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Topic: Due Diligence of Copper at Siemens Energy

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List of abbreviations

3TG	Tantalum, Tungsten, Tin, Gold
bn	billion
CAHRA	Conflict-Affected and High-Risk Areas (no common list is available, the list of the EU and RMI have been applied)[1]
CAHRA FR	CAHRA free rate
CMR	Conflict Minerals Regulation
DFA	Dodd-Frank Act
DRC	Democratic Republic of Congo
EPRM	European Partnership for Responsible Minerals
etc	et cetera
EU	European Union
Directive 2019/1937	Directive of the European Parliament and of the Council on Corporate Sustainability Due Diligence and amending Directive EU 2019/1937
IR	Inquiry rate
mn	million
mt	metric tons
NGO	non governmental organization
No.	number
NP	non-switchable products (Business Unit of Siemens Energy)
OECD	Organization for Economic Co-operation and Development
OECD DD Guidance	Due Diligence Guidance for Responsible Supply Chains of Minerals from CAHRA
PV	purchasing volume
RMI	Responsible Minerals Initiative

[1] See European Union (2022); RMI (2022i).

RMIHERFR	High and extreme risk-free rate
ROW	Rest of world
SCDDA	Act on Corporate Due Diligence Obligations in Supply Chains
SIR	Smelter identification rate
SO	Solutions (Business Unit of Siemens Energy)
SPR	Sourcing policy rate
SRR	Supplier response rate
SSR	Supplier in scope rate
TR	Transparency rate
UN	United Nations
USA	United States of America

1 Worldwide development of sustainability and the effect on supply chains

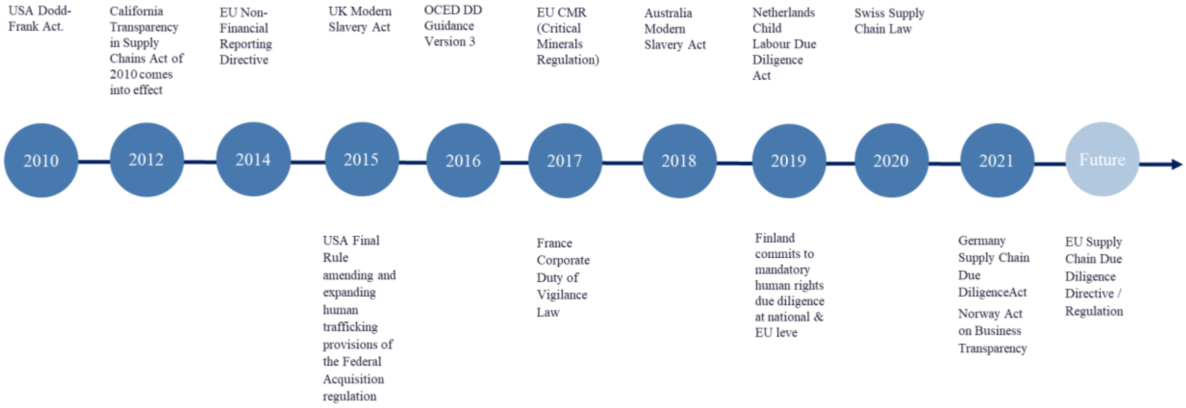
1.1 Sustainability development becomes visible from consumer, investor, and legal perspectives

Sustainability becomes a crucial element in the world today and is demanded by several stakeholders, like consumers, investors, and policymakers.[2] Moreover, globalization brings benefits and risks regarding sustainability in the supply chains.[3] For example, the outsourcing of manufacturing facilities saves cost, while social, environmental, and human rights violations are not visible to the focal firm but occur in their supply chain.[4] Particularly, the sourcing of minerals is essential to serve the ongoing sustainability demands, while it is a major threat as especially the mining of minerals includes abroad set of risks regarding human rights violations including child labor, corruption, and environmental pollution.[5] Furthermore, the mineral supply chains are complex and can reach a length of up to 20 tier suppliers, while a length of 9 tier suppliers is common.[6] Therefore the sustainability threats are far out of reach for the focal firm.[7] Moreover, these supply chains are often characterized by asymmetric power structures that lead to a deterioration of the working conditions of the employees behind tier one.[8] Even if there is low visibility for the focal firm, such risks cause huge liability effects in several forms, like reputational but also legal risks.[9] Additionally, the information asymmetry makes it impossible for civil society to evaluate the socio-ecological footprints of their purchases. Contrary the demand of civil society to consume sustainable products increased which puts pressure on the governance system to fulfill the new demands on green energy and other environment-friendly technologies.[10] Hence, plenty of cooperations across the world started to report their impact on sustainability and entire industries started the shift toward zero-emission strategies like the automotive, steel, cement, chemical, paper, and pulp industry.[11] To implement this shift, new technologies like green energy or the electrification of the transport system are launched.

[2] See Liu, Agusdinata, Eakin, and Romero (2022, p. 2).
[3] See Van den Brink, Kleijn, Tukker, and Huisman (2019, p. 389).
[4] See Hofmann, Schleper, and Blome (2018, p. 115).
[5] See Deberdt and Le Billon (2021, p. 1).
[6] See Sauer (2021, p. 1); Van den Brink et al. (2019, p. 393); Sauer and Seuring (2018, p. 560).
[7] See Sauer and Seuring (2019, p. 33).
[8] See Heinen (2021, p. 160).
[9] See Wilhelm, Blome, Wieck, and Xiao (2016, p. 197).
[10] See Deberdt and Le Billon (2021, p. 1); Liu et al. (2022, p. 2).
[11] See van Sluisveld, de Boer, Daioglou, Hof, and van Vuuren (2021, p. 1); Xiao and Shailer (2021, p. 1).

This requires plenty of minerals among others also critical and conflict minerals.[12] Especially these minerals suffer from sustainability risks in the upstream supply chain.[13] To solve this issue, policymakers around the globe and several initiatives developed frameworks and laws.[14] Especially regulators from the United States of America (USA) and the European Union (EU) drive downstream companies towards more responsible behavior along the supply chain.[15]

Figure 1: Legislative Development regarding mineral sourcing and supply chain due diligence starting in 2010



Source based on: BMAS (2021, p. 1); Business and Human Rights (2021, p. 6); CFTC (2011, p. 838); Europäisches Parlament (2017, p. 1); Konrad Adenauer Stiftung (2021, p. 22).

Figure 1 shows the development of legislative frameworks that hold downstream companies responsible for their suppliers along the supply chain, beginning with the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act, DFA) in 2010. In the following years, the DFA was followed by other legislative regulations which target to broaden the scope of the law, as the DFA was limited to regions, minerals, and the financing of armed groups.[16] In 2021, the German Bundestag published 2021 the "Act on Corporate Due Diligence Obligations in Supply Chains" (SCDDA) which considers next to human rights violations also environmental violations.[17] In the future, a Directive of the European Parliament and the Council on Corporate Sustainability Due Diligence and amend-

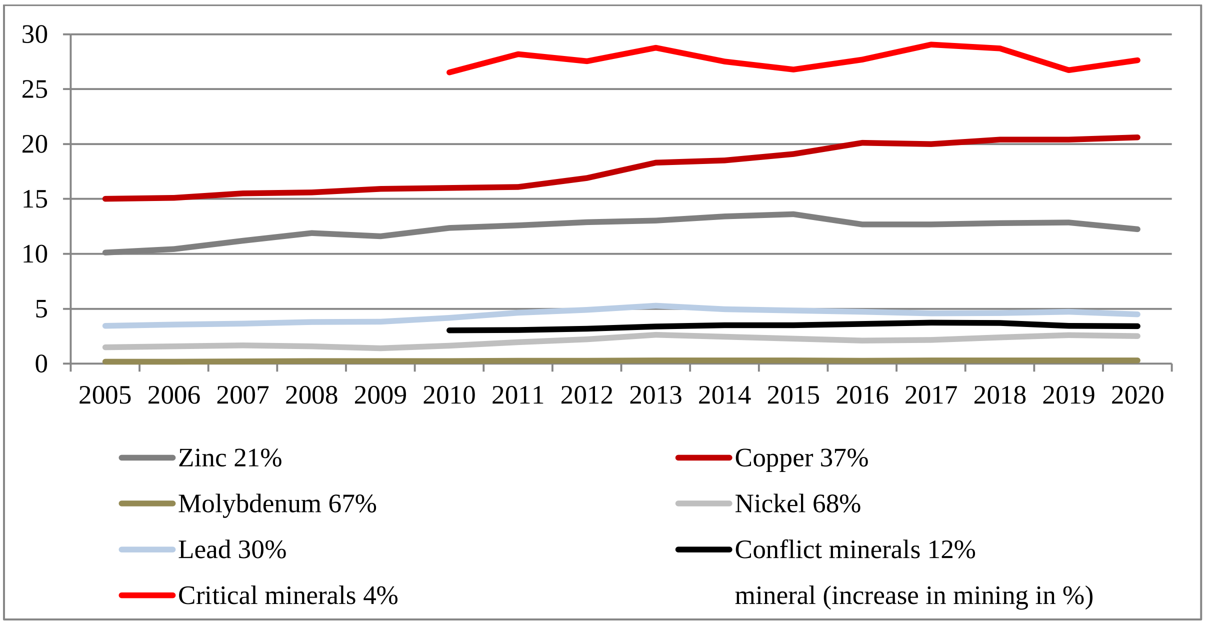
[12] See Department of Homeland Security (2021, p. 66201-62202); European Commission (2020a, p. 18-20); McNulty and Jowitt (2021, p. 1); Nguyen, Eggert, Severson, and Anderson (2021, p. 1).
[13] See Deberdt and Le Billon (2021, p. 1).
[14] See BMAS (2021, p. 1); CFTC (2011, p. 838); Europäisches Parlament (2017, p. 1); OECD (2016, p. 1-4).
[15] See Young, Fernandes, and Wood (2019, p. 2).
[16] See Schwartz (2016, p. 135).
[17] See BMAS (2021, p. 1).

ing Directive 2019/1937, (Directive 2019/1937) is expected which integrated all dimensions of sustainability.[18] A central problem is that the last Due Diligence Guidance for Responsible Supply Chains of Minerals from CAHRA (OECD DD Guidance) was published in 2016 and does not control for risks covered in later regulations.

1.2 Sustainability raises demands on risks affected minerals

The first laws have been limited to conflict minerals in form of the 3TG, while a strong focus is based nowadays on critical minerals as these natural elements are not recycled or just recycled at low levels and cannot easily be substituted which strengthens the supply chain risks.[19] The critical minerals differ across industries and countries, while the main critical minerals are identified by comparing the critical mineral list of the USA and the EU.[20] Plenty of these critical and conflict minerals are by-products that are extracted by mining copper, zinc, nickel, lead, and molybdenum,[21] for example, the critical mineral cobalt is mined together with copper.[22]

Figure 2: Global mining in million mn mt of main minerals from 2005-2020 and by minerals from 2010-2020



[18] See Elkington (1998, p. 38); European Commission (2022b, p. 1); M. E. Silva and Figueiredo (2020, p. 4).
[19] See Graedel, Gunn, and Espinoza (2014, p. 14-20).
[20] See Department of Homeland Security (2021, p. 66201-62202); European Commission (2020a, p. 18-20).
[21] See McNulty and Jowitt (2021, p. 6).
[22] See McNulty and Jowitt (2021, p. 4).

Source based on: Mundi (2022); Statista (2022b); Statista (2022c); Statista (2022d); Statista (2022e); Statista (2022i); Statista (2022j); Statista (2022k); Statista (2022l); Statista (2022m); Statista (2022n); Statista (2022o); Statista (2022q); Statista (2022t); Statista (2022s); Statista (2022r); Statista (2022u); Statista (2022w); Statista (2022y); Statista (2022z); Statista (2022ab); USGS (2014, p. 200); (USGS, 2015); (USGS, 2020); USGS (2022a); USGS (2022b); USGS (2022c); USGS (2022d); USGS (2022e); USGS (2022f); USGS (2022g); USGS (2022h); USGS (2022i).

Figure 2 illustrates the production in million (mn) metric tons (mt) from 2005 to 2020 of the main minerals copper, zinc, nickel, molybdenum, and lead, while the increase in mining is provided in percentage during this period. Furthermore, the amount and increase in mining of conflict and critical minerals between 2010 and 2020 are provided. Especially copper has a key role as it is also mined together with the main minerals zinc, lead, and molybdenum and it is the largest main mined mineral, while conflict minerals play a minor role in global mining based on volume compared to the critical minerals (overview of critical minerals is presented in Appendix A1) or the main minerals. By comparing these critical minerals and the main minerals in their application it becomes visible that they are vital for the sustainability trend as they are highly required for the production of equipment for green energy and other environment-friendly technologies.[23] To become more specific, critical minerals are required to manufacture products like wind turbines, electric vehicles, batteries, solar panels, and several military applications.[24] Especially for the electrification of the economy and therefore for a low-carbon economy the minerals copper, cobalt and nickel have been identified as key minerals.[25] Furthermore, copper is used for turbines, batteries, motors, charging infrastructure, wiring, busbars, machinery, metallurgy, and transportation.[26] The new industry solutions for decarbonization like the mass production of electric vehicles let the demand for minerals grow, for example, the sales of electric vehicles are expected to increase to the amount of 10 mn by 2025 and 28 mn by 2030.[27] Therefore, a rise in copper mining up to 30 mn mt by 2030 is forecasted to cover the demand for the electric automotive industry.[28] Moreover, other industry solutions for decarbonization like solar panels or wind turbines require 10 times more minerals in the production compared to machinery which uses fossil-based solutions to provide the same amount of energy.[29] Hence, the global copper demand for energy solutions is forecasted to increase to 29 mn mt by 2050 to fulfill the demand for renewable energy technologies and storage

[23] See McNulty and Jowitt (2021, p. 1).
[24] See McNulty and Jowitt (2021, p. 1).
[25] See Nguyen et al. (2021, 1).
[26] See Li et al. (2021, p. 1);McNulty and Jowitt (2021, p. 4); Nguyen et al. (2021, p. 1).
[27] See Wu, Alberts, Hopper, and Walton (2019, 11); IEA (2019, p. 7).
[28] See Nguyen et al. (2021, p. 2).
[29] See Fuentes, Negrete, Herrera-León, and Kraslawski (2021, p. 2).

capacities.[30] Other authors forecasted the demand for copper across various industries up to 40 mn mt by 2030 and to 60 mn mt by 2050.[31] In 1972, the Club of Rome forecasted 308 mn mt of copper resources and calculated that the copper reserves will hold for the next 21 – 48 years.[32] However, the Club of Rome missed integrating the discovering of new copper reservers, which was possible due to modernization, technological advancements, structural change, and the fact that plenty of minerals are extracted jointly with other minerals.[33] Moreover, the opportunities to recycle minerals were underestimated in the calculations.[34] In 2012, a new forecast was published with a forecast which is more sophisticated and integrates climate change predictions the forecast.[35] This shows that forecasts are predictions that can be wrong, due to unpredictable circumstances and changes in the environment. Nevertheless, copper is key for the modernization of countries as well as it has a strategic role in the development of the economy.[36] All in all, the demand for copper will increase, there is less potential for substitutability and its mining is related to several critical and conflict minerals, as well as other main minerals. Therefore the responsible sourcing of copper is highly important, as copper is strongly connected to the sustainability movement and the protection of human rights and environmental harm. Moreover, the focus on main minerals like copper follows the logic that a responsible main mineral supply chain causes positive spin-offs regarding sustainability risks in the related by-mineral supply chains.

1.3 How can a multinational downstream company ensure responsible sourcing along the supply chain of minerals with the current and upcoming regulative requirements?

