



Federal Ministry
of Labour and Social Affairs

SECTOR DIALOGUE
Energy Industry



**Selected sections of
the German energy industry**

Potential human rights risks along the supply and value chains

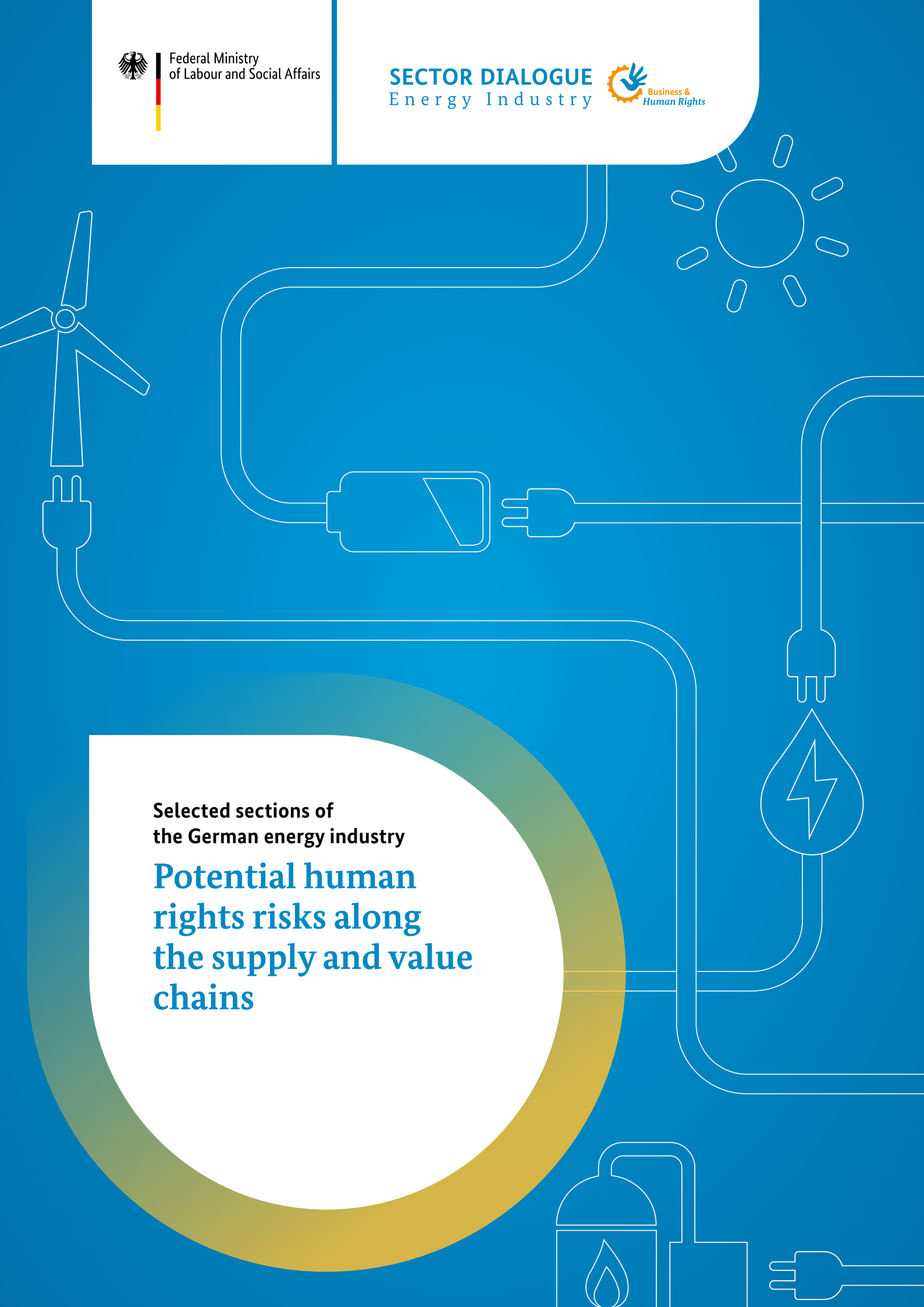


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1. Introduction

Energy Sector Dialogue on respect for human rights

Respect for human rights is key to a sustainable energy supply. In line with the UN Guiding Principles on Business and Human Rights, the German energy industry is committed to its responsibility to respect human rights and implement corporate due diligence obligations wherever it does business. Sustainable action and social acceptance are essential for companies in the energy industry to be and remain commercially successful. In the face of global human rights violations, globally connected companies are confronted with increased demands for corporate due diligence along their supply and value chains. For example, the extraction of raw materials, the production of components for energy generation, the construction and operation of large-scale infrastructure as well as recycling and disposal can involve risks for human rights.

In addition to their individual efforts to respect human rights along their supply and value chains, many companies in the German energy industry are involved in national and international initiatives together with other stakeholders. Since the origin of important raw materials and the production of key components for energy generation are often concentrated with a few suppliers and countries, a joint approach can have an additional impact.

For this reason, companies, industry associations, trade unions, civil society organisations, the German Institute for Human Rights and the Federal Ministry of Labour and Social Affairs (BMAS) have joined forces in a sector dialogue on respect for human rights along the global supply and value chains of the German energy industry (hereinafter referred to as *Energy Sector Dialogue*). They want to pool their expertise and resources and focus on human rights risks of the German energy industry along the global supply and value chains in order to improve the human rights situation.

Potential human rights risks along the supply and value chains of the German energy industry

This publication was jointly created by the members of the *Energy Sector Dialogue*. It provides an overview of the potential risks along the supply and value chains of six selected sections of the industry (photovoltaics, wind energy, electricity distribution grids, natural gas, battery storage, hydrogen). The relevance of the risks described herein for individual companies depends on their respective business operations and the associated supply and value chains. It must be assessed by companies in accordance with the UN Guiding Principles, the OECD Guidelines for Multinational Enterprises and against the background of legal requirements.

This publication can serve as guidance for companies in the German energy industry. It can support companies in meeting requirements arising from the German Act on Corporate Due Diligence Obligations in Supply Chains (*Lieferkettensorgfaltspflichtengesetz* – LkSG, hereinafter the “Supply Chain Act”) as well as from the future EU Corporate Sustainability Due Diligence Directive (CSDDD).

In addition, this publication lays the groundwork for the further cooperation within the *Energy Sector Dialogue*.



Use against the background of the Supply Chain Act:

The first step of the risk analysis in accordance with section 5 of the German Act on Corporate Due Diligence Obligations in Supply Chains (*Lieferkettensorgfaltspflichtengesetz – LkSG*) consists of an abstract risk assessment, particularly with regard to sector and country-specific risks. This publication can be used as a resource for the preparation of a company-specific risk analysis. The potential risks along the supply and value chains of selected sections of the German energy industry described herein are non-exhaustive, but can serve as an initial point of reference for the abstract risk assessment

In the second step of the risk analysis, plausibility checks are carried out for the company's own operational context, including prioritisation and weighting. This is done individually for each company.

Detailed guidance on compliance with section 5 of the Supply Chain Act is provided in the hand-out *Identifying, weighting and prioritizing risks* of the Federal Office of Economic Affairs and Export Control (BAFA).

For the supply chain stages of raw material extraction and raw material processing, the risks mentioned are limited to one raw material that is particularly relevant for the respective section and the associated main production countries or countries of origin for imports to Germany. Chapter 4 explains the nine risk categories considered in the analysis with reference to applicable human rights provisions. Chapter 5 summarises in tabular form the most relevant raw materials, the associated most important producing and extracting countries and the potential human rights risks.

The methodological basis for the identification of risks carried out here is a structured analysis of various publicly available data resources and written resources. This was supplemented by a qualitative analysis of relevant written resources and group interviews with members of the *Energy Sector Dialogue*.¹

Selection of industry sections and categories of potential human rights risks

The selection of industry sections and the grouping of internationally recognised human rights into risk categories is based on an agreement among the members of the *Energy Sector Dialogue* on thematic focal points for future cooperation.

The selection of sections is not based on the current risk exposure of the German energy industry and therefore does not allow any direct conclusions to be drawn about the risk exposure of individual companies. On the one hand, given the German Federal Government's expansion targets for renewable energies with the aim of reducing greenhouse gas emissions from fossil fuels, when selecting sections a strong emphasis is placed on green technologies and energy sources. On the other hand, the fossil energy source natural gas is discussed in detail in a separate chapter. A more in-depth examination of the risks associated with this is carried out against the

Content, structure and methodology

Chapter 2 starts with an overview of the main characteristics of the German energy industry, the risk exposure due to the links with other industries and nine selected risk categories. Chapter 3 then looks in detail at six selected sections and describes potential risks along the supply and value chains.

¹ In order to explore and identify potential human rights risks in the supply and value chains of the German energy industry, the following databases were systematically analysed: **Business and Human Rights Resource Centre (BHRRC) Database**; **SASB – Materiality Finder**; **MVO Netherland – CSR Risk Check**; **UNEP – Human Rights Guidance Tool**; **UNEP – Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)**. In addition to the risk identification based on the databases mentioned above, a qualitative analysis of relevant written resources was carried out, in particular scientific research papers and studies/reports by civil society stakeholders, industry associations and other institutions on sector-, industry- and resource-specific risks. In addition, conclusions from discussions within the context of the *Energy Sector Dialogue* as well as group interviews conducted with members of the Sector Dialogue in April 2023 fed into the preparation of the document.

background of newly concluded supply contracts, e.g. in the course of Russia's war of aggression against Ukraine, even though the energy transition envisages an end to fossil fuels. In addition to this in-depth consideration, Chapter 3.4 provides an overview of climate risks and natural gas, and Chapter 2 contains a brief side note on the human rights risks of coal and crude oil as fossil energy sources.

The classification of internationally recognised human rights into risk categories is based on common categories from the literature (see Chapter 2.3).² The selection of potential risks to the supply and value chains of the respective sections is discussed in Chapter 3. This does not imply an assessment of the severity or likelihood of the risk materialising. The selection of human rights risks does not claim to be exhaustive against the background of current debates. For example, climate risks or negative implications on the natural environment that are not linked to potential local human rights violations are not considered.

Explanatory note

This publication does not allow any statements to be made on whether or to what extent the potential risks along the supply and value chains of selected sections of the energy industry described herein are actually relevant for German companies. It therefore does not replace a risk analysis, which must be carried out at company level.

² See e.g. the study "Die Achtung von Menschenrechten entlang globaler Wertschöpfungsketten. Risiken und Chancen für Branchen der deutschen Wirtschaft".



Federal Minister of Labour and Social Affairs



Energy industry companies



BayWa r.e. AG

EnBW Energie
Baden-Württemberg AG

ENTEGA AG



E.ON SE



EWE AG



Hamburger Energienetze GmbH



Mainova AG



MVV Energie AG



RWE AG



TenneT TSO GmbH



Uniper SE



Vattenfall GmbH

Business associations



8KU GmbH



Energie. Wasser. Leben.

BDEW Bundesverband
der Energie- und
Wasserwirtschaft e.V.

ENERGY IS US

vgbe energy e.V.



IGBCE



Ver.di

Trade unions

Non-governmental organisations (NGOs)



Brot für die Welt

INFOE e.V. für die
Initiative GegenStrömungHamburger Stiftung für
Wirtschaftsethik

PowerShift e.V.

German Institute for Human Rights

Deutsches Institut für
Menschenrechte e.V.

2. The German energy industry: overview

2.1 Main features of the German energy industry

The core business of the German energy industry generally consists of the generation, distribution and sale of energy as well as energy-related infrastructure services and customer services. Most of the value creation takes place in Germany and Europe. Some companies also offer services for the expansion and operation of energy infrastructure and generation facilities in non-European countries, such as solar installations or wind farms.

The energy generation segment is subdivided into electricity and heat generation, which in turn can be broken down into renewable and fossil energy sources. In 2022, fossil fuels such as natural gas, mineral oil, lignite and hard coal accounted for the largest share of energy generation in Germany (UBA 2023a). Renewable energy sources accounted for a total of around 20.4% (equivalent to 494 TWh) of total final energy consumption in Germany (Working Group on Renewable Energy Statistics 2023). For electricity generation, the total share of renewable energies was 44% of gross electricity generation (Statistisches Bundesamt 2023c); for heat generation and refrigeration, renewable energy sources accounted for 17.4% of final energy consumption (UBA 2023a). Among renewable energies for electricity generation, wind energy, followed by photovoltaics (PV), plays a central role while biomass as a renewable energy source is of particular relevance for heat generation (see Figure 1).

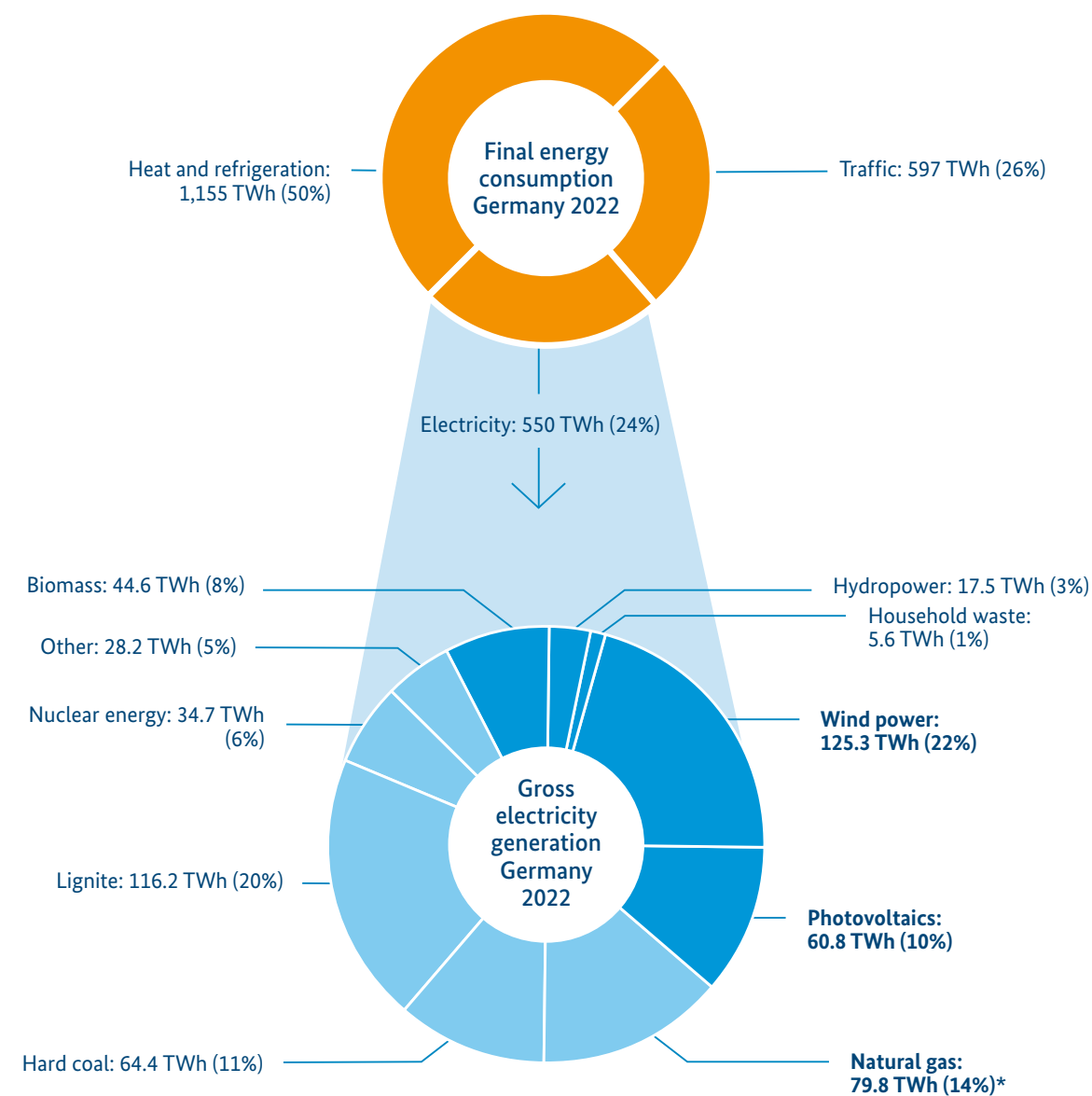
In the future, renewable energies in Germany will be further expanded and the electrification of the energy supply for heating and transport will be promoted. With a simultaneous reduction in the dependence on fossil energy sources, the share of renewable energies in gross electricity consumption is to rise to at least 80% by 2030 (Die Bundesregierung 2023a).³ In addition, the German Federal government plans to install at least 10 GW of electrolysis capacity in Germany by 2030 in order to produce hydrogen locally (Die Bundesregierung 2021; Federal Ministry of Education, Science, Research and Technology 2023a). These plans will result in a further massive demand for renewable energies (Franke et al. 2022).

Currently, about 75% of Germany's energy supply is covered by imports. In 2022, 972.2 TWh of energy resources were produced domestically, which corresponds to a share of about 25% of total primary energy consumption. At 452.5 TWh, renewable energy sources such as wind, solar and biomass contribute more than 50% of the domestically produced energy (UBA 2022b).

In addition to direct imports of energy sources, a large number of raw materials are also required for domestic energy production by way of renewable energy (Chardayre et al. 2022; Müller 2018). Among other things, these are used in the construction of new wind power and solar installations, energy storage systems and the expansion of grids for the increasingly decentralised distribution of electricity (Chardayre et al. 2022; IEA 2022b).

³ Expansion targets for renewable energies by 2030 in detail: wind energy (offshore): 30 GW; wind energy (onshore): 115 GW; solar installations: 215 GW (source: Die Bundesregierung 2023b).

FINAL ENERGY CONSUMPTION AND GROSS ELECTRICITY GENERATION IN GERMANY (2022)



Final energy consumption Gross final energy consumption in Germany was 2,290 TWh in 2022. In addition to electricity generation, final energy consumption also includes energy consumption for transport and for heat generation and refrigeration. Net electricity exports are the reason for the difference between gross electricity consumption (550 TWh) and gross electricity generation (577 TWh in total).

Renewable energies The share of renewable energies in gross electricity generation in Germany was 44% in 2022.

Conventional energy sources The share of conventional energy sources in gross electricity generation in Germany was 56% in 2022.

* In addition to being used to generate electricity, natural gas is also used to generate heat and refrigeration.

Sources: Working Group Renewable Energy Statistics 2023; Statistisches Bundesamt 2023c

Figure 1: Final energy consumption and gross electricity generation in Germany (2022)

Source: UBA 2023a



Human rights risks: coal and crude oil

This publication focuses on green technologies and energy sources as well as on natural gas. The fossil fuels coal and crude oil will remain the main resources for energy production in Germany in 2023. With the EU embargo on Russian crude oil and coal, there was a shift regarding the countries of origin. Crude oil is increasingly sourced from Kazakhstan, Norway, the USA, Saudi Arabia and Nigeria (BGR 2022, p. 79); coal from Colombia, South Africa and the USA (Statistisches Bundesamt 2023). Partly for reasons of increased demand, human rights risks arise in the respective supply and value chains in these countries (Paasch 2022, p. 6). There are regular reports of violations of the rights to life, water, food, health and housing during the extraction of both energy sources. These will be briefly described in the following.

In the case of coal and crude oil extraction, there are reports on the contamination of groundwater, rivers, lakes or seas by heavy metals, mine water, acids or by the direct entry of crude oil (Ganswindt et al. 2013; Paasch 2022, pp. 5–6) as well as on the destruction of agricultural land and the associated threat to the livelihoods of surrounding communities. When it comes to the resettlement of (often marginalised, indigenous) communities, there is a risk of lack of consultation and compensation (Paasch, 2022). There are also documented cases of violence and reprisals against trade union members and human rights defenders in Colombia (Paasch 2022, p. 3; Rötters 2014). Occupational safety is also not guaranteed in many cases, which can lead to accidents, e.g. methane explosions in coal mining (Ganswindt et al. 2013, p. 18).

Raw materials are also still required for the infrastructure for energy production with fossil fuels such as natural gas, e.g. for the construction of transport ships or gas pipelines. Depending on their business model, companies in the German energy sector and their suppliers also procure subcontracted and construction services, which in turn require raw materials, energy and labour, for example for the construction of production facilities for components and machines or the provision of means of transport and transport routes such as roads, canals, etc. (Malin et al. 2022). This is one of the reasons why the supply chains of the energy industry are complex and very diversified on a global scale. The regional dependencies as well as the length and complexity of the supply and value chains vary depending on section and company. Accordingly, they differ with regard to traceability and the extent to which companies work with direct contracts when purchasing components. In principle, this publication considers potential risks along the entire supply and value chain – from raw material extraction (mining) to the end of life (recycling/disposal) of the selected sections. To the extent that companies in the German energy industry develop projects worldwide, it is also of interest to look at the risks of international energy projects.

2.2 Related sectors and their potential risks

The value creation of the German energy industry is linked to other sectors via its supply chain. These have potential human rights risks, which are listed below by way of example.

The global **mining sector** is linked to the German energy industry through the extraction of fossil fuels and relevant raw materials for components and installations for energy production and storage. There are reports of risks in global mining with regard to the rights of indigenous peoples, land use, water consumption, environmental damage, labour rights and occupational safety, health risks, denial of the freedom of association and the right to collective bargaining, conflicts and security, as well as corruption. In the case of large-scale mining (LSM), environmental human rights risks and risks related to land use and property rights are identified, in particular. Artisanal and small-scale mining (ASM) can also be particularly prone to work-related risks. Child labour and precarious working conditions are reportedly widespread in many mining areas around

the world, especially in regions where the mining sector is an important source of income despite poor, precarious working conditions (Dehoust et al. 2020a; Spohr 2016; Weiss et al. 2020; UNEP FI 2014b). Furthermore, the industry uses minerals from conflict and high-risk areas, whose extraction and trade are often particularly risky as they can be linked to the financing of armed conflicts (Manhart et al. 2015).

The global **transport sector** is linked to the German energy industry through the maritime transport of energy carriers (especially gas), but also through the transport of components and raw materials by land, water and air. Various environmental human rights risks and the risk of precarious and exploitative working conditions can exist in this regard (Die Bundesregierung 2023d). The latter can take the form of long working hours, low wages, poor housing and informal employment without any security. Where low-skilled workers are employed on a temporary basis through recruitment agencies, there is also a risk of forced labour (especially in shipping and at terminals/ports) and human trafficking, bribery and corruption within the transport sector. Migrant workers are particularly exposed to these risks, as they are often in a relationship of particular dependency with their employers. The infrastructure required for transport (such as roads, rail networks, canals, ports, etc.) can also be linked to land grabbing and illegal expropriation (BSR, undated; House 2020; Knoke et al. 2023; Manta and Pease 2021). Ports and international shipping are considered high-risk areas due to the risks of accidents at work, fires, explosions, harmful and precarious working conditions, forced labour and discrimination against women. In the case of intra-European freight transport by truck, there are also reports about the circumvention of legal regulations and the associated risks for decent working conditions, which particularly affect migrant workers from Eastern Europe (Knoke et al. 2023).

The **building sector** in general is linked to the German energy industry through the construction of energy-related infrastructure services. According to analyses, it is considered a sector with comparatively high risks in terms of occupational safety and health. The reasons for this are the typically physically demanding activities, the potential contact with harmful substances and the risk of accidents at work, e.g. falls from great heights (KPMG 2014). Where migrant workers are employed in large construction

projects, they are particularly exposed to risks such as precarious working conditions, low wages and discrimination. In addition, large construction projects are associated with environmental implications such as noise, waste and land use, which can have a negative impact on surrounding communities. The use of security services to guard construction projects can also lead to conflicts. In addition, changes in land use occur in the context of land-intensive energy infrastructure projects, in the resolution of which local rights holders are not always sufficiently involved, especially in countries with inadequate protection of human rights. This can lead to conflicts (Huber and Weiß 2021; KPMG 2014; UNEP FI 2014a).

The **industrial production of components**, for example for wind turbines, batteries or solar modules, can take place in regions with relatively low wages and labour protection standards, depending on the stage in the value chain. This can result in various risks in terms of occupational safety and health, wages, working hours and accommodation. Many manufacturing processes can also be associated with negative environmental implications that can affect the health and livelihoods of workers and the surrounding communities. In various regions there are reports of restrictions on the right to freedom of association and the right to organise (BSR, undated; UNEP FI 2014a). In addition, mechanical and plant engineering involves high levels of consumption of raw materials and is thus also closely linked to the risks of the mining sector via the supply chain.

Furthermore, at the **end of the life cycle** of many components in the energy sector, there are various risks if they are disposed of or recycled improperly or if safety standards are not met as they contain hazardous and toxic materials that can cause damage to the environment and the health of workers and residents. Disposing of waste in landfill also poses the risk of land consumption and pollution of water and soil, which according to analyses can lead to long-term environmental damage and affect the livelihoods of surrounding communities (UNEP FI 2014e). In addition, there is a potential risk of precarious working conditions and child labour on landfill sites, especially in countries with inadequate protection of human rights (SPREP 2021).

2.3 Relevant human rights risk categories for the supply and value chains of the German energy industry

Against the background of the core business activities of the German energy industry and its supply and value chains, potential human rights risks can be grouped into relevant risk categories. The following categorisation of possible risks is based on common categories from the literature (BSR, undated; ENCORE 2023; KPMG 2014; MVO Nederland 2023; SASB 2023; UNEP FI 2014d; Weiss et al. 2020) and is unsorted:

- Child labour
- Forced labour and all forms of slavery
- Inadequate occupational safety and health hazards in the workplace
- Failure to respect the freedom of association and the right to collective bargaining
- Discrimination
- Precarious working conditions and denial of a reasonable wage
- Environment-related human rights risks
- Land use conflicts and property rights
- Conflicts and security

For a detailed examination of the supply and value chains as well as the potential risks, the following chapters examine the photovoltaic, battery storage, wind energy, natural gas, electricity grids and hydrogen sections (Chapters 3.1 – 3.6). After that (in Chapter 4), the categories of human rights risks mentioned are discussed on the basis of applicable human rights provisions. Chapter 5 provides an overview of relevant raw materials for the industry and the human rights risks potentially associated with them.

3. Selected sections of the German energy industry

The following chapter takes a detailed look at the six sections of the German energy industry selected as part of the *Energy Sector Dialogue* and describes potential risks along the respective supply and value chains. For this purpose, a systematic analysis of databases⁴ and qualitative evaluation of relevant literature was carried out.

There are three main types of PV modules in use: thin-film as well as monocrystalline and polycrystalline silicon-based modules. Since silicon-based solar cells currently dominate the global market (96% in 2018) (Cararra 2021), the following analysis focuses on silicon-based modules.

Supply and value chain

In simplified terms, the supply and value chain of the photovoltaics section comprises the following steps (1) raw material extraction, (2) raw material processing, (3) manufacturing of components (the production of ingots⁵ and wafers⁶ as well as solar cells and modules), (4) project planning, installation, commissioning and maintenance, (5) power generation, distribution and sale, and (6) recycling and disposal of the components. Many of the companies relevant to the supply and value chain are located in Asia, especially in China (Statistisches Bundesamt 2023b). The value added by the companies in the German energy industry lies mainly in project planning, installation, commissioning and maintenance of ground-mounted photovoltaic and roof-mounted systems, as well as in the generation, distribution and sale of electricity from photovoltaic systems.

