Extract from CP & T (2021), issue-no. 3, page 32 – 43.

Photo: Andreas Bednareck

Scrap, ingots, alloying elements: The purchase prices of metals contribute to the success of foundries, but are dependent on numerous influencing factors.

Price Forecast

What is happening on the commodity markets – and what the future holds?

Anyone who wants to analyze metal prices and forecast their future development must not ignore the social, political and economic framework conditions. The ongoing discourse on electromobility and climate change also has an influence, as do global population trends and a possible structural transformation of China from an industrial to a service society. A current overview of the market position of various foundry-relevant metals, which provides a strategic basis on their availability and future purchase prices.

By Rüdiger Deike, Duisburg

The world market structures for non-energy raw materials on the supply and demand sides started changing in the mid-1990s and more so since 2003, leading to extreme price fluctuations at very short intervals. These developments will become part of the history of business and, according to current knowledge, it can be assumed that these changed market structures will also largely determine developments on global raw material markets during the coming 20 years.

Are commodity prices being talked up?

Unlike scientific problems – where real facts are independent of statements made about them – economic processes are characterized by being shaped by people, companies, politics and numerous other opinion-forming institutions whose perceptions change the rules of social systems. Facts are consequently influenced by statements made about them – sometimes very clearly, often almost imperceptibly [1]. A review of developments on the global raw material markets during the last two decades shows how facts have been influenced by statements made about them – this can be seen particularly clearly when one examines how the prices of rare earths have developed [2]. There were extreme fluctuations in 2011 when, exemplary for the entire group of rare earths, prices for cerium and lanthanum oxides rose from 20 USD/kg in 2010 to 110 USD/kg in 2011 before falling back again to 27 USD/kg in 2012. In April 2021, prices were at about 1.6 USD/kg [2, 3] and the review gives the impression that these changes were brought about by what had been said and written. These developments have led to the destruction of theoretical equilibrium states that should characterize markets and that determine prices from real supplies and real demands. This is an excellent example of how statements about expected future price movements can directly influence current trading at preexisting prices.

By their nature, markets are unstable

This correlation between thinking and reality in business which, according to [1], is described as "reflectivity on the markets" leads to "markets being inherently unstable" so that statements are only possible with a certain level of vagueness. This plays a very special role when individual market participants – either on the supply or the demand side – hold a dominant position. The uncertainty is many times higher if a market participant has a dominant position on both sides, as is definitely the case in some segments of the global raw material markets.

A completely new experience is that worldwide lockdowns can suddenly and drastically run down economic activity in particular sectors, varying regionally and at staggered intervals. The consequences are worldwide existential personal and economic distress to an extent hitherto unknown. Resulting in attempts, all over the world but highly variable, to avoid a total breakdown by introducing state support measures financed with credit. The unpredictable collapses in demand have also led to disturbances in global delivery chains which had previously been taken for granted and assumed to function well.

The re-booting of economic life regionally at very different speeds in combination with the restocking of inventory is now leading to just as drastic temporary and global increases in demand which, however, with all their consequences, can only be calculated with some vagueness.

Nevertheless, it is interesting to think about whether it is indeed perhaps possible to identify signposts for developments on the raw material markets which, despite the vagueness, provide some indication about possible future developments.

The world's population continues to grow

A growing world population will also consume more energy and non-energy raw materials in future. But given that well-founded strategic social and economic decisions can be made, it makes sense to think about whether all raw materials will be equally affected – or whether there are some raw materials whose increase in consumption will be lower or even zero, and others whose consumption will increase far more.

Before one can do this, however, it is necessary to examine the question of whether it is at all possible to make statements about how the world population will probably develop. The trend during the last 50 years shows that as a result of growing prosperity in the world [4 - 6], the growth rate of the world population – which was 2.1% per year between 1965 and 1970 – reached its peak during this period and almost halved to < 1.1% per year between 2015 and 2020. The world population is growing at lower growth rates so that, from today's perspective, no exponential growth can be assumed – but instead logistical growth that approaches a limit value asymptotically. This fact will probably lead to the world population in 2100 asymptotically growing to a value of 9.4 - 12.7 bn. with 95 % probability [6]. Whereby world population growth during the coming decades will largely be due to increasing population in Africa, south of the Sahara, while population numbers will fall in several other regions, of which Europe is one. In 2019, China (with 1.43 billion people) and India (with 1.37 billion) were the world's two most populated countries, representing 19 and 18 percent respectively of the total world population [6]. As a result of its industrial development since the turn of the millennium, China has become the world's most important market participant regarding the consumption and production of many raw materials (Fig. 1) and, with a nominal gross domestic product (GDP) of 14.3 trillion US dollars in 2019, has become the second-largest economy after the USA (21.4 trillion US dollars) [7]. Compared to this, the nominal GDP in Germany in 2019 was 3.9 trillion US dollars and in India 2.9 trillion US dollars. This shows the enormous development potential that can be assumed for India.

Fig. 1 clearly shows the importance of China regarding the global consumption of raw materials, and that – as a result of this structure – future development on the global raw material markets will be determined by how China's economy develops during the coming decades. In this regard, in the mid- and long-term, it is necessary to take into account the fact that according to the most recent census [8], the population of China is falling considerably quicker than had been assumed and will probably reach its maximum next year – and not in 2030 as had been believed. In an aging society with fewer people of working age, the trend will be towards a growing number of pensioners – who will have to be provided for, leading to a decline in economic growth (the same applies for Germany). This development could lead to "China becoming old before it can become rich" [8].

Before this demographic development can have clearly noticeable effects on economic development, it can be assumed that China will change from an industrial to a service economy, like Japan and the traditional industrial nations of Europe did at the start of the 1970s [10, 11].

The transition from an industrial economy to a service economy

The structural change from an industrial to a service society in the affected economies has led to declining growth rates for raw material consumption or, under certain circumstances, the consumption of particular raw materials actually falling. Thus, for example, saturation effects can be detected in the production of steel, as well as iron, steel and malleable cast iron castings, in Europe and Germany [10, 11] since the beginning of the 1970s which – despite intermittent strongly fluctuating production quantities and recovery phases during the last 50 years – show that production quantities are no longer at the levels seen at the start of the 1970s.

