Factsheet: Electric mobility and raw materials

– Needs, availability, environmental impact

Status: September 2020

Introduction

Battery[1] and fuel cell-based electric mobility is regarded as the key to reducing greenhouse gas emissions in the transport sector. The global ramp-up of electric vehicles is therefore necessary to achieve national and international climate protection goals. At the same time, the global vehicle population will increase significantly, particularly due to rising levels of prosperity in China and India. The global passenger car fleet alone is forecast to double to over two billion vehicles by 2050. With the increase in electric vehicles, the demand for battery storage is growing and with it the need for specific raw materials. Various studies calculate scenarios for the corresponding raw material requirements. In order to achieve the goal of sustainable electric mobility, new methods and processes in the production and recycling of the technologies must be fostered, and the environmental and social impacts of the mining of raw materials must be improved.

[1] The term battery is used synonymously with lithium-ion rechargeable batteries throughout the factsheet

Batteries and fuel cells – market ramp-up and raw material requirements

Due to their high energy density, durability and low maintenance requirements, lithium-ion batteries are primarily used in electric vehicles. In the case of hydrogen cars, low temperature fuel cells are used: The polymer electrolyte fuel cell (PEFC) is durable, requires little maintenance and has a high level of operating dynamics. For a more efficient production of hydrogen, polymer electrolyte membrane electrolysis (PEM) is currently under close observation. Raw materials, which are necessary for the production of these technologies, are shown in the overview (Fig. 1). With the market ramp-up of electric mobility, their demand will increase enormously, in part.

