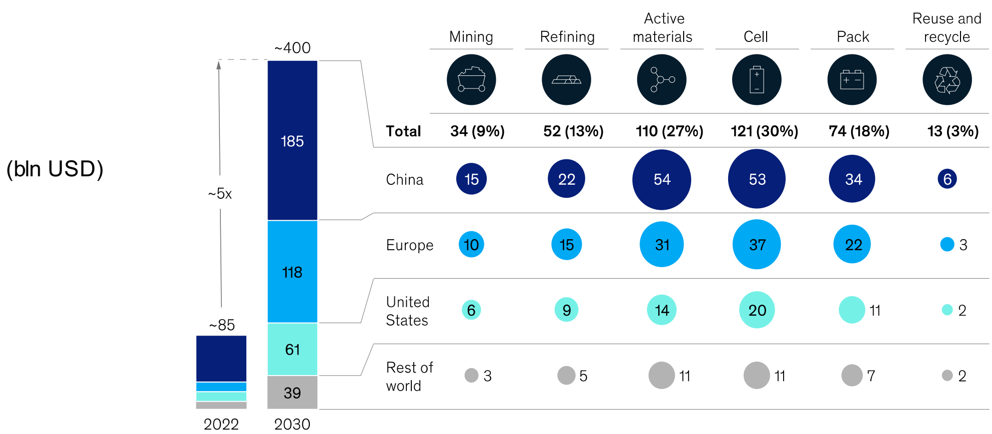

Fig. 7. Comparison of revenues from individual stages in the lithium value chain in 2022 and the forecast for 2030 (billion USD) (McKinsey & Company 2023)

Rys. 7. Porównanie przychodów z poszczególnych etapów w łańcuchu wartości litu w 2022 r. i prognoza na 2030 r. (mld dolarów)

Based on the forecasts prepared by the Mc Kinsey Mine Span team, it can be observed that lithium revenues in the value chain will increase almost fivefold in 2030 compared to 2022. China's share may amount to approximately 185 billion dollars in the future, while Europe could generate around 118 billion dollars.

Currently, Asia (China, Japan, Republic of Korea) supplies 86% of all lithium-ion batteries for the EV industry to global markets. Unfortunately, in this case, the diversification of supply margins is limited. The situation may change somewhat as supply chains may shift with the emergence of new Swedish company Northvolt and LG Chem's branch in Poland, which are both engaged in lithium-ion battery production.

The world is seeking to increase the share of electric cars in total cars for environmental reasons. Therefore, one of the key factors to consider is the carbon footprint generated in these supply chains. A total of 9.34 tCO_2e is emitted in all six supply chains. The largest share of this footprint is attributed to the first, primary supply chain: Australia-China-China-China, accounting for 1.74 tCO_2e, closely followed by the Austria-China-Republic of Korea-Republic of Korea supply chain at 1.66 tCO_2e. This footprint is significant, even though these are the shortest supply chains geographically, they nevertheless deal with the manufacture and transportation of large volumes of lithium products.

These supply chains will undergo continuous changes in the future, mainly due to the depletion of primary lithium resources and an increased focus on extracting lithium from secondary sources.

Despite the fact that the documented reserves and resources in the reserves and resources category continue to grow, as confirmed by the available data (Fig. 8), it seems necessary to obtain lithium from secondary sources. This is because baseline scenarios depicting the balance between the supply and demand of lithium in the market in 2030 will show a significant imbalance towards a lack of lithium supply.

Figure 9 concludes the analyses carried out by McKinsey Mine Spans, which show that in 2030, there will be about a 55% gap between the demand for lithium and its production carried out by each country under the adopted baseline scenario. Even more so, this figure identifies the need to source lithium from secondary sources through recovery and urban mining technologies.

An important point to consider in the presented analyses is the fact that ongoing research is continually exploring the use of other types of batteries, such as sodium-ion batteries. Certainly, there will be an intensification of activities in value chains due to the pursuit of achieving zero emissions. Recently, the utilization of batteries, especially in the automotive market, has witnessed exponential growth. In 2022, 14% of all cars sold in 2022 were electric, compared to approximately 9% in 2021 (IEA 2023).