Similar trends in these logistical growth functions – not as pronounced as for world crude steel production – are also recognizable in the quantities of copper, nickel and zinc produced worldwide (**Fig. 2**) during the period from 1970 to about 1995. Aluminum

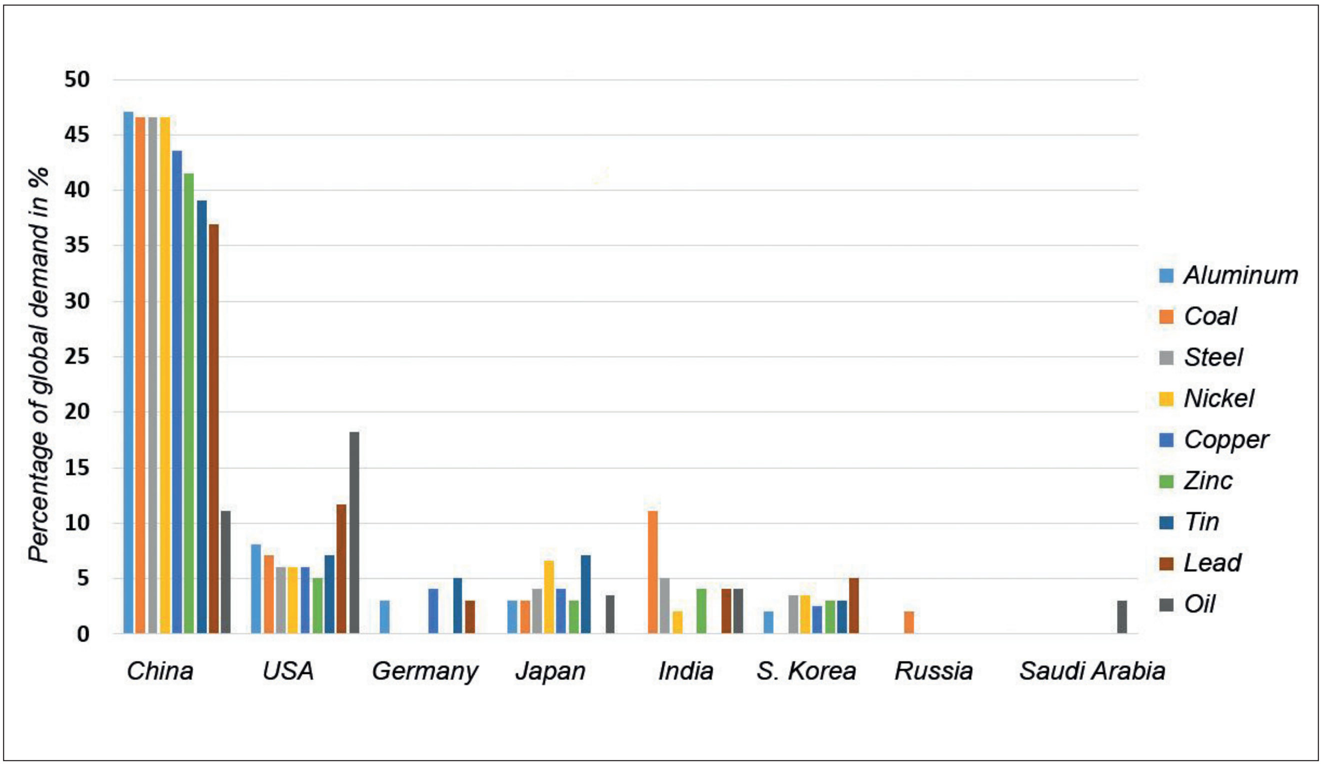

Figure 1: The five most important nations' share of global demand – by industrial raw material in 2017, according to data from the Federal Institute for Geosciences and Natural Resources (BGR) [9].

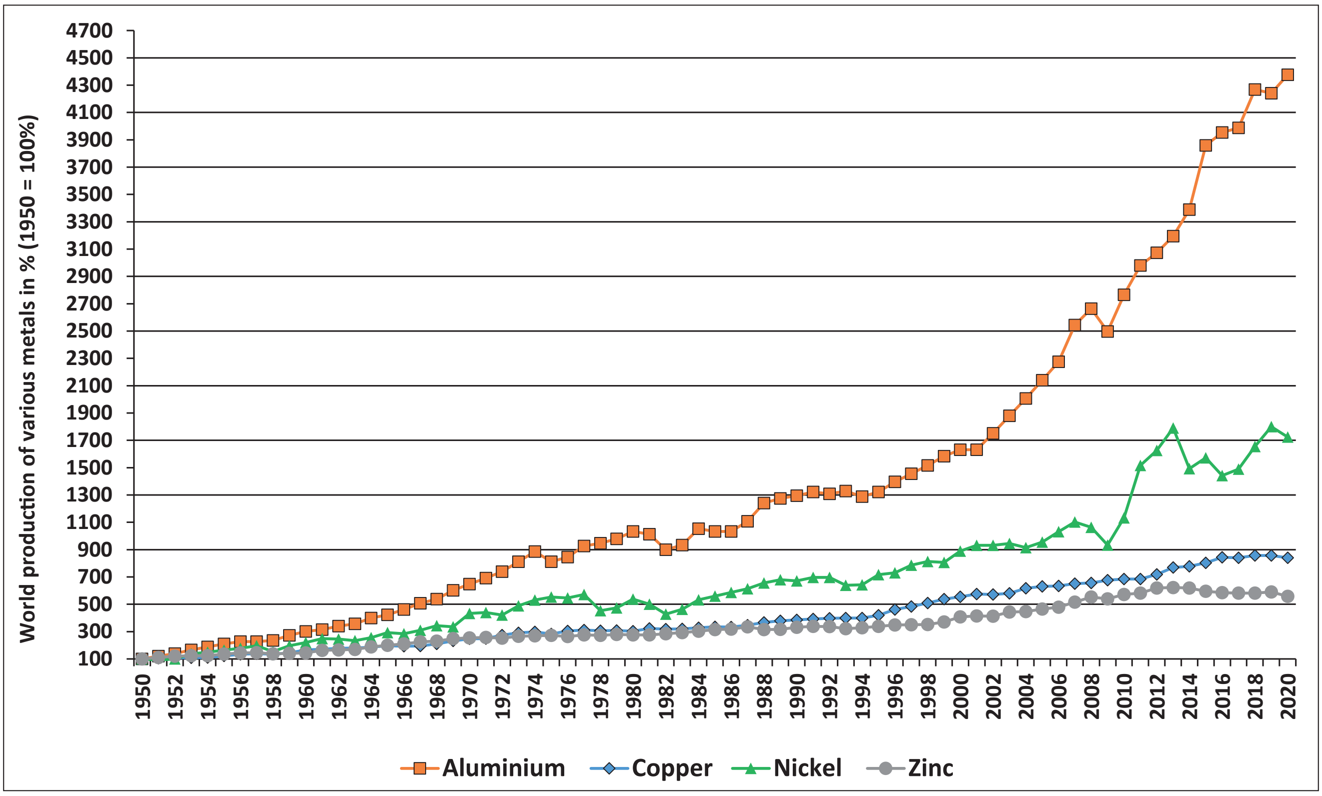

Figure 2: Developments in global mined production of aluminum, copper, nickel and zinc compared to production levels in 1950 (100%) according to data from the Mineral Yearbook of the U.S. Geological Survey [12].

production, however, has only been slightly affected. The saturation effects during this period, on the other hand, are very clearly recognizable when global mined production of metals per capita (Fig. 3) is considered. After 1995, considerable growth rates in the production of the metals are again clearly seen, caused by industrial development in China whereby, however, here too it may be possible to detect a trend towards more constant raw material consumption per capita from 2013 onwards.