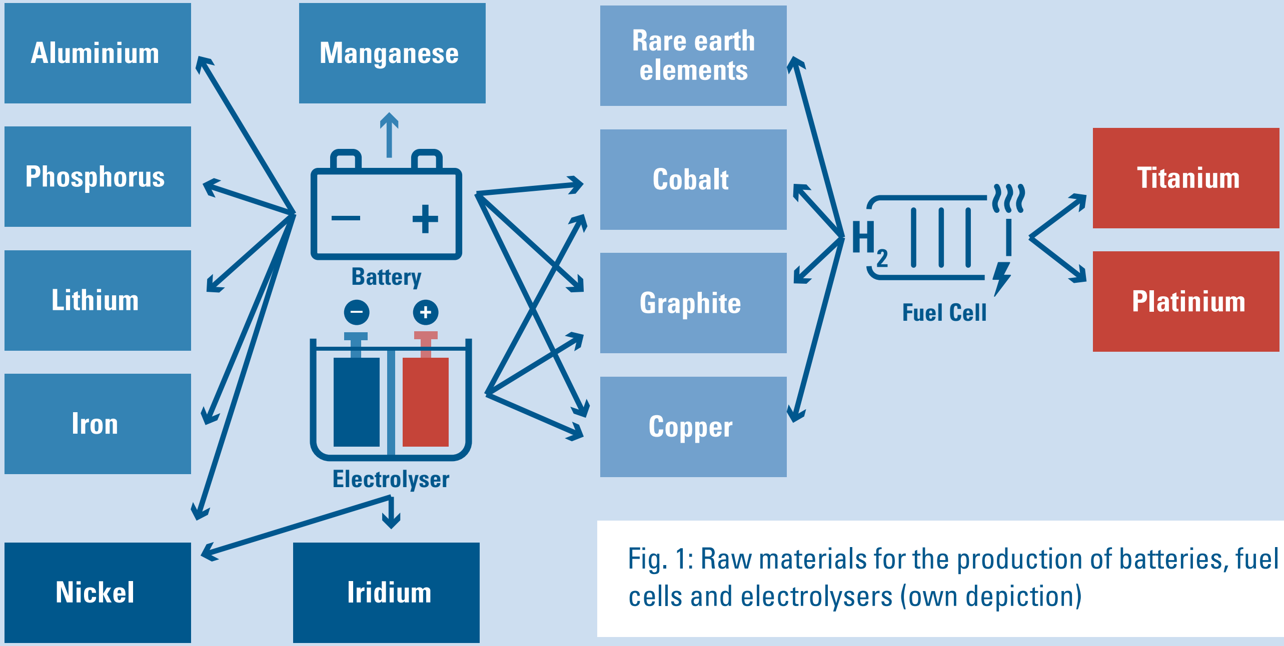
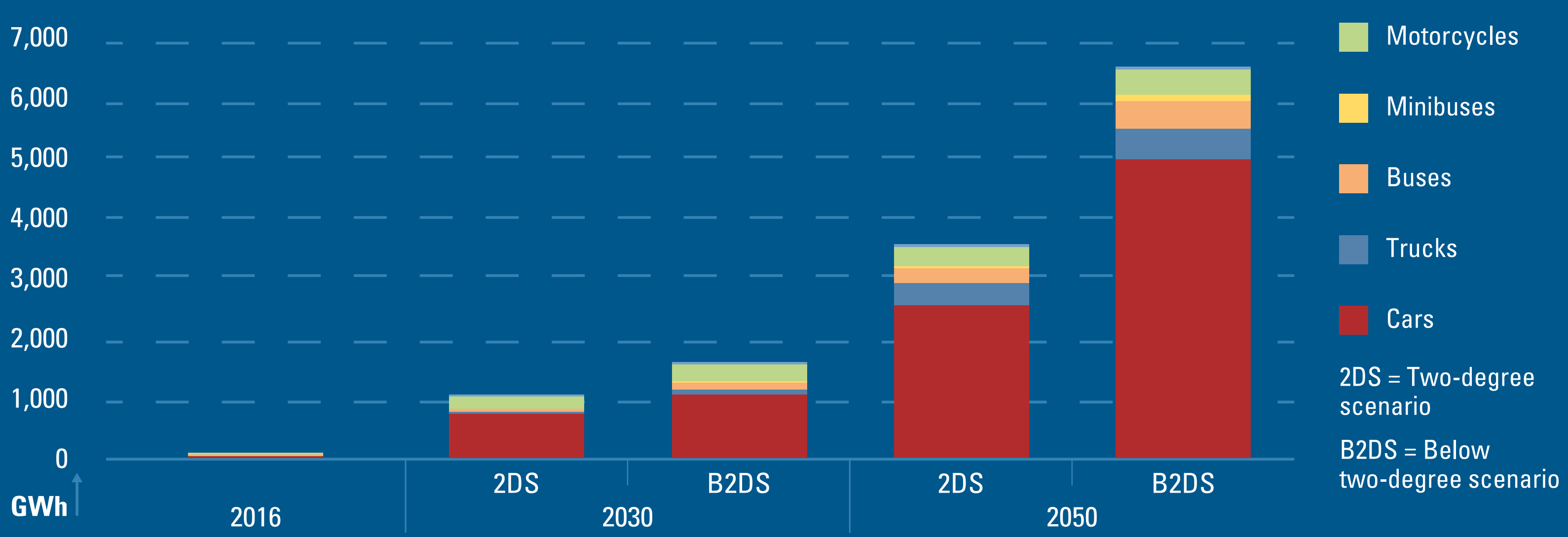


Fig. 1: Raw materials for the production of batteries, fuel cells and electrolysers (own depiction)