The sustainability movement is visible from several perspectives (legal, consumer, investors, etc), several initiatives have been founded and plenty of laws and frameworks are developed to ensure responsible supply chains to diminish sustainability threats around the world. Moreover, for conflict minerals like the 3TG or diamonds, concepts are already implemented and show strength and weakness (Chapter 2.2), while the focus is shifting now to minerals in a more general context. This development raises the complexity for multinational enterprises, as plenty of companies integrated their due diligence approach

30 See Fuentes, Negrete, Herrera-León, and Kraslawski (2021, p. 2).
31 See Ryter, Fu, Bhuwalka, Roth, and Olivetti (2022, p. 32)
32 See Meadows, Meadows, Randers, and Behrens III (1972, p. 56).
33 See Lomborg (2012, p. 29); Randers (2012, p. 56).
34 See Randers (2012, p. 56).
35 See Randers (2012, p. 57).
36 See Li et al. (2021, p. 1).

based on the OECD DD Guidance for the 3TG, while experiences with other minerals and risks not covered in the OECD DD Guidance are lacking.[37] As previously explained several industries developing their businesses with a more sustainable focus to fulfill consumer, investor, and legislative expectations (Chapter 1.1). This effect raises the demand for plenty of minerals and logical ore which put pressure on responsible sourcing (Chapter 1.2). This leads to the goal of this research which is to create a concept to establish the due diligence for minerals at a multinational enterprise in highly complex supply chains beyond the laws based on an established standard to ensure high adaptability. Therefore two research questions are developed:

Research questions:

> *"How can a multinational downstream company ensure responsible sourcing along the supply chain of minerals with the current and upcoming regulative requirements?"*

> *"Which elements are required to reply to the upcoming regulative requirements of the EU regarding responsible souring of minerals"*

This thesis provides a solution via the determination of the strength and the weakness of the OECD DD Guidance concerning the theory of multi-tier supply chain management and sustainability, by addressing the regulative requirements in scope. The analysis of the considered literature regarding multi-tier supply chain management offers several opportunities to strengthen the responsibility on the lower tier level, while the highly collaborative approach promises the largest success.[38] Moreover, the best practices provide a similar result and illustrated that the OECD DD Guidance was a useful tool to establish responsible sourcing for the 3TG.[39] Therefore the conceptual framework of the OECD DD Guidance was adjusted to the requirements of the SCDDA and the Directive 2019/1937 to an-

[37] See EPRM (2022d).
[38] See BGR (2020, p. 2); Bleischwitz, Dittrich, and Pierdicca (2012, p. 20);
Dabhilkar, Bengtsson, and Lakemond (2016, p. 16); Chand and Tarei (2021, p. 4); Fraser (2021, p. 162);
Garcia-Torres, Albareda, Rey-Garcia, and Seuring (2019, p. 96);
Govindan, Shaw, and Majumdar (2021, p. 10); Hofmann et al. (2018, p. 117); Hollensen (2020, p. 364);
Kshetri (2022, p. 11); Mena, Humphries, and Choi (2013, p. 72); Magno and Guzman (2021, p. 1);
Mello, Eckhardt, and Leiras (2017, p. 5); Tachizawa and Wong (2014, p. 652);
Tröster and Hiete (2019, p. 2); Wilhelm et al. (2016, p. 197); Young and Dias (2011, p. 11).
[39] See EPRM (2022d).

swer the research question. Furthermore, the solution is generated with a full design science process applied in a multinational enterprise to ensure the integration of practical experience, applicability and validity. The outcome is a model which shows how responsible sourcing of copper can be established in downstream companies in alignment with the regulative frameworks.

The thesis closes the academic knowledge gap regarding high complex supply chains and sustainability, as most studies are based on a triadic approach in less complex supply chains like the food or textile industry.[40] Therefore, low comparability to prior studies is given as mineral supply chains have a higher complexity due to the vertical and horizontal extension (Chapter 1.1). The current solution in high complex supply chains is the OECD DD Guidance which is already outdated as significant elements are missing to be in alignment with the SCDDA or the upcoming directive of the EU.[41] To conclude the thesis has the potential to close this knowledge gap as it provides a theoretical framework to integrate responsible sourcing in downstream companies operating in high complex supply chains, like the supply chain of minerals.

The practical contribution of this thesis is the implementation of due diligence in the copper supply chain based on the developed model. Missing elements are integrated into the OECD DD Guidance to be in alignment with the current and upcoming regulative requirements of the EU. Managerial knowledge is limited to the 3TG and the DFA, while knowledge reading the SCDDA is developing. The modifications to the OECD DD Guidance are explained to create a general solution, which makes it adaptable to other enterprises and mineral supply chains, especially to the mineral supply chains of the main minerals zinc, nickel, and molybdenum. The regulative frameworks are developing fast in the last decade, which requires a solution with the scope to analyze laws regarding responsible sourcing and due diligence. The gained knowledge has to be integrated into the management system of companies to be able to adopt the upcoming requirements in the purchasing processes. Managers can use the approach of how different regulations are compared to be able to integrate also future requirements into the Management system. Furthermore, the model and the gained experiences provide an overview of the issues in mineral sourcing with a focus on copper and a solution for how supply chains can be shaped beyond geographical limitations or the limitation to specific minerals. This thesis consists of four

[40] See Hofmann et al. (2018, p. 118); Sauer and Seuring (2019, p. 31); Tachizawa and Wong (2014, p. 643); Van den Brink et al. (2019, p. 389).

[41] See Diemel and Hilhorst (2019, p. 455); Hanai (2021, p. 2); Hofmann et al. (2018, p. 118).

chapters, while the first chapter serves as an introduction as it underlines the relevance of this subject. Moreover, it presents Siemens Energy as a multinational enterprise that provided the resources to apply the developed model in its environment. The second chapter is focused on legal frameworks and compares the requirements to the general solution in form of the OECD DD Guidance. Thereupon, the specific solution is developed based on the theoretical knowledge regarding improvement strategies of supplier management for bottleneck items. In the third chapter, the research methodology is given and the developed model is applied at Siemens Energy. In the last chapter, the research question is answered by linking the provided information from the previous parts.

1.4 High awareness of the world sustainability development at Siemens Energy

Siemens Energy AG is a global manufacturer of electric and power engineering with a headquarter in Munich.[42] Moreover, Siemens Energy employs 92 thousand people and generated a turnover of 84 billion (bn) Euro with an after-tax loss of 560 mn Euro in the financial year 2021.[43] Siemens Energy is affected by the sustainability movement on two levels as it is a provider for solutions and Siemens supports other companies to become sustainable. Moreover, these solutions have to be sustainable itself, as this company has declared that its activities are guided by the United Nations' 17 Sustainable Development Goals as well as it is committed to the Ten Principles of the United Nations Global Compact.[44] Siemens Energy's product portfolio is based on the following three major areas, to increase efficiency (turbines, engines et cetera (etc)), to realize fuel shift via hybridization (energy systems, H_2 gas turbines, power to heat, etc), and to implement deep decarbonization (hydropower, green energy storage, power-to-x, etc).[45] To create sustainable solutions, Siemens Energy enrolled in product stewardship activities to ensure economic development in balance with sustainable consumption and production.[46] Therefore all life cycle phases are taken into consideration, starting with product development and design, manufacturing, operation, service, and ending with the end-of-life phase.[47] Moreover, stewardship covers a zero-harm approach which has the target to avoid adverse effects to the envi-

[42] See Siemens Energy AG (2022g, p. 9).
[43] See Siemens Energy AG (2022g, p. 2).
[44] See Siemens Energy AG (2022j, p. 2).
[45] See Siemens Energy AG (2022d).
[46] See Siemens Energy AG (2022j, p. 47).
[47] See Siemens Energy AG (2022j, p. 47).

ronment or health through business operations. Therefore material compliance and lifecycle assessment programs have been enrolled according to the International Finance Corporation's Performance Standards and the Life Cycle Assessment.[48] Especially material compliance is crucial as Siemens Energy is sourcing plenty of materials and substances to manufacture and provide its products and services.[49] In numbers, Siemens Energy has a network of 30.000 suppliers in 140 countries with a procurement volume of 17.3 bn Euro.[50] To establish common commitments along the supply chain, all suppliers and third-party intermediaries of Siemens Energy have to sign a Supplier Code of Conduct which includes the following five aspects: "Human rights and labor practices, Environmental protection, Fair operating practices, Responsible minerals sourcing and Compliance with the Code of Conduct in the supply chain of the supplier".[51] Moreover, Siemens Energy is part of the steering committee of the Responsible Minerals Initiative (RMI), which provides responsible minerals assurance processes that are based on assessment programs on critical nodes in the supply network.[52] Therefore the commitment of Siemens Energy toward sustainability is underlined via its supplier assessment activities.[53] For example, 1.685 Corporate Responsibility Self-Assessments have been carried out in the fiscal year 2021, while 424 supplier quality audits and 157 external sustainability audits have been conducted.[54] Compared to the previous fiscal year the number of Corporate Responsibility Self-Assessments (23%), supplier quality audits (27%), and external sustainability audits (291%) have increased.[55] Furthermore, Siemens Energy collaborates with other companies which conducted external sustainability audits and provide the audit documentation to Siemens Energy.[56] In total 85 external sustainability audits have been accepted in 2021.[57] These efforts make the company a leader in the field of sustainability, as Siemens Energy is ranked number seven of 217 in its industry group by Sustainalytics.[58] Consequently, the company established a responsible mineral sourcing strategy with a focus to avoid the use of minerals that are affected by the risks mentioned in Annex II of the OECD DD Guid-

[48] See Siemens Energy AG (2022j, p. 47).
[49] See Siemens Energy AG (2022j, p. 49).
[50] See Siemens Energy AG (2022j, p. 51).
[51] See Siemens Energy AG (2022j, p. 51).
[52] See Siemens Energy AG (2022j, p. 54).
[53] See Siemens Energy AG (2022j, p. 52).
[54] See Siemens Energy AG (2022j, p. 52-53).
[55] See Siemens Energy AG (2022j, p. 52-53).
[56] See Siemens Energy AG (2022j, p. 53)
[57] See Siemens Energy AG (2022j, p. 53).
[58] See Systainalytics (2022).

ance in its supply chains (Chapter 2.2.5).[59] Hence, the OECD DD Guidance has been implemented for the 3TG and via mineral risk assessments, further minerals have been identified which require additional due diligence. Particularly cobalt is already integrated into the due diligence processes of Siemens Energy.[60] Another relevant mineral that requires further attention at Siemens Energy is copper, which is elaborated in chapter 2.3. Hence public interests and the interests of Siemens Energy regarding the establishment of responsible sourcing for copper are aligned, which makes Siemens Energy an ideal test environment for this thesis. Therefore, the problems regarding the responsible sourcing of copper and related laws are analyzed to develop a solution fitting the environment of Siemens Energy.

2 Problem, laws, solutions: responsible sourcing of copper and its supply chains

2.1 Responsible sourcing is required to manage sustainability in mineral supply chains

The concept of sustainability in the context of supply chain literature is focused on the Tripple Bottom Line perspective, which was developed by Elkington (1998).[61] The Tripple Bottom Line perspective illustrates a balanced approach that is recognized and aimed at a global scale and defines sustainability as the balance of people, planet, and profit.[62] Hence, it describes the harmony of social sustainability, environmental sustainability, and economical sustainability.[63] The people (social dimension) refers to the impact of an organization on society, while the planet (environmental dimension) is related to the impact of an organization on the ecosystems like water, air, or land.[64] The profit (economic dimension) is connected to the financial, and monetary impact of an organization itself and its environment (like a region or a country) and can be measured in the use of resources, sales, profit, and other economic variables.[65] Moreover, the Triple Bottom Line shows the revealing tensions and trade-offs among the three dimensions.[66] Only organizations that balance and

[59] See Siemens Energy AG (2022j, p. 54).
[60] See Siemens Energy AG (2022j, p. 54).
[61] See M. E. Silva and Figueiredo (2020, p. 4).
[62] See M. E. Silva and Figueiredo (2020, p. 4); Elkington (1998, p. 38).
[63] See Elkington (1998, p. 37).
[64] See Dalibozhko and Krakovetskaya (2018, p. 3).
[65] See Dalibozhko and Krakovetskaya (2018, p. 3).
[66] See McWilliams, Parhankangas, Coupet, Welch, and Barnum (2016, p. 195).

fulfill the requirements of the three dimensions are considered to be sustainable.[67] As the Triple Bottom Line suffers from practical orientation, the United Nations (UN) developed 17 Sustainable Development Goals.[68] The Sustainable Development Goals illustrate separate actions which support sustainability in a specific circumstance and establish therefore specific orientations on how sustainability can be achieved and maintained over time.[69] Nevertheless, it is impossible to establish sustainable mineral supply chains based on the Tripple Bottom Line, as the nature of mining and extracting resources of the earth will always put harm the environment.[70] Moreover, minerals can only be extracted once.[71] Therefore, the mining process puts harm to future generations as they cannot mine this resource again.[72] To close this gap responsible sourcing describes the management of the environmental, social, and economical sustainability aspects of the supply chain.[73] For the implementation, it is required to minimize sustainability threats at the lower tier suppliers, especially at the extraction stage.[74] Through the implementation of responsible sourcing, sustainability risks become visible, for the focal companies but also direct and indirect suppliers as well as third parties.[75] In the last decade, several frameworks and laws from governmental and non-governmental organizations have been launched.[76] These frameworks and laws differ mainly in the type of mineral they are made for, the considered requirements regarding social, environmental, and economic dimensions, the traceability scheme, and the focus on the certification or assurance process which can be based on mining, processing, and manufacturing.[77] Moreover, responsible sourcing is mainly implemented via a due diligence approach or a sustainability scheme approach.[78] The due diligence approach of the OECD DD Guidance and the "China Chamber of Commerce of Metals, Minerals & Chemicals Importers and Exporters" (CCCMCG) are the most common ones.[79] These due diligence guidances differ from each other as the OECD DD Guidance is an underlying standard for plenty of certification schemes and audits while it also underlines the CRM of

[67] See Hammer and Pivo (2017, p. 27).
[68] See M. E. Silva and Figueiredo (2020, p. 4).
[69] See M. E. Silva and Figueiredo (2020, p. 4).
[70] See Sauer and Seuring (2017, p. 235).
[71] See Peter (2015, p. 396).
[72] See Sauer and Seuring (2017, p. 235).
[73] See Van den Brink et al. (2019, p. 396).
[74] See Sauer and Seuring (2017, p. 247).
[75] See Van den Brink et al. (2019, p. 393).
[76] See Deberdt and Le Billon (2021, p. 2); Sancha, SJ, and Gimenez (2019, p. 459); Van den Brink et al. (2019, p. 396).
[77] See Van den Brink et al. (2019, p. 396).
[78] See Van den Brink et al. (2019, p. 395).
[79] See Mancini, Eslava, Traverso, and Mathieux (2021, p. 5).

the EU.[80] On the other hand, the CCCMCG consists of minimum standards and guidelines companies have to implement for identifying, preventing, and mitigating risks regarding direct or indirect human rights abuses.[81] Moreover, it includes minimum standards relating to the environmental dimension of sustainability.[82] Following the sustainability schemes approach, the social International Finance Corporation and Life Cycle Assessment achieved international relevance and are also considered by Siemens Energy.[83] The most recent laws regarding the extraction of minerals for western multinational enterprises have been mentioned in figure 1. In the following the DFA, CRM, SCDDA, Directive 2019/1937, and the OECD DD Guidance) are analyzed, as they are most relevant for multinational enterprises like Siemens Energy.