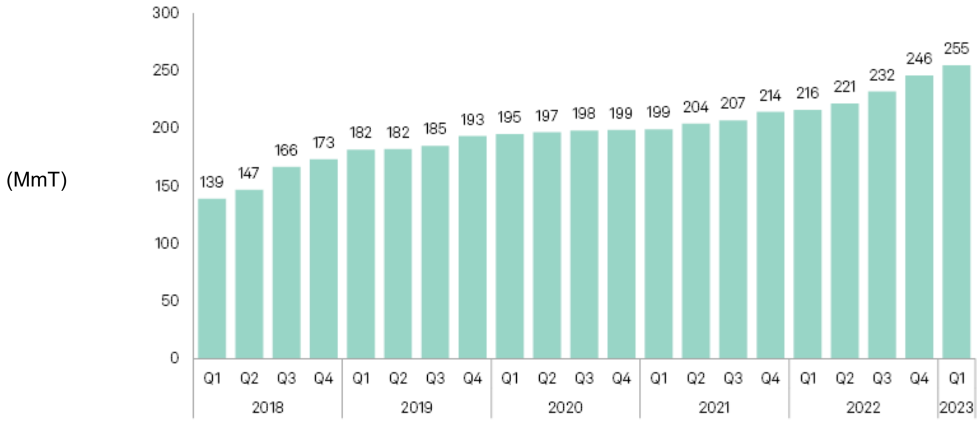

Fig. 8. Total value of global lithium resources in the reserves and resources category as of 2018 (million metric tons – MmT) (S&P Global 2023)

Rys. 8. Całkowita wartość zasobów litu na świecie w kategorii reserves i resources od 2018 roku (MmT)

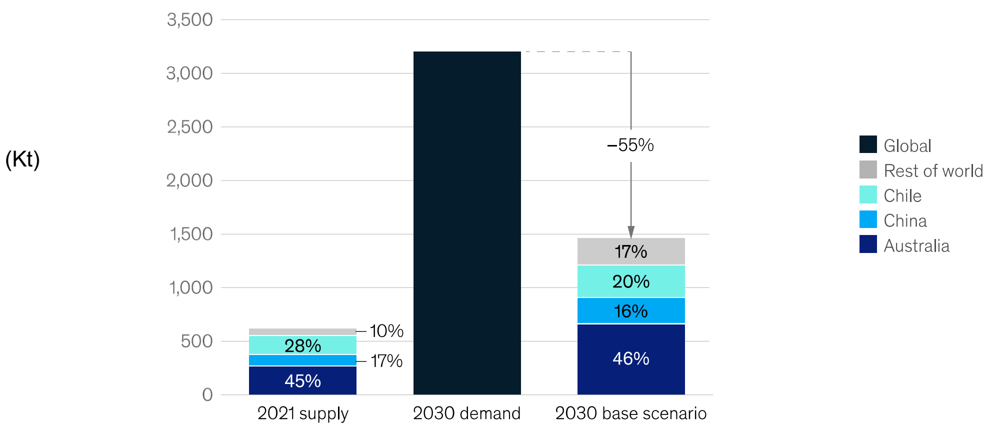

Fig 9. Disparity between lithium demand and production in 2030 (kilo tons) (McKinsey & Company 2023)

Rys. 9. Dysproporcja pomiędzy zapotrzebowaniem na lit a jego produkcja w 2030 roku

Conclusion

Value chain management is often associated with the process of improving the business model with the aim of increasing value for the customer while simultaneously capturing financial benefits to the greatest possible extent. Such a model causes the highest margins to be generated at the end of the entire chain, although the division of margins among individual processes is determined by settlement prices, which may take the form of transfer prices.

The concept of value chains is of particular importance in industries with high capital investments and resulting fixed operational costs. Low margins in the upstream encourage the processes to be combined within the natural flow and value addition and to monetize the increasing processing of the end product.