Passenger cars determine demand for battery capacity

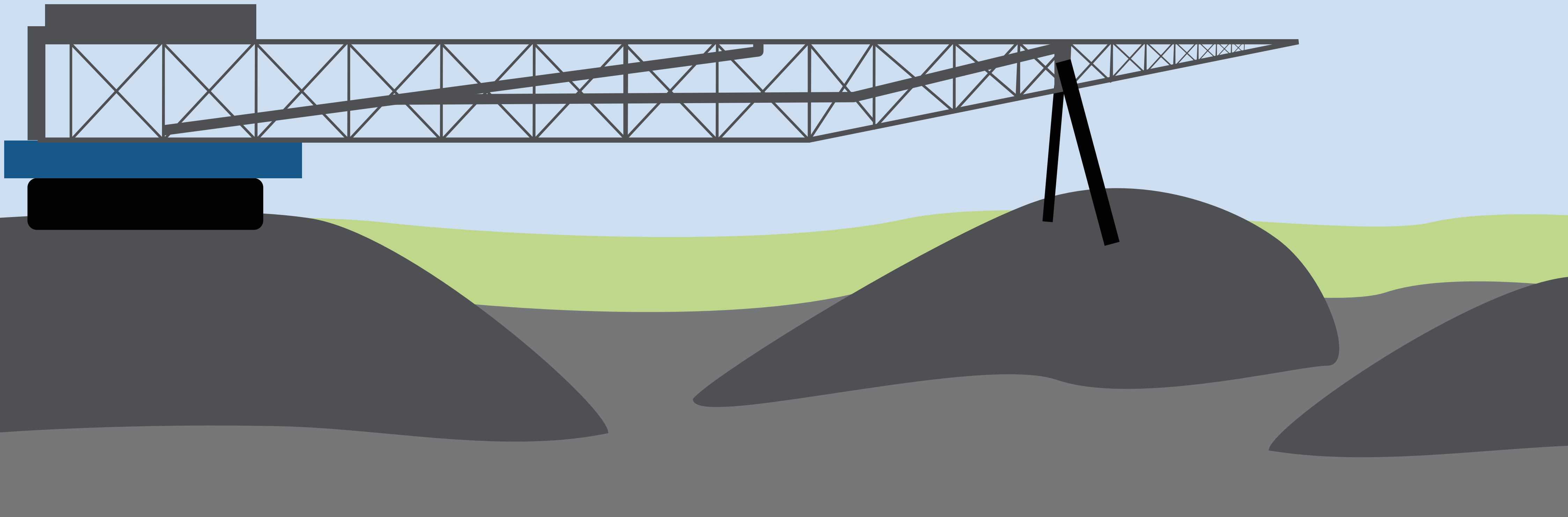
Fig. 2: Predicted demand for the total storage capacity of battery storage units for the various transport modes in different scenarios (Öko-Institut, 2019)



At present, global demand for battery capacity for electric vehicles is below 100 GWh due to relatively low market penetration. Storage requirements of 1,000 to 1,500 GWh are expected by 2030 and 3,500 to 6,600 GWh by 2050. Due to the large vehicle fleet and mileage, the global battery demand will be largely determined by passenger cars (75% share). Trucks and buses will contribute only marginally to total demand. (See Fig. 2.)

Overview of raw materials

The main raw materials that are essential for electric mobility are lithium, cobalt, nickel and platinum.
The global reserves and resources are presented in the following overview.