The rise in nickel production (Fig. 2) during the period from 2010 to 2013 was largely due to increased nickel production in Indonesia and the Philippines

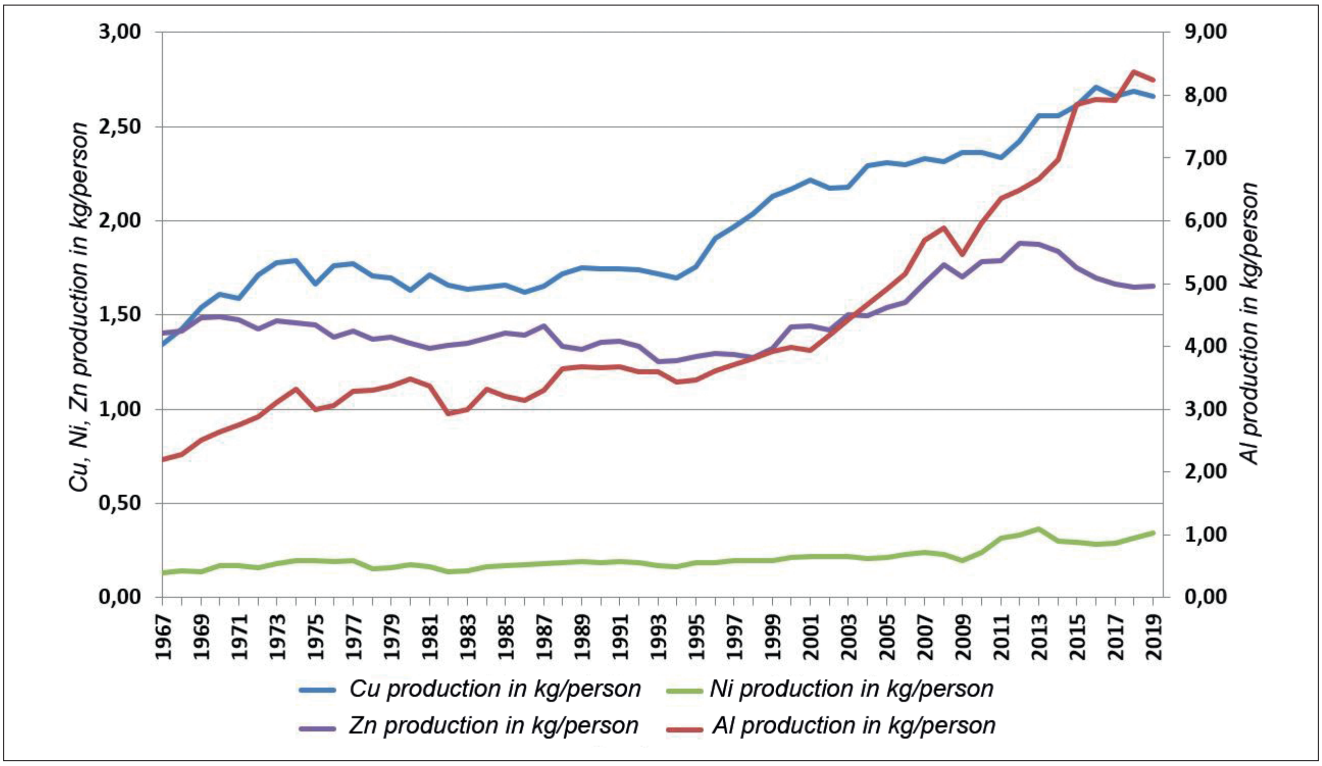

Figure 3: **Developments in global per capita mined production of aluminum, copper, nickel and zinc according to data from the Mineral Yearbook of the U.S. Geological Survey [12] and the World Bank [7].**

[12]. During this period, Indonesia was China's most important supplier of nickel ores and – given an assumed increase in global production of high-alloyed steel (particularly high-grade stainless steel), 60% of which is produced in China – nickel production in Indonesia rose to about 834,000 tonnes in 2013, which represented 31% of world production. In 2014 legislation by the Indonesian government [13] banned the export of nickel with the aim of increasing its own real net output ratio (production depth).

As a consequence, there was a drastic reduction in nickel production (177,000 tonnes/year) though nine melting plants were built up to 2017 and more are planned. Annual production was up to 853,000 tonnes again in 2019. The export ban was temporarily loosened for ores with low nickel contents but, after a recent revision [14], since January 2020 it has been illegal to export nickel ores even with lower nickel content.

Any new future saturation limits indicated for nickel and copper must, however, be considered against the fact that both metals play a major role in the development of e-mobility – and their consumption thus depends upon how e-mobility actually develops. Regarding the consumption of nickel, it should also be mentioned here that nickel is currently also used in larger quantities in super-alloys, from which components are typically made for the aerospace industry and turbine technology. Therefore the future consumption of nickel will also depend on how the aerospace industry recovers and how energy really is generated worldwide.

Metal consumption in Germany between 1950 and 2017 is shown in Fig. 4. It can be seen that, apart from during the economic crisis of 2008, aluminum consumption increased almost linearly during the period under consideration, due to an increase of applications in vehicles, as well as in the building and packaging industries. Compared to this, copper consumption in Germany between 1970 and 1990 remained almost constant and only rose again from 1990, whereby this increase is probably because of Germany's reunification. Further development up to the world economic crisis in 2008 conforms to general development of the world economy during this period. Fig. 4 also shows that zinc consumption in Germany remained largely unchanged for almost 30 years, despite the fact that zinc was increasingly used for corrosion prevention in the automotive industry during this period. In contrast, nickel consumption has clearly fallen since the turn of the millennium. As about 70% of the nickel is currently used in the production of alloyed steels (particularly high-grade stainless steel), nickel consumption mainly depends on the production of these steel grades whereby, in quantity terms, high-grade stainless steel plays the greatest role – with production in Germany of 1.7 m. tonnes in 2006 and only 1.1 m. tonnes in 2013. With nickel contents of these steels averaging 5 - 10%, this would theoretically correspond to a fall in nickel consumption of 30,000 – 60,000 tonnes. As a result of the shutdown of two electric arc furnaces for the production of high-grade stainless steel (in 2014 and 2015), only 436,000 tonnes was produced in Germany in 2017 [15] and nickel consumption is now at about 60,000 tonnes/year.