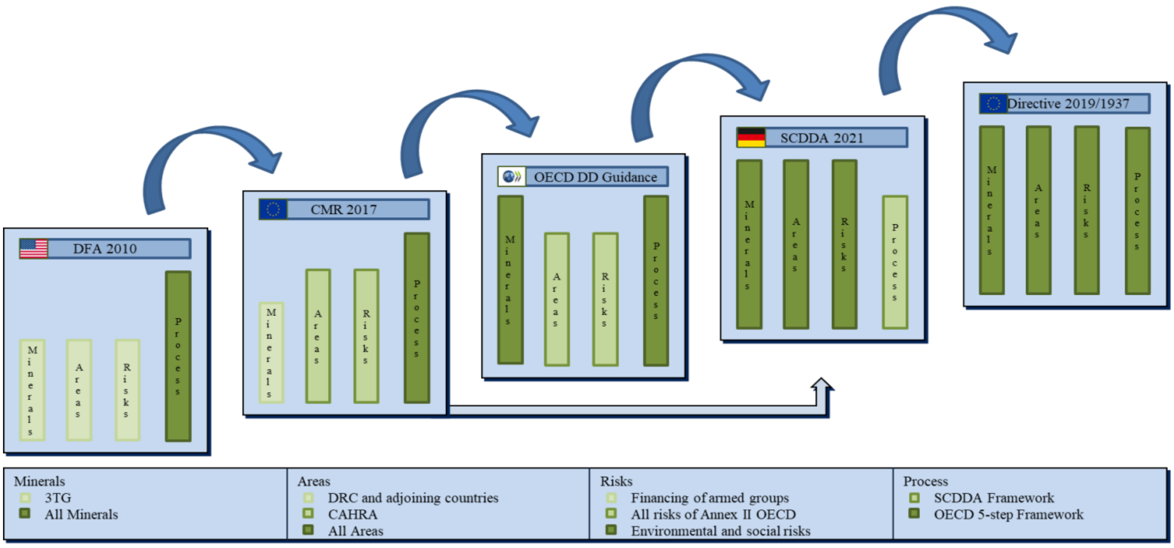
2.2 Mineral sourcing laws, supply chain due diligence laws and the OECD DD Guidance

2.2.1 OECD DD Guidance covers the mineral sourcing laws, while supply chain due diligence laws are not covered

The requirements inform of the DFA, CRM, SCDDA, and Directive 2019/1937, are compared to analyze if the OECD DD Guidance is a general solution to be in alignment with the laws. Therefore the laws and the OECD DD Guidance are compared in this section, while the laws and the OECD DD Guidance are elaborated in the following chapters 2.2.2-2.2.5.

[80] See Mancini et al. (2021, p. 5).
[81] See Mancini et al. (2021, p. 5).
[82] See Mancini et al. (2021, p. 5).
[83] See Mancini et al. (2021, p. 5); Siemens Energy AG (2022j, p. 47).

Figure 3: Development of legislation and international standard for responsible minerals sourcing and due diligence



Source based on: BMAS (2021, p. 1-10); European Commission (2022b, p. 1-67); European Commission (2017, p. 130-150); CFTC (2011, p. 838); OECD (2016, p. 17-19).

Figure 3 illustrates the development and the differences between the DFA, CMR, OECD DD Guidance, SCDDA, and the EU Proposal for a Directive of the European Parliament and the Council on Corporate Sustainability Due Diligence and amending EU Directive 2019/1937, (Directive 2019/1937) regarding the minerals, areas, risks, and processes. Beginning with the minerals, the DFA and the CMR are limited to specific minerals (Chapter 2.2.2), while the OECD DD Guidance, the SCDDA, and the Directive 2019/1937 are not limited to specific minerals (Chapter 2.2.3; 2.2.5.1). Considering the geographical restriction based on areas, the DFA is limited to a fixed region, while the CMR is geographically limited to a non-exclusive list that is regularly updated (Chapter 2.2.2). On the other hand, the OECD DD Guidance, the SCDDA, and the EU Directive 2019/1937 are not restricted to geographic scope (Chapter 2.2.3; 2.2.5.1). In the context of the considered risks, the DFA only focuses on the financing of armed groups, while the CMR and the OECD DD Guidance consider all risks related to Annex II of the OECD (Chapter 2.2.2; 2.2.5.1). The SCDDA and the Directive 2019/1937 integrate the sustainability scope inform of the three dimensions and consider therefore also the environmental dimension (Chapter 2.2.3). Especially the Directive 2019/1937 integrated seven conventions and the Paris agreement into the law (Chapter 2.2.3). The dimension of processes is based on the OECD Framework regarding the DFA, CMR, and the OECD DD Guidance and therefore includes the entire supply chain (Chapter 2.2.2; 2.2.5.1). The process of the Directive 2019/1937 is comparable as it considers also the entire supply chain including subsidiaries, and direct and indirect suppliers, while the SCDDA is more limited to first-tier suppliers and just requires counteractions by the focal firm in case the focal firm has fundamental knowledge about violations in the supply chain (Chapter 2.2.3). Moreover, Directive 2019/1937 is the only directive that considers civil liability for violations (Chapter 2.2.3). Contrary, the SCDDA, and the CMR follow also a risk-based approach without a duty of success, while The DFA follows a compliance-based approach (conflict-free declaration of products) (Chapter 2.2.2- 2.2.3). Overall, the OECD DD Guidance is the leading approach as it is not based on minerals, considering the entire supply chain, is already in action and considers all risks mentioned in Annex 2 (Chapter 2.2.5). To conclude, the main problems of mineral supply chains are covered by the OECD DD Guidance (Chapter 2.2.5). Furthermore, the OECD DD Guidance is based on a risk-based approach and controls therefore for unintended consequences like a de facto embargo of specific regions (Chapter 2.2.4-2.2.5). This approach is strengthened with recommended actions in Annex II, as just in case serious human rights abuses are investigated the business relations have to be stopped immediately, while other violations are recommended to solve with action plans to improve the situation for the local society (Chapter 2.2.5). As a result, multinational companies can align their sourcing activities with the OECD DD Guidance to fulfill the most recent laws and regulations regarding mineral sourcing (Chapter 2.2.2; 2.2.5). However, the laws regarding due diligence require next to the social dimension and also the consideration of the environmental dimension (Chapter 2.2.3). Moreover, the limitation to CAHRA is not valid, as the SCDDA and the Directive 2019/1937 require due diligence without geographical boundaries (Chapter 2.2.3), as also the risks are not solely related to these boundaries (Chapter 2.4.2.2). Furthermore, it remains unclear which areas are CAHRA. For example, the EU defines this geographical scope with a current but non-exclusive list of CAHRA.[84] The RMI describes CAHRA with a list of countries that show high or extreme risk.[85]

2.2.2 Mineral sourcing laws are restricted to regions, specific minerals, and human rights

The focus of the DFA and the CMR is the prevention of the mining of specific minerals that finances armed conflicts or systematically violate human rights.[86] The first law which holds downstream companies responsible for their suppliers along the supply chain was the

[84] See European Union (2022); Huber and Steininger (2022, p. 2); Koch and Burlyuk (2020, p. 1446).
[85] See RMI (2022i).
[86] See European Commission (2017, p. 5); Lukas Rüttinger (2016, p. 3).

DFA section 1502 enrolled in 2010 by the USA.[87] This law applies to all companies which are listed on the stock market of the USA and therefore it forced all companies which were operating with these companies to fulfill the DFA section 1502.[88] To elaborate on this, the companies which are directly affected by the DFA forced their suppliers to ensure that they also conformed with the DFA.[89] Moreover, the DFA is limited to the 3TG (conflict minerals) and to the region of DRC, which includes nine countries.[90] In case these conflict minerals are sourced from the region around the DRC the companies have to prove via a third-party report how due diligence is ensured in the supply chain.[91] Companies that are sourcing these minerals from these regions, have to declare their minerals as conflict-free by proofing the exact origin of the minerals and showing that the minerals are not involved in the financing of armed groups.[92] Next to the country of origin, the smelters, refiners, and other facilities are used to process the conflict minerals, as well as the efforts of the company to investigate the origin of the conflict mineral have to be integrated into the reporting.[93] This information has to be published[94] and the reporting standards are based on the first version of the OECD DD Guidance.[95] To conclude, the DFA follows a compliance-based approach with a name and shame mechanism to motivate companies to avoid suppliers affected by these risks.[96]

The EU enrolled regulation 2017/821 known as the CMR in 2017 which entered into force in 2021 and obligated enterprises in scope to establish the OECD DD Guidance.[97] Like the DFA it is limited to the 3TG and it is relevant for all companies importing conflict minerals into the EU in form of ores, processed metals, or concentrates.[98] Regarding risks the CMR targets to avoid the financing of armed groups along the supply chain like the DFA, but also all other risks according to the OECD DD Guidance Annex II (Chapter 2.2.5.1).[99]

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87 See Deberdt and Le Billon (2021, p. 1); S. Silva and Schaltegger (2019, p. 174).
88 See CFTC (2011, p. 838).
89 See Hofmann et al. (2018, p. 116).
90 See CFTC (2011, p. 838).
91 See CFTC (2011, p. 539); El Baz, Jebli, Temidayo, and Cherrafi (2020, p. 722); S. Silva and Schaltegger (2019, p. 161) .
92 See Deberdt and Le Billon (2021, p. 7);El Baz et al. (2020, p. 722); Hofmann et al. (2018, p. 116); S. Silva and Schaltegger (2019, p. 159).
93 See Sankara, Patten, and Lindberg (2019, p. 212).
94 See Schwartz (2016, p. 135).
95 See Schwartz (2016, p. 149).
96 See Koch and Burlyuk (2020, p. 1446); Schwartz (2016, p. 132).
97 See Europäisches Parlament (2017, p. 1); Van den Brink et al. (2019, p. 396).
98 See European Commission (2017, p. 1); RMI (2020, p. 1); S. Silva and Schaltegger (2019, p. 158); Van den Brink et al. (2019, p. 389).
99 See European Commission (2017, p. 130).

Furthermore, the CMR is geographically limited to CAHRA.[100] According to the requirements of reporting, the importer has to provide the information regarding the description of the mineral, trade name and type, address and name of the supplier, country of origin, exploitation data and rates as well as the name and address of the smelters and refineries.[101] In case the importer imports conflict minerals from the CAHRA, additional information regarding the mineral trading and process place are required.[102] All in all the CMR follows a risk-based approach without a duty of success, as the EU companies have to prove that due diligence based on the OECD DD Guidance is implemented and reported.[103]

2.2.3 Due Diligence laws broaden the scope of sustainability and liability

In 2021, Germany enrolled the SCDDA which accounts for companies with more than 3000 employees in Germany from 2023 on, while the number of employees is lowered to 1000 by 2024.[104] The due diligence follows a risk-based approach without a duty of success.[105] The subjective matter of the SCDDA is the protection of human rights, a direct violation of human rights, or as indirect violations of human rights from environmental harm based on international law conventions, while 11 conventions are related to human rights and three to the environment.[106] The human rights risks include serious human rights abuses (like child labor, forced labor, slavery, etc) and are elaborated with the risks of discrimination, disregard for occupational health and safety, withholding of an adequate wage, the cause of harmful soil, water or air pollution, noise emission, or excessive consumption of water, which harm the natural basis for the preservation and production of food, and the unlawful deprivation of vital land.[107] The law expects focal companies to monitor the whole supply with a focus in form of risk assessment and evaluation of its direct suppliers, while actions for lower-tier (indirect) suppliers are required only if the focal firm has fundamental knowledge about violations.[108] The SCDDA requires the establish-

[100] See Deberdt and Le Billon (2021, p. 7); S. Silva and Schaltegger (2019, p. 158); Van den Brink et al. (2019, p. 389).
[101] See Huber and Steininger (2022, p. 4); European Commission (2017, p. 8).
[102] See Huber and Steininger (2022, p. 4); European Commission (2017, p. 8).
[103] See European Commission (2017, p. 9); Koch and Burlyuk (2020, p. 1446); RMI (2020, p. 1).
[104] See BMAS (2021, p. 1).
[105] See Deloitte (2021a, p. 6); Heinen (2021, p.158); Schöbel and Hellwing (2021, p. 5).
[106] See BMAS (2021, p. 2-5).
[107] See Deloitte (2021a, p. 6); Heinen (2021, p.158); Schöbel and Hellwing (2021, p. 5); Siemens Energy AG (2020a, p. 6).
[108] See Heinen (2021, p. 159).

ment of due diligence based on a risk management system, a risk analysis, a policy statement including the human rights strategy, and communication with its employees, direct suppliers, and the public. Furthermore, an establishment of preventative measures, remedial actions, an internal complaints procedure, and continuous reporting and documentation based on section 10 of the SCDDA are required as well.[109] For violations of this requested due diligence process monetary fines between 100,000-800,000 Euros based on the net turnover will be executed, while companies with a global net turnover of more than 400 mn Euros will be punished with two percent of the global net turnover.[110] Furthermore, administrative punishments are possible in the form of exclusion from public tenders for up to three years.[111]

The Directive 2019/1937 accounts for three groups of companies (a-c). Group a consists of companies with an EU legislative, with 500 employees or more and a net turnover of 150 mn Euro worldwide,[112] group b considers companies with an EU legislative that have more than 250 employees with a net turnover of 250 mn Euros and generated a net turnover of at least 50% in specific sectors on a global scale.[113] These sectors are defined as the textile sector and its related products including production and trading, agriculture, forestry, fishery, aquaculture, food and beverage products and their raw materials, and the mineral sector, and its related products including processing and trading.[114] Group c considers companies have to fulfill the criteria of groups a or b while they are operating in the EU and have legislation of a third country.[115] Companies of groups a and c have two years for implementation, while group b has four years.[116] The subjective matter of the Directive 2019/1937 are human rights and environmental protection based on International law conventions, while 22 conventions are related to human rights and seven to the environment.[117] Regarding the scope of the supply chain, Directive 2019/1937 targets all business operations connected to the up and downstream supply chain while due diligence is required for all subsidiaries, and direct and indirect suppliers.[118] Articles four to 26 consider

[109] See BMAS (2021, p. 6); Deloitte (2021b, p. 2); Heinen (2021, p. 159-160); Konrad Adenauer Stiftung (2021, p. 21).
[110] See BMAS (2021, p. 17-19).
[111] See BMAS (2021, p. 16).
[112] See European Commission (2022b, p. 46).
[113] See European Commission (2022b, p. 46).
[114] See European Commission (2022b, p. 46-47).
[115] See European Commission (2022b, p. 47).
[116] See European Commission (2022b, p. 68).
[117] See European Commission (2022a, p. 1-7); European Commission (2022b, p. 46).
[118] See European Commission (2022b, p. 47-53).

the due diligence responsibilities of the companies which are an integration of due diligence in the companies policies, identification, prevention, and mitigation of actual and potential adverse impacts, an establishment of a complaints procedure along the supply chain, monitoring and actions to ensure the effectiveness of the due diligence policy and communication of the due diligence practices.[119] Moreover, with article 15, the company of group a and group c have to ensure that the business model and strategy are aligned with the Paris Agreement to limit global warming to 1.5 degrees, while the duty of care holds the top management accountable.[120] For violations of the due diligence on a direct level civil liability is proposed which only accounts for subsidiaries and indirect suppliers in case of expected or obvious violations.[121] The exact requirements of the SCDDA and the Directive 2019/1937 are listed in Appendix A2. To conclude, both regulations are not related to specific minerals or regional limitations.