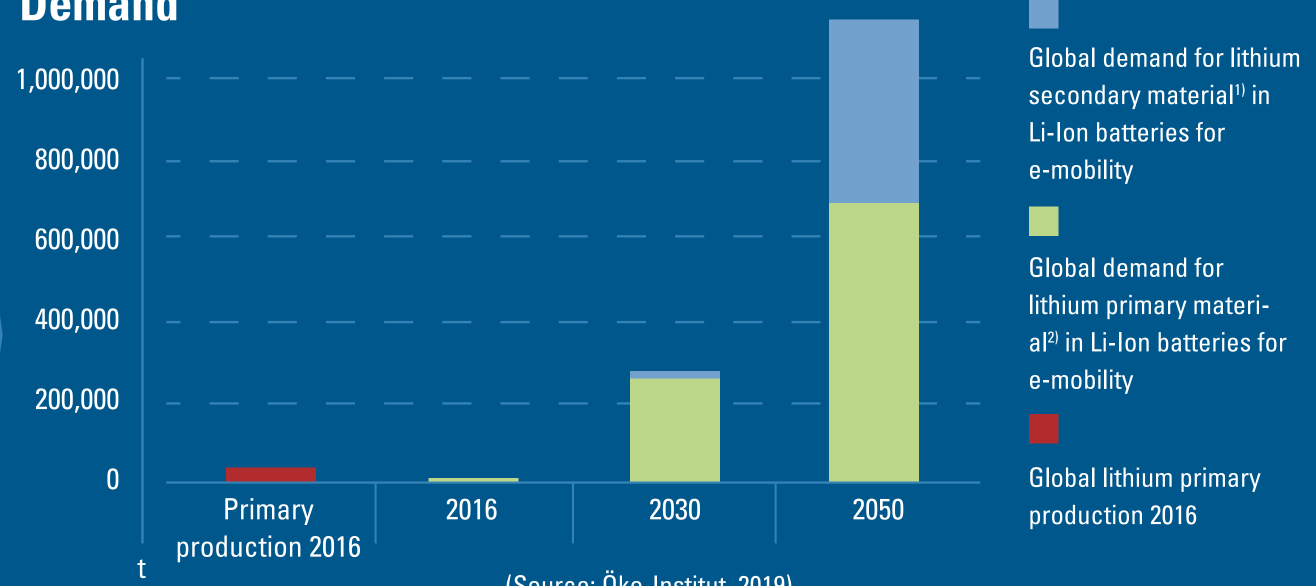
Lithium

36% of current output is used to produce lithium-ion batteries for electric vehicles

14 Mt
Global reserves

47 Mt
Global resources

Demand



(Source: Öko-Institut, 2019)

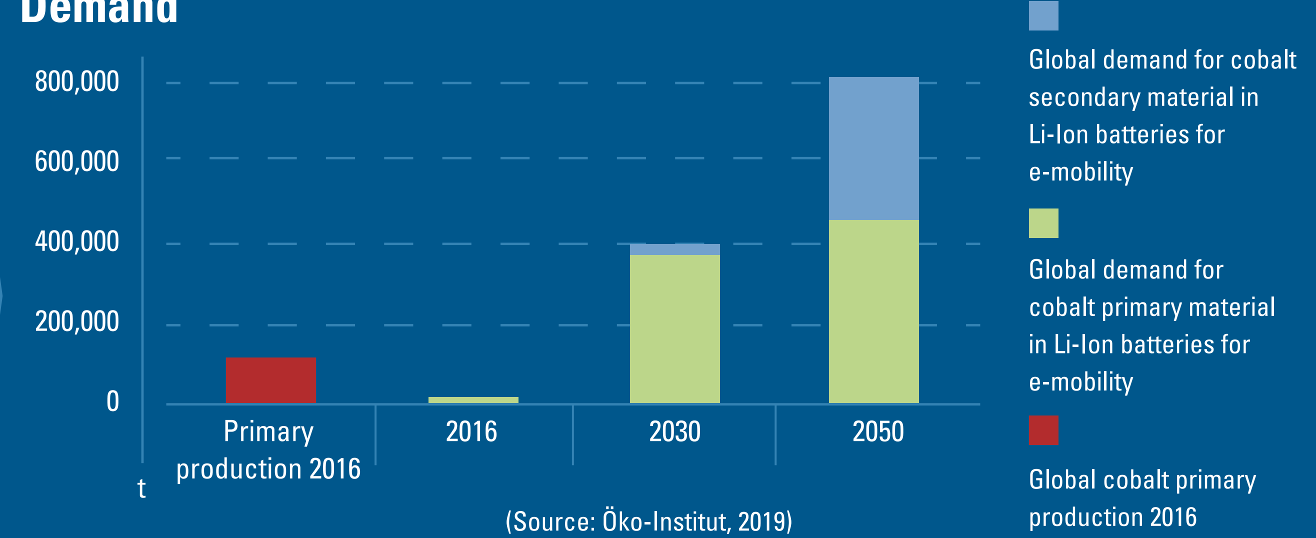
Cobalt

41% of current output is used to produce lithium-ion batteries for electric vehicles

7 Mt
Global reserves

25-120 Mt
Global resources

Demand



(Source: Öko-Institut, 2019)