Fig. 5 shows metal consumption in the USA [12], the world's largest economy and, apart from nickel, it can be seen that metal consumption between 1970 and 1990 remained almost constant – except for during the world economic crisis of 1975, which resulted from the oil price increases between 1973 (3 US dollars/barrel) and 1974 (12 US dollars/barrel). It can be seen that consumption rose between 1990 and 2000 and then fell again thereafter, when the effects of the world economic crisis in 2008 became apparent. Regarding nickel consumption, it should be noted here that Fig. 5 only shows the

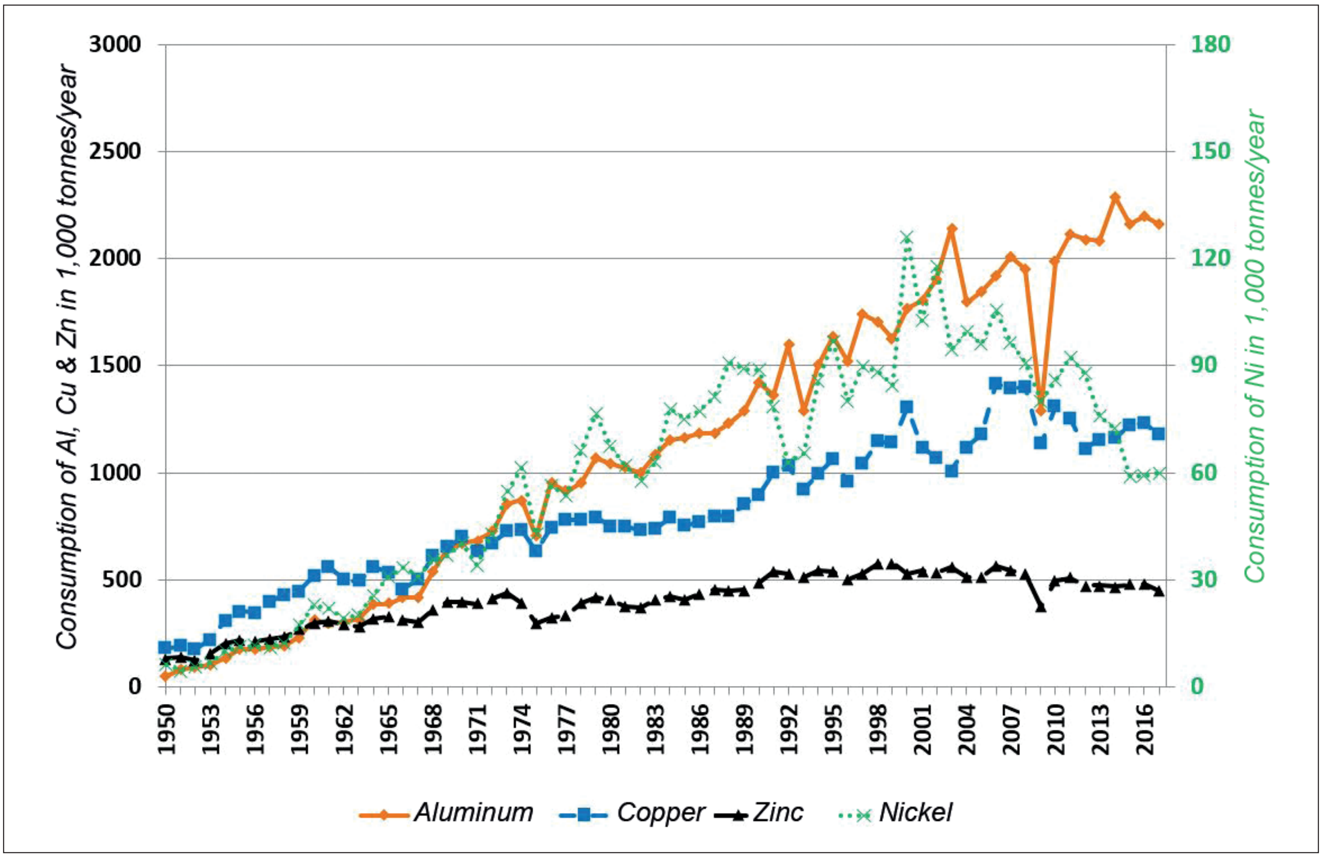

Figure 4: Metal consumption in Germany between 1950 and 2017 according to data from [11].

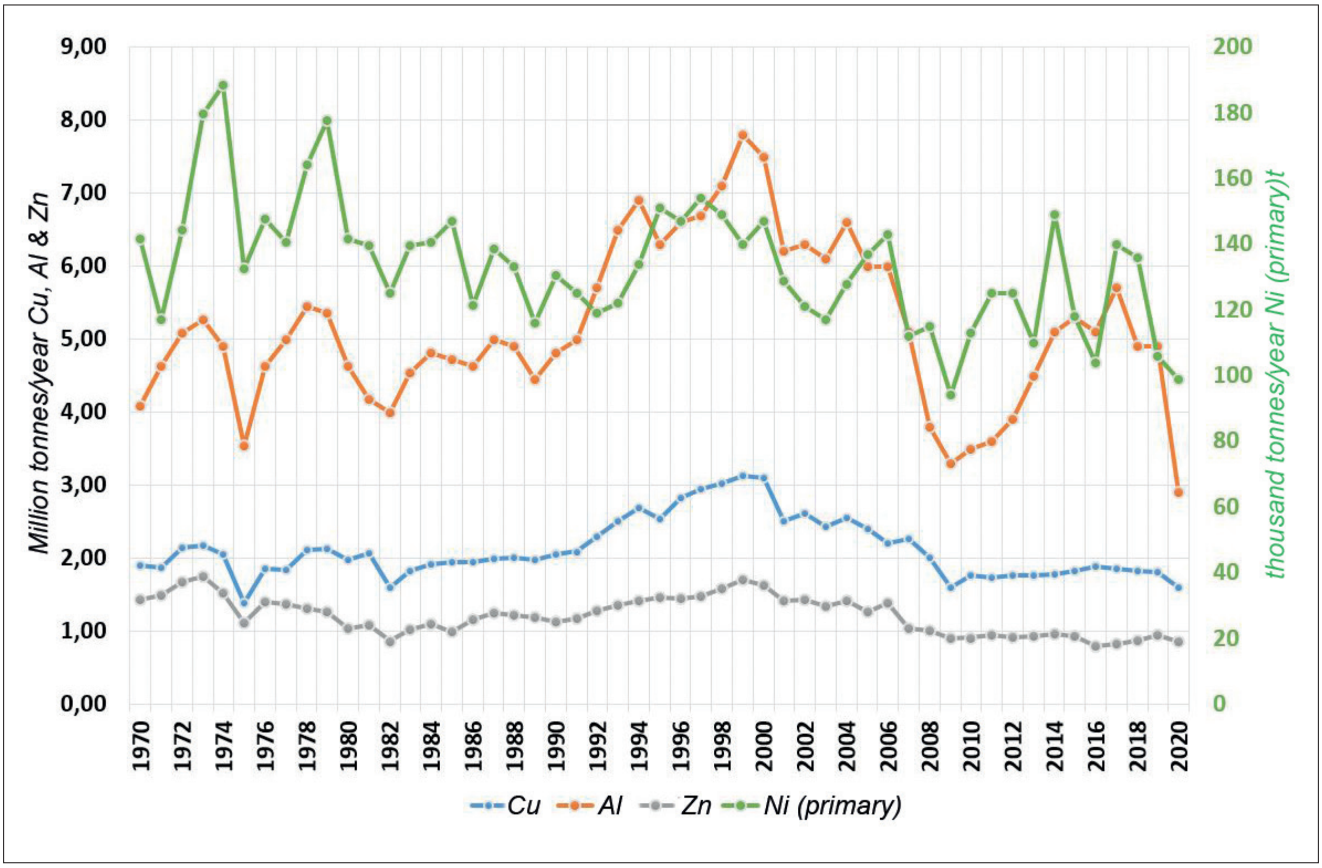

Figure 5: Metal consumption in the USA between 1970 and 2020 according to data from [12].