2.2.4 Responsible sourcing of minerals is required beyond mineral and regional limitations

The DFA, CMR, and the OECD DD Guidance refer to the responsible sourcing of conflict minerals, which are defined by the CMR as minerals that have their origin in CAHRA, while their extraction, processing, or trade is related to human rights abuses or the financing of armed groups.[122] The definition of the DFA is similar while CAHRA is replaced by the DRC and the adjoining countries, which makes the DFA geographically more limited.[123] The considered literature follows mainly the definition of the EU, while some authors do not refer to a specific geographical restriction.[124] Especially the 3TG are considered as conflict minerals.[125] Most violations occur at the mining stage in the supply chain of these minerals, where the main problem is modern slavery.[126] Other violations are child labor, the poorest working conditions combined with heavy metal toxicity and radiological risks, financing of armed groups, conflicts between mining companies and

[119] See European Commission (2022b, p. 53-59).
[120] See European Commission (2022b, p. 53-63); European Commission (2022a).
[121] See European Commission (2022b, p. 65).
[122] See European Commission (2022c, p. 2).
[123] See CFTC (2011, p. 838).
[124] See Deberdt and Le Billon (2021, p. 1); Hofmann et al. (2018, p. 121); Sancha et al. (2019, p. 458).
[125] See Deberdt and Le Billon (2021, p. 1); El Baz et al. (2020, p. 722); Hofmann et al. (2018, p. 121); Huber and Steininger (2022, p. 1); Sancha et al. (2019, p. 458); S. Silva and Schaltegger (2019, p. 158);
[126] See Christ, Burritt, and Schaltegger (2020, p. 1491).

locals, exploitation, extortion, personal enrichment, and resettlement.[127] Especially the poor working conditions in combination with the health-related risks cause cytotoxicity, pulmonary embolisms, hard metal lung disease, birth defects, asthma, slurred speech, confusion, and liver defects.[128] Moreover, the regions are characterized by poor governance, political instability, corruption, and fragile states.[129] The supply chains of these minerals are typically characterized as long, geographically dispersed, and involving multiple agents.[130] This makes it difficult for the focal firm to prevent such problems as the procurement market is non-transparent due to these complexities.[131] Moreover, the problem of minerals supply chains is entrenched in the fact that minerals from different sources are mixed in the next stage of production which raises the complexity to trace the origin of a single specific mineral and that companies are able to abuse human rights while they are not sanctioned by third parties.[132] As the problem is mainly connected to the supply chain, industry, and regional characteristics it becomes visible that the geographical restrictions towards DRC and the neighboring countries do not help, while the EU list of CAHRA is updated but does not include all regions which suffer from these problems.[133] Developing countries with low environmental and social regulations and low enforcement possibilities of regulations are threatened by these risks.[134] Other authors named other specific regions like Ghana, Bangladesh, Myanmar, Sierra Leone, the Ivory Coast, North Korea, Peru, Eritrea, Angola, Pakistan, Bolivia, India, and Zambia.[135] Moreover, these problems are not only related to the 3TG, as other natural resources are treated from these risks as well, like mica, cobalt, copper, nickel, tellurium, oil, gas, lithium, and rare earth elements.[136] Some of these minerals are already listed as critical minerals, while others like copper are not (Chapter 1.2). Therefore it is crucial to consider responsible sourcing be-

[127] See BGR (2020, p. 14); Christ et al. (2020, p. 1482); Govindan et al. (2021, p. 11); Hofmann et al. (2018, p. 119); Huber and Steininger (2022, p. 2); Mancini et al. (2021, p. 2); Sancha et al. (2019, p. 458); Sauer and Seuring (2019, p. 36); S. Silva and Schaltegger (2019, p. 168).
[128] See Huber and Steininger (2022, p. 2)
[129] See Hofmann et al. (2018, p. 119); Huber and Steininger (2022, p. 2); Sauer and Seuring (2019, p. 36).
[130] See Sancha et al. (2019, p. 459).
[131] See Sauer (2021, p. 1); Sauer and Seuring (2018, p. 560); S. Silva and Schaltegger (2019, p. 159).
[132] See Hofmann et al. (2018, p. 116).
[133] See European Union (2022); Hofmann et al. (2018, p. 119) Koch and Burlyuk (2020, p. 1457); S. Silva and Schaltegger (2019, p. 174).
[134] See Sancha et al. (2019, p. 460).
[135] See BGR (2020, p. 12); Christ et al. (2020, p. 1491); Deberdt and Le Billon (2021, p. 4); S. Silva and Schaltegger (2019, p. 174).
[136] See Deberdt and Le Billon (2021, p. 3); Hofmann et al. (2018, p. 119); Huber and Steininger (2022, p. 2); Lukas Rüttinger (2016, p. 15); Van den Brink et al. (2019, p. 396).

yond conflict and critical minerals and fixed geographical regions.[137] The difficulty of this topic can be observed in the diamond supply chain. The increasing concerns about the linkage between mineral extraction, human rights abuses, and conflict received attraction in 1990 and lead to the result that the diamond supply chain is monitored via the Kimberley Process Certification Scheme, which certifies diamonds as conflict-free.[138] However, the image of this system suffers as it still does not manage to break the linkages between diamonds, violence, and other human rights abuses.[139] Another example is the DFA which also follows a compliance-based approach (Chapter 2.2.2). This approach caused regional problems in DRC and its neighboring countries, as plenty of companies started to avoid sourcing 3TG from this region.[140] Hence, the USA created a kind of embargo against the region as an unexpected side effect, which had negative effects on the local society, like a lower level of employment.[141] Especially DRC suffered as the artisanal mining sector employs around two mn people (20% of the working society) and is the largest source of economic development.[142] An evaluation of the CMR on possible side effects is not available yet, as it entered into force in 2021.[143] Hence it is important to learn from existing laws, best practices, and frameworks while establishing responsible sourcing on a corporate level to avoid adverse effects. To conclude, the best practices of companies that implemented the OCED DD Guidance and the guidance itself are reviewed.

2.2.5 General solution: OECD DD Guidance, its limitations, and best practices

2.2.5.1 OECD DD Guidance: lack of environmental dimension and geographical restriction

The OECD published the third version of the Due Diligence Guidance for Responsible Supply Chains of Minerals from CAHRA in 2016, which was integrated into several laws like the CMR.[144] The OECD DD Guidance has the objective to support companies to es-

[137] See S. Silva and Schaltegger (2019, p. 174).
[138] See Van den Brink et al. (2019, 394).
[139] See Howard (2016, p. 138).
[140] See Koch and Burlyuk (2020, p. 1457).
[141] See Lukas Rüttinger (2016, p. 11); Mancini et al. (2021, p. 2).
[142] See Lukas Rüttinger (2016, p. 11); Mancini et al. (2021, p. 2).
[143] See Koch and Burlyuk (2020, p. 1459).
[144] See Hanai (2021, p. 2).

tablish human rights and avoiding to support conflict and insecurity by sourcing minerals as well as establishing transparency in the mineral supply chain.[145] The previous versions were limited to the 3TG, while the third and current version provides a due diligence basis for all minerals.[146] Moreover, the guideline applies to all companies which are using or providing minerals from CAHRA.[147] The OECD DD Guidance consists of a five-step framework for risk-based due diligence in the mineral supply chain, while Annex II provides a model supply chain policy for CAHRA, and Annex III suggests measures and indicators to mitigate risks and measure advancements, as well as possible partners for collaboration are mentioned.[148] The framework suggests the following five steps for the implementation:

1. Strong management system: requires leadership, clear organizational roles including responsibilities and accountabilities, reporting, resources management, evaluation, improvement, grievance mechanism, a possibility for supplier engagement, as well as a system to establish control and transparency in the supply chain.[149]

2. The identification and risk assessment requires the collection of supplier information to do a red flag identification and a risk assessment aligned with Annex II.[150] These risks are grouped into three categories, while the first category consists of serious abuses in relation to the trade, transport, or extraction of minerals, like all forms of cruel, torture, degrading treatment, inhuman treatment, forced labor, compulsory labor, worst forms of child labor, war crimes, sexual violence, violations of international humanitarian law, genocide, crimes against humanity and other human rights violations.[151] The second group integrates risks like the direct or indirect support of armed groups, like state or non-state armed groups, private security forces, public security forces, and private security forces.[152] The last group contains risks like bribery, fraudulent misrepresentation of information regarding the origin of minerals, money laundering, and the payment of taxes, royalties, or fees to governments.[153]

3. The designing and implementing of a strategy to respond to the identified risks is based on a report to the senior management. Next, a risk management plan is developed which

[145] See OECD (2016, p. 4); RMI (2022g, p. 7).
[146] See OECD (2016, p. 4).
[147] See OECD (2016, p. 15).
[148] See OECD (2016, p. 5); OECD (2016, p. 25-29).
[149] SeeOECD (2016, p. 17).
[150] See OECD (2016, p. 18).
[151] See OECD (2016, p. 20-21).
[152] See OECD (2016, p. 21-23).
[153] See OECD (2016, p. 23-24).

includes the option to continue trade or temporarily suspend trade during the risk mitigation. The last step is disengagement with the supplier in case no acceptable risk mitigation is established. The risk management plan also includes continuous performance tracking as well as collaboration in diverse forms with local and central governments, upstream companies, civil society organizations, and other related third parties to respond to the identified risks.[154]

4. The independent third-party audit at the identified points of the supply chain requires that an independent third-party auditor evaluates the supply chain based on the established due diligence practices at the identified critical points, as it is impossible to audit the entire supply chain.[155]

5. The report on supply chain due diligence has to be published regularly and include the supply chain due diligence practices and policies.[156]

The risks referred to in Annex II include any forms of serious human rights violations like torture, inhuman, cruel, degrading treatment, any forms of forced or compulsory labor, the worst forms of child labor, and gross human rights abuses and violations and abuses like sexual violence, war crimes and other serious violations of the international humanitarian law, and crimes against genocide or humanity. Moreover, the direct or indirect support (for example via illegal tax or extortion along the supply chain) of non-state armed groups is also included in Annex II and violations will be handled via an immediate suspension and disengagement of upstream suppliers which also accounts for the serious human rights violations.[157] Public and private security forces should be eliminated and just be accepted to maintain current laws and enforce human rights and safeguard the supply chain. Furthermore, voluntary principles on security and human rights have to be followed as well as the engagement of central and local authorities, international organizations, and civil society have to be engaged to improve the accountability and transparency of payments towards public security forces. The same accounts for the exposure of vulnerable groups like artisanal miners and small-scale mining. Furthermore, bribery, money laundering, and any form of fraudulent misrepresentation of the origin of minerals like a misrepresentation of taxes, fees, and royalties are prohibited. Moreover, payments to governments have to be disclosed following the principles of Extractive Industry Transparency. In case these rules

[154] See OECD (2016, p. 18).
[155] See OECD (2016, p. 19).
[156] See OECD (2016, p. 19).
[157] See OECD (2016, p. 20-22).

are violated the measurable steps have to be implemented and tracked for mitigation. If no reasonable advancements are made after a legitimate timescale a suspension and disengagement of upstream suppliers are intended.[158]

2.2.5.2 Best practice of downstream actors: collaboration, risk identification and assessment

Several multinational enterprises have established supply chain due diligence with the OECD DD Guidance. The European Partnership for Responsible Minerals (EPRM) disclosed the due diligence experiences of 11 companies that operate across various industries and downstream supply chain stages, which allow deriving meaningful best practices. Intel is a downstream company based in the chip industry while it focuses on step 1 of the OECD DD Guidance (implementation of a management system).[159] To elaborate on it, Intel reduced the complexity of its supply chain as it identified its smelters and refiners while it enrolled a responsible supply chain policy and publicized its due diligence expectations.[160] Lebrusan Studio act in the jeweler industry implemented a strong management system to source responsible and directly from artisanal and small scale mining suppliers.[161] Moreover, Lebrusan Studio explained its motivations and focussed on current gaps in the sourcing practices as well as entrenched its due diligence expectations into the suppliers contracts.[162] Makal operates in the same industry and implemented a comparable approach.[163] Another multinational enterprise based in the electronic industry focussed on step 2 (identification and risk assessment), as the multinational enterprise started to strengthen its direct supplier due to due diligence practices.[164] Moreover, the suppliers have been motivated by explaining the importance of implementing due diligence beyond legal compliance, hence the suppliers improved the due diligence in their supply chain.[165] Additionally, the multinational enterprise engaged itself directly on the smelter level to increase transparency.[166] Philips a technological company struggled with the same problem

[158] See OECD (2016, p. 22-24).
[159] See EPRM (2020d, p. 1).
[160] See EPRM (2020d, p. 1).
[161] See EPRM (2020e, p. 1).
[162] See EPRM (2020e, p. 1).
[163] See EPRM (2022a, p. 1).
[164] See EPRM (2020g, p. 1).
[165] See EPRM (2020g, p. 1).
[166] See EPRM (2020g, p. 1).

of a horizontal and vertical complex supply chain and concentrated on the identification of smelters and refiners to reduce the complexity.[167] Another best practice of step 2 is presented by BMW (Bayerische Motoren Werke Aktiengesellschaft) which is a car manufacturer that started to prioritize its raw materials based on risks to be able to mitigate risks at highly affected minerals at first. [168] Moreover, with several partners and peers, BMW entrenched due diligence obligations in its procurement process to increase transparency in its supply chain.[169] NXP Semiconductors N.V. is a semiconductor producer focused on engagement with suppliers, other manufacturers, and business associations to create awareness and pressure for due diligence.[170] A challenge was that suppliers were bought by other companies which made it crucial to review the supply chain at all times.[171] Philips is a provider of technological solutions focused on the development of industry standards via multi-stakeholder initiatives.[172] Therefore Philipps was able to build a critical mass of companies that have adopted these standards.[173] As a result, Philips was able to drive significant changes in the production and processing of gold.[174] Signify is a provider of lighting products and developed a risk analysis process by analyzing the material bill to identify which products are threatened by risks. Next, commodity groups are categorized by risks. In the case of external production, this process is outsourced to suppliers.[175] Fairphone is a mobile manufacturer and focuses on step 3 (designing and implementing a strategy) as it collaborates with NGOs, other downstream companies, suppliers, and governmental institutions to strengthen its position along the supply chain.[176] Parallel minerals are prioritized based on Fairphones power in the supply chain and prioritize the risk mitigation where they have the highest influence.[177] Apple Inc. focuses on step five (reporting), as it reports on all five steps and discloses for example a list of direct suppliers which contains 98% of its total purchasing volume.[178] Moreover, Apple Inc. reports and publishes specific risks in its supply chain and is establishing transparency.[179]

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[167] See EPRM (2020h, p. 1).
[168] See EPRM (2020b, p. 1).
[169] See EPRM (2020b, p. 2).
[170] See EPRM (2020f, p. 1).
[171] See EPRM (2020f, p. 1).
[172] See EPRM (2022b, p. 1).
[173] See EPRM (2022b, p. 1).
[174] See EPRM (2022b, p. 1).
[175] See EPRM (2022c, p. 1).
[176] See EPRM (2020c, p. 1).
[177] See EPRM (2020c, p. 1).
[178] See EPRM (2020a, p. 1).
[179] See EPRM (2020a, p. 1).

By comparing the best practices of downstream companies it can be concluded that downstream companies focus on smelters and refiners to close the supply chain and create visibility. Additionally, they tend to use power to motivate suppliers to cooperate concerning due diligence. Only a minority focussed on the explanation of their own motivation and behavior to motivate upstream suppliers to participate in the due diligence practices. Regarding the focus on steps, it can be concluded that downstream companies prioritize step 2 when they implement the OECD DD Guidance (6 out of 11 companies). Step 1 was implemented by one downstream company and two jewelers which have a less complex supply chain. Steps 3 and 4 are only mentioned by one downstream company mentioned as a key for the integration of the OECD DD Guidance. Collaboration practices are used by all downstream companies.

2.3 Copper is a relevant mineral for due diligence at Siemens Energy

The Siemens Energy risk assessment for specific minerals visualizes the relation of external risk data and the purchasing volume in a matrix that visualizes that the establishment of responsible sourcing for plenty of minerals is highly required.

Figure 4: Risk assessment of minerals at Siemens Energy 2021

The figure is hidden for confidential reasons.
Source: Siemens Energy AG (2020b, p. 4).