1) Secondary material = processed primary material

2) Primary material = unprocessed, natural resources

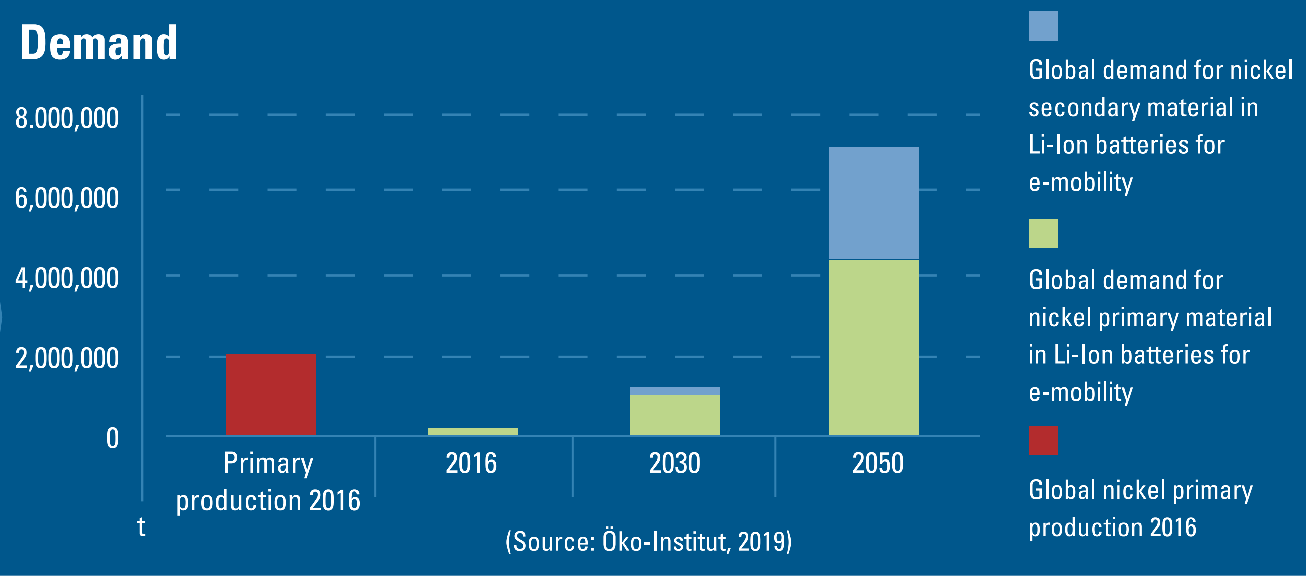
Nickel

High energy demand during mining causes immense GHG emissions (reduction of 30-60% possible through renewable electricity)t