consumption of primary nickel, but that from 1980 increasing quantities of secondary nickel were used – so that a total of 217,000 tonnes of nickel was consumed in the USA in 2019, of which only about half (106,000 tonnes) consisted of primary nickel [12].

The metal consumptions shown in Figs. 4 & 5 are a sign that GDP is generated differently in a service economy than in an industrial economy. With the structural change from an industrial to a service economy there is also a social change because industrial jobs are lost while increasing numbers are found outside industry in sectors such as commerce, social services, finance and public administration. This means that fewer specific raw materials and less energy (oil equivalents) [11] are required to generate one unit of GDP (e.g. 1 m. US dollars). Developments in Germany, as well as in the other traditional industrial nations, show that GDP growth rates are lower in service economies.

In China, the tertiary sector contributed more to GDP than the secondary sector for the first time in 2012. It is therefore to be assumed that China will develop into a service economy during coming years [11]. Consequently, it can be expected that raw material consumption will change in the same way as in the traditional industrial nations since the start of the 1970s, which would mean moderate growth of raw material consumption on the world markets – which will be determined in the medium to long term by economic developments in India and Africa. As a result of the completely different political structures in these countries, it remains to be seen at what rates these economies will develop.

The special aspects of raw material markets

The price structures on the markets for energy and non-energy raw materials – as long as trading is carried out at exchanges – are very greatly influenced by futures transactions, whereby most of these transactions (> 98%) do not lead to real transfers of goods and money [16, 17]. Trading on exchanges makes the market transparent, and developments are largely comprehensible for all market participants. In theory, markets should actually be objective – but in reality they may not be under certain circumstances because they are influenced by psychological and speculative elements that have nothing to do with the fundamental data. In this age of wide-ranging and rapid communication and audiovisual reporting in today's modern media, this risk is many times greater than was the case decades ago when psychological and speculative influences spread very much slower. But ultimately it is still the case that markets are determined by real supply and demand when considered in the medium and long terms. As raw materials are traded in US dollars, exchange rates also tend to play a role.

The following phases can be derived from the global price developments shown in **Fig. 6**:

> Extreme price increases in a market driven by demand for industrial raw materials can be seen as a consequence of industrial development in China from 2003 until the world economic crisis in autumn 2008. It is interesting that nickel and zinc prices collapsed in mid-2007, i.e. about one year before the economic crisis.

> An increase in metal prices, particularly copper, can be seen between 2009 and 2011 which should very probably be seen in connection with economic packages that had been introduced worldwide to overcome the crisis.

> While the period from 2011 to autumn 2016 is characterized by fluctuations, the trend is towards decreased metal prices. In this connection (see Fig. 1), it is necessary to take into account the fact that average annual economic growth was 10.8% in China between 2003 and 2010, but only 7.3% between 2012 and 2016. The official rate of GDP growth for 2019 was 5.95% [7].

> The increase in metal prices between 2016 and 2018 may be because economic growth grew from 1.64% in 2016 to 2.9% in 2018 following the presidential election in the USA in autumn 2016 [7].

> The decreasing prices since 2018 are probably due to disturbances in international trade [19] resulting from the introduction of a variety of special duties by the American government.

> Increased metal prices can be seen from the second quarter of 2020, undoubtedly due to successes in overcoming the coronavirus crisis. At present, it can already be seen that positive economic development, particularly in the USA and China, is leading to price increases – whereby it is not currently recognizable to what extent these developments have a fundamental basis or are caused by the statements about presumed future development that are being intensively communicated in the media.

In the current situation, it must be assumed that the actual development of e-mobility will play an important role in the future development of some mineral raw materials. Worldwide, 2.1 m. purely battery-powered (BEVs) and plug-in hybrid vehicles (PHEVs) – of which 1.2 m. in China alone – were registered in 2018 [20]. Thus the global proportion of newly registered e-vehicles was 2.2% of total registrations in 2018. 3.4 m. vehicles were registered in Germany in 2018, of which 1% were BEVs and 3.8% were PHEVs. The current growth potential of these alternative drives can be seen from the fact that 2.9 m. vehicles were registered in Germany in 2020, of which 6.7% were BEVs and 6.9% PHEVs [21].

As a consequence of increasing e-mobility, it can be expected that the metals listed in **Table 1** and important for the development of e-mobility will undergo price rises. In particular, it can be assumed that this will be the case for the metals lithium, cobalt and nickel whereby, here too, it must be expressly pointed out that statements about markets can only be made with some vagueness. In this case, the uncertainty results, firstly, from the question of what battery type will prevail in the long term. According to [22], batteries with all the important electrochemical compositions (NCA, NMC, LMO, LFP) are currently being built, whereby it can be assumed that – given increasing energy density – the trend will be towards nickel-rich high-capacity NMC materials (NMC 811). Secondly, a global e-mobility battery capacity of 2 TWh [23] – with Europe using about 1 TWh [22] – is assumed, but this could well be higher or lower. The calculation assumed that 2 TWh battery capacity would represent the situation in 2030. Table 1 shows the quantities of raw materials that would theoretically apply if this was to happen using only NMC 111 batteries, or using only NMC 811 batteries – which contain less cobalt, but more nickel.