These dependencies take on particular significance in the raw materials industry, in which the concept of value chains is widely implemented. Market experiences and analyses show that value chains are identified not only in traditional raw materials such as oil, gas and coal but also in materials used in innovative technologies for modern industries most often associated with renewables and e-mobility, as well as the military and space. In each of these industries, key value chains can be identified covering copper, cobalt, lithium, nickel and rare earth elements.

The paper has provided a detailed examination of the lithium value chain, which is primarily used for battery production to meet the needs of energy transformation and electromobility. The conducted analyses has indicated that the demand for lithium is increasing year by year, and in 2030, lithium production will not meet the forecasted demand. This necessitates significant development of technologies and filling the emerging gap through recovery methods, such as urban mining.

Of course, research is ongoing on other battery production technologies, but these remain in the development stage and do not yet have a commercial character.

In summary, the demand for raw materials will continue to increase in the context of the development of new technologies, and the consumption of raw materials may in future be significantly greater than their acquisition through exploration and subsequent extraction. These trends will particularly affect Europe, which consumes a relatively large amount of resources while extracting relatively few. Due to its advanced and innovative technologies and industrial sectors, Europe benefits from raw material value chains. Such a strategy generates money but at the same time can be a source of significant risks in the context of centralizing production processes in the upstream of value chains. As a result, Europe, as a continent, has adopted a strategy of rebuilding exploration and mining capacity in order to become independent in terms of raw material extraction and, at the same time, to develop recovery and processing processes. Educational programs, in the form of studies and training, are also serving this strategy at European universities, preparing professionals for the chosen strategic path. An example of such studies is the Raw Materials Value Chain (RaVeN) master's programme implemented at AGH University in Krakow.

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VALUE CHAINS IN THE HIGH-TECH RAW MATERIALS INDUSTRY – THE EXAMPLE OF THE LITHIUM VALUE CHAIN

Keywords

value chains, raw materials industry, lithium value chain, margins migrations among technologies and branches

Abstract

This paper presents concepts of value chains as strategic models for long-term development and a sustainable approach for ensuring efficiency. It highlights the fact that value chains are of particular importance in the raw materials industry, where the exploration, extraction, processing and metallurgy stages are characterized by high capital expenditure and fixed costs. Additionally, it emphasizes that offering an increasingly valuable product at each stage of production or processing makes it possible to increase earnings and achieve a higher margin. In order to give a practical dimension to the presented analyses, the paper provides an example of lithium value chains and identifies the determinants of their functioning in the current market together with their prospects. The conclusion highlights Europe's need to source raw materials within business models based on value chains.

ŁAŃCUCHY WARTOŚCI W PRZEMYŚLE SUROWCOWYM NA POTRZEBY NOWOCZESNYCH TECHNOLOGII – PRZYKŁAD LITU

Słowa kluczowe

łańcuchy wartości, przemysł surowcowy, łańcuch wartości litu, migracje marż między technologiami i branżami

Streszczenie

W artykule przedstawiono koncepcje łańcuchów wartości jako strategicznych modeli rozwoju długoterminowego i zapewnienia efektywności w zrównoważonym ujęciu. Wskazano, że mają one szczególne znaczenie w przemyśle surowcowym, gdzie etapy związane z eksploracją, wydobyciem, przetwórstwem i metalurgią charakteryzują się dużymi wydatkami inwestycyjnymi i kosztami stałymi. Z drugiej strony podkreślono, że oferowanie coraz bardziej wartościowego produktu na każdym etapie produkcji czy przetworzenia pozwala zarabiać i osiągać wyższe marże. Dla praktycznego wymiaru zaprezentowanych analiz przytoczono przykład łańcucha wartości dla litu oraz wskazano determinanty jego funkcjonowania na obecnym rynku wraz z perspektywami. W konkluzji zwrócono uwagę na potrzeby Europy co do pozyskania surowców w ramach modeli biznesowych opartych na łańcuchach wartości.