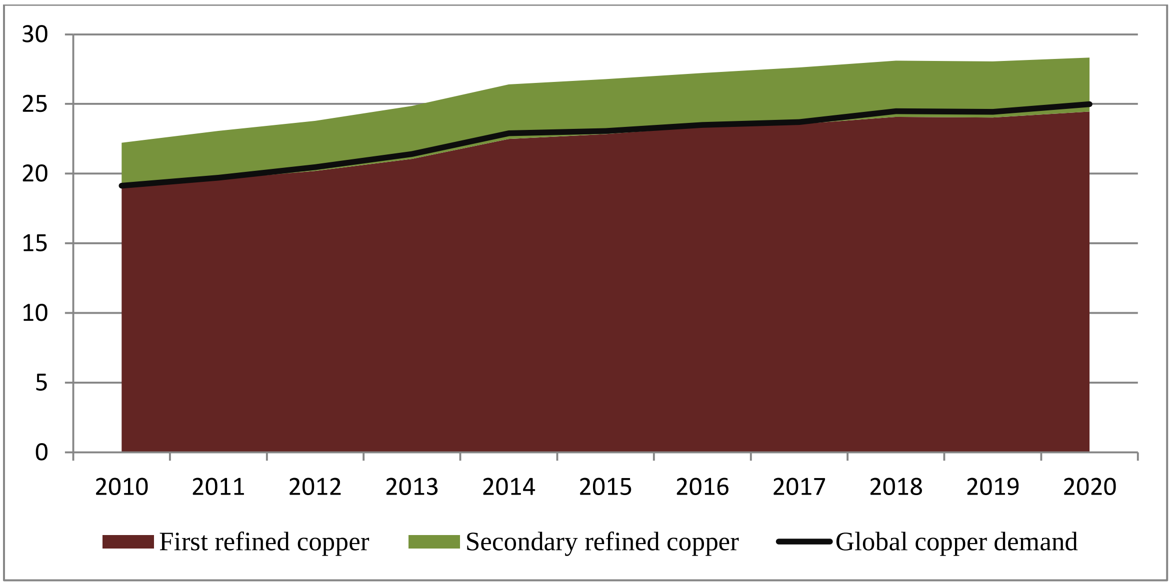
Figure 4 visualizes the risk assessment of minerals by Siemens Energy. The external rating considers the origin of minerals on a country level. This country is then evaluated by different indexes like the Rule of Law Index (30%), World Governance Indicators (30%), Corruption Perception Index (20%), TIP Reporting Index (10%), and the Conflict Barometer Index (10%). These indexes are weighted (value in brackets) and consider several risks like human rights violations, public perception, prices, corruption, money laundering, financing of armed groups, political stability, as well as the country being on a sanction list by the UN or the Office of Foreign Assets Control. Therefore a risk value between 0 and 100 is identified per mineral which is presented on the y-axis. (Text hidden for a confidential reason). Moreover, the purchasing volume of copper is expected to increase in the future due to the sustainability trend combined with the difficulty to substitute copper (Chapter 1.1-1.2) The Responsible Minerals Initiative (RMI) confirmed that copper has a very high functional criticality for the automotive and electronic industry, while it is especially associated with conflicts with indigenous people, acid discharge to the environment, hazardous and radioactive chemicals, and materials.[180] Hence, the copper supply chain is reviewed to identify the sources, risks, and possible chokepoints.

2.4 Copper supply chain: sources, risks, and chokepoints

2.4.1 Lower supply chain stages: role of CAHRA decrease, while the role of high-risk affected countries increases

The violations of responsible sourcing are connected to supply chain, industry, and regional characteristics (Chapter 2.2.4). Hence the global copper market has to be reviewed regarding the availability of copper as well as the regional allocation of copper resources, mining, and production.

Figure 5: Global demand and supply of refined and secondary refined copper between 2010 and 2020 in mn mt



Source based on: Statista (2022f); Statista (2022h); Statista (2022p).

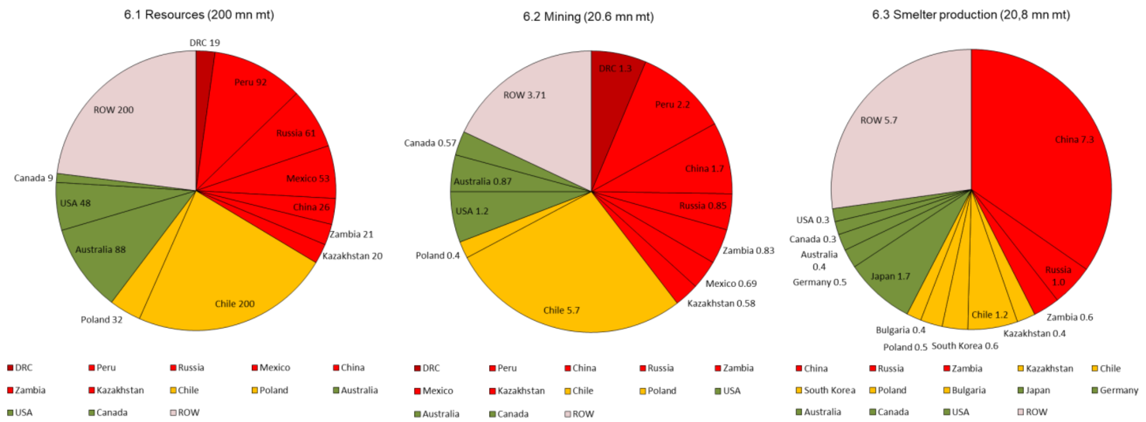
Figure 5 shows a growing production of first refined copper (copper refined from ore) between 2010 and 2020, while it has increased from 18.9 mn mt to 24.5 mn mt. The amount of secondary refined copper is fluctuating around 17% of the total copper production. Moreover, 3.2 mn mt of copper was secondary refined in 2010, while the amount increased

[180] See RMI (2018, p. 18-19).

to 3.8 mn mt of secondary refined copper in 2020. Secondary refined copper refers to copper production without ores from mining and can be considered recycled copper.[181]

In terms of demand, the global demand for copper has increased from 19.1 mn mt in 2010 to 24.9 mn mt in 2020, which is a rise of 30,6%. Furthermore, figure 3 illustrates an excess of supply fluctuating around 13,5 %. This excess of supply stems from the secondary refined copper, as the first refined copper fulfills the demand. The demand for copper is expected to increase dramatically (Chapter 1.2). This makes it necessary to review next to the current production facilities by country, also the resources of copper by country, as these could play a significant role in the future. The countries are important, as the violation of responsible sourcing is related to developing countries with low environmental and social regulations and weak enforcement possibilities of regulations (Chapter 2.2.4).

Figure 6: Global copper reserves, mine and smelter production by country and risk group in mn mt in 2020



Source based on: Source European Union (2022); RMI (2022i); Statista (2021); Statista (2022x); Statista (2022g).

Figure 6 visualizes the global copper reserves, mine, and smelter production in mn mt by country in 2020. As the list of the EU is non-exclusive, the RMI provides a more exclusive list that marks countries based on low, medium, high, and extreme risks which are shown in the legend behind the name of each country. For example, the EU only mentions the DRC and Mexico as CAHRA from the considered countries. In figure 6, CAHRA are countries that show an extreme risk (marked in dark red) or an high risk (marked in red) identified by the RMI. Medium risk countries are marked in yellow and low risk countries in green. Figure 6.1 visualizes that Chile owns 200 mn mt of copper reserves, which makes

[181] See BGR (2020, p. 7); Fuentes et al. (2021, p. 2); ICGS (2021, p. 10).

up for 23% of the global copper reserves, followed by Peru (11%) and Australia (10%). In total the copper reserves account for 869 mn mt in 2020, while the total resources (identified and undiscovered) are estimated at 5,600 mn mt (ICGS, 2021, p. 6). Compared to the forecast of copper reserves of the Club of Rome (308 mn mt Chapter1.2) the real copper reserves are 1818% higher. The CAHRA based on the list of the EU is marked in red and provides 72 mn mt of copper, while Mexico accounts for 6% and DRC for 2% of the global copper reserves. Therefore it becomes visible that 42% of the global copper reserves are based in countries with an extreme or high-risk classification by the RMI, while the category "rest of the world (ROW)" is not considered. Figure 6.2 reports that 20.6 mn mt of copper have been extracted in 2020, while Chile made up 28% of the copper mine production, followed by Peru (11%) and China (8%). The CAHRA are marked in red and provide 2 mn mt of mined copper, while DRC accounts for 3% and Mexico for 6% of the worldwide mined copper. In 2020, the global copper mine production accounts for 20.6 mn mt, while the mines offered a capacity of 24.8 mn mt which shows a rate of utilization of 83%.[182] Considering the RMI risk classification, 48% of the global copper mine production has its origin in countries with an extreme or high-risk classification, while the category resource-based view is not considered.

Figure 6.3 shows that China is the largest copper smelter producer in the world with an outcome of 7.3 mn mt in 2020. This accounts for 35% of the global copper smelter production, while the second-largest producer is Japan with 8%, followed by Chile with 6%. The CAHRA do not play a crucial role in copper smelter production. Considering the RMI risk classification, 61% of the global copper smelter production has its origin in countries with a high-risk classification, while the category rest of the world (ROW) is not considered. To conclude, the resources are primarily located in low and medium risk areas, while the role of CAHRA increases during the mining stage. Furthermore, the higher value-added steps are located in more developed countries like China or Japan. Chile for example owns the most resources (28%) and is leading in copper mine production (23%), while it just produces 6% of the global copper smelters outcome. This makes Chile the largest exporter of copper ores and concentrates followed by Peru and Mexico, while the major importers are China, Japan, and the Korean Republic.[183] However, by comparing the country risk and the copper stages based on the RMI risk classification, it becomes visible that the different

[182] See ICGS (2021, p. 6).
[183] See ICGS (2021, p. 29).

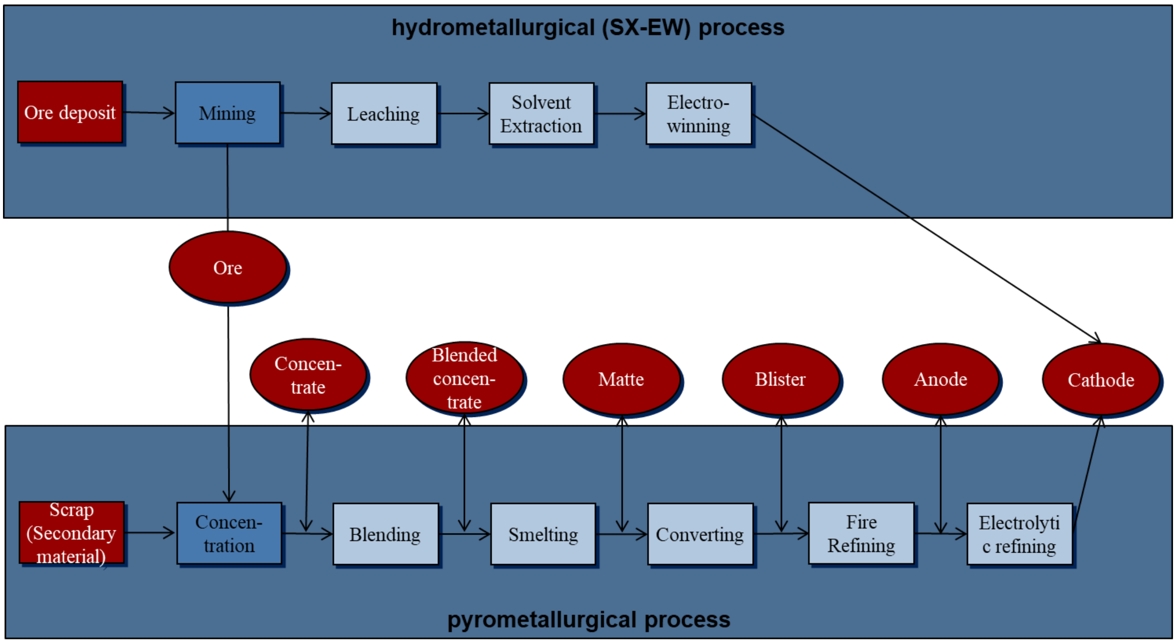
copper production stages are related to high risk countries through the entire upstream supply chain. Moreover, the amount of copper processed in CAHRA increases with higher production stages. This effect is mainly based on China, which plays a key role in copper production and has limited reserves while it is classified as a high-risk country. This confirms that responsible sourcing is required beyond geographical limitations (Chapter 2.2.4).

2.4.2 Upstream supply chain differs: transformation process and risks

2.4.2.1 Copper transformation processes differ in ownership and risks

The copper supply chain differs between the divergent copper production methods.[184] The copper ore is transformed in the upstream supply chain stages into the copper end product.[185] This end product is named copper cathode and consists of pure copper (99.99%).[186] Copper can be transformed in two forms, the hydrometallurgical process, and the pyrometallurgical process, which is shown in figure 7.

Figure 7: Copper transformation via hydrometallurgical process and the pyrometallurgical process



Source based on: Bonnet, Seck, Hache, Simoen, and Carcanague (2019, p. 9); Copper Alliance (2022, p. 2); Copper Mark (2022d, p. 52); Hanni and Podestá (2019, p. 93); (ICGS, 2021, p. 56-57).

[184] See Copper Alliance (2022, p. 2); Copper Mark (2022d, p. 52); ICGS (2021, p. 56-57).
[185] See EPRM (2022e).
[186] See Copper Mark (2022d, p. 51).

Figure 7 visualizes the copper transformation from the copper ore to the copper end product, the copper cathode. The upper part shows the hydrometallurgical process, while the lower part illustrates the pyrometallurgical process. The hydrometallurgical process use oxide ores as a basis and is vertically integrated.[187] Hence, the oxide ores are processed via leaching, solvent extraction, and electrowinning into a copper cathode.[188] The processing facilities are attached to the mine site and operated by the same owner.[189] This kind of production accounts for 15% of global copper production.[190] As every part of the transformation is located at one facility operated by one company the copper is only transported between sides and then traded on local and global markets.[191]

The lower part of figure 7 explains the pyrometallurgical process. In this process sulfide ores and copper scrap are used and 85% of the global copper production is produced via this process.[192] Firstly the ores are crushed and grounded.[193] Then, the scrap and the copper ore are mixed and transformed into copper concentrate, which contains 30% of pure copper.[194] In the following, the concentrate is blended and smelted and a copper matte is produced.[195] The copper matte is then converted to a blister.[196] These steps can be vertically integrated and are usually executed at one location by a smelter.[197] In the next step, the blister is via fire transformed into an anode and electrolytic refining is used to transform the anode into a cathode.[198] The pyrometallurgical process can be vertically integrated, partly integrated, or non-integrated which means that the single stages in the production can be located at one or different locations, and the companies can have different owners.[199] Moreover, interstage products like concentrate, matte, blister, and anode are traded between companies and transported between different locations and countries.[200] To conclude, in this process of copper transformation various actors can be included, and therefore it is more likely that violations of risks according to Annex II of the OECD Guidance,

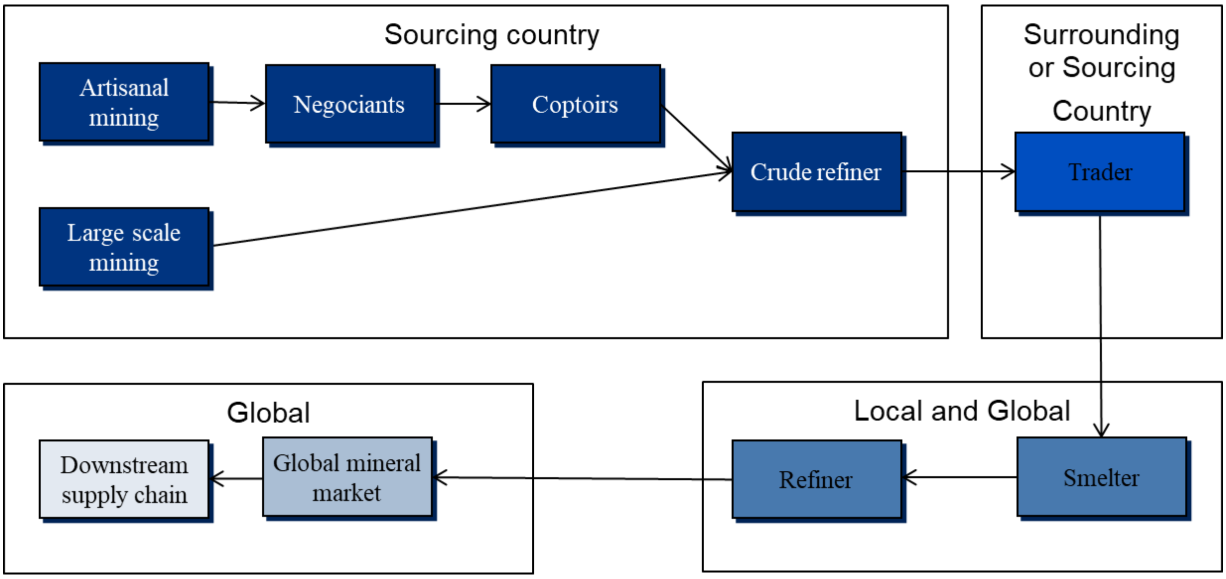
[187] See Copper Mark (2022d, p. 52).
[188] See Wincewicz-Bosy, Dymyt, and Wasowska (2021, p. 210-211).
[189] See Copper Mark (2022d, p. 52).
[190] See Copper Mark (2022d, p. 51).
[191] See Copper Mark (2022d, p. 51).
[192] See Copper Mark (2022d, p. 52).
[193] See Hanni and Podestá (2019, p. 93).
[194] See Copper Mark (2022d, p. 53).
[195] See Hanni and Podestá (2019, p. 93).
[196] See Copper Mark (2022d, p. 53).
[197] See Hanni and Podestá (2019, p. 93).
[198] See Bonnet et al. (2019, p. 11); Wincewicz-Bosy et al. (2021, p. 210-211).
[199] See Copper Mark (2022d, p. 52).
[200] See Bonnet et al. (2019, p. 11); Copper Alliance (2022, p. 2).