According to the NMC 111 scenario, annual production quantities in 2030 would be about 3.8 times greater for lithium and about 5.6 times greater for cobalt than is now required. In the NMC 811 scenario, the additional cobalt requirement for e-mobility, however, would be significantly reduced to about half today's requirement. But in contrast to this, the nickel required for

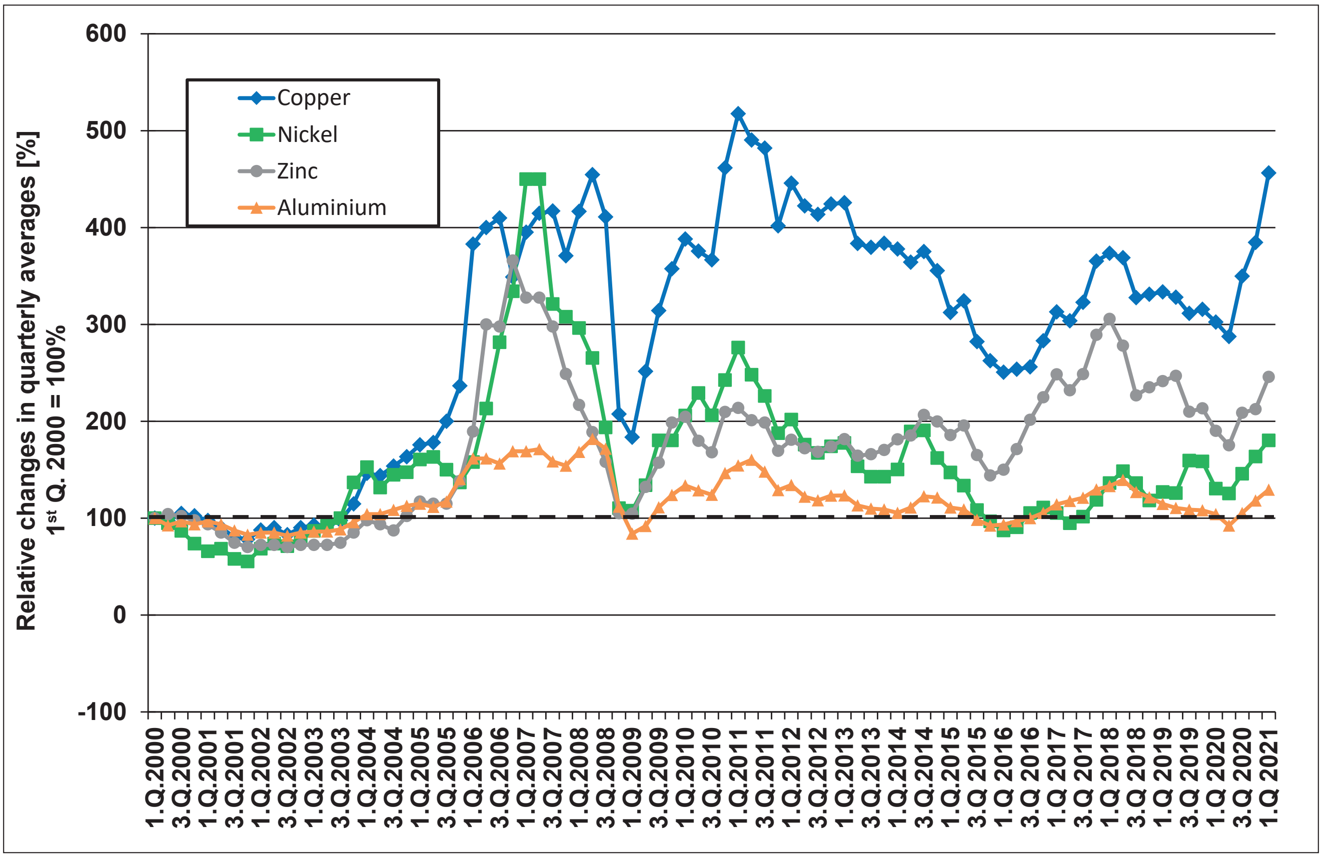

Figure 6: Global price developments for aluminum, copper, nickel and zinc between 2000 and 2020 according to data from [18].

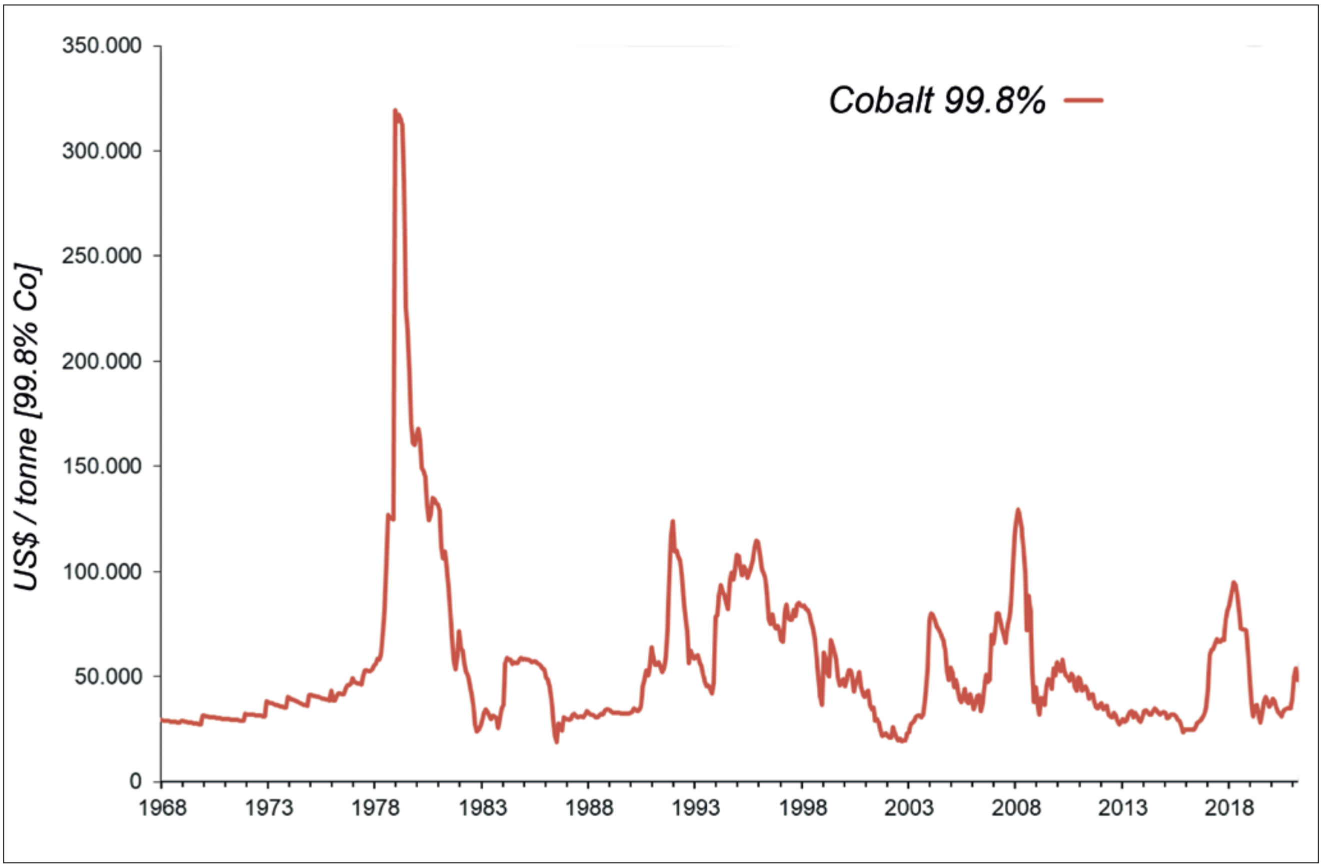

Figure 7: Global price development for cobalt between 1968 and 2020 [27].