The main materials used for the production of the frame and system installation of PV systems are cement, iron, plastics, glass, aluminium, copper and silicon (DERA 2021, Müller 2018). High-purity quartz rock, processed into silicon, is an important basic material for silicon-based solar cells. In principle, there are deposits of high-purity quartz rock all over the world. The processing into metallurgical silicon and subsequently into polysilicon (the raw material

3.1 Photovoltaics

Introduction

Photovoltaics (PV), together with wind energy, is one of the most important forms of electricity generation from renewables. Due to falling manufacturing and installation costs for photovoltaic systems, the industry is growing faster than any other energy technology. Solar energy is expected to be the world's largest energy source by 2050 (IRENA 2021). In view of the German Federal Government's goal of covering 80% of electricity supply with renewables by 2030, electricity generation from photovoltaics will in all likelihood also experience strong growth in Germany over the coming years (Die Bundesregierung 2023b). Photovoltaics is therefore of key importance for the energy transition and the energy industry in Germany, and hence is a focus of this publication.

Photovoltaics can be divided into two areas:

- 1) ground-mounted photovoltaic systems, which are erected on vacant land and often on a large scale with an installed capacity of more than 1 MW, and
- 2) roof-mounted systems, which are installed on buildings and have a lower installed capacity.

⁴ The databases are: [Business and Human Rights Resource Centre \(BHRRC\) Database](#); [SASB – Materiality Finder](#); [MVO Netherland – CSR Risk Check](#); [UNEP – Human Rights Guidance Tool](#); [UNEP – Exploring Natural Capital Opportunities, Risks and Exposure \(ENCORE\)](#) (also see page 3 for the description of the method employed).

⁵ Blocks of melted and purified silicon.

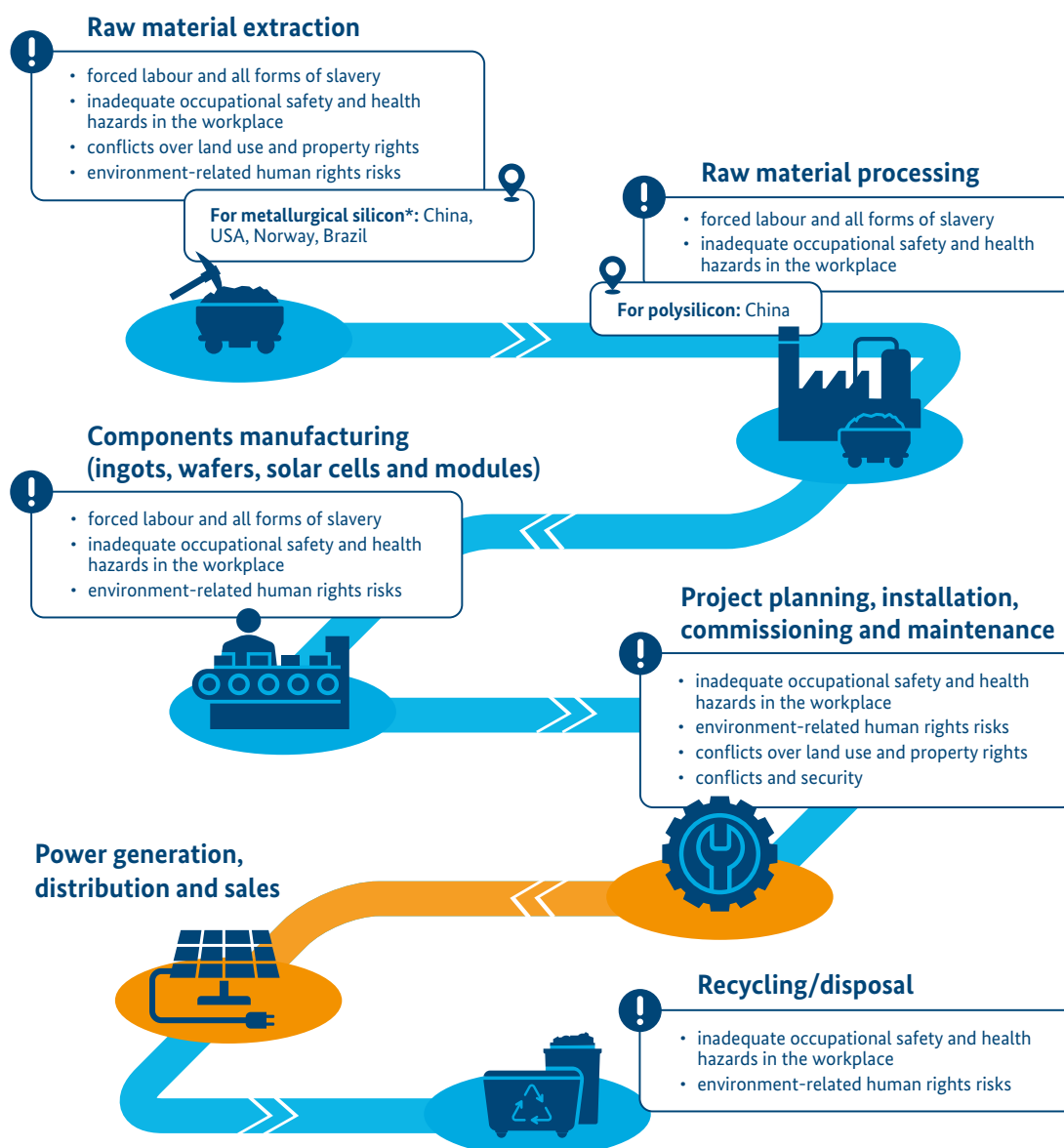
⁶ Blocks of melted and purified silicon (ingots) cut into slices about 200 micrometres (1/5 mm) thick.

for both monocrystalline and polycrystalline solar cells) is highly energy-intensive, which is why the raw material is often transported to where it can be processed at low cost.

In 2022, around 69% of the volume of metallurgical silicon produced globally originated in China, followed by a wide margin by the USA (11.9%), Norway (5.7%) and Brazil (5.7%) (Idoine et al. 2023). Today, the processing of metallurgical silicon into polysilicon also largely takes place in China (Basore and Feldman 2022). 45% of the global supply of silicon for the solar industry comes from the Chinese region of Xinjiang (Murphy and Elimä 2021; Ambrose and Jolly 2021). The manufacturing of components is also dominated by China. For example, in 2022, with an import volume worth 3.1 billion euros, around 87% of PV systems imported into Germany originated in China, followed by a wide margin by the Netherlands (4%) and Taiwan (3%) (Statistisches Bundesamt 2023a).

PV modules are generally easy to recycle, but a complete recovery of all components is not currently carried out on a large scale in Germany. In 2018, around 8,000 tonnes of scrapped PV modules were generated across Germany, which corresponded to less than one percent of the total electronic waste collected. For 2030, there could already be one million tonnes of old PV modules per year. There is no precise record of how many used solar modules are exported from Germany to other countries and are neither reused nor recycled (Storch 2021).

ILLUSTRATION OF THE SUPPLY AND VALUE CHAIN OF PHOTOVOLTAICS



* Other relevant raw materials: antimony, bauxite (aluminium), lead, boron, iron (ore), crude oil (plastic/synthetic materials), copper ore, phosphorus, sand, silver, zinc, tin, cement.

■ Stages of the main value creation of companies in the German energy industry

Figure 2: Illustration of the supply and value chain for photovoltaics

Selection of potential human rights risks along the supply and value chain

The following risks are based on a qualitative evaluation of existing, publicly available data and literature, in particular databases, scientific research papers and studies/reports by civil society stakeholders, industry associations and other institutions, which are mainly available in German or English. For the first two stages of the supply chain, raw material extraction and processing, the analysis focuses on high-purity quartz sand and metallurgical silicon. An overview of information on the risks associated with the extraction of the other relevant raw materials is presented in Chapter 5.

The following risks are potential risks along the supply and value chains of companies in the German energy industry. For a company's own operational context, individual risk analyses are used for purposes of plausibility checks, weighting and prioritisation. Especially for the identified potential risks in the installation, commissioning and maintenance stage, it is important to check whether the examples and country contexts listed in this publication are currently relevant to a company's own operational context.

Raw material extraction (quartz sand/ metallurgical silicon)

- **Forced labour and all forms of slavery:** Xinjiang is estimated to hold 10% of China's reserves of quartz veins which are used for the production of metallurgical silicon. According to reports, some 2.6 million Uyghur and Kazakh women are engaged in forced labour in Xinjiang, with more being forcibly transferred to other parts of China (Murphy and Elimä 2021; USDOL 2022).
- **Inadequate occupational safety and health hazards in the workplace:** Quartz mining can lead to health problems such as the respiratory disease silicosis, especially in countries with patchy enforcement of occupational safety and health standards, such as China (Nazalya 2019).
- **Environment-related human rights risks:** When quartz sand is extracted from a body of water, a widespread extraction method in the USA and elsewhere, water pollution can occur. This can affect access to clean drinking water (Basore and Feldman 2022).
- **Land use conflicts and property rights:** Land use conflicts with local communities and indigenous peoples have been documented in Norway, for example (Fouche and Buli 2021).

Raw material processing (polysilicon)

- **Forced labour and all forms of slavery:** About 45% of the global supply of silicon for the photovoltaic industry is produced in Xinjiang, China. According to reports, some 2.6 million Uyghurs and Kazakhs are engaged in forced labour in Xinjiang, with more being forcibly transferred to other parts of China. Research shows that at least 11 companies in the PV industry in Xinjiang are allegedly linked to forced labour (Murphy and Elimä 2021).
- **Inadequate occupational safety and health hazards in the workplace:** Toxic chemicals are used in the production of silicon, which can have harmful effects on the environment and the health of workers. Enforcement of occupational safety and health standards that would potentially prevent such health hazards is insufficient in key processing countries such as in China (Nazalya 2019).

The manufacturing of components (production of ingots, wafers, solar cells and modules)

- **Forced labour and all forms of slavery:** In the production of solar panels, ingots and wafers, there are reports of forced labour in manufacturing plants in China (Wübbeke and Zenglein 2020; Murphy and Elimä 2021; IEA 2022a). 87% of the PV modules imported into Germany originate in China (Statistisches Bundesamt 2023a).
- **Inadequate occupational safety and health hazards in the workplace:** According to reports, there is a risk of occupational safety and health provisions being violated in China when workers are exposed to hazardous chemicals during the production of PV modules (Nazalya 2019). There are also reports of comparable risks for India, Vietnam, China, Thailand and Malaysia (IEA 2022a).

- **Environment-related human rights risks:** When silicon is heated and cleaned for use in solar cells, it can leak highly toxic silicon tetrachloride, which can cause severe environmental damage and human health problems if not handled and disposed of properly (Wirtz 2019).

Project planning, installation, commissioning and maintenance (silicon-based modules, here: ground-mounted PV)

- **Inadequate occupational safety and health hazards in the workplace:** Workers in the solar energy industry are reportedly exposed to a variety of potential risks, such as burns and explosions from arc flashes, electrocutions, falls and thermal burns (USDOL, undated).
- **Environment-related human rights risks:** The maintenance of solar systems requires, among other things, water for washing the PV modules. Particularly in regions affected by water scarcity, e.g. in North Africa, this can affect local agriculture and livestock (Institute for Middle East Studies, undated).
- **Land use conflicts and property rights:** Large-scale solar projects can affect property rights of local communities and indigenous peoples and threaten livelihoods due to changes in land use. For example, there are reports of conflicts regarding land use and property rights in the Noor solar project in Morocco (Institute for Middle East Studies, undated; Nazalya 2019; Aoui et al. 2020).
- **Conflicts and security:** There is a risk in the construction of large solar installations that state institutions will acquire or expropriate the land used on behalf of private companies. This can also involve the violent suppression of protests, such as in India in 2020 after the expropriation of agricultural land in Mikir Bamuni for the construction of a large solar installation (Stock 2022). In conflict regions, such as in Palestine or West Sahara, the risks of exacerbating existing conflicts when constructing large solar installations are particularly high, according to the BHRRC (BHRRC, undated).

Recycling/disposal (silicon-based modules)

- **Inadequate occupational safety and health hazards in the workplace:** The toxic waste, which contains materials such as lead, antimony or aluminium, can cause serious damage to human health if it is not disposed of properly (Wirtz 2019).
- **Environment-related human rights risks:** If solar modules are not disposed of or recycled properly and break, for example, toxic waste such as lead or cadmium can enter the environment and cause severe damage. If they get into drinking water, for example, they can cause health problems. There are reports from China of toxic waste being disposed of illegally (Wirtz 2019).

3.2 Battery storage

Introduction

Stationary battery storage (systems) play an important role for the energy transition in order to compensate for the fluctuating availability of renewables. The International Energy Agency (IEA) expects that the global installation of battery storage for electricity supply will have to increase 25-fold between 2020 and 2040 in order to achieve the goals of the Paris Climate Agreement (IEA 2022b). The German Federal Government's plans to greatly expand Germany's position in the battery value chain in the coming years. Due to this important, future-oriented function of battery storage, it is a focus of this publication.

There are various battery technologies on the market. At around 90%, lithium-ion batteries (LIB) currently account for the majority of all (stationary) battery storage systems in use. Other technologies are lithium metal anode solid-state batteries (Fraunhofer ZESS, undated) or sodium-ion batteries, which will potentially play a greater role in the future (Köllner 2023). The following analysis focuses on LIB as the central product group as they currently dominate the market and are expected to remain relevant for stationary and mobile use due to falling production costs, despite new technological alternatives (VDMA 2023).

Supply and value chain

The simplified supply and value chain of LIB includes the steps of (1) raw material extraction, (2) raw material processing, (3) production of components (precursors for cathode active material, cathode and anode active material and production of battery cells) and production of the finished battery packs for stationary application, (4) installation, commissioning and maintenance of storage systems, (5) electricity generation, distribution and sales, and (6) recycling or disposal of the electricity storage systems (focus: LIB) (Federal Ministry for Economic Affairs and Climate Action, undated). Both the extraction of raw materials and the production of battery components are highly international in nature. German energy companies are involved in the installation, commissioning and maintenance of storage systems.

Numerous raw materials are required for the production of LIB. Graphite, aluminium, nickel, copper, steel, manganese, cobalt, lithium and iron are used in varying proportions. The demand for the individual minerals and metals varies greatly depending on the cathode and anode chemistries, with nickel, graphite, aluminium and lithium usually accounting for the largest share of the battery in terms of quantity (IEA 2022b). The following analysis concentrates on nickel (or nickel ores as precursors) as an important raw material for the battery storage section. Nickel is associated with a variety of human rights risks (see below) and is expected to be an increasing mass percentage for future battery cell technologies (DERA 2021b). Other raw materials such as lithium, aluminium, copper or cobalt are also important raw materials for battery production that are associated with human rights risks. These are either dealt with elsewhere in the publication (see aluminium in Chapter 3.3, copper in Chapter 3.5, iron in Chapter 3.6 or as an overview in Chapter 5) or the risks have already been very well documented (for lithium see, *inter alia*, Brot für die Welt 2018, Dolega 2020; for graphite see, *inter alia*, Dolega 2020; for cobalt see, *inter alia*, BGR 2019, Save the Children 2021).

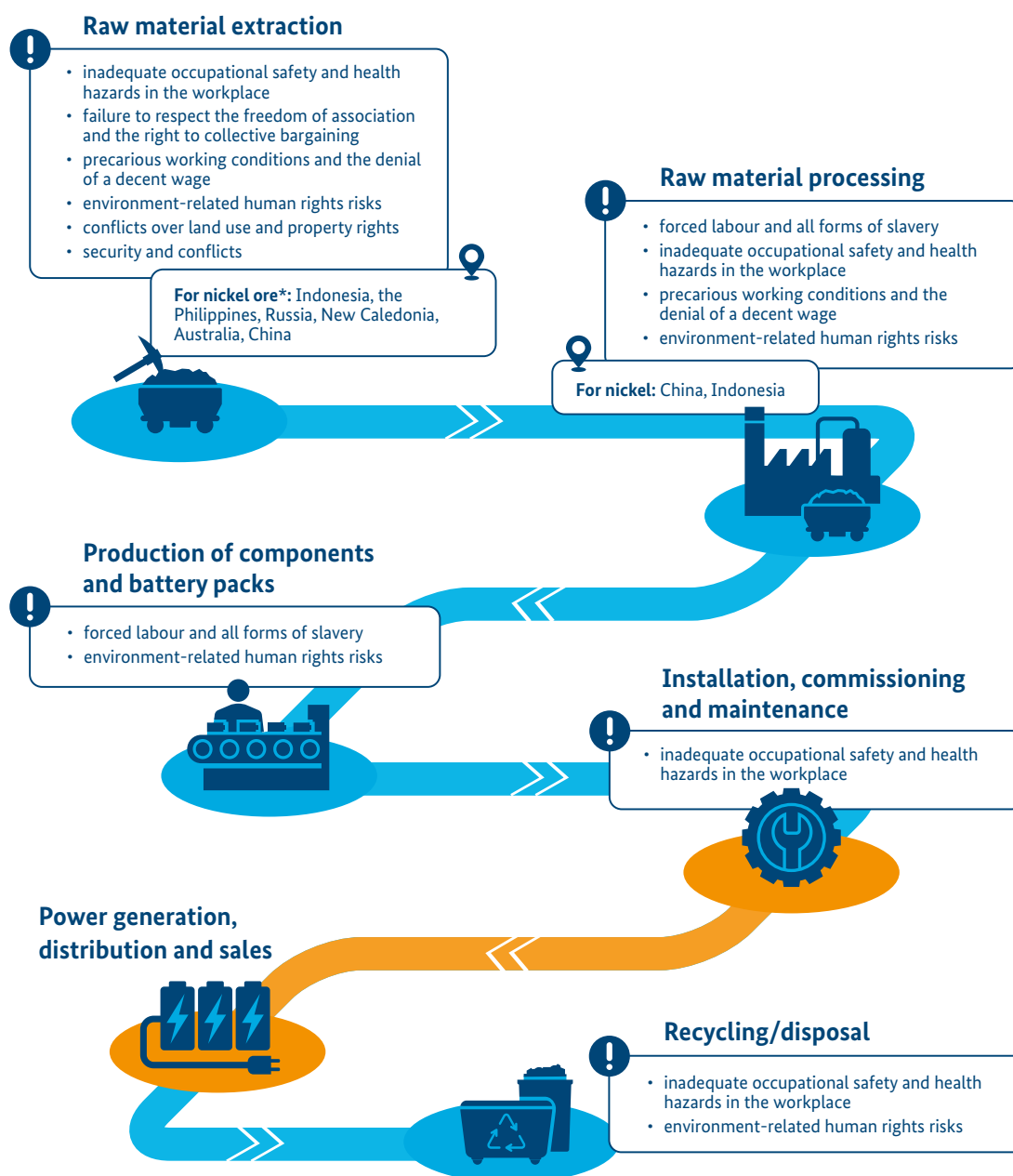
As nickel has the highest cathode performance compared to other materials (DERA 2021b), it is expected to become increasingly important for future battery types. The German Federal Institute for Geosciences and Natural Resources (BGR) expects that as early as by 2030, more than 25% of the global nickel demand

will be used in the production of cathodes for LIB (Vasters et al. 2021). Nickel is largely produced in Indonesia (2019 market share: 33.6%), in the Philippines (12.7%), in Russia (8.8%), New Caledonia (8.2%), Australia (6.1%) and China (4.6%) (USGS 2023d). Raw material processing of nickel mainly takes place in China (30.4%) and Indonesia (15.8%) (Szurlies 2021).

Cell production for the global market is dominated by a few large manufacturers in China, Japan and South Korea. China alone produces two-thirds of all LIB and 70% of all cathode capacities. 75% of all battery cell production capacities, 90% of anode and electrolyte production and 60% of global battery component production is located in China, making the People's Republic the world's most important player in the battery value chain. Other important production countries for anode and cathode material are Japan and South Korea. The production of finished battery modules and packs is also dominated by manufacturers from China, South Korea and Japan, which together accounted for almost 70% of the global battery market in 2021 (Carreon 2023).

There is an obligation in Germany to take back spent batteries free of charge at the end of their useful life (UBA 2022d). Across Europe, about 50 kilotonnes of spent batteries were recycled in 2022. Fraunhofer ISI expects the number of batteries to be recycled in Europe to increase to 420 kilotonnes as early as 2030 (Schmaltz 2023), in particular due to the increase in LIB vehicle batteries. Large quantities of the substances used in the EU are currently still exported to Asia for recycling, where China clearly dominates the market for the recycling of cells, cathode and anode materials (SP Rohstoffe und Entwicklung [GIZ+ BGR] 2021). There have also been reports of e-waste, including spent (industrial) batteries, being exported from Europe to West Africa, where proper recycling is not always guaranteed (Meza 2022; Zeisel and Kaledzi 2012). The planned new EU Battery Regulation provides for binding targets for the recycling of raw materials used in batteries such as nickel and cobalt (95%) or lithium (80%) by 2031 (Halleux 2022). This is meant to promote the expansion of recycling capacities in the EU while reducing Europe's dependence on imports of key raw materials.

ILLUSTRATION OF THE SUPPLY AND VALUE CHAIN OF BATTERY STORAGE SYSTEMS



* Other relevant raw materials: antimony, bauxite (aluminium), lead, iron (ore), graphite, cobalt, copper ore, lithium, manganese, rare earths, steel.

■ Stages of the main value creation of companies in the German energy industry

Figure 3: Illustration of the supply and value chain for battery storage

Selection of potential human rights risks along the supply and value chain

The following risks are based on a qualitative evaluation of existing, publicly available sources of data and literature, in particular databases, scientific research papers and studies/reports by civil society stakeholders, industry associations and other institutions, which are mainly available in German or English. The analysis focuses on the first two stages of the supply chain, the extraction and the processing of raw materials, and on nickel (nickel ore) as an important basic material of LIB.

The following risks are potential risks along the supply and value chains of companies in the German energy industry. Individual risk analyses are used for purposes of plausibility checks, weighting and prioritisation for a company's own operational context. Especially for the identified potential risks in the installation, commissioning and maintenance stage, it is important to check whether the examples and country contexts given are currently relevant to a company's own operational context.

Raw material extraction (nickel ores)

- **Inadequate occupational safety and health and health hazards in the workplace:** There are reports of long-term damage such as asthma and other lung and heart diseases among workers in nickel mines in the Philippines, the world's second largest nickel producer (Müller and Reckordt 2017). In addition, there is a risk of hydrogen sulphide poisoning, explosions and accidents with vehicles and electricity (Drive Sustainability, undated; Müller and Reckordt 2017). Accidents at work resulting in death can also occur in nickel mining (Aprilia 2023).
- **Failure to respect the freedom of association and the right to collective bargaining:** There are reports that the freedom of association and collective bargaining are in some cases severely restricted in the Philippines. According to interviews with local trade union representatives, there are repeated incidents of violence and the suppression of trade unions, including in the country's mining sector (Amnesty International 2021).
- **Precarious working conditions and the denial of a decent wage:** There are reports of workers in nickel mines in the Philippine province of Dinagat Islands being employed without a contract, receiving late wage payments and not receiving mandatory benefits such as social security contributions (Amnesty International 2021). The Rosa Luxemburg Foundation, among others, reports similar things about the nickel industry for batteries in Indonesia (Rushdi et al. 2021). In addition, there are recent reports of insecure employment and short-term lay-offs in nickel mining operations (Drive Sustainability undated; BHRRC 2023b).
- **Environment-related human rights risks:** The large amount of land used for nickel mining can have negative implications on forest areas and biodiversity (Vasters et al. 2021). In the Philippines, nickel mining also contributes to deforestation, which can have a long-term negative impact on the food production of local indigenous and farming communities (BHRRC 2023d). The mining of nickel ores can produce acidic mine water, which can lead to acidification and the entry of heavy metals into groundwater, surface water and soils, and thus to reduced crop yields (Vasters et al. 2021; Drive Sustainability, undated; Pensamiento y Acción Social – PAS et al. 2020; Müller and Reckordt 2017). According to the BHRRC, tests of water quality near a nickel mine in the Philippines revealed highly elevated chromium levels. Chromium can cause cancer in humans, for example, if it is ingested in drinking water or enters the food chain through the irrigation of fields (BHRRC 2023d).
- **Land use and property rights:** There are reports of conflicts with indigenous peoples in nickel mining from New Caledonia, the Philippines, Indonesia and Russia (Vasters et al. 2021; Drive Sustainability, undated; BHRRC 2023c). According to the BHRRC, in the Philippines, for example, the expansion of nickel mining areas frequently leads to the displacement of farmers and indigenous peoples (BHRRC 2023d). There are recent reports from Indonesia about the planned expansion of a nickel mine in areas inhabited by indigenous groups. In those areas, they are threatened with disregard for their rights, including the right to free, prior and informed consent (FPIC), and the destruction of their livelihoods (BHRRC 2023c).

- **Security and conflicts:** In the case of nickel mining in the Philippines, there are reports of threats of physical violence against local communities and activists who criticise the environmental implications of mining, murders of environmentalists, and targeted reprisals to curb information about the activities of companies (BHRRC 2023d; Müller and Reckordt 2017; Drive Sustainability, undated).

Raw material processing (nickel)

- **Forced labour and all forms of slavery:** Some nickel processing plants in China are located in the Xinjiang region. According to reports, some 2.6 million Uyghur and Kazakh women are engaged in forced labour in Xinjiang, with more being forcibly transferred to other parts of China (Murphy and Elimä 2021; USDOL 2022).
- **Inadequate occupational safety and health hazards in the workplace:** Dust and noise emissions from crushing and grinding processes can lead to health problems for workers (Müller and Reckordt 2017). In addition, there is a risk of hydrogen sulphide poisoning, explosions, accidents with vehicles and electricity and when handling hazardous chemicals and waste from refining. For example, there are recent reports on the high number of (sometimes fatal) accidents at work in nickel refineries in Indonesia (IndustriALL 2022).
- **Precarious working conditions and the denial of a decent wage:** Amnesty International reports, among other things, on precarious working conditions in Philippine processing plants. Workers employed on a short-term basis through subcontractors are particularly affected (Amnesty International 2021).
- **Environment-related human rights risks:** Tailings from the processing of sulphide ore are often stored in obsolete landfill dams from which, for example, leachate can escape. This is how toxic sludge ponds developed in Russia and Canada. During the pyrometallurgical processing of sulphide nickel concentrates, dusts containing heavy metals can be released. There are reports from Russia, India and Guatemala about resulting environmental damage, negative health implications and declining crop yields. In leaching operations for nickel, there is also a risk that leaches and acids

can escape and pollute the surrounding environment (Vasters et al. 2021; Drive Sustainability, undated; Müller and Reckordt 2017).

Production of components and battery packs (LIB)

- **Forced labour and all forms of slavery:** There are reports from Xinjiang, China, of forced labour in the production of batteries (Swanson and Buckley 2022).
- **Environment-related human rights risks:** According to analyses, there is a risk of mercury being released into the air, water and soil during the production of battery cells. If mercury enters the human body via the food chain (e.g. when eating fish), it can cause damage to health, e.g. to the kidneys or the central nervous system (UBA 2016). In addition, high water consumption can exacerbate existing regional water stress, as reports from China show (Weiss et al. 2022).



Risks in the manufacture of electronic components

For the production of battery modules and battery packs for stationary applications, further electronic components such as cabling, sensors, power connections, etc. are required in addition to the input materials for the active cathode material, the active cathode and anode material and the battery cells (PEM and VDMA 2015). The production of electronic components can be associated with various risks, especially in Southeast Asia, e.g. excessive working hours, low wages, forced labour and hazardous working conditions due to contact with toxic chemicals (Merk 2021). The risks associated with the production of electronic components are also relevant for the photovoltaics, wind energy and electricity distribution grid sectors.