CMR, DFA, SCDDA, and Directive 2019/1937 occur. Hence, the further analysis of the upstream copper supply chain is based on the pyrometallurgical process.

2.4.2.2 Most risks occur in the early stage of the upstream supply chain

The upstream supply chain of copper starts with the mining stage and ends in the global mineral market. Hence the upstream supply chain is focussing on the mining, trading, smelting, and shipping of copper.[201] A detailed visualization is provided in figure 8.

Figure 8: Upstream supply chain of copper based on the pyrometallurgical process



Source based on: BSR (2010, p. 9); EPRM (2022e, p. 9); Hofmann et al. (2018, p. 118); Sancha et al. (2019, p. 464); Van den Brink et al. (2019, p. 392).

In the first stage of the supply chain, the copper ore is extracted from the earth via artisanal and small scale mining or large-scale mining.[202] Large-scale mining makes up for 99% of the worldwide copper mine production, while artisanal and small scale mining accounts for 1% of the global production.[203] Contrary, 40 mn people are employed via artisanal and small scale mining structures, which makes it impossible to avoid ores from artisanal and small scale mining as this de facto embargo would punish 90% of the global miners[204] and should be avoided (Chapter 2.2.1; 2.2.4). Furthermore, the greater stability of copper prices

[201] See El Baz et al. (2020, p. 723).
[202] See Copper Mark (2022d, p. 50).
[203] See Copper Mark (2022d, p. 50).
[204] See OECD (2019, p. 13).

compared to cobalt prices let artisanal miners switch from cobalt to copper in 2018.[205] The RMI classified the risk that copper mining is associated with artisanal and small scale mining as high.[206] The main risks occur in this stage of the supply chain, while especially artisanal and small scale mining is connected with forced and compulsory labor, child labor, illegal taxation, extortion of intermediaries, torture, violence, and the direct or indirect support of armed groups.[207] Moreover, governments generally do not consider the legitimacy of artisanal mining or charge high fees for licenses which makes the artisanal miners easier to exploit than miners from large-scale mining.[208] Artisanal and small scale mining is highly work-intensive, which makes it attractive for low-skilled workers and child laborers.[209] Especially copper ores with the origin from artisanal and small scale mining are often not directly transformed into concentrate.[210] Before they are transformed, the minerals are transported via several routes to negotiants who serve as sales agents.[211] The negotiants sample and weighted the copper ores.[212] Then the ores are sold to comptoirs, who serve as trading houses, as crude refiners just buy large amounts of minerals.[213] Often negotiants and comptoirs are located together in depots.[214] In case the artisanal and small-scale mining side, trading routes, sales agents, trading houses, or depots are controlled by armed groups the sourcing effect from companies is negative, as the generated money is not used to strengthen the local infrastructure or working conditions, as it is used for self-enrichment and weapons.[215] Another risk in this stage is that minerals related to risks from Annex II and conflict-free minerals are mixed, which raises difficulties for a tracking system.[216] On the other hand, large-scale mining is more linked with tax evasion, corruption, and money laundering.[217] In the next stage, the minerals are crude refined and then sold to a trader, which can be within the sourcing country or in a surrounding country.[218] In the DRC most traders are located in surrounding countries, while in e.g. Chile the most traders

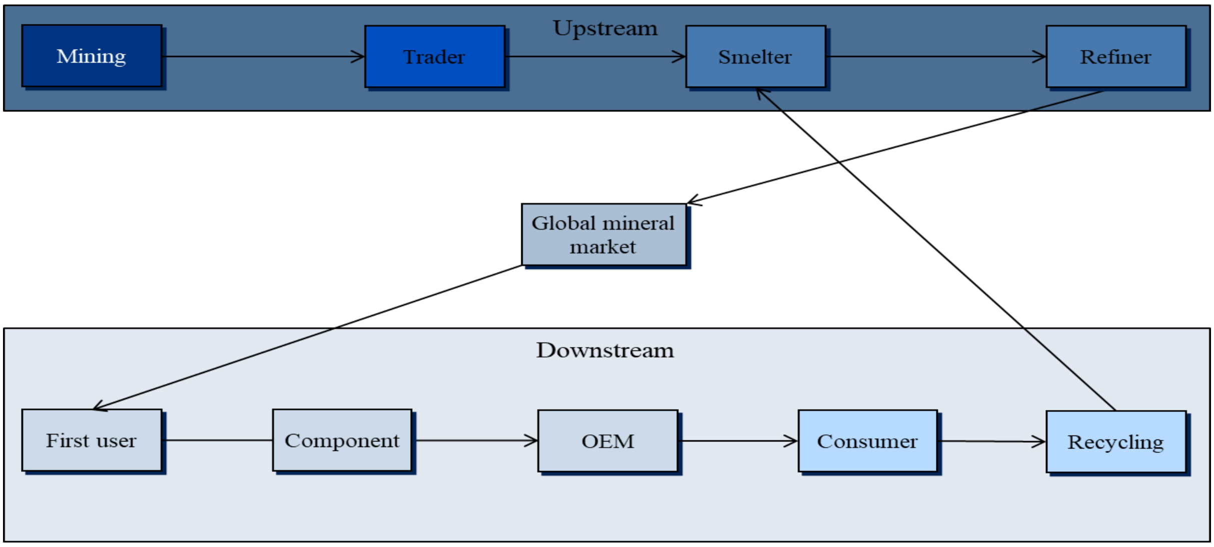
[205] See OECD (2019, p. 11).
[206] See RMI (2018, p. 41).
[207] See BSR (2010, p. 9-10); Hofmann et al. (2018, p. 119); OECD (2019, p. 35); RMI (2018, p. 41).
[208] See BSR (2010, p. 10); OECD (2019, p. 13).
[209] See André and Godin (2014, p. 162).
[210] See BSR (2010, p. 11).
[211] See BSR (2010, p. 11).
[212] See OECD (2019, p. 29).
[213] See BSR (2010, p. 11).
[214] See OECD (2019, p. 30).
[215] See Hanni and Podestá (2019, p. 91); OECD (2019, p. 35).
[216] See Hofmann et al. (2018, p. 116).
[217] See OECD (2019, p. 13).
[218] See BSR (2010, p. 9); Hanni and Podestá (2019, p. 92).

are located in the country.[219] The main risks related to this stage are illegal taxation, bribery, and extortion.[220] Moreover, there is still a risk that information concerning the origin of the mineral is misrepresented, as minerals affected by conflicts can be mixed with conflict-free minerals.[221] Most traders are a part of a vertically integrated supply chain, as they are connected to smelters and refiners through ownership or exclusive buying relationships.[222] The traders sell and export a large amount of copper concentrate to smelters.[223] The smelters are often located abroad and therefore not in the sourcing region or its neighboring countries.[224] Moreover, smelters and refiners can be vertically integrated.[225]

2.4.2.3 Downstream supply chain risks are driven by the upstream supply chain, where smelters and refiners are the chokepoints

The downstream supply chain starts at the global mineral market and ends with recycling.[226] Hence it contains all stages related to the usage retail, disposal, and recycling of copper.[227] The downstream supply chain is presented in figure 9.

Figure 9: Downstream supply chain of copper



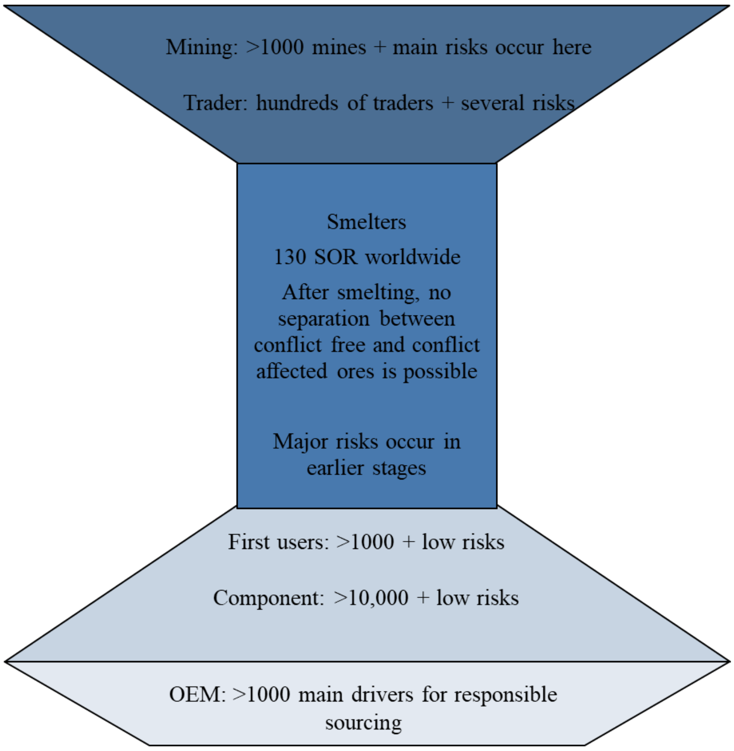
[219] See BSR (2010, p. 9); Hanni and Podestá (2019, p. 92).
[220] See BSR (2010, p. 9); Hanni and Podestá (2019, p. 92).
[221] See Hofmann et al. (2018, p. 118); OECD (2019, p. 32).
[222] See OECD (2019, p. 31).
[223] See OECD (2019, p. 9).
[224] See OECD (2019, p. 9); Pérez et al. (2021, p. 218).
[225] See Copper Mark (2022d, p. 54).
[226] See Copper Mark (2022d, p. 50); EPRM (2022e); ICGS (2021, p. 28).
[227] See El Baz et al. (2020, p. 723).

Source based on: EPRM (2022e); Hofmann et al. (2018, p. 118); ICGS (2021, p. 57); Sancha et al. (2019, p. 464); Van den Brink et al. (2019, p. 392).

In the global mineral market copper is mainly traded in form of the concentrate and cathode, while the trade of copper scrap, anode, blister, matte, and ore has 5-6 times lower trading volumes.[228] The companies which buy copper on the global mineral markets are named the first users of copper.[229] Copper is manufactured by the first users in various forms like wires, tubes, rods, sheets, strips, plates, powders, castings, and other shapes.[230] These copper alloy semis are applicable in various industries, which are named in chapter 1.1.[231] In the later downstream stages of the supply chain, the copper is processed via several component manufacturers and later on into a final product by an original equipment manufacturer.[232] Siemens Energy is operating at these stages of the supply chain.[233] After the final product is used by the consumer it is or could be recycled. Therefore, the copper scrap is separated and integrated again into the upstream supply chain.[234] An exception is high-grade copper scrap, which is directly used again in semifinished products.[235] The violation of human rights and other violations of the risks of Annex II rarely occur at the downstream stages of the supply chain, while the responsibility of the downstream companies is threatened by the responsibility risks in the upstream supply chain.[236] Moreover, the chokepoint in the copper supply chain can be identified and is presented in figure 10.

[228] See Copper Mark (2022d, p. 50); ICGS (2021, p. 28).
[229] See ICGS (2021, p. 35).
[230] See ICGS (2021, p. 35).
[231] See Bonnet et al. (2019, p. 11).
[232] See Bonnet et al. (2019, p. 11).
[233] See Siemens Energy AG (2022d).
[234] See Copper Alliance (2022, p. 2); Copper Mark (2022d, p. 51).
[235] See Copper Alliance (2022, p. 2).
[236] See Hofmann et al. (2018, p. 119); Sancha et al. (2019, p. 459).

Figure 10: Chokepoint in the copper supply chain



Source based on: BSR (2010, p. 9); Copper Mark (2021f, p. 2); EPRM (2022e); Hofmann et al. (2018, p. 118); Sancha et al. (2019, p. 464); USGS (2021, p. 1); Van den Brink et al. (2019, p. 392); Young et al. (2019, p. 2).

Figure 10 implies the three main reasons that have been identified, which make the smelters and refiners the chokepoint in the copper supply chain. The first reason is numerical, as there are thousands of copper mines worldwide and hundreds of traders, while only 124 smelters or refiners have been identified by the United States Geological Survey (USGS) in 2003.[237] The International Copper Study Group identified 130 smelters or refiners around the world in 2021.[238] Moreover, the downstream supply chain shows a similar structure as there are thousands of first users and tens of thousands of component manufacturers. At the end of the downstream supply chain, thousands of original equipment manufacturers are the main drivers for responsible sourcing in the supply chain.[239] As a result, the smelters and refiners (smelter or refiner) are identified as the chokepoints in the copper supply chain, as they are the narrowest points in the supply chain. Furthermore, after the ore is processed into metal, it becomes impossible to identify which part of the copper is affected by conflict and which is conflict-free. In addition, the major risks occur before the copper ore reached the smelter or refiner. Smelters or refiners are considered jointly as the

[237] See USGS (2021, p. 1).
[238] See Copper Mark (2021f, p. 2).
[239] See Young et al. (2019, p. 2).

chokepoint due to the high level of vertical integration in the supply chain and the fact that plenty of mines crude refine copper and are therefore also a smelter or refiners.[240] To conclude, Siemens Energy has to manage the smelters or refiners in its supply chain to mitigate risks in the upstream supply chain. Therefore different strategies are derived.