74-79 Mt
Global reserves

130 Mt
Global resources

Demand



Platinum

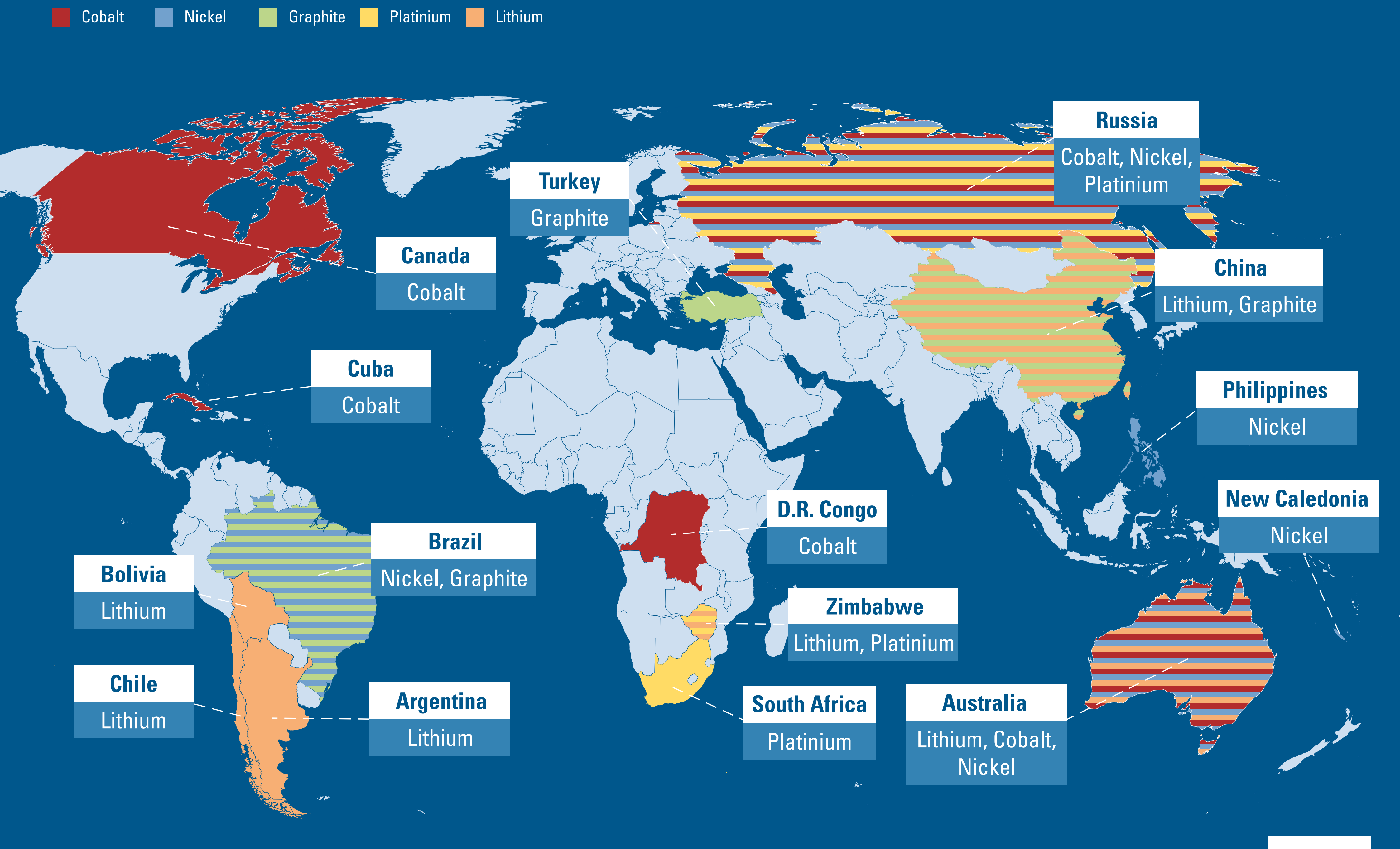
17% of current output is used for the production of fuel cells

Iridium

Catalyst in PEM electrolysis	Extremely low prevalence, 85% in South Africa
Substitution not foreseeable	Recycling is possible and partially realised