Installation, commissioning and maintenance (LIB-based storage systems)

- **Inadequate occupational safety and health hazards in the workplace:** Improper transport, installation and maintenance of lithium-ion battery storage systems (e.g. in combination with PV home systems) can pose a risk of fire and explosion (Eger and Laukamp 2019; UBA 2022d). In case of any damage, gaseous or liquid substances can escape which are harmful to the environment and to health. If batteries containing lithium catch fire, they can produce irritating, corrosive and toxic vapours and substances (UBA 2022d).

Recycling/disposal (LIB)

- **Inadequate occupational safety and health hazards in the workplace:** LIBs are highly flammable if not handled properly (Weiss et al. 2022). In 2021, an explosion occurred at a factory in China that recycles batteries and produces cathode precursors for LIB, injuring several people (Reuters 2021).
- **Environment-related human rights risks:** In the event of damage due to improper disposal or storage of used batteries, gaseous or liquid substances can escape which are harmful to the environment and health. A fire involving batteries that contain lithium can produce irritating, corrosive and toxic vapours and substances (UBA 2022d).

3.3 Wind energy

Introduction

The largest share of renewable energy in the German electricity grid is generated by wind power. In 2022, wind energy covered about a quarter (26%) of the total electricity supply in Germany. This made wind power the second most important energy source in Germany in 2022 (Statistisches Bundesamt 2023b), and it is growing continuously (Müller 2018). Wind power is used to generate electricity in over 100 countries and accounts for about 5.9% of global electricity generation. Due to the huge importance of wind power for the German energy industry, it is a focus of this publication.

In the case of wind turbines, a distinction can be made between energy generation on land (onshore) and at sea (offshore). The number of wind turbines in Germany is significantly higher on land than at sea. At the end of 2022, 1,539 offshore wind turbines with a total capacity of 8.1 GW were in operation, compared to 28,443 onshore wind turbines with a total capacity of 58.1 GW (Deutsche WindGuard GmbH 2022). By 2030, it is intended for German offshore wind energy to reach a capacity of 15 GW and onshore wind energy to be expanded to 115 GW (Federal Ministry for Economic Affairs and Climate Action, undated).

Due to the much greater significance of onshore wind energy generation, the following analysis focuses on onshore wind turbines.

Supply and value chain

The simplified supply and value chain of wind turbines includes (1) raw material extraction, (2) raw material processing, (3) manufacturing of the components of a wind turbine (focus: nacelle and rotor), (4) project planning, installation, commissioning and maintenance of wind turbines (focus: onshore wind turbines), (5) electricity generation, distribution and sales, and (6) recycling and disposal of the components (Müller 2018). The value added by companies in the German energy industry mainly lies in the project planning, installation, commissioning and maintenance of wind turbines in Europe as well as in the generation, distribution and sale of electricity from

wind turbines. In some cases, wind turbines are also installed outside Europe.

The production of wind turbines requires a large amount of different raw materials. The foundation is usually made of steel and/or concrete, which in turn contains cement, gravel and water, while the tower is made of either steel or concrete. The nacelle contains a variety of materials such as iron, copper, plastics, aluminium, chromium, manganese, selenium, molybdenum and niobium. The generators contain iron as well as rare earths such as neodymium, dysprosium, praseodymium, boron and terbium (SOMO and ActionAid Netherlands 2018). If permanent magnets are used, the rare earths mentioned are also found in those. In addition, there are externally excited generators that do not require rare earths in their production. However, they are more costly and are therefore used less frequently. The gearbox of the wind turbines is made of stainless steel containing chromium, manganese, selenium, molybdenum and niobium. The rotors are made of balsa wood, carbon, glass fibre and epoxy resin. For the magnetic field in the generators, a copper coil is required for geared turbines, while permanent magnets are installed in direct-drive turbines (World Bank Group 2017). The following analysis focuses on aluminium (or bauxite as a precursor) as an important raw material for wind energy, as it is associated with human rights risks and is one of the most important metallic raw materials for wind turbines (Hund et al. 2020). Aluminium is used in wind turbines in the nacelle, the generator with the permanent magnet and the grid connection (Müller 2018). Other important raw materials such as iron (or steel) and copper are considered in detail in Chapters 3.6 and 3.5.

Globally, in 2022, Australia (26%), China (24%) and Guinea (23%), followed by Brazil (9%), Indonesia (6%) and India (4%) (USGS 2023e) are the most important producing countries for bauxite, the mother ore used in aluminium production. Guinea is by far the most important trading partner for Germany. In 2019, 93% of the bauxite imported by Germany came from Guinea (Hartmann 2019). In the same year, the processing of raw materials into aluminium oxide was dominated by China with a production share of

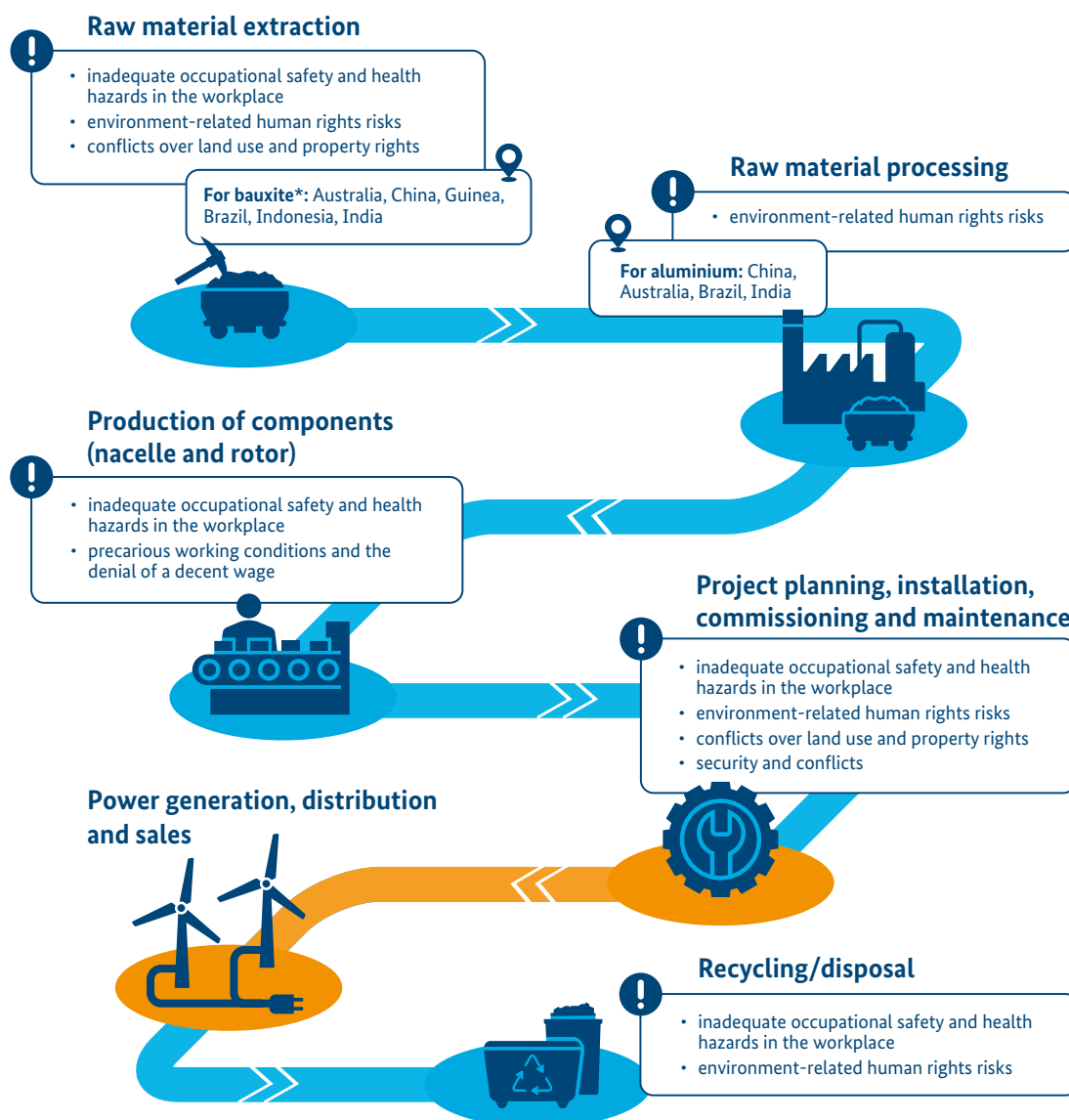
over 54%. This was followed by Australia (15%), Brazil (8%) and India (5%) (USGS 2023a).

Onshore wind turbines and individual components are largely manufactured in China. In 2022, six of the ten largest manufacturers of onshore wind turbines (by share of new construction) were from China. Major manufacturers are also based in Denmark, the USA, Spain and Germany (BNEF 2023). The final assembly of the installations usually takes place in the country where the installation is to be erected (Müller 2018).

Currently, rotor blades, which are often glass or carbon-fibre reinforced, are only being recycled to a limited extent, but second-life recycling or downcycling is becoming increasingly important.⁷ According to estimates by the Federal Environment Agency (UBA), up to 30,000 tonnes of rotor blade waste that is difficult to recycle could be generated each year from the dismantling of wind turbines over the next two decades. According to information from the Federal Environment Agency in 2019, there is currently only one plant in Germany that can recycle fibre-reinforced rotor blades, so there is a risk that rotors will be exported abroad and disposed of in landfill or improperly recycled there. In contrast, other raw materials such as concrete, steel, copper and aluminium, which are also produced during the dismantling of wind turbines, can be easily processed in the existing recycling infrastructure in Germany (UBA 2019; Kühne et al. 2022).

⁷ Members of the *Energy Sector Dialogue* in a group interview.

ILLUSTRATION OF THE SUPPLY AND VALUE CHAIN OF WIND ENERGY



* Other relevant raw materials: balsa wood, carbon, chromium, iron (ore), epoxy resin, crude oil (plastic/synthetic materials), germanium, glass fibre, copper, magnesium, manganese, molybdenum, nickel, niobium, silica sand, sand, selenium, rare earths, steel, rock salt, zinc.

■ Stages of the main value creation of companies in the German energy industry

Figure 4: Illustration of the supply and value chain for wind energy

Selection of potential human rights risks along the supply and value chain

The following risks are based on a qualitative evaluation of existing, publicly available data and literature, in particular databases, scientific research papers and studies/reports by civil society stakeholders, industry associations and other institutions, which are mainly available in German or English. For the first two stages of the supply chain, i.e. the extraction and processing of raw materials, the analysis focuses on aluminium as an important metal for wind turbines in terms of quantity and the associated raw material bauxite. Information on the risks associated with the extraction of other relevant raw materials, such as neodymium, is presented in Chapter 5.

The following risks are potential risks along the supply and value chains of companies in the German energy industry. Individual risk analyses are used for purposes of plausibility checks, weighting and prioritisation for a company's own operational context. Especially for the identified potential risks in the installation, commissioning and maintenance stage, it is important to check whether the examples and country contexts given are currently relevant to a company's own operational context.

Raw material extraction (bauxite)

- **Inadequate occupational safety and health hazards in the workplace:** The mining of bauxite causes dust emissions, which can potentially lead to health risks for workers (respiratory diseases, deterioration of eyesight) (Lee et al. 2017; JET 2020).
- **Environment-related human rights risks:** The dust settles on surrounding fields and can thus contribute to the land becoming barren and unusable for agriculture. Bauxite mining is also associated with high levels of water consumption, which can lead to a reduction in water levels and thus to an increase in the concentration of pollutants in rivers and groundwater. According to reports, in the important mining country of Guinea this has led to rivers drying up, which has impacted on access to drinking water for local communities (Hartmann 2019; Human Rights Watch 2018; Kind and Engel 2018). Furthermore, bauxite mining is very land-intensive. Research from Brazil finds a link between deforestation of primary tropical forest and illegal

logging along roads built for purposes of bauxite mining (Rüttinger et al. 2016; Kind and Engel 2018; Griffin 2020).

- **Land use conflicts and property rights:** In Guinea and Australia (Queensland), for example, land use and ownership conflicts have arisen in the past between construction and bauxite mining companies and local communities or indigenous peoples. There are various reports of mining concessions being granted without adequate compensation or financial remuneration and non-compliance with the right to free, prior and informed consent (FPIC) (Doyle et al. 2015; Hartmann 2019; Wormington 2018). The use of land for bauxite mining can also affect the supply of food and water to local communities and endanger the livelihoods of local residents (Hartmann 2019; Human Rights Watch 2018).

Raw material processing (aluminium)

- **Environment-related human rights risks:** The further processing of bauxite into aluminium oxide produces what is known as red mud, which contains high levels of pollutants such as arsenic, mercury and chromium. If stored improperly, environmental damage can pose a risk to the health of local communities (Kind and Engel 2018). Especially in countries with heavy rainfall, such as Brazil and India, there is a risk that landfill dams for red mud overflow and the heavy metals thereby enter surrounding waters or soils (Kerkow et al. 2012).

Production of components (nacelle and rotor)

- **Inadequate occupational safety and health and health hazards in the workplace:** Fibre-reinforced plastics and epoxy resin are used in the production of wind turbines. The styrene contained in epoxy resin escapes as a fugitive emission during the manufacturing process and can pose a health risk (e.g. kidney damage, irritation to the respiratory tract) if inadequate protective measures are taken and the workers inhale it (Karanikas et al. 2021).
- **Precarious working conditions and the denial of a decent wage:** Wind turbine components are produced in China, among other places, where labour rights are reportedly often inadequately protected (Kiezebrink et al. 2018; SOMO and ActionAid Netherlands 2018).

Project planning, installation, commissioning and maintenance of the systems (here: onshore wind turbines)

- **Inadequate occupational safety and health hazards in the workplace:** Specific risks to which wind energy workers can be exposed include falls, severe burns from electric shock and arcing/fires, and crush injuries (Karanikas et al. 2021; USOSHA, undated). During the maintenance and repair of wind turbine blades, workers can be exposed to hazardous substances and toxic fumes (such as epoxy resins, synthetic chemicals and fibreglass fumes), e.g. when removing old and damaged coatings, rinsing surfaces, applying new coatings and filling gaps (Karanikas et al. 2021).
- **Environment-related human rights risks:** If wind turbines cause strong noise emissions, this can lead to long-term damage to the health of residents, such as stress and cardiovascular problems (BMUV 2017b; UBA 2022c). The construction and maintenance of wind turbines often requires new access roads, which involve land consumption and can have a negative impact on biodiversity or food production in the surrounding area. In principle, there is a risk that the newly created infrastructure will pollute the surroundings of the installations, for example through fine dust or dust turbulence when driving on access roads (eia 2022). Depending on the location and planning, wind turbines can also lead to an increase in the mortality of certain bird species (Siekman 2022).
- **Land use conflicts and property rights:** Land-intensive projects such as wind farms have been associated with land rights violations in the past, including violations of indigenous peoples's rights to land, consultation and free, prior and informed consent (FPIC), for instance in Mexico and Morocco (Nazalya 2019; Gouritin 2018; BHRRC 2018; BHRRC 2016). In Sweden and Norway, where the indigenous Sámi group has lived in the northern regions for thousands of years, there are reports that the rapid expansion of wind farms is posing a threat to traditional reindeer herding (Cambou and Poelzer 2022).
- **Conflicts and security:** For example, in Oaxaca, Mexico, attacks by security forces (including intimidations, death threats and violent assaults)

on protesters who have publicly spoken out against controversial wind farm mega-projects have been recorded (Kiezebrink et al. 2018; Nazalya 2019; Gouritin 2018; PBI – Peace Brigades International 2014; Vargas 2020). Due to the lack of co-determination and participation of local communities and the lack of benefits for local communities, energy projects such as wind farms can exacerbate or re-ignite existing conflicts and increase marginalisation. This has happened, for example, in relation to pastoralists around Lake Turkana wind farm in Kenya (Waters-Bayer 2020).

Recycling/disposal

- **Inadequate occupational safety and health hazards in the workplace:** If rotor blades are not recycled properly, inhalable dusts and fibres containing carbon fibres or epoxy resins can be released during shredding and dismantling, which can lead to lung damage in workers (Kühne et al. 2022).
- **Environment-related human rights risks:** If rotor blades are not dismantled, transported or disposed of properly, this can lead to negative environmental implications, e.g. through air emissions. In Germany, it is prohibited to dispose of waste containing carbon fibres in landfill; however, according to the Federal Environment Agency, there is a risk that rotor blades are exported abroad for recycling or to be disposed of in landfill. If sawing operations are carried out during dismantling, this can lead to dust pollution of the air and the environment and can introduce potentially harmful substances into the surrounding soil or water (Kühne et al. 2022).

Specific risks for offshore wind power



The value chain of offshore wind turbines differs from that of onshore wind turbines, particularly at the level of installation, commissioning and maintenance.

Risks for occupational safety and health in the workplace: Due to the often extreme weather conditions and the heavy physical work, offshore workers are exposed to bigger accident and health risks at work than many onshore workers. Due to being located far from the coast and the fact that some areas of the installation are difficult to access, there is a high risk of suffering damage to health in the event of an accident.⁸ This is due, among other things, to the difficult accessibility of the site for rescue forces in the event of an accident. The Supreme Occupational Safety and Health Authority in Schleswig-Holstein, for example, in cooperation with the competent authority in Lower Saxony, has therefore developed a [Strategy for the immediate rescue and medical care of workers in the offshore wind industry](https://www.schleswig-holstein.de/DE/fachinhalte/A/arbeitschutz/offshore_rettung_medVersorgung.html).

Action 2023). The German Federal Government is planning to greatly expand the LNG infrastructure, partly because of the loss of Russian natural gas supplies. For example, the LNG Acceleration Act (*LNG-Beschleunigungsgesetz*), passed in May 2022 and amended in July 2023, provides for an accelerated expansion of land-based and floating LNG terminals and the necessary pipelines.

Due to the current central importance of natural gas in Germany, this subchapter takes a closer look at its supply and value chain, including the potential risks.

Supply and value chain

The supply and value chain of pipeline natural gas differs from the LNG value chain in certain regards, which is why the value chains are considered separately in the following risk analysis. Both processes include (1) production and processing, i.e. exploration of natural gas deposits and natural gas extraction. In the case of pipeline natural gas, this is followed by (2) transport via pipelines, (3) trading and distribution to wholesalers and municipal companies, (4) storage, and (5) use for electricity and heat generation or consumption by end customers.

The LNG value chain, on the other hand, is more complex. The (2) transport first takes place via pipelines to the coast to the export terminal. Then follow (3) liquefaction and cooling, (4) intermediate storage, (5) overseas transport on LNG tankers, (6) renewed intermediate storage in a land terminal or floating terminal, and (7) re-gasification of the liquid natural gas. Similar to pipeline gas, this is followed by (8) the transport of regasified LNG via national pipelines and (9) trading and distribution to wholesalers and municipal companies, (10) storage, and (11) use for electricity and heat generation or consumption by end customers (Bukold 2023). Companies in the German energy sector are particularly involved in storage, the provision of natural gas to end customers and the conversion of natural gas into electricity, while the raw material is mainly imported from abroad.

3.4 Natural gas

Introduction

Natural gas is a flexible energy source in Germany and is used in various sectors. The most important field of application in Germany is heat supply, into which almost 90% of the natural gas flows. With a share of 44%, natural gas is the central energy source for private heat supply. In addition, natural gas is used in power generation and in industry. The traditional form, which has dominated in Germany to date, is gaseous natural gas, which is transported via pipelines. In addition, liquefied natural gas (LNG), which can be transported by ship, is increasingly being used (Federal Ministry for Economic Affairs and Climate

⁸ Schleswig-Holstein state portal (2023): Offshore-Windparks. Last accessed on 22 June 2023 at https://www.schleswig-holstein.de/DE/fachinhalte/A/arbeitschutz/offshore_rettung_medVersorgung.html

Germany obtains almost 94% of this energy source from abroad. The origin has been subject to great fluctuations in recent years. At the beginning of May 2023, 40% of the natural gas imported into Germany came from Norway, 28% from Belgium, 23% from the Netherlands (Federal Network Agency 2023). The Netherlands and Belgium act mainly as transit countries, and in addition to Norway, Great Britain, Algeria and Azerbaijan are important suppliers of European gas (McWilliams et al. 2023). Approximately 8% of German gas consumption was imported as LNG, mainly from the USA, Qatar, Russia, Angola, UAE and Nigeria (Federal Network Agency 2023, European Council, undated). In the most important LNG supplier, the USA (Filges 2023), the natural gas for LNG production is mainly obtained through fracking. The German Federal Government wants to increase LNG imports from countries such as Qatar and the United Arab Emirates in the future (Filges 2023).

Since natural gas is a standardised product and purchasing/trading is based on standardised volumes, most trading in Germany takes place via energy exchanges, brokers or bilaterally between wholesalers at the virtual natural gas trading points. These are purely balance-sheet transactions. Trading at virtual gas trading points currently makes it impossible for gas traders to trace the traded gas back to the source of production and thus exert direct influence on gas producers.

The gaseous natural gas is transported from the main supplier countries via pipelines to Germany or to terminals such as the Netherlands or Belgium. So far, three floating LNG terminals have been put into operation in Germany for the transport of liquefied natural gas. Two more will be added by the end of 2023 (Atif 2023). Other important European LNG terminals are located in Greece, Italy, Spain, Belgium and the Netherlands.



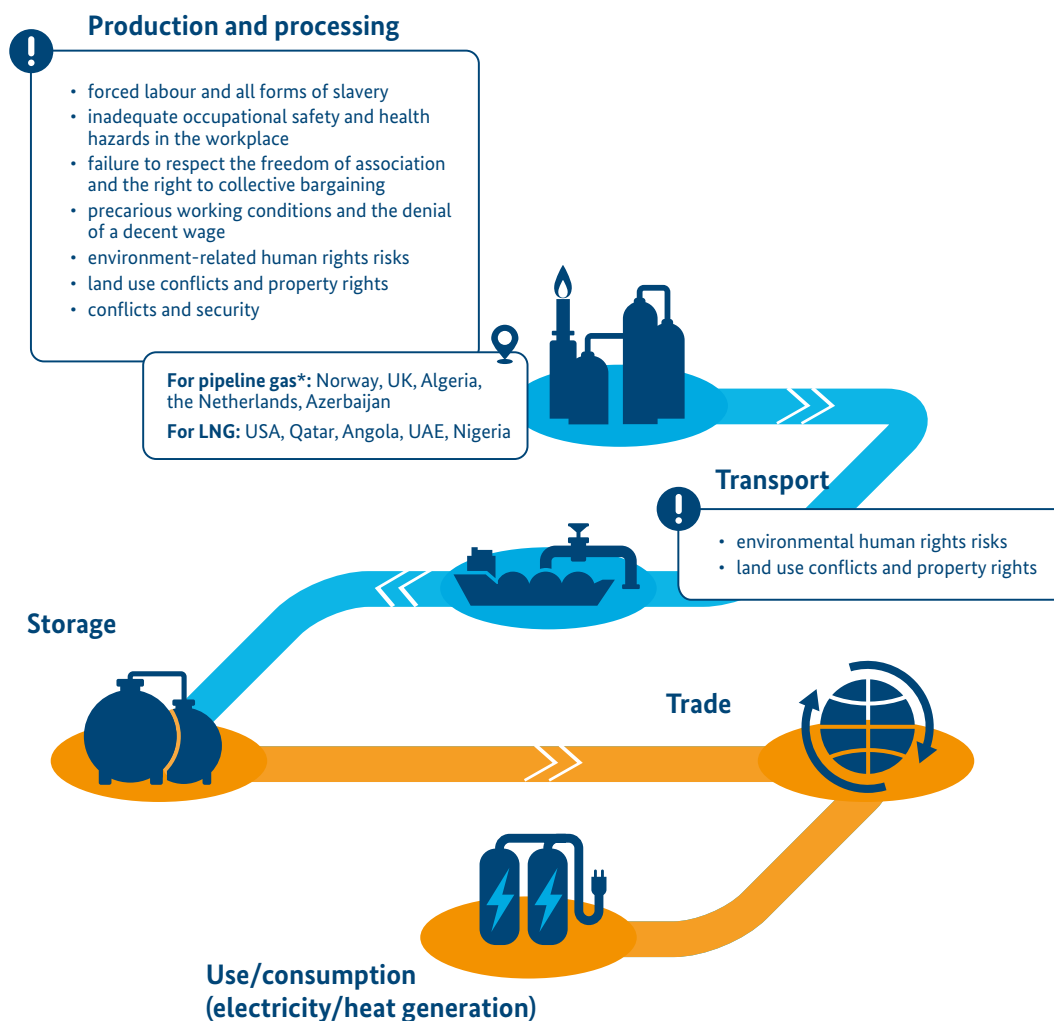
Natural gas: climate risks and human rights

Greenhouse gas (GHG) emissions are largely responsible for climate change. The onset of climate change is already having a negative impact on various human rights and could negatively affect the exercise of all human rights in the future.

In 2022, fossil energy sources held a share of 45% of electricity generation in Germany (Statistisches Bundesamt 2023c). As a result, 227 million tonnes of CO₂ equivalents (30% of Germany's GHG emissions) were produced for electricity generation in Germany in 2022 (UBA 2023d). Electricity generation is thus one of the most GHG-emitting sectors in Germany (UBA 2023e) and contributes to global climate change. The lower CO₂ emissions involved in the use of natural gas for electricity and heat generation compared to coal and crude oil (UBA 2023f; UBA 2023e) (14% of German electricity production [Statistisches Bundesamt 2023c], 44% of private heat supplies [Arbeitsgruppe Energiebilanzen e.V. (Working Group Energy Footprint) 2023]) must be viewed in relation to the climate impact of methane emissions during extraction, storage, transport and consumption, meaning the climate impact of natural gas was underestimated for a long time (Brauers et al 2021; Howarth 2014).

Against the background of the human rights implications of climate change, the UN Working Group on Business and Human Rights specifies: corporate responsibility to respect human rights also includes ending the use of fossil fuels and greenhouse gas emissions (OHCHR 2023).

ILLUSTRATION OF THE SUPPLY AND VALUE CHAIN OF NATURAL GAS



* Other relevant raw materials: bauxite (aluminium), iron (ore), helium, copper, sand (concrete), nickel, manganese, copper, crude oil (plastic), steel, nitrogen.

■ Stages of the main value creation of companies in the German energy industry

Figure 5: Illustration of the supply and value chain of natural gas

Selection of potential human rights risks along the supply and value chain

The following risks are based on a qualitative evaluation of existing, publicly available data and literature, in particular databases, scientific research papers and studies/reports by civil society stakeholders, industry associations and other institutions, which are mainly available in German or English. In addition to natural gas itself, other raw materials, especially iron ore for the production of steel and copper, are also relevant for the natural gas section. Steel is used inter alia in pipelines, ships and tanks (Steiner et al. 2023). Copper is used inter alia for valves and seals. The associated human rights risks are outlined in Chapter 5. The human rights risks associated with the mining and processing of copper and iron ore are discussed in Chapters 3.5 (copper) and 3.6 (iron).