Table 1: Calculations of possible future annual metal requirements in 2030 assuming a battery capacity of 2 TWh, and assuming that this is made up only using NMC 111 (nickel, manganese, cobalt 1:1:1) batteries or only NMC 811 batteries [24, 25].

Element	Current metal production acc. to [12] in tonnes/year	Consumption of NMC 111 in kg/KWh acc. to [24,25]	Consumption of NMC 811 in kg/KWh acc. to [24,25]	Consumption of NMC 111 in 2030 in tonnes	Consumption of NMC 811 in 2030 in tonnes
Lithium	77,000	0.148	0.107	296,471	214,118
Nickel	2,500,000	0.395	0.749	790,588	1,498,824
Cobalt	140,000	0.395	0.033	790,588	65,882
Manganese	16,600,000	0.371	0.091	741,176	181,176
Copper	20,400,000	0.300	0.300	600,000	600,000

e-mobility in 2030 would rise by an additional 1.5 m. tonnes/year, corresponding to about 60% of current production.

Independent of the scenarios considered above, two other studies [22, 26] point out that raw materials such as lithium, cobalt, nickel, graphite and platinum are present in sufficient quantities for rapid worldwide growth of e-mobility. While it is correct that there are currently no problems regarding reserves and resources, these facts do not, however, permit any forecasts about how prices could increase – due to the oligopolies and monopolies that are sometimes found in the raw materials sector. It should be pointed out here that the nickel price in 2003 averaged 10,000 US dollars/tonne rising to 37,000 US dollar/tonne in 2007 (Fig. 6) but that in this period nickel production only rose from 1.37 m. tonnes in 2003 to 1.60 m. tonnes in 2007.

The purely theoretically calculated metal costs for a 30 KWh NMC 111 battery at current metal prices [9] may therefore be somewhere in the region of 1,100 US dollars and for an NMC 811 battery about 580 US dollars. The lower metal costs for the more nickel-rich NMC 811 type are due to their lower cobalt content – currently the most expensive metal in the battery, at about 52 US dollar/kg.

Cobalt is one of the metals that has commonly undergone extreme price fluctuations since the turn of the millennium. The time series [27] for the prices of various metals, shown in Figures 7 – 11, present different examples of how price increases can appear and disappear again very suddenly due to the dominant positions of market participants on both the supply and demand sides – in combination with corresponding statements about the changes that may be expected. In many cases, the global markets for metals are characterized by about 50 - 70% of total world production taking place in just three countries where the particular metals are mined. The same distribution of 50 -70% also applies for global consumption of these metals by the three most important countries, though it is not always the same countries that are involved in the mining activities. As already shown in Fig. 1, China is often the country that both produces and consumes the largest amounts of the affected metals – so economic development in China (on both the demand and supply sides) has determined developments on the global raw material markets during the last 20 years, and will continue to do so. The global markets for the metals whose price developments are shown can be characterized as follows.

Cobalt

As previously mentioned, cobalt is currently one of the most important metals in the production of lithium-ion batteries. 140,000 tonnes of cobalt were mined in 2020 [12], 61% of which came from the Democratic Republic of Congo (DRC). 50 - 60% of the world's cobalt is currently used in lithium-ion batteries, whereby their market relevance is roughly twice as great in the electronics sector as in e-mobility. In the metal industry, cobalt is used as an alloying element in tool steels and for the production of super-alloys [28]. The production of chemicals containing cobalt mainly takes place in China, where the production of lithium-ion batteries also takes place – with a global market share of about 75%. As a result of Chinese investments in the DRC and other countries, China has been able to reduce its net dependency on imports of ores containing cobalt and intermediate products from 97% to an estimated 68% [29]. The price rises in 1978 were due to the USA no longer selling cobalt from its own stocks [30]. During the period around 1994, war in Ruanda and the flight of hundreds of thousands of refugees to the DRC led to almost uncontrollable political conflicts [31], as a consequence of which the prices for cobalt rose. The price rises from 2015 were probably due to statements made about the potential future development of e-mobility and, here too, it turned out that prices actually developed differently.

Vanadium

Vanadium production in 2020 amounted to about 86,000 tonnes and the most important producing countries were China (62 %), Russia (21 %) and South Africa (9 %), which together accounted for 92 % of the world's mined production.

91 % of vanadium is used in iron alloys and high-strength steels, as well as in mixtures of iron and aluminum. It is used for catalytic converters for the aviation and space industries, for pipelines in the oil and gas industry, and for surgical equipment. 51% of vanadium is used by China – so China has the dominant position on both the supply and demand sides. The drastic price rise in 2018 (Fig. 8) was due to the Chinese government increasing the vanadium content in structural steels through a change to the standards [32] to improve their strength properties. Actual implementation of this, however, took place slower than originally intended [12], and the consumption of vanadium in the USA fell from 9,980 tonnes in 2018 to 4,800 tonnes in 2020, whereby global production during this period rose from 71,000 tonnes/year to the above-mentioned 86,000 tonnes/year in 2020, with the consequence that prices for vanadium drastically crashed again.

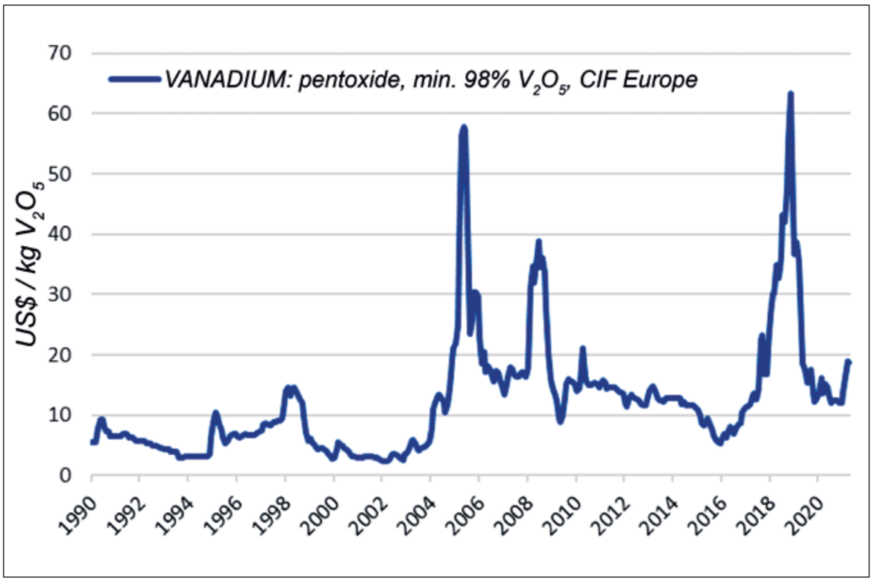

Figure 8: **Global price developments for vanadium pentoxide between 1990 and 2020 [27].**