2.5 Improvement strategies of supplier management for bottleneck items

2.5.1 Kraljic matrix: Copper is a bottleneck item for Siemens Energy

Kraljic classified the purchasing items of a company based on the value and profit impact of the item for the buying company and the complexity and risk of the item connected with the buying firm and the supply market.[241] This classification enables a company to enroll specific strategies per item based on the market power and dependence of the buying and selling company.[242] Additionally, several criteria have been developed to estimate a category (Strategic, Bottleneck, Leverage, Routine) an item belongs. Regarding the value for the company, relative spending and price elasticity are relevant categories.[243] The complexity and risks are defined by the impact on supply shortage and evaluated on costs and revenue (substitutability, interruption of operations, differences for customers), design maturity, supply complexity, supply chain complexity, experience with the item, market capacity, competitiveness, entry barriers, and supply market research.[244]
<u>Copper value:</u> Siemens Energy has a purchasing volume for copper items of X mn Euro which counts for X% of the entire purchasing volume of X bn Euro.[245] Hence, copper has a low value for Siemens Energy. The global procurement market is shaped by the 20th largest smelters or refiners which own a market share of 40.4% and are operated by 16 companies. The largest company produced copper with an estimated value of 5.1 bn Euro and the smallest at about 1.9 bn Euro (Appendix A4).[246] Hence, the purchasing volume of Siemens Energy is low in relation to the global procurement market. The price elasticity

[240] See Schmitz (2022c).
[241] See Peter Kraljic (1983, p. 3); Hesping and Schiele (2015, p. 145).
[242] See Caniels and Gelderman (2005, p. 141).
[243] See FVPR052 Portfolio Analysis Criteria (2022, p. 1-7); Hesping (2015, p. 71); Hesping and Schiele (2016, p. 112); Peter Kraljic (1977, p. 74); Peter Kraljic (1983, p. 3).
[244] See FVPR052 Portfolio Analysis Criteria (2022, p. 1-7); Hesping (2015, p. 71); Hesping and Schiele (2016, p. 112); Peter Kraljic (1977, p. 74); Peter Kraljic (1983, p. 3).
[245] See Siemens Energy AG (2022j, p. 51).
[246] See ICGS (2021, p. 21); Statista (2022a); Statista (2022v).

could be observed when the supply-demand decreases, then the price, shows a moderate negative effect.[247] As a result, moderate price elasticity is estimated (Appendix A4). To conclude Siemens Energy has low market power in the copper market.

Complexity and risks for Copper: Copper has a low level of substitutability (Chapter 1.2) and is integrated into several solutions of Siemens Energy. [248] For example, X commodity codes have been identified which contain a high amount of copper, while X contains a lower amount of copper (Chapter 3.1.2). (The Text is hidden for confidential reasons). On the other hand, the copper market shows an excess supply for the last decade (Figure 5), which reduces the probability of no availability. Opposed the copper demand is forecasted to grow fast, which could result in supply issues (Chapter 1.2). The copper processing complexity from ore to the copper end product (Chapter 2.4.2.1; 2.4.2.2) is low which results in a low design maturity and makes copper a volume item. Contrary, only X of the purchasing volume is related to the copper end product or a prior production stage (Appendix A4). The other X are already integrated into products, while this share will increase when the scope of relevant commodity codes will be extended in the future. For example, copper is used in wind power tower sections, which are produced globally and are a commodity at Siemens Energy, (hidden for confidential reasons). [249] This raises the complexity of the supply process, design maturity, and entry barriers. (Text hidden for confidential reasons).[250] Regarding market competitiveness, the competitiveness between the single items varies, while the chokepoints in the supply chain are the 130 copper smelters or refiners based in 40 different countries (Chapter 2.4.2.3).[251] Hence, the copper market has an international character and does not suffer from a monopolistic structure as multiple sources are available (Chapter 2.4.1). However, the 20th largest smelters or refiners are operated by 16 different companies, while the Chinese ownership of these smelters or refiners is 45,5% based on the produced copper value (Appendix A4). To conclude, (Text hidden for confidential reasons), and is considered a bottleneck item.[252] The classical solutions to tackle bottleneck items are recommended by several authors and elaborated on in the following chapter.[253]

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[247] See FVPR052 Portfolio Analysis Criteria (2022, p. 6).
[248] See Siemens Energy AG (2021a, p. 1).
[249] See Siemens Energy AG (2022c).
[250] See Schmitz (2022d).
[251] See Copper Mark (2021f, p. 2).
[252] See Gelderman and Van Weele (2002, p. 35); Olsen and Ellram (1997, p. 105).
[253] See Adesanya, Yang, Iqdara, and Yang (2020, p. 415); Caniels and Gelderman (2005, p. 145); Dabhilkar et al. (2016, p. 16); Gelderman and Van Weele (2002, p. 35);

2.5.2 Derivation of strategies to manage bottleneck items regarding responsible sourcing

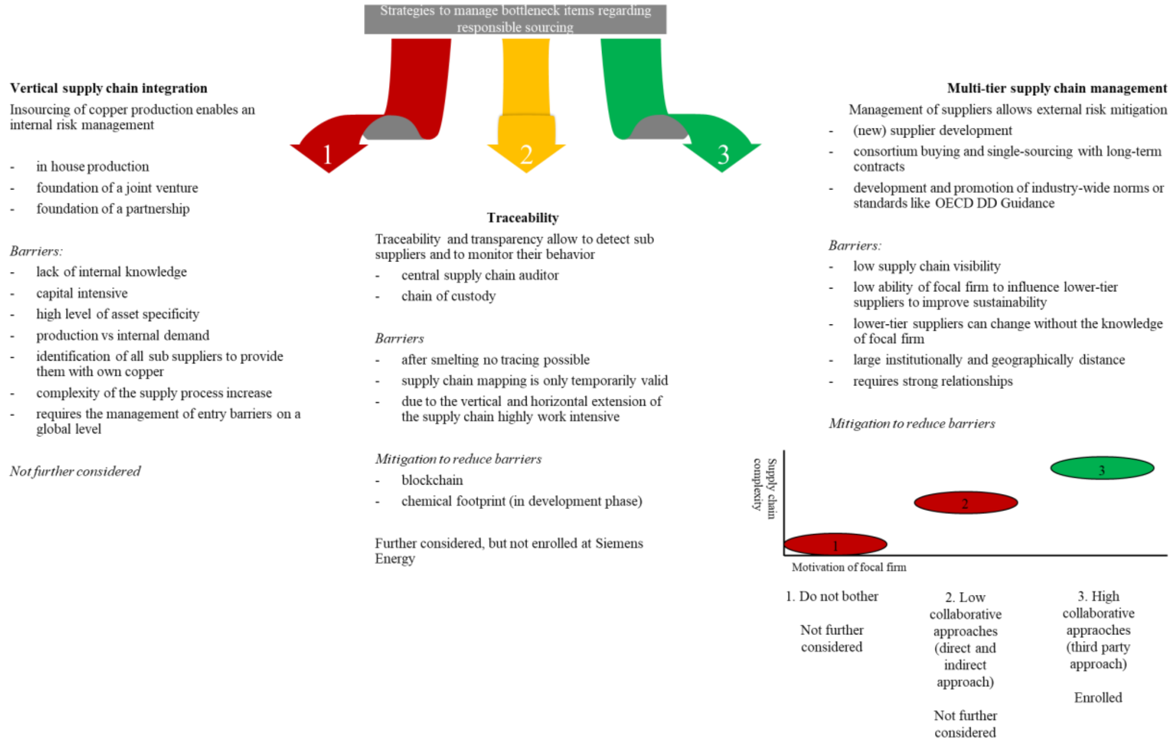
These classical solutions are not directly applicable to solve the problem, as they are focussed on direct suppliers and the switch to non-critical or leverage items, like through the reduction of entry barriers and supplier dependency, the development of new suppliers, the development of alternative solutions to substitute the bottleneck item, insourcing, foundation of joint ventures, consortium buying to aggregate volume, single sourcing with long-term contracts, development and promotion of industry-wide norms or standards, and inventory strategies. Hence, they do not consider sustainability and indirect suppliers directly.[254] In the context of sustainability and bottleneck items, Dabhilkar et al. demonstrated that environmental and social sourcing programs do not show success due to the lack of power of the buying organization.[255] Firstly solutions derived from Kraljic are shortly described which are not suitable, like the development of substitutional items. Due to the vital role of copper, its broad application in various technical solutions, (Text hidden for confidential reasons) (Chapters 1.2 and 2.3). However, this solution would not allow to answer the research question and it would be an engineering project and is therefore not further considered. Another solution for bottleneck items offered by Kraljic is the enrolment of inventory strategies. Inventory strategies do not help to strengthen responsible sourcing in the upstream supply chain, and neither they are related to due diligence. As a result, these solutions are not further elaborated. However, some solutions can be adopted for responsible sourcing and are presented in figure 11.

Gelderman and Van Weele (2003, p. 212); Mello et al. (2017, p. 6);
Pagell, Wu, and Wasserman (2010, p. 59); Olsen and Ellram (1997, p. 105).

[254] See Adesanya et al. (2020, p. 415); Caniels and Gelderman (2005, p. 145); Dabhilkar et al. (2016, p. 16); Gelderman and Van Weele (2002, p. 35); Gelderman and Van Weele (2003, p. 212); Mello et al. (2017, p. 6); Pagell et al. (2010, p. 59); Olsen and Ellram (1997, p. 105).

[255] See Dabhilkar et al. (2016, p. 16).

Figure 11: Strategies to manage bottleneck items regarding responsible sourcing



Source based on: BGR (2020, p. 2); Bleischwitz et al. (2012, p. 20); Dabhilkar et al. (2016, p. 16); Chand and Tarei (2021, p. 4); Fraser (2021, p. 162); Garcia-Torres et al. (2019, p. 96); Govindan et al. (2021, p. 10); Hofmann et al. (2018, p. 117); Hollensen (2020, p. 364); Kshetri (2022, p. 11); Mena et al. (2013, p. 72); Magno and Guzman (2021, p. 1); Mello et al. (2017, p. 5); Tachizawa and Wong (2014, p. 652); Tröster and Hiete (2019, p. 2); Wilhelm et al. (2016, p. 197); Young and Dias (2011, p. 11).

The vertical integration of the supply chain is a possibility to control the risks internally or with a close partner. Hence, in-house production or the foundation of joint ventures could be a suitable solution. Hence, this solution is elaborated in chapter 2.5.3. In the context of indirect suppliers, transparency and traceability are required to be able to know and monitor indirect suppliers, as the indirect suppliers act outside of the visible horizon of the buying organization (Chapter 2.1). This solution is elaborated in chapter 2.5.4. The development of new suppliers, as well as consortium buying and single-sourcing with long-term contracts, require strong relationships with other companies and the supplier. Moreover, the reduction of entry barriers for suppliers decreases dependencies and increases competition and could be a possibility to broaden the market. The concept of the development and promotion of industry-wide norms or standards is difficult to implement, due to supplier dependency and the difficulty that norms or standards need to reach a critical threshold to be efficient.[256] As these solutions require partnerships, the literature on relationship management in the context of a multi-tier supply chain is reviewed and three approaches have

[256] See Mello et al. (2017, p. 5); Tröster and Hiete (2019, p. 2).

been identified (Chapter 2.5.5).

2.5.3 Mitigation of sustainability risks by vertical supply chain integration

The vertical integration of the supply chain targets to produce the copper in-house or via a joint venture[257] or with a partnership[258] and would allow for internal risk mitigation.[259] Therefore the make or buy decision of the supply strategy has to be reviewed under the consideration of sustainability aspects.[260] The most common related theories regarding make or buy decisions are the resource based view and the transaction costs economics.[261] Transaction cost economics argues that an item should be sourced in case the marginal cost to produce the item is higher than the costs to buy it on the market.[262] Contrary the resource based view considers the own and the external resources concerning the creation of unique values.[263] To conclude, a make or buy decision is a strategic decision based on the core competencies and capabilities of the firm and its environment and the tradeoff of costs and benefits.[264] The decision targets to create value for the customer and to achieve a competitive advantage.[265] Firstly the competencies of Siemens Energy are reviewed to evaluate if insourcing would be possible. Secondly, the supply market is analyzed to investigate if a positive or a negative tradeoff between costs and benefits can be gained to get a competitive advantage.

From the internal resource perspective, Siemens Energy has X regarding the transformation process of copper or any other metal.[266] Regarding the financial resources, Siemens Energy generated negative results in the first two years (-1,859 mn Euro in 2020 and -560, mn Euro in 2021), which resulted in a decreasing equity ratio from 36% to 34%, while the value of investments increased from 958 mn Euro to 1,036 Euro.[267] Furthermore, Siemens Energy plans to overtake Siemens Gamesa to 100% which cost approximately 4 bn Eu-

[257] See Magno and Guzman (2021, p. 1).
[258] See Hollensen (2020, p. 364).
[259] See Magno and Guzman (2021, p. 1).
[260] See Ahtonen and Virolainen (2009, p. 264).
[261] See Ahtonen and Virolainen (2009, p. 264).
[262] See Williamson (2008, p. 6).
[263] See Barney (1991, p. 99).
[264] See Ahtonen and Virolainen (2009, p. 266).
[265] See Hollensen (2020, p. 365).
[266] See Siemens Energy AG (2022a).
[267] See Siemens Energy AG (2022g, p. 16-17).

ro.[268] Additionally, the upstream copper supply chain shows a high level of asset specificity and high capital intensity.[269]

Regarding the supply market, different competitors are available as on the narrowest point in the supply chain are 130 smelters or refiners active, while the 20[th] largest smelter or refiner are operated by 16[th] different companies (Chapter 2.4.2.3; Appendix A4.). In the last decade, the copper market showed an overproduction of 3.52 mn mt of refined copper worldwide which is an average of 13.55% of the global production. (Chapter 2.4.1). Moreover, 26 smelters or refiners operated by 9 different owners fulfill already the standards of the Copper Mark which makes a market available to source copper responsibly.[270] Furthermore, 13 smelter or refiner with 6 different owners participates in the Copper Mark Assurance Framework. In case all participants succeed, the market will grow in the next two years to 29 smelters or refiners with 15 different owners.[271] This makes up 22.3% of all operating smelters or refiners worldwide.[272] Furthermore, internal copper production raises the complexity of the supply process and requires the management of entry barriers, as the sub-suppliers (which are not all identified) have to be supplied with the copper produced by Siemens Energy. As all sub-suppliers across the globe and supply chain stage have to be supplied, Siemens Energy has to generate a transaction cost advantage in each market for each volume which seems to be impossible. To conclude, from the resource based view and the transaction cost economics perspective Siemens Energy should not consider insourcing, as no competencies regarding the production of copper or any other metals are internally available. Furthermore, the own financial resources in relation to the large investment costs and the planned overtake of Siemens Gamesa limits the financial feasibility of the vertical integration. The production of copper is a volume business, which means that Siemens Energy needs an overproduction of its own copper demand to be efficient on the market.[273] Furthermore, large copper producers like Aurubis or JX Nippon Mining & Metals Co., Ltd getting certified with some sites.[274] To conclude, even if Siemens Energy would have success, a unique value would not be achieved as competitors have already such a product on the market and are well known by their customers. Therefore it will be difficult to gain a competitive advantage through the own production of cop-

[268] See Siemens Energy AG (2022e).
[269] See Inter-American Development Bank (2021, p. 5).
[270] See Copper Mark (2022b).
[271] See Copper Mark (2022b).
[272] See Copper Mark (2021f, p. 2); Copper Mark (2022b).
[273] See BGR (2020, p. 2).
[274] See Copper Mark (2022b).

per in the near future. It seems to be more efficient to motivate the smelter or refiner in the supply chain to get certified and develop the market.

Another alternative is the foundation of a joint venture, which is a partnership of at least two firms to provide complementary skills and gain therefore several opportunities like cost share or access to knowledge.[275] This partnership can be equity-based or non-equity-based (contractual).[276] As the contractual joint venture is close to a strategic alliance it is further analyzed in chapter 2.5.5.3. From the perspective of Siemens Energy, a coalition could be attractive, as Siemens Energy operates in the downstream supply chain and require skills from the upstream supply chain.[277] Therefore, the internal knowledge gap could be closed, while the joint venture has comparable disadvantages for Siemens Energy like insourcing. The purchasing volume of copper is quite low compared to the required investment costs, even if possible costs would be shared and the global distribution of copper to each supplier creates high transaction costs. Therefore the vertical integration of the supply chain is not further considered.