The following risks are potential risks along the supply and value chains of companies in the German energy industry. Individual risk analyses are used for purposes of plausibility checks, weighting and prioritisation for a company's own operational context. In particular for the identified potential risks at the stages of transport, storage, use and consumption, it is important to check whether the examples and country contexts cited are currently relevant for a company's own operational context.

Production and processing (conventional drilling and fracking)

- **Forced labour and all forms of slavery:** In certain producing and processing countries, there are reports of forced labour and forms of slavery. Amnesty International has reported such risk, for example, for Qatar, even after the official abolition of the “Kafala” system,⁹ which involves far-reaching powers of control over workers (Jensen 2022). The International Trade Union Confederation (ITUC), among others, has reported that in countries such as the United Arab Emirates (UAE), relationships of strong dependency between workers and employers are the rule (ITUC CSI 2021).
- **Inadequate occupational safety and health hazards in the workplace:** Workers in gas drilling operations can be at increased risk of accidents and illnesses such as explosions, hazardous substance spills, noise, vibration, and stress. In addition, gas plant sites are often remote, which can limit access to health and emergency facilities (ILO 2022). Amnesty International, for example, reports frequent deaths among migrant workers in Qatar, which are attributed, among other things, to poor working conditions (Jensen 2022). In the UAE, too, there are reportedly recurring work-related injuries, accidents and fatalities (Basdr 2023).¹⁰
- **Failure to respect the freedom of association and the right to collective bargaining:** According to a 2022 report by the International Labour Organization (ILO), workers in the oil and gas sector in the UAE, Russia and Angola are at risk of violations of the freedom of association and the right to collective bargaining. According to the report, some oil and gas producing countries are hostile to workers' organisations. While in other producing countries, the right to freedom of association and collective bargaining is enshrined in law, the ILO has received information that this is often not implemented in practice (ILO 2022).
- **Precarious working conditions and the denial of a decent wage:** According to Amnesty International and the ITUC, migrant workers in Qatar and the UAE report low wages and late payment of wages (ITUC CSI 2021; Jensen 2022).
- **Environment-related human rights risks:** The drilling sludge and reservoir water produced during the conventional production of natural gas can be contaminated with carcinogenic hydrocarbons and toxic heavy metals. If these leak, e.g. through leaking pipes, the groundwater can become contaminated. Fracking can also pollute groundwater with heavy metals, radioactive elements and fracking fluids (UBA 2023c). In the USA, harmful levels of air pollutants such as benzene and increased ozone levels have also been found in the vicinity of various fracking sites (CHPNY et al. 2022).

⁹ The “Kafala” system is a “sponsorship system” in which an employer is granted far-reaching powers of control over the worker. In Qatar, for example, the “Kafala” system is the central basis for worker migration into the country (Sons 2022).

¹⁰ However, according to industry observers, safety standards in the oil and gas sector in the UAE are better than in other sectors (e.g. construction).

- **Land use conflicts and property rights:** The underground injection wells in the fracking process can increase the risk of earthquakes. In the USA and the UK, among other countries, studies have concluded that there are links between fracking and earthquakes (Krauter 2019; USGS, undated). Fracking also requires significantly more land than conventional gas drilling, which can lead to competition for land, e.g. with food production (Food & Water Watch 2016). In the USA, there are also reports of disputes with indigenous groups who see their use and customary rights and access to cultural sites restricted because of fracking projects (The Guardian 2020).
- **Conflicts and security:** Gas workers in remote areas are often at increased risk of politically or economically motivated attacks on energy infrastructure, e.g. by gangs and criminal activities, domestic extremist groups or international terrorism (ILO 2022). SOCAR, the state-owned energy company of the Republic of Azerbaijan, plays a central role in the Memorandum of Understanding to increase gas supplies signed between the EU and Azerbaijan in July 2022. SOCAR announced in 2020 that its oil and gas infrastructure was partially guarded by the army due to fighting in the conflict over the Nagorno-Karabakh region (Reuters Staff 2020).
- **Land use conflicts and property rights:** According to the Institute for Human Rights and Business (IHRB) and Shift, there are reports of pipeline routes affecting or blocking access to land, e.g. for livestock or school routes, without sufficient consultation or compensation for the local population (IHRB and Shift 2014). The construction of pipeline networks for the transport and distribution of gas has led to conflicts with indigenous peoples over land use in Canada, among other places. The local population has not been granted access to land and water resources for management or the right to free, prior and informed consent (FPIC), according to a report (FoE Japan 2021).

Transport (via pipelines/construction of pipelines)

- **Environment-related human rights risks:** Pipelines can run through ecologically sensitive areas. If leaks or explosions occur (due to corrosion or excavation work), this can lead to air, water and soil contamination, which can also cause damage to the health of residents (Piri and Faure 2014).



Specific risks for LNG

The value chain of LNG differs greatly at the transport level from that of pipeline natural gas, which means that other risks can arise in this regard. To be able to transport the gas in tankers across the sea, the volume of the gas must first be reduced. This is done through energy-intensive cooling to around –162 degrees Celsius, which liquefies the gas into LNG. After being transported in tankers, the gas is converted back into a gaseous state in LNG terminals or regasification plants and transported to the final consumers via pipelines. There are various risks associated with these intermediate steps:

Inadequate occupational safety and health hazards in the workplace: LNG is highly flammable, so there is an increased risk of fires and explosions on tankers (Khalid 2022). Explosions can also occur in LNG export facilities. For example, in June 2022, an explosion occurred at the US Freeport LNG plant in Texas after highly flammable methane gas escaped from a pipe and ignited (Baddour and Erdenesanaa 2023). Volatile impurities must be removed in liquefaction plants before the gas is cooled, which can lead to the chemical compound escaping into the air (CHPNY et al. 2022). For example, benzene, which is

carcinogenic and leads to damage of internal organs and bone marrow in case of long-term inhalation, is removed (UBA 2021a). The construction of new infrastructure such as LNG terminals is associated with the general risks to human rights inherent in the construction sector such as precarious working conditions, low wages and discrimination, environment-related human rights risks and land use conflicts (see Chapter 2.2). Ports and international shipping are considered high-risk sectors overall because of the high number of accidents at work, fires, explosions, harmful and precarious working conditions, forced labour and discrimination against women (Knoke et al. 2023).

Environment-related human rights risks: For the construction of further LNG terminals in Germany, the LNG Acceleration Act stipulates, among other things, exemptions for environmental impact assessments that can be applied under certain conditions (Die Bundesregierung 2023c). Accelerated approval procedures in general and exemptions from environmental impact assessments can limit the involvement and say of right-holders and result in potential environment-related human rights risks not being adequately considered in the planning process.

3.5 Power grids

Introduction

The electricity grid plays a general and central role in the energy supply by transporting electrical energy from various sources to the final consumers. This role is currently undergoing an extensive transformation resulting from the growing share of renewable energies in the electricity mix in Germany. Since the generation of electricity from renewable sources is more decentralised, on a smaller scale and geographically less evenly distributed than that of traditional power plants, there is currently a need to expand the grid in order to connect the growing number of renewable energy installations to the grid (Federal Ministry for Economic Affairs and Climate Action 2020; Dena

2023; ZVEI 2023). This results in a global demand for new transmission and distribution grids that is up to 50% higher than in the past 10 years (IEA 2022, p. 77).

Due to the central importance of power grids and the changes in terms of quality and quantity they are currently undergoing, this document also takes a closer look at this section.

A distinction is made between transmission and distribution grids. Transmission grids transport electricity nationwide over long distances at maximum voltage between energy sources and consumption centres. Distribution grids transport electricity in high, medium and low voltages to the final consumers regionally (Dena 2023).

The central product groups for transmission and distribution grids include (underground) cables and wires, transformer stations, electricity pylons and transformers as electricity transmission in Germany takes place via overhead lines on pylons and via cables underground (IEA 2022, p. 79; EnBW, undated). In addition, electrical installation material, information and communication technology, cable yarn and connection material, switchgear and disconnection switches are among the products that are relevant for distribution grid operators.¹¹ The following section focuses on cables that, among other things, are used in the electricity grid in the form of transmission and distribution lines, but also as electrical lines in buildings.

Supply and value chain

The simplified supply and value chain of electricity grids comprises the steps of (1) raw material extraction, (2) raw material processing, (3) component manufacturing (focus: cables), (4) planning and construction of the grids/installations, (5) use/operation of the electricity grids including maintenance, and (6) recycling or disposal (focus: cables). German companies in the energy industry are particularly involved in the planning and construction of grids and installations as well as their operation in Europe, mainly in Germany.

For the production of the relevant product groups, large quantities of metallic raw materials such as copper and bauxite (aluminium) are used as components of the cables, as well as iron (steel) and in some cases sand (concrete) for the pylons (IEA 2022b; Acatech 2023; EnBW, undated). In addition to the elements for the power lines and pylons, information and communication technologies are used in smart grids, which in turn involve the consumption of specific raw materials.

The following analysis concentrates on copper (or copper ore as a precursor) as an important raw material for power grids since aluminium (or bauxite) is already considered in detail in Chapter 3.3. In 2019, almost 16% of the copper consumed worldwide went into infrastructure (electricity grid and data network) (Dorner 2020). According to IEA estimates, in 2020 around five million tonnes of copper were used around the world for the construction of electricity grids (more than 55% of this volume for distribution grids) (IEA 2022a). The extensive grid expansion in the future is also expected to lead to a further increase in copper demand (Falkenberg et al. 2019). The world's largest mining and producing countries for copper (ore) are Chile (24%), Peru (10%), DR Congo (10%), China (9%), the USA (6%) and Zambia (4%) (USGS 2023c). China, Chile, Japan, Russia, Zambia and India are global leaders in the processing (smelting) of copper concentrates (USGS 2018). Globally, cables are mainly produced in Asia, especially in China and Japan (Beyer 2021). However, some important manufacturers for high, medium and low voltage, underground and submarine cables are located in Europe and Germany¹² (Acatech 2023; Europacable 2015).

The around 200,000 tonnes of cable waste generated in Germany each year are increasingly being recycled in Germany (EU Recycling 2020).

¹¹ Information based on group interviews with members of the *Energy Sector Dialogue*.

¹² Companies that are members of the *Energy Sector Dialogue* stated that they purchase their cables almost exclusively from suppliers in Europe with whom they have a close working relationship. (Source: interview with the *Energy Sector Dialogue* on 24 April 2023)

ILLUSTRATION OF THE SUPPLY AND VALUE CHAIN OF ELECTRICITY GRIDS

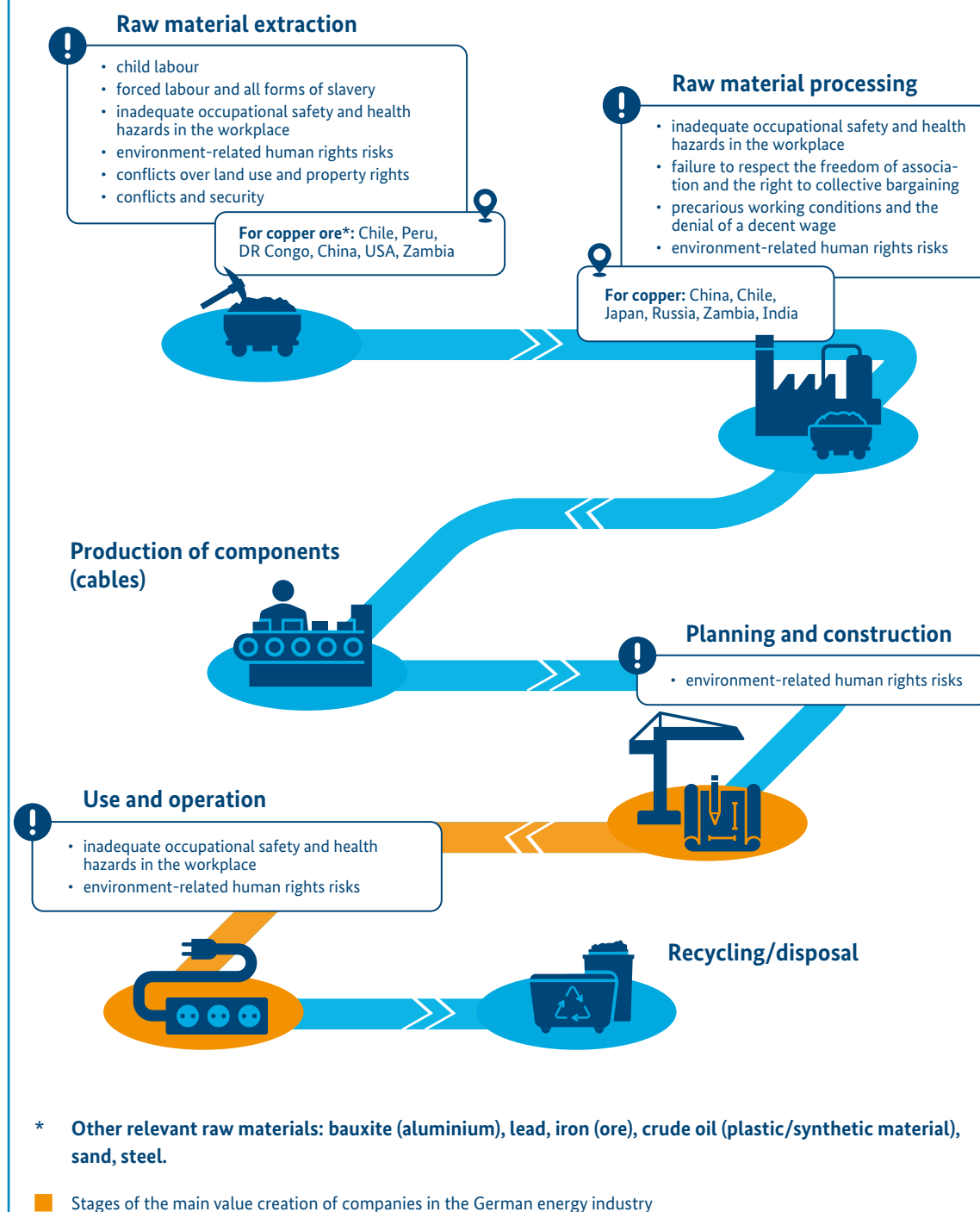


Figure 6: Illustration of the supply and value chain for electricity grids

Selection of potential human rights risks along the supply and value chain

The following risks are based on a qualitative evaluation of existing, publicly available data and literature, in particular databases, scientific research papers and studies/reports by civil society stakeholders, industry associations and other institutions, which are mainly available in German or English. The analysis focuses on copper for the first two stages of the supply chain, the extraction and processing of raw materials, and on cables for the production of components. Information on the risks associated with the extraction of other relevant raw materials is outlined in Chapter 5. Aluminium is considered in detail in Chapter 3.3. Steel is considered in detail in Chapter 3.6.

The following risks are potential risks along the supply and value chains of companies in the German energy industry. Individual risk analyses are used for purposes of plausibility checks, weighting and prioritisation for a company's own operational context. In particular for the identified potential risks in the planning and construction stage, it is important to check whether the examples and country contexts cited are currently relevant to a company's own operational context.

Raw material extraction (copper ores)

- **Child labour:** According to reports, children are often employed in small-scale mining, for example in the DR Congo and Zambia. According to these reports, 40% of all workers in small-scale mining are children (Verité 2017; USDOL 2022).
- **Forced labour and all forms of slavery:** There are reports of forced labour in copper production in the DR Congo and Zambia (Verité 2017).
- **Inadequate occupational safety and health hazards in the workplace:** There are reports of unsafe working conditions and lack of protective equipment in copper mining in the DR Congo (mainly small-scale mining) (Verité 2017; OECD 2019a). The inhalation of dust containing heavy metals can lead to health risks (Drive Sustainability and Responsible Minerals Initiative 2018).
- **Environment-related human rights risks:** In the vicinity of copper mines there can be high levels of water consumption as well as water and soil pollution (Verité 2017; UBA 2022; Südwind 2019). This can have a negative impact on local communities and exacerbate regional problems such as water scarcity (Scott Jacobsson 2019). As copper itself is toxic, too high a concentration in the soil can lead to contamination of drinking water and thus threaten access to clean drinking water. Bioaccumulation in plants and food animals poses additional health risks to communities near copper mines (SOMO and ActionAid Netherlands 2018; Drive Sustainability and Responsible Minerals Initiative 2018).
- **Land use conflicts and property rights:** Copper mining can lead to the displacement and resettlement of the local population without (sufficient) compensation being provided (MVO Nederland, undated).
- **Conflicts and security:** There are reports of protests by indigenous peoples against copper mines being crushed, including in Peru (Drive Sustainability and Responsible Minerals Initiative 2018; DCAF 2021).

Raw material processing (copper)

- **Inadequate occupational safety and health hazards in the workplace:** In copper smelters in Zambia and China, there are reports of work under conditions that are hazardous to health and work stress due to excessive working hours (Gilsbach 2020).
- **Failure to respect the freedom of association and the right to collective bargaining:** Cases of discrimination against trade union representatives have been reported from copper smelters in Zambia and China (Gilsbach 2020).
- **Precarious working conditions and the denial of a decent wage:** In copper smelters in China, complaints were reportedly punished with salary cuts and dismissals (Gilsbach 2020).
- **Environment-related human rights risks:** The roasting of copper ores can release air pollutants that are harmful to the environment and to health (UBA 2022) as was reported, for example, from Zambia and Chile (Scott Jacobsson 2019; Gilsbach 2020). In the vicinity of copper smelters, e.g. in

Chile and southern India, elevated levels of heavy metal contamination have been measured in soils and waters (Gilsbach 2020). The high water consumption in copper ore mining can exacerbate the risk of local water scarcity and thus affect access to drinking water or food security through arable farming (Weiss et al. 2022).

Planning and construction

There are fundamental risks in construction projects, including forced labour and all forms of slavery, inadequate occupational safety and health hazards in the workplace, the denial of a decent wage and precarious working conditions, discrimination, land use conflicts and property rights, and conflict and security (see Chapter 2.2).

- **Environment-related human rights risks:** The construction and expansion of electricity grids can result in the emission of air and water pollutants that can be harmful to the environment and to human health. The expansion of the power grid and the construction of access roads to power lines can cause soil erosion and strong noise emissions. In addition, large areas of land are used and deforestation can occur since tall vegetation is often removed to make way for power lines in order to prevent fires. Hazardous substances are often used in construction work and must be disposed of properly to prevent soil and water contamination. The use of heavy machinery in the construction of power lines can also cause damage to rivers and other bodies of water when power lines cross them. Among other things, this can restrict access to water for residents (UN DESA 2006; Huber and Weiß 2021).

Use and operation

- **Inadequate occupational safety and health hazards in the workplace:** Improper installation and maintenance can result in a risk of electric shock (BSR, undated). Uncontrolled cable fires can release lead and other toxic heavy metals (Toxics Use Reduction Institute 2002).
- **Environment-related human rights risks:** The operation of power lines can increase the risk of forest fires if trees fall over and come into contact with lines. Forest fires can cause significant damage to

the environment and thus destroy the livelihoods of surrounding communities. In addition, electromagnetic fields generated by power lines can have a negative impact on the health of people living nearby (UN DESA 2006).

Recycling/disposal

- **Environment-related human rights risks:** When older substations have to be modernised or upgraded for the installation of connecting lines, polychlorinated biphenyls (PCBs) can leak out and have to be disposed of properly as they are harmful to the environment and human health (UN DESA 2006).

3.6 Hydrogen

Introduction

Hydrogen is seen as an important pillar of the energy transition given that this source of energy can also be used flexibly in areas that cannot be electrified and can be produced in a climate-friendly manner (Bullmann et al. 2020). The German Federal Government plans to use hydrogen produced in an environmentally friendly way to decarbonise industry and transport (Die Bundesregierung 2022). The national hydrogen strategy of 2020 aims to strengthen Germany's pioneering role in the production of green hydrogen (Federal Ministry for Economic Affairs and Climate Action 2020a) and to increase generation capacities to 5 GW total capacity by 2030; the current update of the strategy aims to increase the target to 10 GW (Federal Ministry for Economic Affairs and Climate Action 2020a; Die Bundesregierung 2023a).

Since hydrogen is an important green energy source for certain sectors, this chapter will focus on hydrogen. Depending on how it is produced, hydrogen is called grey, blue or green.

Grey hydrogen is produced by steam reforming of fossil hydrocarbons, usually natural gas. In Germany today, mainly grey hydrogen is produced and consumed (Kruse and Wedemeier 2021). Since comparatively large amounts of CO₂ are emitted into the atmosphere during the production of grey

hydrogen, it is not climate-friendly and, according to the national hydrogen strategy, should be replaced by more environmentally friendly production processes (Federal Ministry for Economic Affairs and Climate Action 2020a).

Like grey hydrogen, **blue hydrogen** is produced by steam reforming from natural gas or coal gasification. However, the CO₂ is to be captured and either stored underground in the long term (carbon capture storage [CCS]) or used in products (carbon capture usage [CCU]). The large-scale applicability of these technologies is currently still in the test phase (Loria et al. 2021).

Green hydrogen is produced by electrolysis. In this process, water (H₂O) is split into its components hydrogen (H₂) and oxygen (O₂). Various technologies for electrolysis are available and are currently being ramped up.¹³ A distinction is made between alkaline, high-temperature and PEM electrolysis. Hydrogen is referred to as green hydrogen if the electrolysis was carried out exclusively with electricity from renewable energies (IEA 2022b).

Due to the increasing importance of green hydrogen, the following analysis will focus on this.

Supply and value chain (green hydrogen)

The simplified supply and value chain for green hydrogen includes (1) raw material extraction, (2) raw material processing, (3) provision of energy and water, (4) electrolysis, (5) transport and distribution, (6) storage and (7) use/consumption (Fraunhofer IPK 2023). Companies in the German energy industry are currently mainly involved in the production of grey hydrogen in Germany. The production capacities for green hydrogen are still under development, especially in Germany and other European countries. Some companies are involved in the construction and operation of power-generating installations outside Europe. In the future, purchase agreements can create a link to the production of green hydrogen in non-European countries, which can then be convert-

ed, stored and made available to end customers by German companies or used to generate electricity.

Although water is the main raw material required for the production of green hydrogen, the expansion of electrolysis capacities and the construction of the installations and infrastructure for hydrogen production (e.g. large solar thermal, PV or wind power plants) also require steel, aluminium, platinum, nickel, iridium, yttrium, palladium and scandium, among others. The demand for the individual minerals and metals varies depending on the electrolysis process used (Geitmann 2020; Fraunhofer ICT, undated).

Due to the large mass percentage of steel used, the following analysis focuses on the mining of iron ore as a raw material and its processing into steel. Steel is used in various process stages of green hydrogen production (Geitmann 2020). For example, pipelines for transporting water are made of steel, which will lead to a high demand for steel for the expansion of the water infrastructure (Brauer et al. 2018).

Steel and stainless steel are also used in the construction of electrolyzers and in the process of alkaline electrolysis (AEL) (Geitmann 2020; DiLiCo engineering GmbH, undated; Wilken et al. 2014). In 2021, all iron ores for German pig iron production were imported from abroad. The countries with the largest iron ore production are Australia, Brazil, China, India and Russia (USGS 2023d). For German imports of non-agglomerated ores and concentrates, the predominant countries of origin were South Africa (38.7%), Brazil (26.1%) and Canada (19.3%) (BGR 2022). Imports of agglomerated ores and concentrates predominantly originated from Canada (30.6%), Russia (26.4%), Sweden (18.8%) and Ukraine (10.4%) (BGR 2022).

Germany is one of the ten largest steel producers in the world, but still imports about 25% of its steel (2022), with other EU countries being the most important countries of origin (OEC, undated). Globally, China, Japan, India, Russia, South Korea and Brazil are among the largest producers (USGS 2023d).

¹³ There are currently three relevant processes for electrolysis: alkaline electrolysis, PEM electrolysis (PEM stands for “proton exchange membrane”) and high-temperature electrolysis. Alkaline electrolysis is ahead of PEM electrolysis and high-temperature electrolysis in terms of durability and system costs. However, PEM electrolysis and high-temperature electrolysis, which are currently still being expanded, are expected to be more efficient in the future (Till Bullmann et al. 2020).

Germany will be dependent on imports for the production of green hydrogen for the foreseeable future as the energy demand will continue to exceed German resources going forward. For imports, Germany is seeking partnerships with Australia, Namibia, Chile, Morocco and South Africa as wind and solar power for the production of green hydrogen can be produced particularly cheaply in these countries due to favourable conditions (BMBF 2023b).

So far, with the exception of the shipping of liquefied hydrogen, no international transport takes place. In the future, hydrogen will be transported in gaseous form (pipeline), in liquefied form or as a derivative, such as in the form of ammonia or methanol (ship, truck). Green hydrogen is currently being produced on a small scale. The German Federal Government plans to expand electrolysis capacities in Germany to at least 10 GW by 2030.

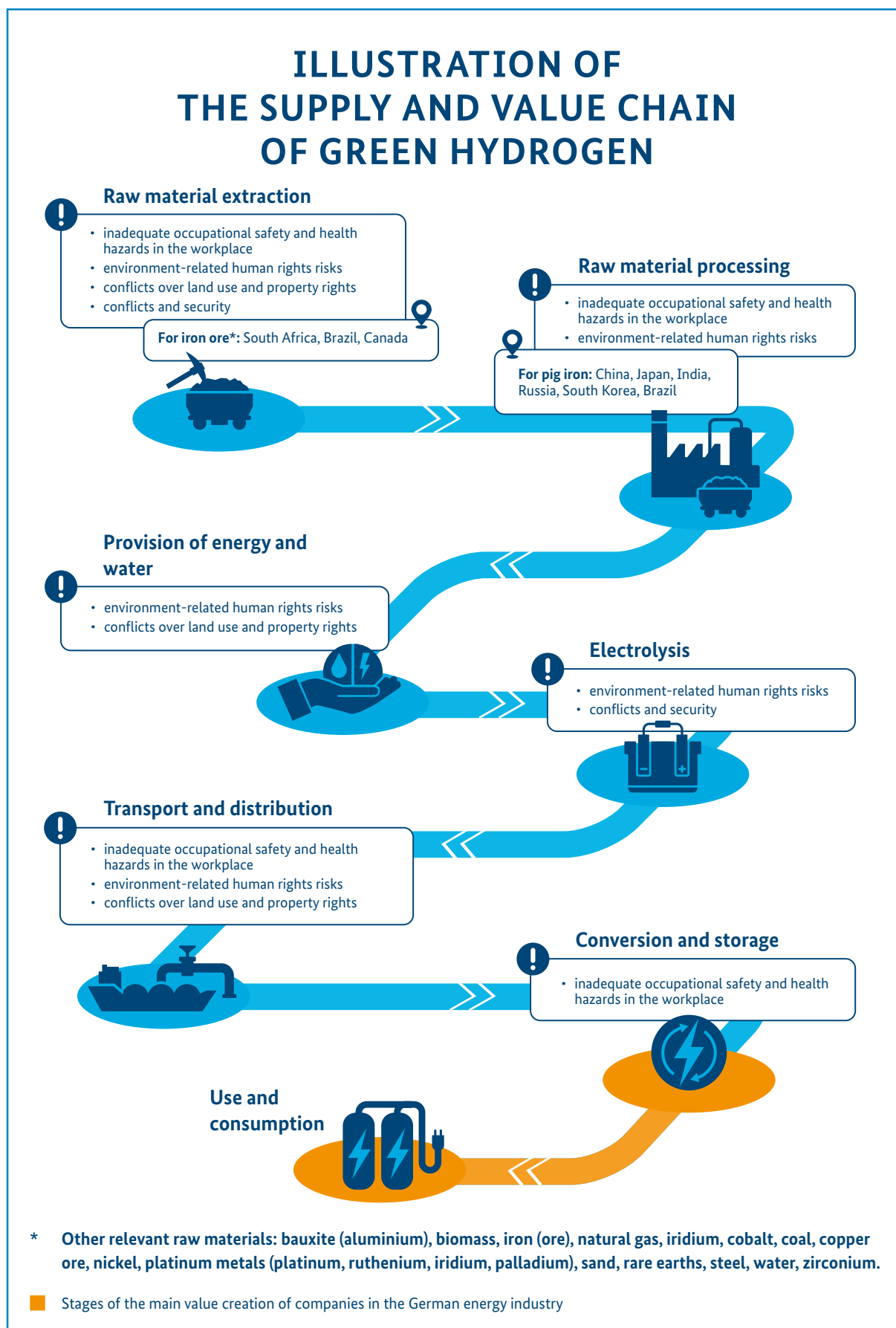


Figure 7: Illustration of the supply and value chain of green hydrogen

Selection of potential human rights risks along the supply and value chain

The following risks are based on a qualitative evaluation of existing, publicly available data and literature, in particular databases, scientific research papers and studies/reports by civil society stakeholders, industry associations and other institutions, which are mainly available in German or English. The analysis focuses on iron ore for the first two stages of the supply chain, the extraction and the processing of raw materials. The potential human rights risks of the other relevant raw materials are outlined in Chapter 5.