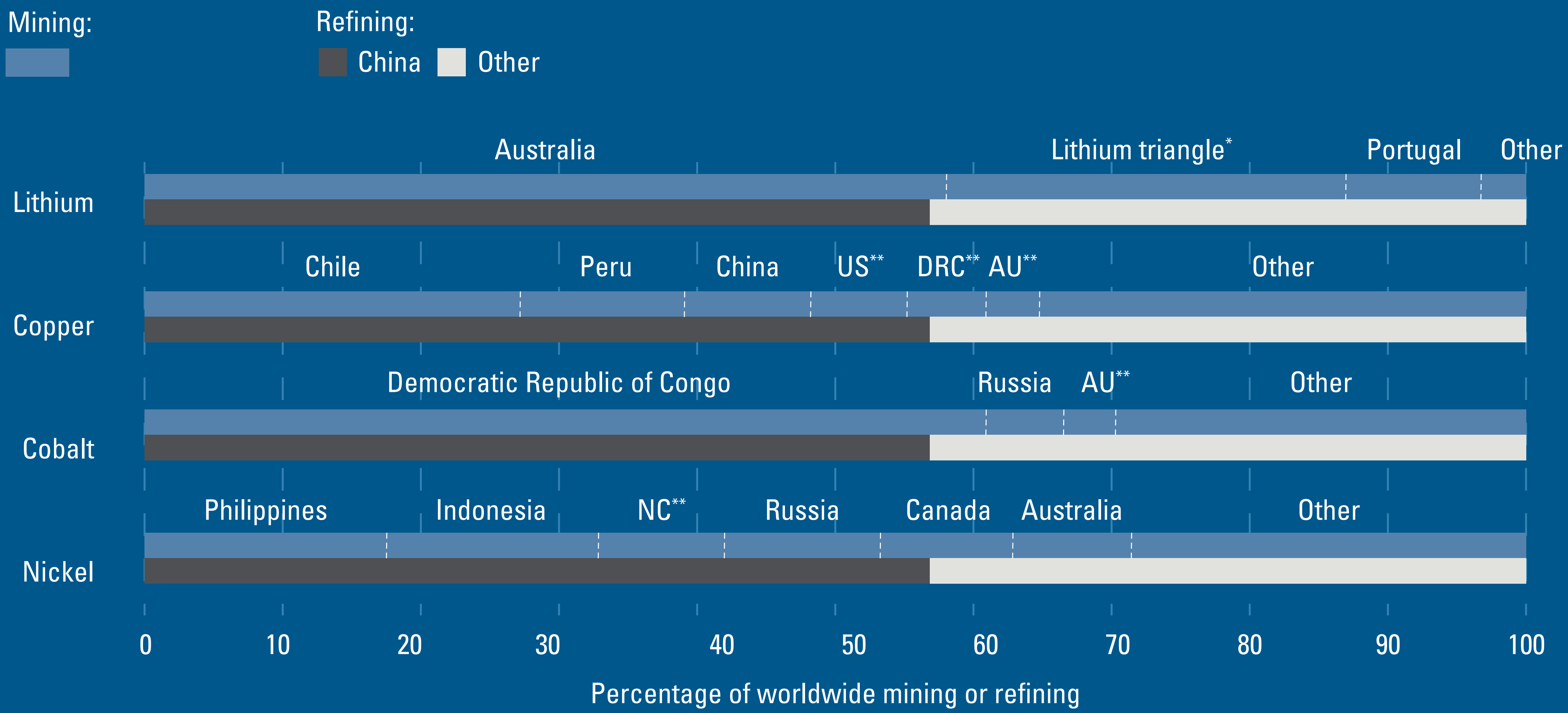
Besides the raw materials presented here in detail, other elements are needed for electric mobility. These include graphite, copper, aluminium, manganese, scandium, gallium, titanium and rare earth elements. The mining of these raw materials also reflects the complex problem of resource extraction discussed in this document.

Only a few countries with raw materials for electric vehicles



Main producing and refining countries of raw materials for electric vehicles

In order to use the raw materials in battery and fuel cell technologies, they must first be refined. Most of the refining process does not take place in the mining and producing countries, but mainly in China: Almost 60% of lithium and cobalt are refined there. The refining countries therefore have massive influence on the raw materials market.



(Source: IEA (2019): Global EV Outlook 2019 – Scaling-up the transition to electric mobility.)

* Lithium triangle: Argentina, Bolivia, Chile
** US: United States of America; AU: Australia; DRC: Democratic Republic of Congo; NC: New Caledonia

Environmental and social compatibility of critical raw materials

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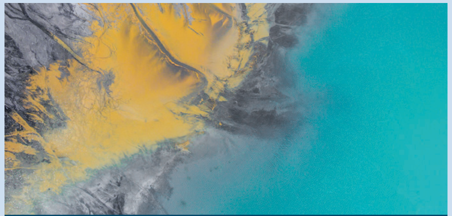
The effects of mining raw materials of all kinds can have a global impact – through associated greenhouse gas emissions, or a local impact – through emissions of other substances. A relative comparison of the different environmental and social impacts of raw material extraction in different locations is therefore difficult for both technical and ethical reasons. The informative value of Life Cycle Assessments (LCA) in terms of the environmental impact often suffers from the limited data available due to the lack of transparency of many mining companies and outdated or inadequate LCA databases. In addition, critical impact categories (e.g. ecotoxicity) are complex to model and there is still a great need for research. Nevertheless, it is necessary to identify and continuously minimise the negative consequences of raw material mining in practice.