Figure 9: **Global price development for molybdenum between 1990 and 2020 [27].**

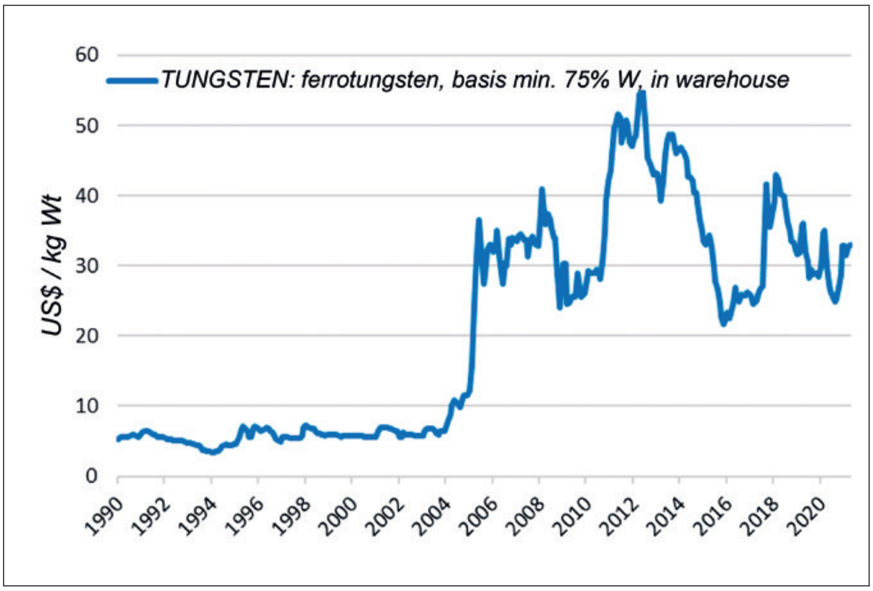

Figure 10: **Global price developments for tungsten between 1990 and 2020 [27].**

Molybdenum

Molybdenum production was about 300,000 tonnes in 2020 and the most important countries were China (40 %), Chile (19 %) and Australia (16 %) [12], which together represented 75 % of global mined production. About 70 % of the molybdenum is used in alloyed steels. As almost 60 % of these steels are produced in China, about 40 % of molybdenum is consumed in China – so China also holds the dominant position here on both the supply and demands sides. From 2011, molybdenum prices (Fig. 9) developed similarly to those of the metals described in Fig. 6.

Tungsten

About 84,000 tonnes of tungsten was produced in 2020 and the most important country was China, with a world market share of 82 % of mined production. Tungsten is used for products in the transport industry (34 %), in the mining and construction industries (21%), and in mechanical engineering (11 %). The worldwide supply of tungsten is dominated by production in China and exports from China. The Chinese government regulated the tungsten industry by limiting the number of mining and export licenses, defining quotas for production of the concentrate, and introducing restrictions on mining and processing. The Chinese government wanted production of tungsten concentrate outside China to remain at less than 20 % of world production in 2020 [12]. Again, China also holds the dominant position for tungsten on both the supply and the demand sides. From 2011, tungsten prices developed similarly to those of molybdenum and the metals described in Fig. 6.

Tin

About 270,000 tonnes of tin were produced in 2020 and the most important countries were China (30 %), Indonesia (24 %) and Myanmar (12 %) [12], which together accounted for 66 % of global mined production. The refined tin produced worldwide in 2019 [33] was mainly used for tin solder (49 %), chemicals (18 %) and tinplate (12 %). China is responsible for about 45 % of tin consumption, which is probably because of the high proportion of electronic products manufactured in China. So here, too, China holds the dominant position on both the supply and demand sides. From 2011, tin prices (Fig. 10) developed similarly to those of

Figure 11: Price developments for tin in the period from 1990 to 2020 [27].

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the metals described in Fig. 6, whereby the price rise in 2020 was considerably greater than was the case for the other metals. This may be due to the fact that Myanmar, an important producing country, was worse hit by the Covid-19 pandemic than its neighbors [34], so that less tin could be produced – and the limited supply and rising demand from China and the USA led to considerably higher prices.

Summary

Economic processes are characterized by being shaped by people, companies, politics, and numerous other opinion-forming institutions whose perceptions change the rules of social systems. In the social debate we find ourselves in the middle of a discussion whose consequences will be profound changes – though the real effects can only be described with some vagueness because facts are influenced by statements made about them. What this means can currently be seen very clearly in the discussion about vaccines and their actual effectiveness. Here, public communication about the side-effects of the vaccines – very strongly led by non-experts – influences their actual acceptance, and therefore their current sales potential. This correlation between thinking and reality in business leads to "markets being inherently unstable" [1] so that statements are only possible with a certain degree of vagueness.

With this in mind, it can be assumed that a growing world population will also consume more energy and non-energy raw materials, though the population is growing at lower growth rates and will probably reach its maximum in around 2100 with a population of between 9 and 12 bn.

Due to its industrial development, especially since the turn of the millennium, China has become the most important global market participant regarding the consumption and production of many raw materials, and has risen to the second-largest economy behind the USA. According to the most recent census in China, it can be assumed that the population will contract considerably more rapidly than previously thought. Before this demographic development can have clearly palpable effects on economic development, it can be assumed that China will have changed from an industrial to a service economy, as was the case in Japan and the traditional industrial nations in Europe at the start of the 1970s. The structural change from an industrial to a service economy leads to lower growth rates for raw material consumption and, under certain circumstances, a fall in the absolute consumption quantities of particular raw materials, as can be seen from the example of the consumption of some metals in the USA and Germany. In addition, developments in Germany and the other traditional industrial nations show that GDP growth rates are also lower in service economies.

Prices on the markets for energy and non-energy raw materials are very greatly influenced by futures transactions, as long as trading takes place on exchanges. Developments are comprehensible for all market participants and in theory markets should actually be objective, though in reality under certain circumstances they are not – when they are influenced by psychological and speculative elements that have nothing to do with the fundamental data. In today's age of extensive and rapid communication and audiovisual reporting in modern media this risk is many times greater than was the case decades ago. Developments regarding e-mobility are also to be considered in this light, because they will very greatly determine the markets for lithium, copper and nickel in future.

Although no problems regarding future reserves and resources are apparent, this fact does not permit any forecasts of price increases that may occur – due to the oligopolies and monopolies that exist to some extent in the raw materials sector. It is not even possible to guess with some level of vagueness how prices will develop when the demand for metals such as lithium and cobalt may be three to five times higher than today's production quantities.

Prof. Dr. Rüdiger Deike is Professor of Metallurgy in Iron and Steel Production at the University Duisburg-Essen, Germany

The author thanks the German Mineral Resources Agency (DERA) in the Federal Institute for Geosciences and Natural Resources (BGR) for the time series on the development of metal prices.

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