The following risks are potential risks along the supply and value chains of companies in the German energy industry. Individual risk analyses are used for purposes of plausibility checks, weighting and prioritisation for a company's own operational context. Especially for the identified potential risks in the electrolysis, transport and distribution, and storage stages, it is important to check whether the examples and country contexts cited are currently relevant for a company's own operational context.

Raw material extraction (iron ores)

- **Inadequate occupational safety and health hazards in the workplace:** Iron ore mining is often carried out using diesel generators, which release CO₂ and other pollutants and can cause considerable air and noise pollution that can affect the health of workers in particular (Raw Material Outlook Platform, undated). In addition, sexual assault and harassment of women has been documented in one of Australia's largest iron ore mining companies, which can be a sign of an unsafe working environment for women in mining camps (Raw Material Outlook Platform, undated). In India, there have been records of injuries and deaths due to accidents in mines (Dhaatri Resource Centre for Women and Children and mines, minerals & people 2010).
- **Environment-related human rights risks:** Iron ore mining can result in chemical contamination of surface water and groundwater through the release of fuels and other pollutants, with adverse implications on local communities (Drive Sustainability and Responsible Minerals Initiative 2018). Breaches of landfill and storage dams, such

as in Brumadinho or in Samarco, both Brazil, in 2019 and 2015 respectively, have serious negative consequences on the livelihoods and health of the population (Deutsche Welle 2019; SOMO and ActionAid Netherlands 2018). In addition, iron ore mining, e.g. in Brazil, China and Russia, release significant amounts of dust that can pollute air quality, cause serious health problems and threaten the livelihoods of local populations by negatively affecting agriculture (Drive Sustainability and Responsible Minerals Initiative 2018). The pollution of watercourses by iron ore mining waste, for example, can lead to reduced access to clean water for indigenous peoples and local communities and thus threaten livelihoods (Raw Material Outlook Platform, undated).

- **Land use conflicts and property rights:** Iron ore is primarily mined by machine in large-scale mines. The majority of these mines are opencast mines. This can lead to expropriation of land and forced displacement, resulting in loss of identity and culture and loss of livelihoods, and can affect the rights of indigenous peoples, especially if internationally recognised rights such as FPIC are not guaranteed (Raw Material Outlook Platform, undated). Such incidents have been documented in Brazil, among other places (UBA 2022c).
- **Conflicts and security:** In the Carajás region in the Brazilian state of Para, for example, there have reportedly been repeated violent conflicts in recent years between the local population and a security firm engaged by a mining company, in which several people were injured (DGB Bildungswerk BUND 2021).

Raw material processing (iron/steel)

- **Inadequate occupational safety and health hazards in the workplace:** The hazards arising from air pollution and the release of pollutants in the production and processing of iron (see next point) not only affect the local population but also the workers employed in these sectors.
- **Environment-related human rights risks:** The pollutants released during the production of steel in the form of dust and pollution can lead to health problems such as asthma, skin problems and diarrhoea, and in the past have also been linked to

the occurrence of cancers and tuberculosis (Raw Material Outlook Platform, undated). For example, in the state of Maranhão in north-eastern Brazil, significant health implications have been reported in communities living in the immediate vicinity of iron and steel plants (Drive Sustainability and Responsible Minerals Initiative 2018). The residues from steel production can have a considerable impact on the environment and destroy livelihoods in the form of dust, leachate and land use if not treated properly. It has been reported in Brazil, China, Russia and India that the dust released from iron ore mining can pollute the air and cause serious health problems, as well as threatening the livelihoods of local communities by having a negative effect on agriculture (Drive Sustainability and Responsible Minerals Initiative 2018). Furthermore, in the treatment processes of ferrous metal production in China, India and Russia, among other places, there is a risk that, in the event of leakages, water bodies will be polluted by acidic wastewater and heavy metals will be introduced into water cycles (Drive Sustainability and Responsible Minerals Initiative 2018).

Provision of energy and water (green hydrogen)

The provision of energy from solar or wind power plants, for example, can be associated with various risks to human rights. Please also refer to Chapters 3.1 and 3.3 in this regard.

- **Environment-related human rights risks:** The production of green hydrogen, which involves high water consumption, takes place in regions that already suffer from water scarcity (for example, South Africa, Namibia or Morocco as well as other places) and can exacerbate this (Denter and Friess 2023; Villagrasa 2022). The livelihood of the local population can be threatened if it depends on the sufficient availability of water (Heinemann and Mendelevitch 2021). When desalination plants are used, the release of highly concentrated brine can damage marine ecosystems that provide a basis for life (Steinwandel and Schnittker 2022; Morgen et al. 2022).
- **Land use conflicts and property rights:** In countries with freshwater scarcity and existing levels of high water stress, the additional use of the

available water for the production of hydrogen can exacerbate the existing problems. In arid regions such as large parts of Africa, there is a danger that existing water conflicts will be exacerbated or new ones created in this way. Reports on the construction of large-scale plants point out the threat to livelihoods from land conversion, a lack of compensation, lack of integration and lack of benefit of the plants for the population. Particularly for nomadic communities without formal land ownership title, this can contribute to further marginalisation and deprive them of their livelihoods (Steinwandel and Schnittker 2022; Denter and Friess 2023). Any emerging conflicts between local communities and companies can sometimes be resolved through the courts; however, there have been reports of violent disputes (Waters-Bayer 2022; Villagrasa 2022). Furthermore, care must be taken to ensure that the renewable energy sources established for hydrogen production do not use land that would be required to supply the local population with renewable energy. Otherwise, hydrogen production could prevent the local shift to renewable energy, slow down the development of the necessary infrastructure and perpetuate energy poverty. This in turn could lead to conflicts with local communities (Heinemann and Mendelevitch 2021).

Electrolysis (green hydrogen)

- **Environment-related human rights risks:** The production of hydrogen involves a high demand for water and energy for electrolysis and desalination plants. The risks associated with their provision are described above under “Provision of energy and water”.
- **Conflicts and security:** Local communities are often unable to benefit from hydrogen production, either in terms of energy use or job creation, as some are not connected to electricity grids and lack the necessary qualifications. These points could lead to conflicts in the future that go beyond the conflicts around land used referred to above (Heinemann and Mendelevitch 2021).

Transport and distribution¹⁴

- **Inadequate occupational safety and health hazards in the workplace:** Pipeline networks and transport routes for hydrogen can pose risks as hydrogen is a highly flammable gas and can lead to dangerous situations in the event of leaking pipes or improper transport.
- **Environment-related human rights risks:** Explosions, leakages and spills of ammonia can cause environmental damage and thereby harm the population in the surrounding communities (Heinemann and Mendelevitch 2021).
- **Land use conflicts and property rights:** The construction of pipelines can lead to land consumption or destruction, especially if the pipelines run through sensitive environmental and settlement areas. Pipeline routes could thus change access to land and lead to the violation of property and participation rights, especially of indigenous peoples (FPIC) and local communities (IHRB and Shift 2014; FoE Japan 2021).

Conversion and storage

- **Inadequate occupational safety and health hazards in the workplace:** Processing hydrogen comes with potential risks. In particular, an increased risk of explosions can pose a threat to occupational safety and health at the processing site (Amyotte 2018). The production of green or blue ammonia poses additional health risks as ammonia is highly toxic and, when it comes into contact with the skin or the eyes, can cause serious injuries (IEA 2019; Heinemann and Mendelevitch 2021). The situation is similar when ammonia is converted into hydrogen at its destination.

¹⁴ The two main options for transporting hydrogen are ships (liquefied or in the form of derivatives such as ammonia or methanol) and, going forward, pipelines. That means that the same means of transport are used for natural gas and hydrogen. Even if the means of transport are technically adapted, depending on the energy carrier, the risks associated with the transport of these two energy sources are similar. In order to avoid redundancies with Chapter 3.4 on natural gas, the risks that overlap with the transport of gas are only briefly touched upon here.



Specific risks of blue hydrogen

The different production method of blue compared to green hydrogen involves different risks. Taken as a whole, the following risks are particularly relevant in the supply and value chain of blue hydrogen compared to green hydrogen:

Provision of fossil energies and water

Since blue hydrogen is produced from fossil energy sources, the risks compared to green hydrogen differ primarily at the level of energy production. The potentially negative implications along the entire supply and value chain of natural gas are relevant in this regard. These are explained in detail in Chapter 3.4.

Although no electrolysis of water takes place in the production of blue hydrogen, water is still needed to operate the plants. Problems with water scarcity and the associated consequences for the local population as well as potential conflicts can be particularly severe in regions that are already arid as has been set out under the point “Provision of energy and water” regarding green hydrogen.

Steam reforming and processing

Chemical plants or refineries usually produce the necessary hydrogen on site through the process of steam reforming (Bullmann et al. 2020). The process of producing hydrogen from a chemical reaction between carbon monoxide and water vapour can pose risks to human rights.

Furthermore, in contrast to green hydrogen, the various methods of capturing, storing or using the CO₂ produced during manufacturing potentially pose an additional risk. The use of carbon-capture methods has not yet been established as a standard process in the production of blue hydrogen. The risks of carbon capture and storage (CCS) and carbon capture and utilisation (CCU) are difficult to assess due to limited experience and a lack of long-term studies (IPCC 2023).

4. Description of human rights risks under consideration

The following chapter illustrates the categories of human rights risks referred to in relation to the relevant human rights provisions. Examples from the literature provide insights into documented negative effects.

4.1 Child labour

According to the International Labour Organization and Article 10 of the UN Social Covenant, child labour includes any work that deprives children of their childhood, their potential and their dignity and that is harmful to their physical and mental development. This includes work that interferes with children's education by preventing them from attending school, forcing them to leave school early, or requiring them to combine school attendance with excessively long and hard work (UNGC, undated). In exceptional cases, child labour is permitted, e.g. when children help their families with the harvest for a short time or when they are older than 15 years and work in safe conditions (OHCHR 2017, p. 68).

ILO Core Labour Standards No. 138 and No. 182 and the United Nations Convention on the Rights of the Child provide the framework for national law on child labour. ILO Core Labour Standard No. 138 on the Minimum Age for Admission to Employment (1973) sets a general minimum age of 15 years for employment, with some exceptions. ILO Core Labour Standard No. 182 on the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour prohibits the most serious forms of child labour, including hazardous work by young workers under the age of 18. The United Nations Convention on the Rights of the Child (CRC) recognises that children are particularly vulnerable, prohibits child labour and obliges signatory states to regulate the minimum age and working conditions for children.

Example from the literature



The DR Congo accounts for almost 70% of global cobalt production (DERA 2021a). The Central African state thus plays an important role in the extraction of raw materials for battery storage, wind energy and hydroelectric power generation. There are reports from the DR Congo from Amnesty International, amongst others, about the use of young children, some as young as seven years old, in cobalt mining, mainly in small-scale mining. In total, around 40,000 children are said to be employed in cobalt mines in the Central African country, where they often work up to 12 hours a day in harmful and dangerous conditions. Wages are typically less than two US dollars per day. The money is needed to support the often low-income families of the children. The Congolese government only carries out sporadic and inadequate checks of artisanal small-scale mining operations; legal safeguards are almost non-existent.

Permanent contact with cobalt and inhalation of dust containing cobalt can lead to various chronic diseases and sometimes fatal lung diseases, especially in children. Many of the mines are also at risk of collapse, posing a further danger to the children and adults working there (Amnesty International 2017). In addition to the physical dangers to health and safety at work, child labour can also damage the mental health of minors. A study by Save the Children reports that children working in cobalt mines often have poor mental health and experience depressive moods (Spiess 2022).

4.2 Forced labour and all forms of slavery

Forced labour includes any work or service which is exacted from a person under the threat of any penalty and for which said person has not offered themselves voluntarily (ILO Core Labour Standard No. 29 and the 2014 Protocol to the Forced Labour Convention). According to Article 8 of the UN International Covenant on Civil and Political Rights, all forms of slavery and servitude are prohibited, and the signatory states have committed themselves in ILO Core Labour Standard No. 105 to eliminate forced labour. The right to freedom from slavery also includes the economic or sexual exploitation and degradation of persons, especially in the context of human trafficking, servitude and bonded labour (OHCHR 2017, p. 27). In this context, the fact that work is paid does not necessarily mean that labour is not forced if the other elements of forced labour are fulfilled (OHCHR 2017, p. 27). An example is when a person is forced to work to pay off their debts, or when a migrant worker deposits identity documents with an employer and is forced to work to get the documents returned to them. In contrast to slavery, the right to freedom from forced labour can be restricted, e.g. in the case of emergencies and disasters, or in the case of restrictions due to prison labour or military service.



Example from the literature

One of the most important areas of origin for silicon is the autonomous Xinjiang region in the north-west of China. This makes the region particularly important for the photovoltaic sector. About 45% of the silicon needed for solar plants worldwide is produced in Xinjiang. In Xinjiang, an estimated 2.6 million Uyghur and ethnic Kazakh women are reportedly subjected to forced labour, coercion and “re-education programmes”. There is evidence that silicon producers in the region participate in the government’s so-called “worker transfer programmes”, which, according to a report by Sheffield Hallam University, use workers from internment camps who are subject to “unprecedented coercion” and constant threats (Murphy and Elimä 2021). In August 2022, the Office of the United Nations High Commissioner for Human Rights also published a report on various human rights violations against the Uyghur and Kazakh minorities in China, including forced labour and severe coercion (UN OHCHR 2022). Due to the transfer of labour of Uyghurs, there is a risk that such human rights violations will also occur in other regions of China outside Xinjiang (Svec 2022). As a result of these allegations, a law came into force in the USA in 2022 that prohibits the import of products containing polysilicon produced in Xinjiang for US companies. Exceptions to this import ban are only permitted if the companies can prove that no production step involved forced labour (Bastian 2022).

4.3 Inadequate occupational safety and health hazards in the workplace

Occupational safety and health means the creation and maintenance of safe and healthy working conditions. According to Article 7 of the UN International Covenant on Economic, Social and Cultural Rights, the right to just conditions of work includes a safe and healthy workplace, rest and leisure and reasonable limits on working hours. ILO Core Labour Standard No. 155 defines occupational safety and health as the prevention of accidents and damage to health arising out of, in connection with, or in the course of work, by reducing the causes of danger. According to this ILO Core Labour Standard, companies must ensure that equipment, machinery and chemical and biological substances used do not pose a health risk to workers and that appropriate protective equipment is available. ILO Convention 176 additionally defines specific requirements for occupational safety and health in the mining sector. These include, among other things, the provision of escape routes, protection against collapse, the provision of rescue teams and adequate inspections.

According to ILO Convention 161, employers are also generally obliged to monitor risks and health hazards in the workplace through medical advisory services. Companies are particularly required to protect the rights of certain vulnerable groups, such as women, younger and older workers, people with disabilities, migrant workers and informal workers (OHCHR 2017, p. 87).

Example from the literature



Chile is one of the world's largest copper ore producing countries – two of the world's largest copper mines are located in Chile – and also plays a central role in the processing of copper concentrates (Gilsbach 2020). The raw material is used in practically all sectors of the energy industry. Among other things, the expansion of the grid to connect solar and wind farms to the electricity grid is expected to lead to an increase in copper demand (Dorner 2020). In 2021 alone, 20 fatal accidents occurred in Chilean copper mines (Cambero et al. 2022). A year later, a general strike took place due to safety concerns at the world's largest copper mine Escondida in northern Chile (Cambero 2022). As early as 2010, there were initial discussions about safety in Chilean mining, when 33 miners were trapped underground for 69 days after a partial collapse in the San José copper mine (Bonnefoy 2013). Working in the mines exposes workers to a variety of health and safety risks, including injuries from landslides, cave-ins and inadequate protective clothing. According to reports, occupational safety in large Chilean mines has improved significantly since the miners were rescued in 2010. However, there is still evidence of poor safety practices in small-scale artisanal mines, which pose significant health and safety risks to workers (Mur 2020).

4.4 Failure to respect the freedom of association and the right to collective bargaining

Freedom of association is the right of every person to form or join trade unions and workers' organisations for the promotion and protection of economic and social interests. This right is enshrined in ILO Core Labour Standard No. 87, the UN International Covenant on Civil and Political Rights (Article 22) and the UN International Covenant on Economic, Social and Cultural Rights (Article 8). A person may not be treated unfavourably because they have joined a trade union. On the other hand, no one may be forced to associate themselves or join an association or trade union. Furthermore, the right to strike (UN International Covenant on Economic, Social and Cultural Rights, Article 8) is an essential component of the freedom of association as it is indispensable for the enforcement of workers' interests. It may only be restricted under certain conditions. ILO Core Labour Standard No. 98 also includes the right to collective bargaining, according to which workers have the right to voluntarily join together and negotiate collective agreements with regard to pay and working conditions.

Example from the literature



Azerbaijan is an important supplier of fossil fuels to EU member states. It thus plays a role in both oil supply and the production of heat and electricity from natural gas. According to reports, despite legally established standards the freedom of association of workers in Azerbaijan is severely restricted in some cases (European Commission 2022). A 2022 report by the U.S. Department of State notes that while collective bargaining is a right in Azerbaijan, it is in fact impossible because the board members of state-owned companies are appointed by the government and are therefore not independent. According to the report, many trade unions are close to the government. Furthermore, the laws on workers' freedom of association are not consistently enforced and violations are often not dealt with under the law (USDOS 2022).

4.5 Discrimination

Discrimination includes any form of different treatment, exclusion, restriction or preference on the basis of certain characteristics which affects a person's equal opportunities. Article 2 of the UN International Covenant on Economic, Social and Cultural Rights and Article 26 of the UN International Covenant on Civil and Political Rights prohibit racial discrimination and discrimination on the grounds of sex, language, age, religion, political beliefs, national or social origin, property or birth. In order to counter discrimination in the labour context, Article 7 of the UN International Covenant on Economic, Social and Cultural Rights requires that equal remuneration must be paid for work of equal value without distinction of any kind and that there must be no less favourable working conditions for certain groups of people – especially in relation to work of equal value carried out by women and men. Everyone must have an equal opportunity to be promoted in their employment, subject to no considerations other than those of seniority and competence. ILO Core Labour Standards No. 100 on Equal Remuneration and No. 111 on Discrimination in Respect of Employment and Occupation require member states to promote equality of opportunity, treatment and remuneration in order to eliminate any discrimination in this area.



Example from the literature

Guinea is one of the world's largest exporters of bauxite, which is processed into aluminium. 93% of the bauxite imported into Germany comes from Guinea (Hartmann 2019). In the energy sector, it is used, among other things, for wind power and solar installations as well as for electricity distribution grids. The strong growth of the bauxite industry, especially in the Boké region in north-west Guinea, is accompanied by negative human rights implications that particularly affect women. For example, local communities are often forced to give up their farmland to make way for the expansion of bauxite mining operations without receiving adequate compensation. Where financial compensation is paid, much of it goes to men, who are traditionally seen as leaders in communities and families and as owners of the land (Human Rights Watch 2018). Women, on the other hand, are often left empty-handed, even though they were equally involved in cultivating the arable land before the land was taken. In this way, the growth of the mining industry leads to a redistribution of property and income within local communities, and women become more dependent on men due to the loss of land. As they are often put at a disadvantage in local decision-making processes, they are also less able to influence the submission of complaints (Human Rights Watch 2018) and settlements with companies in their favour. The discrimination is reinforced by the fact that women, unlike men, very rarely find work in mining companies. While they remain responsible for meeting food needs, they have fewer options to compensate for the loss of income (Human Rights Watch 2018).

4.6 Precarious working conditions and the denial of a decent wage

Precarious working conditions are employment relationships that do not provide adequate pay, are subject to unclear and informal working conditions, unpaid overtime and excessive working hours, as well as a lack of social protection. According to Article 7 of the UN International Covenant on Economic, Social and Cultural Rights, workers must be paid a wage that allows them and their families to earn a decent living. The UN Committee on Economic, Social and Cultural Rights adds that an adequate wage must be based on the local cost of living (comment no. 23, paragraph 18). Article 23 of the Universal Declaration of Human Rights (UDHR) further defines that “every-one who works has the right to just and favourable remuneration ensuring for himself and his family an existence worthy of human dignity [...]”.

Workers are entitled to a fair wage, which can include additional benefits such as health insurance and food allowances (OHCHR 2017, p. 87). According to ILO Convention 1, working time must be limited, ideally to eight hours per day without overtime, with some flexibility. Workers should have at least one day of rest per week, preferably two consecutive days, and sufficient time for rest, leisure and paid leave (ILO Convention 132). Under ILO Convention 131 on minimum wages, companies must pay at least statutory minimum wages, with payment being made regularly, in full and without unauthorised deductions. The governing principle is: equal pay for equal work. Fixed-term contracts may not be used to get around paid leave. Workers should receive a supplementary payment when they work on public holidays (ILO Convention 132).

Example from the literature



The DR Congo accounts for almost 70% of global cobalt production (DERA 2021a). The Central African state thus plays an important role in the extraction of raw materials for battery storage, wind energy and hydrogen production. Recent reports by Rights and Accountability in Development (RAID) and the Centre d’Aide Juridico-Judiciaire (CAJJ) suggest that workers in many of these industrial mines suffer severe violations of labour rights. Workers employed indirectly by sub-contractors – up to 70% in some mines – are particularly affected. In addition to excessively long working hours, violence, discrimination and a lack of health and safety precautions, the workers questioned stated that they received extremely low wages, in some cases barely 93 euros¹⁵ per month (Pattisson 2021). A calculation by the civil society organisations RAID and CAJJ showed that the living wage in the DR Congo (Kolwezi region) in March 2023 amounted to 445 euros per month¹⁶ (RAID 2023). Days off or absences due to illness often result in lower pay. Workers of subcontractors are also often hired on short-term contracts or without any contract, have limited access to social benefits and constantly face dismissal. China’s growing share in the cobalt industry in the DR Congo has led to a sharp deterioration in conditions, according to reports. While working with subcontractors often allows mine operators to cut costs and shift responsibility away from themselves, many workers are forced to accept the catastrophic conditions for lack of other job opportunities (Pattisson 2021; Business & Human Rights Resource Centre 2021a, 2021b).

¹⁵ Own conversion, based on GBP; exchange rate as at 8 June 2023.

¹⁶ Own conversion, based on USD; exchange rate as at 8 June 2023.

4.7 Environmental human rights risks

In terms of environmental risks, the *Energy Sector Dialogue* agreed during the preparation of this publication to take a more in-depth look at those risks that have indirect potential negative implications on human rights of the local population (environment-related human rights risks). The human rights implications of climate change are recognised (ENNHRI 2021) but are not dealt with in detail in this publication.

Environmental risks are generally understood to mean negative impairments of the environmental media air, water and soil as well as natural resources, biological diversity and ecosystems. Business activities can be associated with negative implications on the environment, which in turn can lead to local negative implications on human rights. The protection of life under Article 6 of the UN International Covenant on Civil and Political Rights, the protection of health under Article 12 of the UN International Covenant on Economic, Social and Cultural Rights, and the guarantee of sufficient food, water and sanitation under Article 11 of the UN International Covenant on Economic, Social and Cultural Rights can be particularly affected.



Example from the literature

The USA is one of the main suppliers of LNG to Germany and the EU. LNG from the USA thus plays an important role in the production of heat and electricity from natural gas. The necessary LNG terminals are mainly constructed in Louisiana and Texas and threaten large parts of the wetlands there. As well as providing protection against hurricanes, these wetlands also provide the livelihood of fishermen as they are nursery areas for fish and crabs. Environmental organisations also point out that the companies concerned have been exempted from environmental impact assessments and that the environmental-impact analyses carried out are inadequate (IEEFA 2023; Reuters 2022). In addition, gas flaring at export terminals can emit hazardous air pollutants such as benzene and volatile organic compounds. Prolonged exposure to these air emissions, e.g. by continuous flaring of gas, can affect the health of the population. This particularly affects the black and Hispanic population, who are more likely to live near industrial plants (Cushing et al. 2021). For example, there are reports in the local press of increased cancer rates in the town of Port Arthur in Texas, where fracked gas is already being produced and which is to be developed into an LNG export hub (Gheorghiu and Richter 2023).

These effects can be amplified by operational problems and accidents. This can involve leakages and, in some cases, the permanent flaring of gas (actually an emergency mechanism), which lead to significantly higher emissions compared to normal operations (Earthworks 2023).

4.8 Land use conflicts and property rights

Land use conflicts are generally defined as disputes over the use of land. There is a particular human rights risk when local communities or indigenous groups are deprived of land use and property rights by external stakeholders. Such conflicts can manifest in the denial of customary land tenure, rights of way and rights of use. A variety of human rights are affected, including the right to an adequate standard of living and the right to self-determination under Article 1 of the UN International Covenant on Civil and Political Rights and the UN Social Covenant, as well as the right to own property under Article 17

of the Universal Declaration of Human Rights. The special rights of indigenous groups are set out in ILO Convention 169. According to this, special measures shall be adopted as appropriate for safeguarding the persons, institutions, property and environment of indigenous groups and to recognise rights to ownership and possession. The United Nations Declaration on the Rights of Indigenous Peoples also recognises the need to respect and promote the rights of the indigenous peoples derived from their political, economic and social structures, traditions and history, in particular their rights to land. ILO Convention 169 (Article 17) also refers to the right to consultation and free, prior and informed consent (FPIC) of indigenous communities, especially if land is to be transferred to persons outside the community.

Examples from the literature

Morocco is set to become an important supplier of solar power and green hydrogen to Germany in the future. To that end, the German-Moroccan Energy Partnership and the Hydrogen Agreement between Germany and Morocco were put in place. To expand energy production for export, the construction of new solar and wind farms is planned in Morocco, most of which are financially supported by large development banks. The German KfW Development Bank, for example, contributed 830 million euros for the construction of the Moroccan Noor solar power plant, which amounts to a good third of the total investment sum (Baumann 2021).