Effects of raw material extraction on the ecological and social system

Water

Air

Flora & Fauna



Ground

Climate

Effects of mining activities	Ecological impacts	Social impacts
E.g. acid mine drainage, pollutant emissions, noise	E.g. endangering biodiversity, driving climate change	E.g. drinking water quality, migration

Sources: Sonter et al. (2020), Öko-Institut (2020), Oehoust et al. (2017), ELAW (2010)

In addition to the ecological impacts and their negative consequences for human life, political control over the extraction of raw materials has far-reaching local and geopolitical consequences. People in mining areas are often confronted with:

- Displacement and resettlement (sometimes under duress)
- Disregard of age limits, wages, working hours, occupational health and safety, etc.
- Restrictions on cultural and traditional values

Initiatives at the international political level and by industry to minimise these harmful effects are in dire need of being strengthened and legitimised.
(Source: Kickler et al., 2018).

Approaches towards solutions

As the extraction of raw materials can never be completely sustainable, the inherent risks must be minimised. There are several legally binding standards (e.g. EU legislation on conflict minerals) and various voluntary sustainability standards within international normative frameworks and principles. Major challenges are their heterogeneity, fragmentation due to the focus on individual raw materials or regions/countries, a lack of local/international legitimacy in some cases, and different legal frameworks and difficulties in cost recovery (Kickler et al., 2018). Current initiatives include the “Cobalt for Development” pilot project, in which the BMW Group, BASF SE, Samsung SDI and Samsung Electronics are seeking to improve the working conditions of people in a selected small-scale cobalt mine in the Democratic Republic of Congo. In another project, Volvo Cars is investigating the potential suitability of blockchains to trace the origin of cobalt.

Conclusion

1

Availability of raw materials no obstacle to electric mobility

The availability of the most important raw materials listed here is not a fundamental obstacle to the progressive ramp-up of electric mobility. Rather, temporary shortages of raw materials on the market may lead to drastic price increases for individual raw materials, as is anticipated for lithium and cobalt in particular. In this context, shortages can be attributed specifically to insufficient exploitation of deposits in connection with complex political situations.

3

Efficient use of raw materials

The field of conventional drivetrains looks back on over a century of research history. At present, there is still great potential in the development of electric drives in terms of optimisation and increased efficiency. The greenhouse gas balance of batteries, for example, can be significantly improved by using them in stationary storage facilities in the sense of a "second life". In addition, rising prices for primary raw materials have already led to an increasing emphasis on recycling, as this can reduce the demand for raw materials from new resources and increase recycling. Similarly, other chemical compositions can reduce the demand for individual raw materials – a goal of current battery research.

4

Sustainable use of raw materials

The consumption of raw materials must become more sustainable overall. We are still at the beginning of the path towards resource-saving, emission-free mobility. The extraction of the above-mentioned raw materials is currently linked to environmental and social problems. Initiatives, standards and regulations for a sustainable and responsible supply chain must be expanded, promoted and closely monitored in the further process so that the negative consequences of raw material extraction, as we already have witnessed for the materials and fuels of conventional vehicles, are not repeated.

2

Complex data issues

The scientific basis also presents a complex picture. Studies on individual issues in the context of raw materials often consider scenarios whose different assumptions make comparability difficult or indeed impossible. In addition, data are often not available or of questionable quality. In order to improve this situation, transparency and consistent data exchange are needed so that comparable holistic analyses will be possible in the future. In addition, continuous monitoring of the raw material situation (availability and demand) is recommended.