Moroccan civil society organisations criticise the state's fixation on mega power plants as large solar power plants like Noor are planned without the involvement of local residents. Accordingly, the local population hardly benefits from energy transition projects, as the green energy is exported and only a few jobs would be created in Morocco. In addition, the production of green hydrogen is associated with high water consumption. In areas where water is scarce, the new projects threaten the water supply for agriculture and thus the livelihood of local farmers (Baumann 2021).

Construction work on Norway's largest onshore wind power project, Fosen Wind, began in 2016. One of the areas affected by the construction project, Storheia, is of great importance for the local Sámi reindeer herders as grazing land. They have a right of use for the area (Andreassen 2022).

In December 2018, the UN Committee on the Elimination of Racial Discrimination (CERD) called on Norway to suspend the project to investigate a complaint that the project was disrupting traditional Sámi reindeer herding (BHRRC 2018). However, the Norwegian Ministry for Crude Oil and Energy has announced that it will continue to pursue the project. The Sámi and the Society for Threatened Peoples called on the private investors to stop the project, withdraw their investments and commit to the principle of free, prior and informed consent (FPIC) for all future investors (BHRRC 2018). The Norwegian Supreme Court ruled in 2022 that the cultural rights of the Sámi people had been disregarded during the construction of two of the three wind farms in Fosen (Andreassen 2022).



4.9 Conflicts and security

Conflict and risk areas include politically unstable regions with repression, weak institutions, lack of security or the collapse of civil infrastructure, as well as widespread and inappropriate violence. Human rights violations and infringements of national and international law frequently occur in such areas. The use of unreasonable force can, for example, violate the right to life (Article 6 of the UN International Covenant on Civil and Political Rights) and the right to liberty and security of person (Article 9 of the UN International Covenant on Civil and Political Rights). Furthermore, there can be violations of the right to protection from extensive violence, torture (Article 7 of the UN International Covenant on Civil and Political Rights) and violations of the freedom of association (Article 22 of the UN International Covenant on Civil and Political Rights) by private or state security forces. In post-conflict situations, there is a risk that old lines of conflict will re-emerge and lead to new violent conflicts as underlying causes such as access to resources, inequality and discrimination have not yet been overcome or compensation has not been paid, e.g. after displacement and flight from lost land or housing.



Example from the literature

The Isthmus of Tehuantepec in southern Mexico is an isthmus between the Atlantic and Pacific oceans that has one of the highest wind potentials in the world. This makes the region significant for the generation of electricity from wind energy. With the support of the Mexican government, international companies are strongly pushing the development of wind farms in the region. However, the development of land-intensive energy infrastructure projects such as wind and solar farms, for example in countries with poor enforcement of human rights laws, can lead to conflicts with local communities and indigenous groups. In the region, the indigenous Zapotec community, for example, fears negative implications of wind farm projects on their way of life and the local environment because indigenous land rights are not being recognised. There have therefore been repeated protests against the construction measures and the companies. In interviews, local residents and members of the indigenous community report threats against local activists who publicly speak out against the wind power companies. In addition, according to reports from local civil society organisations, indigenous activists have disappeared or died in unexplained circumstances. When indigenous communities protest against the construction of new wind farms in the form of marches and blockades, there have been repeated violent clashes with the security forces commissioned by the wind power companies (Vargas 2020).

5. Tabular overview of relevant raw materials

Raw material	Main producing/ extracting countries ¹⁷	Potential risks	Industry sections	Further sources
Antimony	China, Russia, Tajikistan	Environment-related human rights risks, land use conflicts and property rights	Photovoltaics, battery storage	Schmidt 2013 van Brink et al. 2022
Balsa wood	Ecuador, Peru	Forced labour and all forms of slavery, denial of a decent wage	Wind energy	Morton 2022 IHRB – Institute for Human Rights and Business 2022 Clean Energy Council and Norton Rose Fulbright 2022 Forest Policy Trade and Finance Initiative 2022
Bauxite (aluminium)	Australia, China, Guinea (important partner for Germany), Brazil, Indonesia, India	Inadequate occupational safety and health hazards in the workplace, environment-related human rights risks, land use conflicts and property rights	Photovoltaics, power grids, battery storage, Wind energy, hydrogen, natural gas	Drive Sustainability and Responsible Minerals Initiative 2018 Weiss et al. 2022 Dehoust et al. 2020b Buderath et al. 2021
Lead	China, Australia, USA, Mexico, Peru	Environment-related human rights risks	Photovoltaics, battery storage, power grids	UBA 2023b DERA 2021b Singh and Li 2014
Chrome	South Africa, Kazakhstan, Turkey	Child labour, forced labour and all forms of slavery, inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Wind energy	Drive Sustainability and Responsible Minerals Initiative 2018 Dehoust et al. 2020b

¹⁷ Unless otherwise stated, the information in this column is taken from the following source: German Renewable Energy Act (USGS) 2023.

Raw material	Main producing/ extracting countries	Potential risks	Industry sections	Further sources
Iron (ore)	Australia, Brazil, China, India, Russia German imports: South Africa, Brazil, Canada, Russia, Sweden ¹⁸	Inadequate occupational safety and health hazards in the workplace, precarious employment conditions and the denial of a decent wage, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Photovoltaics, battery storage, wind energy, power grids, hydrogen, natural gas	USDOL 2022 Drive Sustainability and Responsible Minerals Initiative 2018 Dehoust et al. 2020b MVO Nederland 2023
Natural gas	Global natural gas production: USA, Russia, Iran, China, Qatar ¹⁹ Pipeline gas for Europe: Norway, UK, Algeria, Azerbaijan, the Netherlands ²⁰ LNG for Germany: USA, Qatar, Russia, Angola, UAE, Nigeria ²¹	Forced labour and all forms of slavery, insufficient occupational safety and health hazards in the workplace, failure to comply with the freedom of association and the right to collective bargaining, precarious working conditions and the denial of a decent wage, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Natural gas	MVO Nederland 2023 ITUC CSI 2021 Jensen 2022 ILO 2022 Food & Water Watch 2016 ILO 2022
Crude oil (plastic/synthetic materials)	USA, Russia, Saudi Arabia ²²	Inadequate occupational safety and health hazards in the workplace, failure to comply with the freedom of association and the right to collective bargaining, environment-related human rights risks, conflicts and security, land use conflicts and property rights	Wind energy, power grids, photovoltaics, natural gas	MVO Nederland 2023 Weiss et al. 2020 Basdr 2023 UNEP FI 2014c
Germanium	China, Russia, USA ²³	Failure to comply with the freedom of association and the right to collective bargaining, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Wind energy	Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Dehoust et al. 2020b

¹⁸ BGR 2022.¹⁹ BP 2022a.²⁰ McWilliams et al. 2023.²¹ Federal Network Agency 2023; European Council, undated.²² BP 2022b.²³ USGS 2022.

Raw material	Main producing/ extracting countries	Potential risks	Industry sections	Further sources
Graphite	China, Mozambique, Madagascar, Brazil	Inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, discrimination, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Battery storage	Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Dehoust et al. 2020b Drive Sustainability, undated Dolega et al. 2020
Cobalt	DR Congo, Indonesia, Russia, Australia	Child labour, forced labour and all forms of slavery, inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Battery storage	OECD 2019a Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Dehoust et al. 2020b DCAF – Geneva Centre for Security Sector Governance 2021 Clean Energy Council and Norton Rose Fulbright 2022
Copper ore	Chile, Peru, DR Congo, China, USA, Zambia	Child labour, forced labour and all forms of slavery, inadequate occupational safety and health hazards in the workplace, environment-related human rights risks, conflicts and security	Photovoltaics, power grids, battery storage, wind energy, hydrogen, natural gas	USDOL 2022 Verité 2017 OECD 2019a Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Dehoust et al. 2020b Buderath et al. 2021 DCAF – Geneva Centre for Security Sector Governance 2021 BHRRC, undated
Lithium	Australia, Chile, China, Argentina	Inadequate occupational safety and health and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Battery storage	Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Dehoust et al. 2020b DCAF – Geneva Centre for Security Sector Governance 2021 Bloomberg 2019

Raw material	Main producing/ extracting countries	Potential risks	Industry sections	Further sources
Magnesium	China, USA, Turkey, Brazil, Russia	Inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Wind energy	Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Dehoust et al. 2020b
Manganese	South Africa, Gabon, Australia	Inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, discrimination, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Battery storage, wind energy, natural gas	Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Dehoust et al. 2020b Drive Sustainability, undated González and Wilde-Ramsing 2021
Molybdenum	China, Chile, USA, Peru, Mexico	Inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, environment-related human rights risks, land use conflicts and property rights	Wind energy	Drive Sustainability and Responsible Minerals Initiative 2018 Dehoust et al. 2020b Drive Sustainability, undated
Nickel	Indonesia, Philippines, Russia, New Caledonia, Australia, China, Canada	Inadequate occupational safety and health hazards in the workplace, failure to comply with the freedom of association and the right to collective bargaining, precarious working conditions and the denial of a decent wage, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Battery storage	Drive Sustainability, undated Drive Sustainability and Responsible Minerals Initiative 2018 Dehoust et al. 2020b MVO Nederland 2023 Müller and Reckordt 2017 BHRRC, undated
Niobium	Brazil, Canada, DR Congo, Russia, Rwanda	Inadequate occupational safety and health hazards in the workplace, precarious employment conditions and the denial of a decent wage, environment-related human rights risks, land use conflicts and property rights	Wind energy	Penke 2021 Mpaka 2023

Raw material	Main producing/ extracting countries	Potential risks	Industry sections	Further sources
Platinum metals (platinum, ruthenium, iridium, palladium)	South Africa, Zimbabwe, Russia ²⁴ , Canada ²⁵	Inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Hydrogen	Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Federal Environment Agency 2020 Steinweg and Haan 2007 DERA 2022 Bahadur et al. 2018 Steinweg and Haan 2007 Prillaman 2019
Sand (cement)	China, India, Vietnam, USA	Child labour, forced labour and all forms of slavery, inadequate occupational safety and health hazards in the workplace, environment-related human rights risks, land use conflicts and property rights	Photovoltaics, wind energy, power grids, hydrogen	USDOL 2022 Verité 2017 MVO Nederland 2023 Buderath et al. 2021
Selenium	China, Japan, Germany, Russia, Belgium	Inadequate occupational safety and health hazards in the workplace, environment-related human rights risks, land use conflicts and property rights	Wind energy	MVO Nederland 2023 Dehoust et al. 2020b
Rare earths (neodymium, dysprosium, praseodymium, boron and terbium, scandium, lanthanum, cerium, yttrium)	China, USA, Australia, Myanmar, Thailand, Turkey, Chile, Peru, Bolivia, Russia, India ²⁶ , Brazil, Canada ²⁷	Child labour, inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, discrimination, precarious working conditions and the denial of a decent wage, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Wind energy, hydrogen, power grids, battery storage	Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Dehoust et al. 2020b Drive Sustainability, undated Duydu and Başaran 2023 ISE, undated

²⁴ Garside 2022.

²⁵ acatech and DECHEMA 2022.

²⁶ ISE, undated.

²⁷ Gambogi 2020.

Raw material	Main producing/ extracting countries	Potential risks	Industry sections	Further sources
Silver	Mexico, China, Peru	Child labour, forced labour and all forms of slavery, inadequate occupational safety and health hazards in the workplace, failure to comply with the freedom of association and the right to collective bargaining, discrimination, precarious employment working conditions and the denial of a decent wage, environment-related risks with local impacts, land use conflicts and property rights, conflicts and security	Photovoltaics	USDOL 2022 Verité 2017 Drive Sustainability and Responsible Minerals Initiative 2018 MVO Nederland 2023 Dehoust et al. 2020b Verité and U.S. Department of State's Office to Monitor and Combat Trafficking in Persons 2021–2022
Silicon (metallurgic)	China, USA, Norway, Brazil ²⁸	Forced labour and all forms of slavery, insufficient occupational safety and health hazards in the workplace, environment-related human rights risks, land use conflicts and property rights	Photovoltaics	Morton 2022 Murphy and Elimä 2021 Spohr 2016 Nazalya 2019
Rock salt (PVC: together with crude oil/ natural gas)	China, India, USA, Germany, Australia, Canada	Child labour, forced labour and all forms of slavery, inadequate occupational safety and health hazards in the workplace, discrimination, denial of a decent wage, environment-related human rights risks, land use conflicts and property rights	Wind energy	USDOL 2022 Verité 2017 MVO Nederland 2023 Verité and U.S. Department of State's Office to Monitor and Combat Trafficking in Persons 2021–2022
Zinc	China, Peru, Australia, USA, Mexico, India	Child labour, inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, discrimination, precarious working conditions and the denial of a decent wage, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Photovoltaics, wind energy	USDOL 2022 Verité 2017 Drive Sustainability and Responsible Minerals Initiative 2018 Dehoust et al. 2020b Drive Sustainability, undated Verité and U.S. Department of State's Office to Monitor and Combat Trafficking in Persons 2021–2022 BHRRC, undated

²⁸ Idoine et al. 2023.

Raw material	Main producing/ extracting countries	Potential risks	Industry sections	Further sources
Tin	China, Indonesia, Myanmar, Peru, Bolivia, DR Congo, Brazil	Child labour, forced labour and all forms of slavery, inadequate occupational safety and health hazards in the workplace, failure to respect the freedom of association and the right to collective bargaining, discrimination, precarious employment conditions and the denial of a decent wage, environment-related human rights risks, land use conflicts and property rights, conflicts and security	Photovoltaics	Verité 2017 Drive Sustainability and Responsible Minerals Initiative 2018 Dehoust et al. 2020b DCAF – Geneva Centre for Security Sector Governance 2021

Bibliography

acatech [German Academy of Science and Engineering] 2023: Energiesysteme der Zukunft. Last accessed on 4 May 2023 at <https://energiesysteme-zukunft.de/themen/metalle-fuer-die-energiewende>.

acatech and DECHEMA [German Society for Chemical Engineering and Biotechnology] 2022: Wasserstoff Kompass, Rohstoffe für die Elektrolyseur-Produktion.

Ambrose, J. and Jasper, J. 2021: Revealed: UK solar projects using panels from firms linked to Xinjiang forced labour. Last accessed on 11 May 2023 at <https://www.theguardian.com/environment/2021/apr/23/revealed-uk-solar-projects-using-panels-from-firms-linked-to-xinjiang-forced-labour>.

Amnesty International 2017: Time to Recharge. Corporate Action and Inaction to Tackle Abuses in the Cobalt Supply Chain.

Amnesty International 2021: Philippines: Undermining Workers' Rights. Labour Abuses in Nickel Supply Chains.

Amyotte, P. 2018: Hydrogen Logistics: Safety and Risks Issues. In: Hydrogen infrastructure for energy applications. Production, storage, distribution and safety: Academic Press.

Andreassen, B. L. 2022: Reindeer herders want Norwegian wind farm demolished. Last accessed on 25 May 2023 at <http://www.nordiclabourjournal.org/i-fokus/in-focus-2022/theme-the-green-shift/article.2022-03-18.6489804485>.

Aoui, A.; el Amrani, M. A.; Ringnall, K. 2020: Global Aspirations and Local Realities of Solar Energy in Morocco. Last accessed on 11 May 2023 at <https://merip.org/2020/10/global-aspirations-and-local-realities-of-solar-energy-in-morocco/>.

Aprilia, K. 2023: two workers killed in nickel waste landslide at China-owned plant in Indonesia. Last accessed on 13 June 2023 at <https://www.benarnews.org/english/news/indonesian/workers-killed-04282023132751.html>.

Arbeitsgruppe Energiebilanzen e. V. [Working Group Energy Footprint] 2023: Endenergieverbrauch nach Energieträgern und Anwendungszwecken. Last accessed on 21 August 2023 at: https://ag-energiebilanzen.de/wp-content/uploads/2023/01/AGEB_21p2_V3_20221222.pdf.

Arbeitsgruppe Erneuerbare Energien-Statistik [Working Group Renewable Energy Statistics] 2023: Zeitreihen zur Entwicklung der erneuerbaren Energien in Deutschland. Last accessed on 14 August 2023 at https://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/zeitreihen-zur-entwicklung-der-erneuerbaren-energien-in-deutschland-1990-2022.pdf?__blob=publicationFile&v=3.

Atif, E. 2023: Energiesicherheit. Wie weit sind Deutschlands LNG-Terminals? Last accessed on 11 May 2023 at <https://www.tagesschau.de/wirtschaft/lng-bundesregierung-101.html>.

Baddour, D.; Erdenesanaa, D. 2023: After Explosion, Freeport LNG Rejoins the Gulf Coast Energy Export Boom. Last accessed on 10 June 2023 at <https://insideclimatenews.org/news/23022023/freeport-lng-texas-louisiana-explosion/>.

BAFU [Federal Office for the Environment] 2019: Aufbereitung und Entsorgung von Altkabel. Last accessed on 12 July 2023 at <https://www.bafu.admin.ch/bafu/de/home/themen/abfall/fachinformationen/abfallpolitik-und-massnahmen/vollzugshilfe-ueber-den-verkehr-mit-sonderabfaellen-und-anderen-/umweltvertragliche-entsorgung-von-sonderabfaellen-und-anderen-k/umweltvertragliche-entsorgung-von-metallischen-abfaellen/aufbereitung-und-entsorgung-von-alkabel.html>.

Bahadur, A.; Leifker M.; Lincoln S. 2018: Edles Metall – Unwürdiger Abbau. Platin aus Südafrika und die Verantwortung deutscher Unternehmen.

Basdr, Z. 2023: Migrant workers face risks building Europe's new gas supplies in the UAE. Last accessed on 10 June 2023 at <https://www.climatechangenews.com/2023/04/05/migrant-workers-face-risks-building-europes-new-gas-supplies-in-the-uae/>.

Basore, P.; Feldman D. 2022: Solar Photovoltaics: Supply Chain Deep Dive Assessment.

Bastian, N. 2022: Schmutzige Solarrohstoffe: Darf Deutschland importieren, was die USA ablehnen? Last accessed on 17 May 2023 at <https://www.handelsblatt.com/meinung/kolumnen/asia-technomics-schmutzige-solarrohstoffe-darf-deutschland-importieren-was-die-usa-ablehnen/28444754.html>.

Baumann, B. 2021: Grüner Wasserstoff aus Marokko – keine Zauberformel für Europas Klimaneutralität. Last accessed on 25 May 2023 at <https://www.boell.de/de/2021/01/20/gruener-wasserstoff-aus-marokko-keine-zauberformel-fuer-europas-klimaneutralitaet>.

Becker, T. 2022: Alternative für russisches Gas. Last accessed on 11 May 2023 at <https://www.zdf.de/nachrichten/politik/lng-terminals-fluessigerdgas-nordseekueste-faq-100.html>.

Beyer, Günter (Ed.) 2021: The global cable industry. Weinheim: Wiley-VCH.

BGR [German Federal Institute for Geosciences and Natural Resources] 2019: Analyse des artisanalen Kupfer-Kobalt-Sektors. Last accessed on 11 July 2023 at https://www.bgr.bund.de/DE/Themen/Min_rohstoffe/Downloads/studie_BGR_kupfer_kobalt_kongo_2019.pdf?__sessionid=4628036EE0F2C50B6C82E6585FED5C97internet991?__blob=publicationFile&v=4.

BGR [German Federal Institute for Geosciences and Natural Resources] 2022: Deutschland – Rohstoffsituation 2021.

BHRRC [Business and Human Rights Resource Centre], undated: Human Rights in the Mineral Supply Chains of Solar Panels. Last accessed on 15 June 2023 at <https://www.business-humanrights.org/en/from-us/briefings/transition-minerals-sector-case-studies/human-rights-in-the-mineral-supply-chains-of-solar-panels/>.

BHRRC [Business and Human Rights Resource Centre] 2016: Morocco/Western Sahara: Report warns wind energy companies from engaging in projects in Western Sahara without consent of local communities.

BHRRC [Business and Human Rights Resource Centre] 2018: Norway to build wind farm despite UN calls to suspend project over concerns of impact on indigenous herders' livelihoods. Last accessed on 25 May 2023 at <https://www.business-humanrights.org/en/latest-news/norway-to-build-wind-farm-despite-un-calls-to-suspend-project-over-concerns-of-impact-on-indigenous-herders-livelihoods/>.

BHRRC [Business and Human Rights Resource Centre] 2020: Renewable Energy & Human Rights Benchmark. Key Findings from the Wind & Solar Sectors.

BHRRC [Business & Human Rights Resource Centre] 2021a: DRC: Report reveals dire working conditions, discrimination & low pay across cobalt mines supplying electric vehicle manufacturers – Business & Human Rights Resource Centre. Last accessed on 30 May 2023 at <https://www.business-humanrights.org/en/latest-news/drc-report-reveals-dire-working-conditions-discrimination-low-pay-across-cobalt-mines-supplying-electric-vehicle-manufacturers/>.

BHRRC [Business & Human Rights Resource Centre] 2021b: DRC: Workers mining Cobalt for electric vehicles report abuse, low wages & racial discrimination. Last accessed on 30 May 2023 at <https://www.business-humanrights.org/en/latest-news/drc-congolese-workers-mining-cobalt-for-electric-vehicles-report-abuse-low-wages-racial-discrimination/>.

BHRRC [Business and Human Rights Resource Centre] 2023a: Azerbaijan: Abuses by oil companies include wage delays, workplace discrimination, illegal termination of contracts, health & safety violations, environmental pollution, says NGO report; incl. co. response & non-responses. Last accessed on 31 May 2023 at <https://www.business-humanrights.org/en/latest-news/azerbaijan-dozens-of-violations-of-oil-workers-rights-in-2022-tracked-in-new-report-incl-cos-responses-non-responses/>.

BHRRC [Business and Human Rights Resource Centre] 2023b: Indonesia: Three Chinese nickel workers file complaint to national human rights commission over workplace conditions; Companies did not respond. Last accessed on 9 June 2023 at <https://www.business-humanrights.org/en/latest-news/indonesia-three-chinese-nickel-workers-file-complaint-to-national-human-rights-commission-over-workplace-conditions-companies-did-not-respond/>.

Bloomberg 2019: Mining lithium for electric cars is hurting this desert's local environment. Last accessed on 11 May 2023 at https://www.washingtonpost.com/lifestyle/kidspost/mining-lithium-for-electric-cars-is-hurting-this-deserts-local-environment/2019/06/12/aa5a5f64-83b9-11e9-95a9-e2c830afe24f_story.html.

BMBF [Federal Ministry of Education and Research] 2023a: Update der Nationalen Wasserstoffstrategie: Turbo für die H2-Wirtschaft. Last accessed on 14 August 2023 at https://www.bmbf.de/bmbf/de/forschung/energiewende-und-nachhaltiges-wirtschaften/nationale-wasserstoffstrategie/nationale-wasserstoffstrategie_node.html.

BMBF [Federal Ministry of Education and Research] 2023b: Grüner Wasserstoff: Welche internationalen Projekte fördert das BMBF? Last accessed on 16 May 2023 at <https://www.bmbf.de/bmbf/shareddocs/kurzmeldungen/de/woher-soll-der-gruene-wasserstoff-kommen.html#:~:text=Fest%20steht%20allerdings%3A%20Deutschland%20wird,die%20Deutschland%20selbst%20produzieren%20kann.>

BMUV [Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection] 2017a: Fracking – Risiken für die Umwelt. Last accessed on 22 May 2023 at <https://www.bmuv.de/themen/wasser-und-binnengewasser/grundwasser/grundwasserisiken-hydraulic-fracturing>.

BMUV [Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection] 2017b: Lärmwirkung. Last accessed on 10 June 2023 at <https://www.bmuv.de/themen/laerm/laerm-schutz-im-ueberblick/laermwirkung>.

BMWK [Federal Ministry for Economic Affairs and Climate Action], undated: Batterien “made in Germany” – ein Beitrag zu nachhaltigem Wachstum und klimafreundlicher Mobilität. Last accessed on 16 May 2023 at <https://www.bmwk.de/Redaktion/DE/Dossier/batteriezellfertigung.html>.

BMWK [Federal Ministry for Economic Affairs and Climate Action], undated: Windenergien auf See: Ziele. Last accessed on 11 May 2023 at <https://www.erneuerbare-energien.de/EE/Navigation/DE/Technologien/Windenergie-auf-See/Ziele/ziele.html>.

BMWK [Federal Ministry for Economic Affairs and Climate Action] 2020a: Die Nationale Wasserstoffstrategie.

BMWK [Federal Ministry for Economic Affairs and Climate Action] 2020b: Analyse weltweiter Energiemärkte 2020. Eine Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie.

BMWK [Federal Ministry for Economic Affairs and Climate Action] 2022: Batteriespeicher in Netzen. Final report commissioned by the BMWi [Federal Ministry for Economic Affairs and Energy].

BMWK [Federal Ministry for Economic Affairs and Climate Action] 2023: Erdgasversorgung in Deutschland. Last accessed on 16 May 2023 at <https://www.bmwk.de/Redaktion/DE/Artikel/Energie/gas-erdgasversorgung-in-deutschland.htm>.

BMZ [Federal Ministry for Economic Cooperation and Development] 2023: Umwelt und Bergbau. Last accessed on 26 May 2023 at <https://rue.bmz.de/rue/themen/umwelt-103858>.

BNEF [BloombergNEF] 2023: Goldwind and Vestas in Photo Finish for Top Spot as Global Wind Power Additions Fall. Last accessed on 12 June 2023 at <https://about.bnef.com/blog/goldwind-and-vestas-in-photo-finish-for-top-spot-as-global-wind-power-additions-fall/>.

Bonnefoy, P. 2013: Inquiry on mine collapse in Chile ends with no charges. Last accessed on 31 May 2023 at <https://www.nytimes.com/2013/08/02/world/americas/inquiry-on-mine-collapse-in-chile-ends-with-no-charges.html>.

Bornschlegel, T.; Ocampo, D.; Urrutia, I. 2021: Free Prior Informed Consent (FPIC) in the mining sector. Solution-oriented approaches from Canada and their implications for strengthening indigenous peoples's right to consultation in Chile and Peru.

Brauer, H.; Simm, M.; Wanzenberg, E.; Henel, M. 2018: Transport von gasförmigem Wasserstoff via Pipelines: Mannesmann Line Pipe GmbH.

Brauers, H.; Braunger, I.; Hoffart, F.; Kemfert, C.; Oei, P.; Präger, F.; Schmalz, S.; Troschke, M. 2021: Ausbau der Erdgas-Infrastruktur: Brückentechnologie oder Risiko für die Energiewende?

Brot für die Welt 2018: Das weiße Gold. Umwelt und Sozialkonflikte um den Zukunftsrohstoff Lithium. Last accessed on 11 July 2023 at https://www.brot-fuer-die-welt.de/fileadmin/mediapool/blogs/Online-Redaktion/bfdw_analyse_lithium-broschuere_report.pdf.

BSR [Business for Social Responsibility], undated: 10 Human Rights Priorities for the Power and Utilities Sector. Last accessed on 11 May 2023 at <https://www.bsr.org/en/primers/10-human-rights-priorities-power-and-utilities-sector>.

BSR [Business for Social Responsibility], undated: 10 Human Rights Priorities for the Transport and Logistics Sector. Last accessed on 11 May 2023 at <https://www.bsr.org/en/primers/10-human-rights-priorities-for-the-transport-and-logistics-sector#risk>.

Buderath, M.; Weiß, D.; van Ackern, P.; Garcia, B.; Dovidat, L.; Kraft, C.; Padubrin, F. 2021: Rohstoffe im Fokus. Menschenrechts- und Umweltrisiken integrativ betrachten.

Bukold, S. 2023: LNG-Boom in Deutschland. Pläne, Kritik, Fakten, Hintergründe.

Bullmann, T.; Gollnick, C.; Schorpp, J.; Oswald, H. 2020: Wasserstoff. Fact Paper of the Association of German Chambers of Commerce and Industry (DIHK).

Bundesnetzagentur (Federal Network Agency) 2022: Bundesnetzagentur veröffentlicht Zahlen zur Gasversorgung 2022. Last accessed on 11 May 2023 at https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2023/20230106_RueckblickGasversorgung.html.

Bundesnetzagentur 2023: Gasimporte in GWh/Tag. Last accessed on 16 May 2023 at https://www.bundesnetzagentur.de/DE/Gasversorgung/aktuelle_gasversorgung/svg/Gasimporte/Gasimporte.html;jsessionid=5CC4BF3095415E3B4FBB67D56994F16B.

Camero, F. 2022: Workers at Chile's Escondida copper mine to strike over safety concerns. Last accessed on 17 May 2023 at <https://www.reuters.com/world/americas/workers-chiles-escondida-copper-mine-threaten-strike-2022-09-07/>.

Camero, F.; Villegas, A.; Shumaker, L. 2022: Chile rethinks mine safety after worker deaths and expanding sinkhole. Last accessed on 17 May 2023 at <https://www.reuters.com/world/americas/chile-rethinks-mine-safety-after-worker-deaths-expanding-sinkhole-2022-08-10/>.

Cambou, D.; Poelzer, G. 2022: Enhancing energy justice in the Arctic. An appraisal of the participation of Arctic indigenous peoples in the transition to renewable energy. In: Koivurova, T. (ed.): Renewable Economies in the Arctic: Taylor & Francis.

Carrara, S.; Alves Dias, P.; Plazzotta, B.; Pavel, C.; Meng, D.; Hu, Y.; Xiao, C.; Wei, T.; Zou, Q.; Wang, M. 2020: Raw materials demand for wind and solar PV technologies in the transition towards a decarbonised energy system // Chronic heat stress inhibits immune responses to H5N1 vaccination through regulating CD4+ CD25+ Foxp3+ Tregs: European Commission.

Carreon, A. R. 2023: The EV Battery Supply Chain Explained. Last accessed on 16 May 2023 at <https://rmi.org/the-ev-battery-supply-chain-explained/>.

Chaydare, T.; Reckordt, M.; Schnittker, H. 2022: Metalle für die Energiewende. Warum wir die Rohstoffwende und die Energiewende zusammendenken sollten.

CHPNY [Concerned Health Professionals of NY]; PSR [Physicians for Social Responsibility]; SEHN [Science and Environmental Health Network] 2022: Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking and Associated Gas and Oil Infrastructure. 8th edition.

Clean Energy Council and Norton Rose Fulbright 2022: Addressing modern slavery in the clean energy sector.

CESCR [Committee on Economic, Social and Cultural Rights] 2016: General Comment No. 23 (2016) on the right to just and favorable conditions of work: ESCR-Net.

Cushing, L.; Khang, C.; Franklin, M.; Johnston, J. 2021: Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US. Environmental Research Letters, 16/3.

Consentec GmbH 2022: Batteriespeicher in Netzen.

DCAF [Geneva Centre for Security Sector Governance] 2020: PRIVATE SECURITY AND HUMAN RIGHTS. Last accessed on 30 May 2023 at <https://www.dcaf.ch/private-security-and-human-rights>.

DCAF [Geneva Centre for Security Sector Governance] 2021: Security and Human Rights Implementation Mechanism (SHRIM). Annual Report 2021.

Dehoust, G.; Manhart, A.; Dolega, P. 2020a: Environmental Criticality of Raw Materials. Federal Environment Agency.

Dehoust, G.; Manhart, A.; Dolega, P. 2020b: Weiterentwicklung von Handlungsoptionen einer ökologischen Rohstoffpolitik ÖkoRess II. Final report. Federal Environment Agency.

dena – German Energy Agency 2023: Das Stromnetz von morgen. Last accessed on 11 May 2023 at <https://www.dena.de/themen-projekte/energiesysteme/stromnetze/>.

Denter, L.; Friess, S. 2023: Unternehmensverantwortung im Maschinen- und Anlagenbau. Warum die nachgelagerte Lieferkette nicht ausgelagert werden darf.

DERA [German Mineral Resources Agency] 2021a: Batterierohstoffe für die Elektromobilität.

DERA [German Mineral Resources Agency] 2021b: DERA-Rohstoffinformationen. Rohstoffrisikobewertung – Nickel.

Deutsche Welle 2019: Brumadinho einen Monat nach der Schlammlawine. Last accessed on 1 June 2023 at <https://www.dw.com/de/brumadinho-einen-monat-nach-der-schlammlawine/a-47668225>.

Deutsche WindGuard GmbH 2022: Status des Windenergieausbaus an Land in Deutschland. Jahr 2022.

DGB Bildungswerk BUND 2021: Bergbau gegen Menschenrechte: Landkonflikte im Norden von Brasilien. Last accessed on 12 June 2023 at <https://www.dgb-bildungswerk.de/weltweit/bergbau-gegen-menschenrechte-landkonflikte-im-norden-von-brasilien>.

Dhaatri Resource Centre for Women and Children; mines, minerals & people 2010: India's childhood in the "pits". A report on the impacts of mining on children in India.

Die Bundesregierung 2021: Koalitionsvertrag zwischen SPD, Bündnis 90/Die Grünen und FDP. Mehr Fortschritt wagen: Bündnis für Freiheit, Gerechtigkeit und Nachhaltigkeit.

Die Bundesregierung 2023a: EEG 2023. Last accessed on 11 May 2023 at <https://www.bundesregierung.de/breg-de/themen/klimaschutz/novelle-ee-gesetz-2023-2023972#:~:text=Bis%202030%20sollen%20mindestens%2080%20Prozent%20des%20Stromverbrauchs,bedeutet%20fast%20eine%20Verdoppelung%20des%20Anteils%20am%20Gesamtstromverbrauch>.

Die Bundesregierung 2023b: Energiewende beschleunigen. Last accessed on 8 May 2023 at <https://www.bundesregierung.de/breg-de/themen/klimaschutz/energiewende-beschleunigen-2040310>.

Die Bundesregierung 2023c: LNG-Beschleunigungsgesetz. Last accessed on 25 May 2023 at <https://www.bundesregierung.de/breg-de/schwerpunkte/klimaschutz/secure-gas-supply-2038906>.

Die Bundesregierung 2023d: "Wind-an-Land-Gesetz". Last accessed on 11 May 2023 at <https://www.bundesregierung.de/breg-de/schwerpunkte/klimaschutz/onshore-wind-energy-act-2060954>.

Die Bundesregierung 2023e: Nationale Wasserstoffstrategie – Energie aus klimafreundlichem Gas. Last accessed on 16 May 2023 at <https://www.bundesregierung.de/breg-en/news/hydrogen-technology-2204238>.

DiLiCo engineering GmbH, undated: Elektrolyzers. Last accessed on 13 June 2023 at <https://www.dilico.de/en/elektrolyseure.php>.

Dolega, P.; Buchert, M.; Betz, J. 2020: Ökologische und sozio-ökonomische Herausforderungen in Batterie-Lieferketten: Graphit und Lithium.

Dorner, U. 2020: Rohstoffrisikobewertung – Kupfer (DERA Rohstoffinformationen).

Doyle, C. M.; Tugendhat, H.; Halip, R. 2015: Mining, the Aluminium Industry and Indigenous Peoples: Asia Indigenous Peoples Pact (AIPP).

Drive Sustainability, undated: The Raw Material Outlook Platform. Last accessed on 11 May 2023 at <https://www.rawmaterialoutlook.org/>.

Drive Sustainability and Responsible Minerals Initiative 2018: Material Change. A study of risks and opportunities for collective action in the materials supply chains of the automotive and electronic industries.

Duydu, Y.; Başaran, N. 2023: Effects of boron exposure on human reproduction and development. In: Current Opinion in Toxicology, no. 34, p. 100403.

Earthworks 2023: Freeport LNG Reopens Despite Concerns from Local Residents. Last accessed on 30 May 2023 at <https://earthworks.org/releases/freeport-lng-reopens-despite-concerns-from-local-residents/>.

EC [European Commission] 2022: Just and sustainable economy: Commission lays down rules for enterprises to respect human rights and environment in global value chains. Last accessed on 11 May 2023 at https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1145.

ECHA [European Chemicals Agency], undated: Phthalates. Last accessed on 23 May 2023 at <https://echa.europa.eu/hot-topics/phthalates>.

Eger, F.; Laukamp, H. 2019: Brandrisiken und Schadensfälle bei PV-Heimspeichern. Fraunhofer Institute for Solar Energy Systems ISE. Berlin.

eia [Energy Information Administration] 2022: Wind explained. Last accessed on 12 June 2023 at <https://www.eia.gov/energyexplained/wind/wind-energy-and-the-environment.php#:~:text=Wind%20turbines%20do%20not%20release,pollution%20and%20carbon%20dioxide%20emissions>.

EnBW, undated: Stromnetz. Last accessed on 11 May 2023 at <https://www.enbw.com/energie-entdecken/verteilung-und-transport/stromnetz/>.

ENCORE 2023: Exploring Natural Capital Opportunities, Risks and Exposure. Last accessed on 11 May 2023 at <https://encore.naturalcapital.finance/en/explore>.

ENNHRI [European Network of National Human Rights Institutions] 2021: Climate Change and Human Rights in the European Context. Last accessed on 12 June 2023 at https://ennhri.org/wp-content/uploads/2021/05/ENNHRI-Paper-Climate-Change-and-Human-Rights-in-the-European-Context_06.05.2020.pdf.

ESCR-Net 2016: General Comment No. 23 (2016) on the Right to just and favorable conditions of work. Last accessed on 22 May 2023 at <https://www.escr-net.org/resources/general-comment-no-23-2016-right-just-and-favorable-conditions-work>.

Eunjung, C. A. 2008: Solar Energy Firms Leave Waste Behind in China. Last accessed on 13 June 2023 at <https://www.business-humanrights.org/en/latest-news/solar-energy-firms-leave-waste-behind-in-china/>.

EU-Recycling 2020: Vom Kabelschrott zum Rohstoff. Last accessed on 11 May 2023 at <https://eu-recycling.com/Archive/26988>.

Europacable 2015: The Europacable Industry Charter. Last accessed on 11 May 2023 at https://europacable.eu/wp-content/uploads/2021/01/Europacable-Industry-Charter_dw_2.pdf.

European Commission 2023: REACH: Kommission verbietet Blei in PVC-Produkten. Last accessed on 12 July 2023 at https://germany.representation.ec.europa.eu/news/reach-kommission-verbietet-blei-pvc-produkten-2023-05-03_de#:~:text=Blei%20darf%20nicht%20mehr%20in,Schutz%20von%20Mensch%20und%20Umwelt.

European Commission 2022: EU and Azerbaijan enhance bilateral relations, including energy cooperation. Last accessed on 31 May 2023 at https://ec.europa.eu/commission/presscorner/detail/en/IP_22_4550.

European Council, undated: Infographic – Where does the EU's gas come from? Last accessed on 11 July 2023 at <https://www.consilium.europa.eu/en/infographics/eu-gas-supply/>.

Falkenberg, H.; Krampe, L.; Lambert, J.; Lübbers, S.; Lühr O.; Sandhövel, M. 2019: Rohstoffbedarf im Bereich der erneuerbaren Energien. Final report: BMWK – Federal Ministry for Economic Affairs and Energy.

Filges, T. 2023: Statt Gas aus Russland: Aus diesen Ländern bezieht Deutschland jetzt das wichtige LNG. Last accessed on 16 May 2023 at <https://www.businessinsider.de/wirtschaft/statt-gas-aus-russland-aus-diesen-laendern-bezieht-deutschland-jetzt-das-wichtige-lng/>.

Fink, Z.; Manhart, A. (ed.) 2016: Das Geschäft mit dem Schrott. Last accessed on 6 June 2023 at <https://internationalepolitik.de/de/das-geschaef-mit-dem-schrott>.

FoE Japan 2021: Japan Needs to Withdraw from LNG Canada Serious Human Rights Violations in Coastal GasLink Pipeline. Last accessed on 25 May 2023 at https://www.foejapan.org/en/aid/jbic02/lngcanada/pdf/211124_en.pdf.

Food & Water Watch 2016: Fracking and the food system.

Forest Policy Trade and Finance Initiative 2022: Gone with the wind. China's balsa wood consumption is exposing flaws in Peru's forest regulations and enforcement regime: Forest Policy Trade and Finance Initiative.

Fouche, G.; Buli, N. 2021: Investors scrutinise Elkem's plan to mine quartz on Sámi reindeer pastures. Last accessed on 11 May 2023 at <https://www.reuters.com/world/europe/exclusive-investors-scrutinise-elkems-plan-mine-quartz-sami-reindeer-pastures-2021-12-02/>.

Franke, D. et al. 2022: BGR Energiestudie. Daten und Entwicklungen der deutschen und globalen Energieversorgung.

Fraunhofer ICT [Institute for Chemical Technology], undated: Materialien und Komponenten für die Wasserstoffelektrolyse.

Fraunhofer IPK 2023: Produktion und virtuelle Produktentstehung entlang der H2-Wertschöpfungskette. Last accessed on 16 June 2023 at <https://www.ipk.fraunhofer.de/de/kompetenzen-und-loesungen/digital-engineering/wasserstoff-wertschoepfungskette.html>.

Fraunhofer ZESS, undated: Lithium-Festkörperbatterien. Last accessed on 22 May 2023 at https://www.zess.fraunhofer.de/de/schwerpunkte/zess_lithium-festkoerperbatterien.html.

Gambogi, J. 2020: Zirconium and Hafnium Statistics and Information. Last accessed on 16 May 23 at <https://www.usgs.gov/centers/national-minerals-information-center/zirconium-and-hafnium-statistics-and-information>.

Ganswindt, K.; Rötters, S.; Schücking, H. 2013: Bittercoal: Ein Dossier über Deutschlands Steinkohleimporte. Last accessed on 16 May 23 at https://www.en.envstudies.carsoncenter.uni-muenchen.de/student-broadcasts/blogging/clean-green-better-coal/bittercoal_mai_broschue_web.pdf.

Garside, M. 2022: Distribution of ruthenium supply worldwide in 2021, by region. Last accessed on 15 June 2023 at <https://www.statista.com/statistics/1305819/worldwide-share-of-ruthenium-supply-by-region/>.

Geitmann, S. 2020: Spezialmetalle für die Wasserelektrolyse. Last accessed on 13 June 2023 at <https://hydrogeit.de/blog/2020/12/01/spezialmetalle-fuer-die-wasserelektrolyse/>.

Gheorghiu, A.; Richter, R. 2023: Investitionen ins Klimachaos. Wie deutsche Banken und Unternehmen Fracking-LNG-Projekte ermöglichen: Deutsche Umwelthilfe e. V.

Gilsbach, L. 2020: Kupfer. Informationen zur Nachhaltigkeit.

González, A.; Wilde-Ramsing J. 2021: How the green energy transition fuels human rights abuses in South Africa. Last accessed on 15 June 2023 at <https://www.somo.nl/the-green-energy-transition-could-fuel-human-rights-abuses-as-new-research-exposes-health-and-social-impacts-of-manganese-mining-in-south-africa/>.

Gouritin, A. 2018: Extractivism and renewable energies: human rights violations in the context of socio-environmental conflicts. Illustration using wind farms in San Dionisio del Mar, Oaxaca. Heinrich Böll Stiftung European Union.

Griffin, O. 2020: Amazon road-building could deforest millions of hectares: report. Last accessed on 11 May 2023 at <https://www.reuters.com/article/us-latam-deforestation-idUKKBN27Z1S6>.

Halleux, V. 2022: New EU regulatory framework for batteries. Setting sustainability requirements.

Hartmann, K. 2019: Landraub für deutsche Autos. Wie ein Bergbaukonzern beim Bauxit-Abbau in Guinea Menschenrechte verletzt.

Heinemann, C.; Mendelevitch, R. 2021: Working Paper. Sustainability dimensions of imported hydrogen.

House, F. 2020: The Invisible Transport Workforce Keeping Supply Chains Moving. Last accessed on 11 May 2023 at <https://www.ihrb.org/other/supply-chains/commentary-invisible-transport-workforce-keeping-supply-chains-moving>.

Howarth, R. 2014: A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas. Last accessed on 18 August 2023 at <https://onlinelibrary.wiley.com/doi/epdf/10.1002/ese3.35>.

Huber, A.; Weiß, D. 2021: Menschenrechts- und umweltbezogene Sorgfaltspflicht in der Baubranche. Was Unternehmen jetzt beachten sollten.

Human Rights Watch 2014: Whose Development? Human Rights Abuses in Sierra Leone's Mining Boom.

Human Rights Watch 2020: What Do We Get Out of It? The Human Rights Impact of Bauxite Mining in Guinea. Last accessed on 11 July 2023 at https://www.hrw.org/sites/default/files/report_pdf/guinea1018_web2.pdf.

Idoine, N.; Raycraft, E.; Price, F.; Hobbs, F.; Deady, A.; Everett, P.; Shaw, A.; Evans, E.; Mills, A. 2023: World mineral production 2017–2021. British Geological Survey. Last accessed on 11 July 2023 at https://nora.nerc.ac.uk/id/eprint/534316/1/WMP_2017_2021_FINAL.pdf.

IEA [International Energy Agency], undated: Energy security. Last accessed on 30 May 2023 at <https://www.iea.org/topics/energy-security>.

IEA [International Energy Agency] 2019: The Future of Hydrogen. Seizing Today's Opportunities: International Energy Agency.

IEA 2022a: Special Report on Solar PV Global Supply Chains: International Energy Agency.

IEA [International Energy Agency] 2022a: Special Report on Solar PV Global Supply Chains: International Energy Agency.

IEA [International Energy Agency] 2022b: The Role of Critical Minerals in Clean Energy Transitions: International Energy Agency.

IEEFA [Institute for Energy Economics and Financial Analysis] 2023: Comments of the Institute for Energy Economics and Financial Analysis to the Federal Energy Regulatory Commission regarding the Environmental Assessment for the Proposed Venture Global Plaquemines LNG Uprate Amendment Project. Last accessed on 11 July 2023 at <https://ieefa.org/media/3597/download?attachment>.

IHRB [Institute for Human Rights and Business] and Shift 2014: Oil and Gas Sector Guide on Implementing the UN Guiding Principles on Business and Human Rights.

IHRB [Institute for Human Rights and Business] 2022: What are the Rights Implications of Wind Energy. Last accessed on 11 May 2023 at <https://www.ihrb.org/explainers/what-are-the-rights-implications-of-wind-energy/>.

ILO [International Labour Organization], undated: Child labour: Causes. Last accessed on 25 May 2023 at https://www.ilo.org/moscow/areas-of-work/child-labour/WCMS_248984/lang-en/index.htm.

ILO [International Labour Organization] 1960: Convention 111: Convention on discrimination in employment and occupation, 1958. Last accessed on 31 May 2023 at https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---normes/documents/normativeinstrument/wcms_c111_de.htm.

ILO [International Labour Organization] 2008: Freedom of association in practice. Lessons learned: global report under the follow-up to the ILO Declaration on Fundamental Principles and Rights at Work: International Labour Conference, 9th session 2008.

ILO [International Labour Organization] 2019: Child Labour in Mining and Global Supply Chains.

ILO [International Labour Organization] 2022: The future of work in the oil and gas industry: Opportunities and challenges for a just transition to a future of work that contributes to sustainable development.

ILO [International Labour Organization]; Walk Free; IOM [International Organization for Migration] 2022: Global estimates of modern slavery. Forced labour and forced marriage.

IndustriALL 2022: Urgent need to stop mine accidents at Indonesia Morowali Industrial Park. Last accessed on 9 June 2023 at <https://www.industriall-union.org/urgent-need-to-stop-mine-accidents-at-indonesia-morowali-industrial-park>.

Institute for Middle East Studies, undated: Moroccan Farmers Compete with Solar Complexes for Access to Dwindling Water Resources. Last accessed on 11 May 2023 at <https://imes.elliott.gwu.edu/public-outreach-and-educator-resources/impop/moroccan-farmers-battle-with-solar-complexes-for-access-to-dwindling-water-resources/>.

Interview with *Energy Sector Dialogue* April 2023: *Energy Sector Dialogue* – Group Interview Battery Storage.

Interview with *Energy Sector Dialogue* from 2023: *Energy Sector Dialogue* – Group Interview Electricity Distribution Networks.

IPCC [Intergovernmental Panel on Climate Change] 2023: Climate Change 2023: Synthesis Report.

IRENA [International Renewable Energy Agency] 2021: Renewable Energy Statistics 2021.

IRENA [International Renewable Energy Agency] 2022: World Energy Transitions Outlook 2022. 1.5 °C Pathway. Abu Dhabi: International Renewable Energy Agency.

ISE [The Institute for Rare Earths and Metals AG], undated: Rare Earth Elements. Last accessed on 15 June 2023 at <https://institut-seltene-erden.de/seltene-erden-und-metalle/seltene-erden/>.

ITUC CSI [International Trade Union] 2021: UAE labour law reforms fail to address abuses of workers' rights. Last accessed on 10 June 2023 at <https://www.ituc-csi.org/uae-labour-law-reforms-fail?lang=en>.

Jellicoe, M.; Delgado M. 2014: Quantifying the risks of underground natural gas storage. Policy Brief, 24: The National Agriculture and Rural Development Policy Center.

Jensen, A. 2022: Schmutzige Energie. Last accessed on 10 June 2023 at <https://www.amnesty.de/informieren/amnesty-journal/katar-erdgas-ukraine-krieg-energiepolitik-bundesregierung-menschenrechte>.

JET [Jamaica Environment Trust] 2020: Red dirt. A multidisciplinary review of the bauxite-aluminium industry in Jamaica.

Jia, H.; Liang, L.; Xie, J.; Zhang, J. 2022: Environmental Effects of Technological Improvements in Polysilicon Photovoltaic Systems in China—A Life Cycle Assessment. In: Sustainability, issue 14/14, p. 8670.

Joseph, S.; Wynhoven, U.; Shubha, C. 2017: Human rights translated 2.0. A Business Reference Guide. Melbourne, Australia: Monash University, Castan Centre for Human Rights Law.

- Karanikas, N.; Steele, S.; Bruschi, K.; Robertson, C.; Kass, J.; Popovich, A.; MacFadyen, C. 2021: Occupational health hazards and risks in the wind industry. In: Energy Reports, no. 7, pp. 3750–3759.
- Kerkow, U.; Martens J.; Müller A. 2012: Vom Erz zum Auto. Abbaubedingungen und Lieferketten im Rohstoffsektor und die Verantwortung der deutschen Automobilindustrie.
- Khalid, S. U. 2022: Safety Features on LNG Powered Ships. Last accessed on 10 June 2023 at <https://www.marineinsight.com/marine-safety/safety-features-on-lng-ships/>.
- Kiezebrink, V.; Wilde-Ramsing, J.; ten Kate, G. 2018: Human Rights in Wind Turbine Supply Chains. Towards a truly sustainable energy transition.
- Kind, T.; Engel, K. 2018: Rohstoffboom zwischen Gewinnen und Verlusten. Deutschlands ökologischer Fußabdruck durch Stahl und Aluminium. Berlin: WWF – World Wildlife Fund.
- Knoke, I.; Ferenschild, S.; Hütz-Adams, F. 2023: Bitte wenden! Menschenrechtliche Risiken in der Transport- und Logistikbranche.
- Köllner, C. 2023: Das sind die Trends der Batterieindustrie 2023. Last accessed on 8 June 2023 at <https://www.springerprofessional.de/batterie/energiespeicher/das-sind-die-trends-der-batterieindustrie-2023/23895432>.
- KPMG 2014: CSR Sector Risk Assessment. Considerations for Dialogue.
- Krauter, R. 2019: Warum Großbritannien alle Bohrungen stoppt. Last accessed on 9 June 2023 at <https://www.deutschlandfunk.de/erdbebengefahr-durch-fracking-warum-grossbritannien-alle-100.html>.
- Kruse, M.; Wedemeier J. 2021: Potenzial grüner Wasserstoff: langer Weg der Entwicklung, kurze Zeit bis zur Umsetzung. Last accessed on 30 May 2023 at <https://www.wirtschaftsdienst.eu/inhalt/jahr/2021/heft/1/beitrag/potenzial-gruener-wasserstoff-langer-weg-der-entwicklung-kurze-zeit-bis-zur-umsetzung.html#:~:text=Bereits%20heute%20werden%20rund%2055,et%20al.%2C%202020>.
- Kühne, C. et al. 2022: Entwicklung von Rückbau- und Recyclingstandards für Rotorblätter. Aufbereitung von Rotorblättern.
- Lee, K. Y.; Ho, L. Y.; Tan, K. H.; Tham, Y. Y.; Ling, S. P.; Qureshi, A.; Ponnudurai, T.; Nordin, R. 2017: Environmental and Occupational Health Impact of Bauxite Mining in Malaysia: A Review. In: IJUM Medical Journal Malaysia, 16/2, pp. 137–150.
- Levin-Nally, E.; Whitaker, S.; Racionero-Gomez, B. 2020: How to bring about forest-smart mining: strategic entry points for institutional donors.
- Loria, P.; Bright, M.: Lessons captured from 50 years of CCS projects. The Electricity Journal, 34/7. Last accessed on 11 May 2023 at <https://www.sciencedirect.com/science/article/abs/pii/S1040619021000890>.
- Malin, L.; Jansen, A.; Kutz, V. 2022: Energie aus Wind und Sonne: Welche Fachkräfte brauchen wir? KOFA – Kompetenzzentrum Fachkräftesicherung.
- Manhart, A.; Rüttinger, L.; Griestop, L. 2015: RohPolRes. Die Debatte um Konfliktrohstoffe und mögliche Bezüge zu Umweltaspekten bei der Rohstoffgewinnung
- Manta, F.; Pease A. 2021: Not a moving target: the responsibility to respect human rights in the transport and logistics sector. Last accessed on 11 May 2023 at <https://eu.boell.org/en/2021/10/05/not-moving-target-responsibility-respect-human-rights-transport-and-logistics-sector>.
- Maranhão, C.; Trindade, P. 2009: Fighting Forced Labour: The Example of Brazil: ILO, Special Action Programme to Combat Forced Labour.
- McQue, K. 2022: Up to 10,000 Asian migrant workers die in the Gulf every year, claims report. Last accessed on 10 June 2023 at <https://www.theguardian.com/global-development/2022/mar/11/up-to-10000-asian-migrant-workers-die-in-the-gulf-every-year-claims-report>.
- McWilliams, B.; Sgaravatti G.; Zachmann G. 2021: European natural gas imports. Last accessed on 11 July 2023 at <https://www.bruegel.org/dataset/european-natural-gas-imports>.
- Meza, E. 2022: Clear rules needed for shipping used e-car batteries to Africa – researchers. Last accessed on 9 June 2023 at <https://www.cleanenergywire.org/news/clear-rules-needed-shipping-used-e-car-batteries-africa-researchers>.
- Mills Lindsay, J. 2012: Compulsory Acquisition of Land and Compensation in Infrastructure Projects (PPP Insights, 3. Washington: PPP in Infrastructure Resource Center for Contracts, Laws and Regulation [PPPIRC]).
- Mononen, T.; Kivinen, S.; Kotilainen, J. M.; Leino, J. 2022: Social and Environmental Impacts of Mining Activities in the EU.
- Morgen, S.; Schmidt, M.; Steppe, J.; Wörlen, C. 2022: Fair Green Hydrogen: Chance or Chimera in Morocco, Niger and Senegal?
- Morton, A. 2022: Evidence grows of forced labour and slavery in production of solar panels, wind turbines. Last accessed on 11 May 2023 at <https://www.theguardian.com/environment/2022/nov/29/evidence-grows-of-forced-labour-and-slavery-in-production-of-solar-panels-wind-turbines>.
- Mpaka, C. 2023: Australian niobium mining project instills 16 years of anxiety for Malawi communities. Last accessed on 15 June 2023 at <https://news.mongabay.com/2023/01/australian-niobium-mining-project-instills-16-years-of-anxiety-for-malawi-communities/>.
- Müller, A. et al. 2021: A comparative life cycle assessment of silicon PV modules: Impact of module design, manufacturing location and inventory. In: Solar Energy Materials and Solar Cells, no. 230.
- Müller, A. 2018: Rohstoffe für die Energiewende. Menschenrechtliche und ökologische Verantwortung in einem Zukunftsmarkt. Aachen: MISEREOR.
- Müller, M.; Reckordt, M. 2017: Ohne Verantwortung und Transparenz. Menschenrechtliche Risiken entlang der Nickellieferkette.

Mur, M. 2020: Chile mine safety much improved since 2010 cave-in, but critics unconvinced. Last accessed on 31 May 2023 at <https://www.laprensa-latina.com/chile-mine-safety-much-improved-since-2010-cave-in-but-critics-unconvinced/>.

Murphy, L.; Elimä, N. 2021: In Broad Daylight: Uyghur Forced Labour and Global Solar Supply Chains. Sheffield, UK: Sheffield Hallam University, Helena Kennedy Centre for International Justice.

MVO Nederland 2023: CSR Risk Check. Last accessed on 11 May 2023 at <https://www.mvorisicochecker.nl/en/start-check>.

Nazalya, S. 2019: Human rights cast shadow over green energy's clean image. Last accessed on 19 April 2023 at <https://www.maplecroft.com/insights/analysis/human-rights-cast-shadow-over-green-energys-clean-image/>.

NDR [Northern German public radio and TV broadcasting service] 2023: LNG-Terminal Brunsbüttel: Lärm und Licht stören Anwohner. Last accessed on 10 June 2023 at <https://www.ndr.de/nachrichten/schleswig-holstein/LNG-Terminal-Brunsbuettel-Laerm-und-Licht-stoeren-Anwohner.lng652.html>.

Ng, A. 2022: China's electric vehicle battery supply chain shows signs of forced labor, report says. Last accessed on 11 May 2023 at <https://www.cnn.com/2022/06/22/signs-of-forced-labor-found-in-chinas-ev-battery-supply-chain-report.html>.

OEC [Observatory of Economic Complexity], undated: Germany (DEU) Exports, Imports, and Trade Partners. Last accessed on 11 July 2023 at <https://oec.world/en/profile/country/deu/>.

OECD [Organization for Economic Cooperation and Development] 2015: In It Together. Why less inequality benefits all.

OECD [Organization for Economic Cooperation and Development] 2019a: Issue Paper – Reducing the health risks of the copper, rare earth and cobalt industries. The transition to a low-carbon economy.

OECD [Organization for Economic Cooperation and Development] 2019b: OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.

OHCHR [Office of the United Nations High Commissioner for Human Rights] 2017: Human Rights Translated 2.0. Last accessed on 30 May 2023 at https://www.ohchr.org/sites/default/files/Documents/Publications/HRT_2_0_EN.pdf.

OHCHR [Office of the United Nations High Commissioner for Human Rights] 2023a: Climate change and the UNGPs. Last accessed on 11 July 2023 at <https://www.ohchr.org/en/special-procedures/wg-business/climate-change-and-ungps>.

OHCHR [Office of the United Nations High Commissioner for Human Rights] 2023b: Information Note on Climate Change and the Guiding Principles on Business and Human Rights. Last accessed on 11 July 2023 at <https://www.ohchr.org/sites/default/files/documents/issuues/business/workinggroupbusiness/Information-Note-Climate-Change-and-UNGPs.pdf>.

Paasch, A. 2022: Der Ukrainekrieg und die Rohstoffe: Warum wir jetzt erst recht ein wirksames EU-Lieferkettengesetz brauchen. Last accessed on 30 May 2023 at https://lieferkettengesetz.de/wp-content/uploads/2022/06/Initiative-Lieferkettengesetz-Briefing-Ukraine-Rohstoffe_final.pdf.

Pattison, P. 2021: Like slave and master. Last accessed on 30 May 2023 at <https://www.theguardian.com/global-development/2021/nov/08/cobalt-drc-miners-toil-for-30p-an-hour-to-fuel-electric-cars>.

PBI [Peace Brigades International] 2014: Wind farms and concerns about human rights violations in Oaxaca. Last accessed on 11 May 2023 at <https://pbi-mexico.org/news/2014-03-14/wind-farms-and-concerns-about-human-rights-violations-oaxaca>.

Penke, M. 2021: The toxic damage from mining rare elements. Last accessed on 15 June 2023 at <https://www.dw.com/en/toxic-and-radioactive-the-damage-from-mining-rare-elements/a-57148185>.

Pensamiento y Acción Social – PAS; Heinz, R.; Sydow, J. 2020: Warum umweltbezogene Sorgfaltspflichten in Rohstofflieferketten wichtig sind. Der Fall von Cerro Matoso, Kolumbien.

Piri, M. D.; Faure, M. 2014: The Effectiveness of Cross-Border Pipeline Safety and Environmental Regulations (under International Law). In: North Carolina Journal of International Law, 40/1, pp. 55–133.

Pöyhönen, P.; Areskog Bjurling, K.; Cuvelier, J. 2010: Voices from the inside: Local views on mining reform in Eastern DR Congo: Finnwatch and Swedwatch.

Prillaman, J. 2019: How Mining Companies Can Mitigate Their Biggest Risk. Last accessed on 15 June 2023 at <https://thepalladiumgroup.com/news/How-Mining-Companies-Can-Mitigate-Their-Biggest-Risk>.

RAID [Rights and Accountability in Development] 2023: Workers at DRC's industrial cobalt mines pushed further into poverty. Last accessed on 8 June 2023 at <https://raid-uk.org/workers-at-drcs-industrial-cobalt-mines-pushed-further-into-poverty/>.

Raw Material Outlook Platform, undated: Iron Ore: Raw Material Outlook Platform.

Reuters 2021: One dead as explosion rocks CATL plant in China. Last accessed on 22 May 2023 at <https://www.reuters.com/world/china/one-dead-explosion-rocks-catl-plant-china-2021-01-08/>.

Reuters Staff 2020: Azerbaijan's SOCAR says its oil infrastructure guarded by army: Interfax. Last accessed on 9 June 2023 at <https://www.reuters.com/article/us-armenia-azerbaijan-oil-idUSKBN26K15L>.

Reuters 2022: Green groups sue Louisiana over Venture Global LNG permit exemption. Last accessed on 11 July 2023 at <https://www.reuters.com/business/energy/green-groups-sue-louisiana-over-venture-global-lng-permit-exemption-2022-11-16/>.

Rothermel, M. 2022: LkSG – Lieferkettensorgfaltspflichtengesetz. Frankfurt am Main: Fachmedien Recht und Wirtschaft; dfv Mediengruppe.

- Rötters, S. 2014: Steinkohleimporte aus Kolumbien: Billige Energie auf Kosten Anderer. Last accessed on 11 July 2023 at https://www.cora-netz.de/wp-content/uploads/2015/03/CorA-ForumMR_Steckbrief-Kohle.pdf.
- Rushdi, M.; Sutomo, A.; Ginting, P.; Anwar, R. M. 2021: Fast and Furious for Future. The dark side of electric battery vehicle components and their impacts in Indonesia: Rosa-Luxemburg-Stiftung, Climate Justice Dialogue Programme.
- Rüttinger, L.; Treimer, R.; Tiess, G.; Griestop, L. 2016: Umwelt- und Sozialauswirkungen der Bauxitgewinnung und Aluminiumherstellung in Pará, Brasilien. Berlin: adelphi research gGmbH.
- SASB [Sustainability Accounting Standards Board] 2023: Materiality Finder. Last accessed on 19 April 2023 at <https://www.sasb.org/standards/materiality-finder/?lang=en-us>.
- Save The Children 2021: Kinderrechte in der Kobaltlieferkette. Last accessed on 11 July 2023 at https://www.savethechildren.de/fileadmin/user_upload/Downloads_Dokumente/Berichte_Studien/2022/kinderrechte-in-der-kobaltlieferkette-drc-save-the-children.pdf.
- Schlitt, A. L. 2022: EU will Gasimport aus Aserbaidschan verdoppeln. Last accessed on 24 May 2023 at <https://www.zeit.de/wirtschaft/2022-07/ursula-von-der-leyen-erdgas-aserbaidschan-klima>.
- Schmaltz, T. 2023: Recycling von Lithium-Ionen-Batterien wird in Europa stark zunehmen. Last accessed on 9 June 2023 at <https://www.isi.fraunhofer.de/de/blog/themen/batterie-update/recycling-lithium-ionen-batterien-europa-starke-zunahme-2030-2040.html#:~:text=Recycling%20von%20Lithium%2DIonen%2DBatterien%20wird%20in%20Europa%20stark%20zunehmenvon%20Dr.&text=Aktuell%20werden%20j%C3%A4hrlich%20ungef%C3%A4hr%2050,Herkunft%20dieser%20Batterien%20ver%C3%A4ndert%20sich>.
- Schmidt, M. 2013: Rohstoffrisikobewertung – Antimon DERA-Rohstoffinformationen, 18.
- Schröter-Schlaack, C. 2020: Lichtverschmutzung. Ausmaß, gesellschaftliche und ökologische Auswirkungen sowie Handlungsansätze. Arbeitsbericht, 186.
- Scott Jacobsson, L. 2019: Copper with a cost. Human rights and environmental risks in the mineral supply chains of ICT: A case study from Zambia: Swed Watch.
- Siekmann, A. 2022: Studienergebnisse. Windkraftanlagen: Diese Maßnahmen retten Vögel. Last accessed on 11 May 2023 at <https://www.agrarheute.com/energie/windkraftanlagen-diese-massnahmen-retten-voegel-593577>.
- Singh, N.; Li, J. H. 2014: Environmental Impacts of Lead Ore Mining and Smelting. In: Advanced Materials Research, no. 878, pp. 38–347.
- SOMO and ActionAid Netherlands 2018: Human rights in wind turbine supply chains. Towards a truly sustainable energy transition. Last accessed on 11 July 2023 at https://www.somo.nl/wp-content/uploads/2018/01/Final-ActionAid_Report-Human-Rights-in-Wind-Turbine-Supply-Chains.pdf.
- Sons, S. 2022: Arbeitsmigration und Menschenrechte. Last accessed on 10 June 2023 at <https://www.bpb.de/shop/zeitschriften/izpb/katar/514610/arbeitsmigration-und-menschenrechte/>.
- SP Rohstoffe und Entwicklung (GIZ+ BGR) 2021: Rohstoffe für die E-Mobilität. Entwicklungspolitische Perspektiven.
- Spiess, M. 2022: DR Kongo: Mehr Schutz von Kinderrechten im Kobalt-Kleinbergbau. Last accessed on 11 May 2023 at <https://www.savethechildren.de/news/dr-kongo-mehr-schutz-von-kinderrechten-im-kobalt-kleinbergbau/>.
- Spohr, M. 2016: Human Rights in Mining. A Baseline Study: BGR – Federal Institute of Geosciences and Natural Resources.
- SPREP [Secretariat of the Pacific Regional Environment Programme] 2021: Situational Analysis of Human Rights Issues in the Waste Management Sector: Literature Review.
- Statistisches Bundesamt: 2,2 Millionen Photovoltaik-Anlagen in Deutschland installiert. Last accessed on 11 May 2023 at https://www.destatis.de/DE/Presse/Pressemitteilungen/2022/06/PD22_N037_43.html#:~:text=Mit%20den%20Photovoltaikanlagen%20konnten%20im,Quartal%202021.
- Statistisches Bundesamt (ed.) 2023a: 87 % der importierten Photovoltaikanlagen kamen im Jahr 2022 aus China. Last accessed on 12 June 2023 at https://www.destatis.de/DE/Presse/Pressemitteilungen/2023/03/PD23_N012_43.html.
- Statistisches Bundesamt (ed.) 2023b: Stromerzeugung 2022: Ein Drittel aus Kohle, ein Viertel aus Windkraft. Last accessed on 11 May 2023 at https://www.destatis.de/DE/Presse/Pressemitteilungen/2023/03/PD23_090_43312.html.
- Statistisches Bundesamt (ed.) 2023c: Bruttostromerzeugung in Deutschland. Last accessed on 14 August 2023 at <https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Energie/Erzeugung/Tabellen/bruttostromerzeugung.html>.
- Steiner, M.; Marewski, U.; Silcher, H. 2023: Investigation of Steel Materials for Gas Pipelines and Plants for Assessment of Their Suitability with Hydrogen: Deutscher Verein des Gas- und Wasserfachs e. V.
- Steinwandel, L.; Schnittker, H. 2022: Green hydrogen. Ein Blick auf Risiken und Nachhaltigkeitskriterien für deutsche Importvorhaben. PowerShift.
- Steinweg, T.; de Haan, E. 2007: Capacitating Electronics. The corrosive effects of platinum and palladium mining on labour rights and communities.
- Stock, R. 2022: Triggering resistance: Contesting the injustices of solar park development in India. In: Energy Research & Social Science, no. 86, p. 102464.
- Storch, L. 2021: Wie umweltschädlich sind Solarzellen? Last accessed on 12 June 2023 at <https://www.tagesschau.de/wissen/technologie/photovoltaik-recycling-101.html>.
- Stratmann, K. 2019: Energiewende – Ausbau des Stromnetzes verteuert sich um 19 Milliarden Euro. Last accessed on 11 May 2023 at <https://www.handelsblatt.com/politik/deutschland/energiewende-ausbau-des-stromnetzes-verteuert-sich-um-19-milliarden-euro/24066482.html>.

Südwind e.V. 2019: Copper with a cost – Human rights and environmental risks in the minerals supply chains of ICT. Last accessed on 30 June 2023 at https://www.suedwind.at/fileadmin/user_upload/suedwind/Themen/Elektronik/94_Zambia_190429_enkelsidor.pdf.

Svec, J. 2022: Labour transfers as a means of ‘civilizing’ and forcibly assimilating ethnic minorities in western China. In: Central Asian Survey, 41/3, pp. 385–401.

Swanson, A.; Buckley, C. 2022: Red Flags for Forced Labor Found in China’s Car Battery Supply Chain. Last accessed on 11 May 2023 at <https://www.nytimes.com/2022/06/20/business/economy/forced-labor-china-supply-chain.html>.

Szurliés, M. 2021: Rohstoffrisikobewertung – Nickel. DERA-Rohstoffinformationen, 48.

The Guardian 2020: “Their greed is gonna kill us”: Indian Country fights against more fracking. Last accessed on 11 July 2023 at <https://www.theguardian.com/us-news/2020/jun/10/new-mexico-fracking-navajo-indian-country>.

Thielmann, A.; Sauer, A.; Wietschel, M. 2015: Gesamt-Roadmap Lithium-Ionen-Batterien 2030.

Toxics Use Reduction Institute 2002: Environmental, health and safety issues in the coated wire and cable industry: University of Massachusetts Lowell.

UBA [Umweltbundesamt] 2016: Quecksilber – Risiko für Mensch und Umwelt? Last accessed on 13 June 2023 at <https://www.umweltbundesamt.de/themen/quecksilber-risiko-fuer-mensch-umwelt>.

UBA [Umweltbundesamt] 2019: Zu geringe Recyclingkapazitäten für Rückbau von Windenergieanlagen. Last accessed on 12 June 2023 at <https://www.umweltbundesamt.de/presse/pressemitteilungen/zu-geringe-recyclingkapazitaeten-fuer-rueckbau-von>.

UBA [Umweltbundesamt] 2021a: Benzol. Last accessed on 24 May 2023 at <https://www.umweltbundesamt.de/themen/luft/luftschadstoffe-im-ueberblick/benzol>.

UBA [Umweltbundesamt] 2021b: Ressourcennutzung und ihre Folgen. Last accessed on 26 May 2023 at <https://www.umweltbundesamt.de/themen/abfall-ressourcen/ressourcennutzung-ihre-folgen>.

UBA [Umweltbundesamt] 2022a: Altbatterien. Last accessed on 17 May 2023 at <https://www.umweltbundesamt.de/daten/ressourcen-abfall/verwertung-entsorgung-ausgewaehlter-abfallarten/altbatterien#im-jahr-2021-hat-deutschland-alle-von-der-eu-geforderten-mindestziele-erreicht>.

UBA [Umweltbundesamt] 2022b: Primärenergiegewinnung und -importe. Last accessed on 11 May 2023 at <https://www.umweltbundesamt.de/daten/energie/primaerenergiegewinnung-importe>.

UBA [Umweltbundesamt] 2022c: Lärm von Windenergieanlagen. Last accessed on 12 June 2023 at <https://www.umweltbundesamt.de/themen/laerm/nachbarschaftslaerm-laerm-von-anlagen/laerm-von-windenergieanlagen>.

UBA [Umweltbundesamt] 2022d: Lithium-Batterien und Lithium-Ionen-Akkus. Last accessed on 31 May 2023 at <https://www.umweltbundesamt.de/umwelttipps-fuer-den-alltag/elektrogeraete/lithium-batterien-lithium-ionen-akkus#unsere-tipps>.

UBA [Umweltbundesamt] 2022e: CO₂-Emissionsfaktoren für fossile Brennstoffe. Aktualisierung 2022. Last accessed on 18 August 2023 at https://www.umweltbundesamt.de/sites/default/files/medien/479/publikationen/cc_28-2022_emissionsfaktoren-brennstoffe_bf.pdf.

UBA [Umweltbundesamt] 2023a: Erneuerbare Energien in Zahlen. Last accessed on 11 May 2023 at <https://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-in-zahlen#uberblick>.

UBA [Umweltbundesamt] 2023b: Photovoltaik. Last accessed on 16 May 2023 at <https://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/photovoltaik#photovoltaik>.

UBA [Umweltbundesamt] 2023c: Fracking. Last accessed on 16 August 2023 at <https://www.umweltbundesamt.de/themen/wasser/gewaesser/grundwasser/nutzung-belastungen/fracking>.

UBA [Umweltbundesamt] 2023d: CO₂-Emissionen pro Kilowattstunde Strom stiegen in 2022. Last accessed on 16 August 2023 at <https://www.umweltbundesamt.de/themen/co2-emissionen-pro-kilowattstunde-strom-stiegen-in>.

UBA [Umweltbundesamt] 2023e: Emissionsquellen. Last accessed on 16 August 2023 at <https://www.umweltbundesamt.de/themen/klima-energie/treibhausgas-emissionen/emissionsquellen#energie-stationar>.

UBA [Umweltbundesamt] 2023f: Treibhausgas-Emissionen in Deutschland. Last accessed on 16 August 2023 at <https://www.umweltbundesamt.de/daten/klima/treibhausgas-emissionen-in-deutschland#emissionsentwicklung>.

UN DESA [United Nations Department of Economic and Social Affairs] 2006: Multi Dimensional Issues in International Electric Power Grid Interconnections.

UN OHCHR [Office of the United Nations High Commissioner for Human Rights] 2022: OHCHR Assessment of human rights concerns in the Xinjiang Uyghur Autonomous Region, People’s Republic of China.

UNEP FI [United Nations Environment Programme Finance Initiative] 2014a: Human Rights Issues by Sector. Last accessed on 16 May 2023 at <https://www.unepfi.org/humanrightstoolkit/infrastructure.php>.

UNEP FI [United Nations Environment Programme Finance Initiative] 2014b: Human Rights Issues by Sector. Last accessed on 5 May 2023 at <https://www.unepfi.org/humanrightstoolkit/mining.php>.

UNEP FI [United Nations Environment Programme Finance Initiative] 2014c: Human Rights Issues by Sector. Last accessed on 5 May 2023 at <https://www.unepfi.org/humanrightstoolkit/oil.php>.

UNEP FI [United Nations Environment Programme Finance Initiative] 2014d: Human Rights Issues by Sector. Last accessed on 5 May 2023 at <https://www.unepfi.org/humanrightstoolkit/power.php>.

UNEP FI [United Nations Environment Programme Finance Initiative] 2014e: Human Rights Issues by Sector. Last accessed on 23 May 2023 at <https://www.unepfi.org/humanrightstoolkit/utilities.php>.

UNGC [United Nations Global Compact], undated: Discrimination. Last accessed on 26 May 2023 at <https://bhr-navigator.unglobalcompact.org/issues/discrimination/>.

UNGC [United Nations Global Compact], undated: Child labour. Last accessed on 8 May 2023 at <https://bhr-navigator.unglobalcompact.org/issues/child-labour/definition-and-legal-instruments/?lang=en>.

UNGC [United Nations Global Compact], undated: Occupational Safety and Health. Last accessed on 26 May 2023 at <https://bhr-navigator.unglobalcompact.org/issues/occupational-safety-and-health/>.

USDOL [United States Department of Labor], undated: Green Job Hazards. Last accessed on 11 May 2023 at <https://www.osha.gov/green-jobs/solar>.

USDOL [United States Department of Labor] 2022: 2022 list of goods produced by child labor or forced labor.

USDOS [United States Department of State] 2022: Azerbaijan 2022 Human Rights Report (Country Report on Human Rights Practices in 2022).

USGS [United States Geological Survey] 2018: Minerals Yearbook. Copper. Last accessed on 12 July 2023 at <https://pubs.usgs.gov/myb/vol1/2018/myb1-2018-copper.pdf>.

USGS [United States Geological Survey] 2023a: Bauxite and Alumina. Last accessed on 12 June 2023 at <https://www.usgs.gov/centers/national-minerals-information-center/bauxite-and-alumina-statistics-and-information>.

USGS [United States Geological Survey] 2023b: Mineral Commodity Summaries 2023. Reston, Virginia: U.S. Geological Survey.

USGS [United States Geological Survey] 2023c: Copper Statistics and Information. Last accessed on 11 July 2023 at <https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-copper.pdf>.

USGS [United States Geological Survey] 2023d: Nickel. Last accessed on 11 July 2023 at <https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-nickel.pdf>.

USGS [United States Geological Survey] 2023e: Bauxite and Alumina. Last accessed on 11 July 2023 at <https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-bauxite-alumina.pdf>.

USGS [United States Geological Survey], undated: Does the production of oil and gas from shales cause earthquakes? Last accessed on 16 August 2023 at <https://www.usgs.gov/faqs/does-production-oil-and-gas-shales-cause-earthquakes-if-so-how-are-earthquakes-related-these>.

USOSHA [US Department of Labor, Occupational Safety and Health Administration], undated: Green Job Hazards. Last accessed on 16 May 2023 at <https://www.osha.gov/green-jobs/wind-energy#:~:text=Wind%20Energy%20workers%20are%20exposed,have%20been%20reported%20to%20OSHA>.

van Brink, S.; Kleijn, R.; Sprecher, B.; Mancheri, N.; Tukker, A. 2022: Resilience in the antimony supply chain. In: Resources, Conservation and Recycling, no. 186, p. 106586.

Vargas, N. 2020: The Effects of the Wind Farms on the Indigenous Zapotec Community of the Isthmus of Tehuantepec, Mexico.

Vasters, J.; Franken, G.; Szurles, M. 2021: Nickel – Informationen zur Nachhaltigkeit.

VDMA Batterieproduktion [Mechanical and Plant Engineering Association] (2023): Roadmap Batterie-Produktionsmittel. Last accessed on 11 July 2023 at https://vdma.org/documents/34570/35405938/VDMA+Batterieproduktion_Roadmap_2023.pdf/ee2452cd-ed44-93bf-4762-6a09ce29b4b7?t=1683038844317.

Verité 2017: Strengthening Protections Against Trafficking in Persons in Federal and Corporate Supply Chains.

Verité and U.S. Department of State's Office to Monitor and Combat Trafficking in Persons. 2021–2022: Responsible Sourcing Tool Commodity Report. Last accessed on 16 May 2023 at <https://www.responsible sourcingtool.org/>.

Villagrana, D. 2022: Green hydrogen: Key success criteria for sustainable trade & production. A synthesis based on consultations in Africa & Latin America.

Walk Free 2022: Global Slavery Index. Last accessed on 31 May 2023 at <https://www.walkfree.org/global-slavery-index/>.

Waters-Bayer, A. 2022: Pastoralism and large-scale renewable energy and green hydrogen projects. Potentials & Threats.

Weiss, D.; Garcia, B.; van Ackern, P.; Rüttinger, L.; Albrecht, P.; Dech, M.; Knopf, J. 2020: Die Achtung von Menschenrechten entlang globaler Wertschöpfungsketten. Risiken und Chancen für Branchen der deutschen Wirtschaft. BMAS – Federal Ministry of Labour and Social Affairs.

Weiss, D.; Grüning, C.; von Ackern, P.; Kriege, K.; Buderath, M.; Dovidat, L.; Jungmichel, N.; Aron, M. 2022: Umweltrisiken und -auswirkungen in globalen Lieferketten deutscher Unternehmen – Branchenstudie Automobilindustrie. adelphi research gGmbH; Systain Consulting GmbH.

Wilken, D. et al. 2014: Schlussbericht zum Verbundvorhaben "Speicherung elektrischer Energie aus regenerativen Quellen im Erdgasnetz – H₂O-Elektrolyse und Synthese von Gas components". Im Rahmen der BMBF-Fördermaßnahme "Technologien für Nachhaltigkeit und Klimaschutz – Chemische Prozesse und stoffliche Nutzung von CO₂".

Williams, H. F.; Havens, D. L.; Banks, K. E.; Wachal, D. J. 2008: Field-based monitoring of sediment runoff from natural gas well sites in Denton County, Texas, USA. In: Environmental Geology, issue 55:7, pp. 1463–1471.

Wirtz, B. 2019: Solar Panels Produce Tons of Toxic Waste – Literally. Last accessed on 16 May 2023 at <https://fee.org/articles/solar-panels-produce-tons-of-toxic-waste-literally/>.

World Bank Group 2017: The Growing Role of Minerals and Metals for a Low Carbon Future.

World Bank Group 2022: Nearly 2.4 Billion Women Globally Don't Have Same Economic Rights as Men. Last accessed on 26 May 2023 at <https://www.worldbank.org/en/news/press-release/2022/03/01/nearly-2-4-billion-women-globally-don-t-have-same-economic-rights-as-men>.

Wormington, J. 2018: "What Do We Get Out of It?". The Human Rights Impact of Bauxite Mining in Guinea.

Wübbeke, J.; Zenglein, M. 2020: Xinjiang Solar Industry: A Global Value Chain Analysis: Mercator Institute for China Studies – MERICS.

Zeisel, C.; Kaledzi I. 2012: Europas Schrottplätze in Westafrika. Last accessed on 17 May 2023 at <https://www.dw.com/de/europas-schrottpl%C3%A4tze-in-westafrika/a-15741351>.

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