2.5.4 Traceability in complex supply chains to mitigate sustainability risks

Due diligence represents a holistic approach in the context of mineral supply chains to establish a chain of custody that targets to track and trace ores from the mine to the exporter.[278] Tracking requires high transparency along the supply chain to ensure that conflict-free minerals and minerals affected by conflict are not mixed, which is just possible till the smelting stage is reached.[279] Tracing requires a chain combined with documentation or a chemical footprint to identify the source of the mineral.[280] As the chemical footprint regarding the provenance of the metal is not available, the entire upstream supply chain could be monitored by a central mineral supply chain auditor to mitigate risks at the bottom stage.[281] As upstream suppliers can change their sub-suppliers without the knowledge of the customer, a simple mapping of the supply chain is only temporarily valid.[282] Other barriers are related to the complexity of the supply chain itself, costs, and the lack of stand-

[275] See Hollensen (2020, p. 365).
[276] See Hollensen (2020, p. 365).
[277] See Hollensen (2020, p. 366).
[278] See Bleischwitz et al. (2012, p. 20).
[279] See Fraser (2021, p. 162); Young and Dias (2011, p. 11).
[280] See Young and Dias (2011, p. 11).
[281] See Hofmann et al. (2018, p. 117); Young et al. (2019, p. 11).
[282] See Fraser (2021, p. 162).

ards and resources.[283] This makes it difficult to establish a traditional chain of custody for a downstream company, while a solution to diminish this issue is blockchain technology, as it allows real-time confirmation in combination with a high level of compatibility.[284] This is enabled by the key characteristics of the blockchain, which are decentralization, security, smart execution, and audibility.[285] The blockchain is an online ledger that contains information like data, certificates, transaction documents, etc. which cannot be changed by others and is visible to all approved participants.[286] Firstly information must be verified and then uploaded to the online ledger.[287] Then the verified information is copied plenty of times in a decentralized manner to establish trust in the blockchain.[288] Decentralization is key, as it is impossible to delete all copies which are stored decentrally.[289] Therefore the information cannot be changed anymore, is easily reviewable, transparency is established and a low amount of trust is required.[290] In the context of mineral supply chains, the transactions could be documented with the weight, volume, times, and dates of the mineral.[291] Hence, the visibility along the supply chain is increased, while actors who violate the standards can be identified.[292] In comparison, the traditional information systems are limited as different participants have access to information which are stored centrally and can therefore be manipulated, which is solved by the blockchain.[293] To conclude, the transaction and governance costs can be reduced as well as power asymmetry.[294] Moreover, various stakeholders can get legitimacy by following the standards.[295] Therefore, the blockchain can support the management system as well as the identification and risk assessment required by the OECD DD Guidance (Chapter 2.2.5.1). However, blockchain technology has limitations and barriers regarding operation and establishment. For example, blockchain quality depends on the quality of the information in the blockchain, and especially in CAHRA, it is difficult to get access to verified data.[296] Moreover, blockchain technology is still in the early stages of the development and adoption process for complex supply

[283] See Garcia-Torres et al. (2019, p. 96).
[284] See Fraser (2021, p. 163).
[285] See Saberi, Kouhizadeh, Sarkis, and Shen (2019, p. 2119).
[286] See Van den Brink et al. (2019, p. 395).
[287] See Saberi et al. (2019, p. 2119).
[288] See Saberi et al. (2019, p. 2119).
[289] See Saberi et al. (2019, p. 2119).
[290] See Saberi et al. (2019, p. 2119).
[291] See Van den Brink et al. (2019, p. 395).
[292] See European Commission (2020b, p. 447).
[293] See Kshetri (2022, p. 6).
[294] See Kshetri (2022, p. 20); Schmidt and Wagner (2019, p. 8).
[295] See Calvão and Archer (2021, p. 9); European Commission (2020b, p. 447).
[296] See Deberdt and Le Billon (2021, p. 9); Kshetri (2022, p. 20).

chains, and several intra- and inter-organizational barriers have to be considered as well as system-related and external barriers.[297] For example, technological uncertainty, development costs, and scalability issues raise major problems.[298] Other new technologies to ensure traceability in complex supply chains are face recognition software to confirm the identities of miners in combination with aerial imagery, machine learning, and satellite data to ensure that the supply chain participant's actions are aligned with the current guidelines.[299] Furthermore, the International Business Machines Corporation is developing a solution to be able to pinpoint the origin of cobalt based on chemical analysis.[300] To conclude this could be a solution in the future, while the blockchain could enable a chain of custody that includes the up and downstream supply chain. To get an overview of the applicability of a chain of custody within the supply chain of Siemens Energy, the suppliers are asked if they have already established a chain of custody for copper or an alternative system (Appendix A3). (Text hidden for confidential reasons).

2.5.5 Responsible sourcing in multi-tier supply chain management: barriers and solutions

2.5.5.1 Barriers to multi-tier supply chain management in context of responsible sourcing

To source responsible transparency and traceability are required, as the focal firm is far away from the mining stage and therefore the tier n suppliers act outside of the visible zone (Chapter 2.4.2). The main barrier is therefore supply chain visibility as it weakens the focal firm's ability to influence lower-tier suppliers to improve sustainability.[301] Moreover, the supply chains are dynamic, and lower-tier suppliers can change without the knowledge of the customer.[302] Due to the supply chain and internal complexity, it is impossible to vet the entire supply chain.[303] Furthermore, lower-tier suppliers are often located in emerging countries that are institutionally and geographically distant compounds which is a barrier to managing the relationships.[304] To elaborate, the focal firm suffers from a lack of control of its lower-tier suppliers, as the identity of the lower-tier suppliers is often unknown, the

[297] See Saberi et al. (2019, p. 2125).
[298] See Schmidt and Wagner (2019, p. 1).
[299] See Kshetri (2022, p. 11).
[300] See Kshetri (2022, p. 11).
[301] See Fraser (2021, p. 141).
[302] See Fraser (2021, p. 162); Young and Dias (2011, p. 11).
[303] See Fraser (2021, p. 143); Kim and Davis (2016, p. 1897); Timmer and Kaufmann (2017, p. 345).
[304] See Wilhelm et al. (2016, p. 197).

business with these suppliers is just a small percentage, and key resources like the availability of knowledge regarding sustainability and responsible sourcing are missing, as well as contractual arrangements.[305] Even if these suppliers follow sustainability standards they often do not request them from their suppliers.[306] Therefore, the focal firm's influence on lower-tier suppliers is decreasing with a growing distance in the supply chain.[307] The growing distance is next to others related to a missing common goal along the supply chain, while this is negatively correlated to establishing common standards and transparency.[308] The distance of the supply chains creates power and information asymmetry, as well as a lack of dependency between the buyer and the supplier which is negatively related to transparency.[309] To conclude it is not enough to manage the barriers related to the supply chain, industry, and geographical characteristics, as also internal barriers related to multi-tier supply chain management needed to be addressed.[310] The main internal barriers are lack of commitment, weak information sharing, lack of mutual trust, lack of supplier involvement, lack of resource availability like financing or capacity issues, passivity toward sustainability, and lack of supply chain learning.[311]

The OECD DD Guidance offers the best possibility to fulfill the legislative perspective of responsible sourcing (DFA; CMR) with the five-step framework (Chapter 2.2.5). A possible solution to implement the five-step framework is multi-tier supplier management, which can be enrolled via four forms direct, or indirect, work with third parties, and do not bother.[312] The "do not bother" approach fits in case the focal firm has no or limited power, is placed in a less complex supply chain, and has no motivation to influence lower-tier suppliers.[313] Hence, it is not suitable for the problem, as the case company has strong motivation to influence lower-tier suppliers (Chapter 1.4). The direct, indirect, and third party/multi-stakeholder approach to multi-tier supplier management is suggested by three authors and visualized in figure 12.[314]

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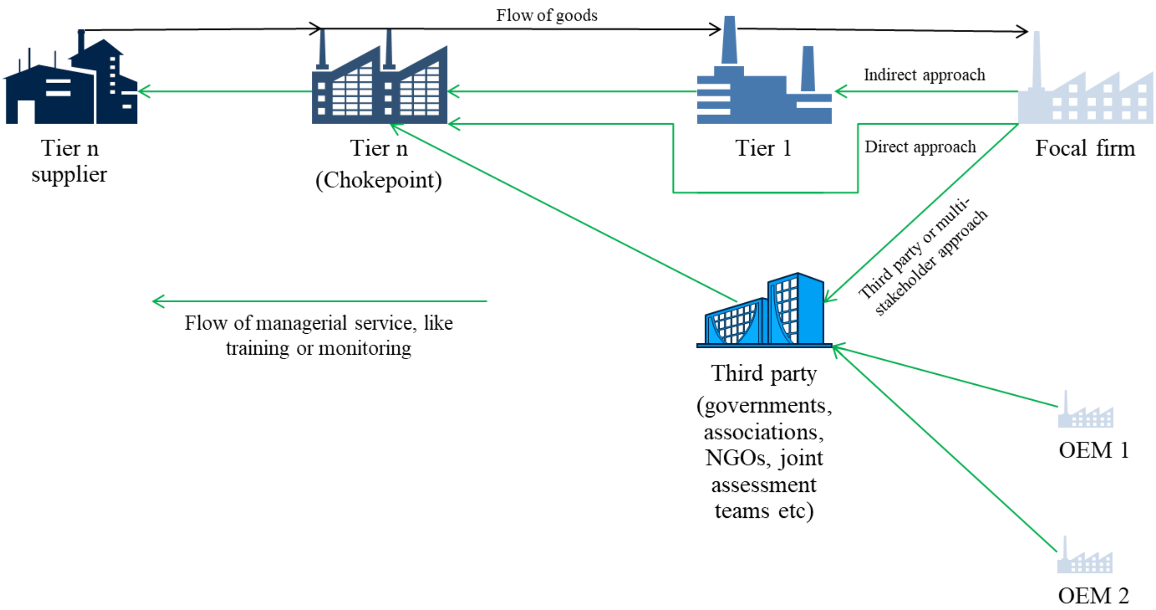
[305] See Lechler, Canzaniello, and Hartmann (2019, p. 65); Villena and Gioia (2018, p. 66); Wilhelm et al. (2016, p. 197).
[306] See Lechler et al. (2019, p. 65); Villena and Gioia (2018, p. 66); Wilhelm et al. (2016, p. 197).
[307] See Fraser (2021, p. 153).
[308] See Chand and Tarei (2021, p. 4); Hoejmose, Grosvold, and Millington (2013, p. 278).
[309] See Chand and Tarei (2021, p. 4); Hoejmose et al. (2013, p. 278).
[310] See Chand and Tarei (2021, p. 1).
[311] See Chand and Tarei (2021, p. 4); Govindan et al. (2021, p. 10).
[312] See Tachizawa and Wong (2014, p. 652).
[313] See Tachizawa and Wong (2014, p. 656); Wilhelm et al. (2016, p. 197).
[314] See Mena et al. (2013, p. 72); Tachizawa and Wong (2014, p. 652); Wilhelm et al. (2016, p. 197).

Figure 12: Approaches to multi-tier supplier management



Source based on: Mena et al. (2013, p. 72); Tachizawa and Wong (2014, p. 656); Wilhelm et al. (2016, p. 197).

The direct approach is based on monitoring and other bilateral actions like training, while the indirect approach is based on first-tier supplier training to enable the supplier to monitor its suppliers.[315] As the focal firm mainly acts alone, these approaches are summarized as low collaborative approaches and elaborated in Chapter 2.5.5.2. The third-party approach fits in the case the focal firm and its direct suppliers cannot train, monitor, or pressure the lower-tier suppliers and is therefore considered in Chapter 2.5.5.3.[316] The OECD suggests a multi-stakeholder approach which includes the collaboration with several parties like governments, associations, NGOs, and joint assessment teams to establish joint-industry schemes.[317] This is comparable to the third-party approach.

2.5.5.2 Low collaborative approaches are driven by low complexity and lack of partners

The low collaborative approach contains the direct and the indirect approach (Chapter 2.2.5.1). As the focal firm acts alone, it is mainly facing complexability issues as the supply chain is consisting of hundreds and thousands of mid-tier suppliers.[318] Therefore it is

[315] See Tachizawa and Wong (2014, p. 652).
[316] See Sauer and Seuring (2018, p. 562).
[317] See OECD (2021, p. 39).
[318] See Fraser (2021, p. 142).

necessary to close the supply chain by engaging with key suppliers in the upstream supply chain, which are called chokepoints.[319] This is similar to the cascaded approach, where the supply chain is separated into the downstream and upstream parts to identify in each part a focal firm.[320] Hence, both focal firms can interact with each other directly.[321] This is positively related to the structural, behavioral, and relational barriers in multi-tier supply chain management.[322] Additionally, the information and power asymmetry between both focal firms is mitigated.[323] After the supply chain is closed the direct or indirect approach can be enrolled by the focal firm. In the direct approach, the focal firm engages directly with the other focal firm in the upstream supply chain.[324] Therefore the downstream focal firm can collaborate, monitor, and govern the upstream focal firm (chokepoint) to strengthen the social, environmental, and economical performance.[325] Moreover, the management by a focal firm of a dispersed supply network is more efficient.[326] Additionally, structural issues in the supply network can be closed and the focal firm can gain a leading role in the network, as it is close to the end customer and has the ability to create connections.[327] Therefore, the risk that the focal firm is exploited by the opportunistic behavior of its suppliers can be reduced.[328] However, the main disadvantages of the direct approach are related to the managerial effort, as the focal firm has to identify and engage with the upstream choke points.[329] This disadvantage is strengthened as the identified chokepoints in the supply chain of minerals are typically smelters or refiners, while it is highly likely that the suppliers of the focal firm receive materials from several smelters or refiners.[330] Moreover, the focal firm suffers still from power in the relationship with the chokepoints, as the business with the chokepoints remains small.[331] Hence, the stimulus provided by the focal firm through the engagement could be too low to change the behavior of the chokepoints.[332] The indirect approach tries to bridge this gap, as the focal firm engages with another sup-

[319] See Fraser (2021, p. 142); Jia, Gong, and Brown (2019, p. 52).
[320] See Sauer and Seuring (2019, p. 39).
[321] See Sauer and Seuring (2019, p. 39).
[322] See Kembro, Näslund, and Olhager (2017, p. 78).
[323] See Tachizawa and Wong (2014, p. 652).
[324] See Tachizawa and Wong (2014, p. 651).
[325] See Sauer and Seuring (2019, p. 39); Tachizawa and Wong (2014, p. 651).
[326] See Pilbeam, Alvarez, and Wilson (2012, p. 358).
[327] See Tachizawa and Wong (2014, p. 651).
[328] See Tachizawa and Wong (2014, p. 651).
[329] See Mena et al. (2013, p. 72).
[330] See El Baz et al. (2020, p. 723); Sancha et al. (2019, p. 464); Van den Brink et al. (2019, p. 392).
[331] See Wilhelm et al. (2016, p. 197).
[332] See Sauer and Seuring (2018, p. 562); Wilhelm et al. (2016, p. 197).

plier where the focal firm has a power advantage.[333] This supplier is then motivated to engage and monitor lower-tier suppliers.[334] To conclude, the complication of managing the supply chain for the focal firm is reduced via cross-tier collaboration.[335] Contrary, the information flow from the choke point towards the focal firm becomes less stable through the involved supplier.[336] The coordination of lower-tier suppliers can be improved via standards and certifications.[337] Moreover, standards are positively related to the reduction of information asymmetry and transaction costs.[338] However, these standards need to be accepted and adopted to be successful and therefore a critical mass of committed stakeholders is required.[339] To conclude, it is key to share information as well as to train key suppliers to adopt, implement, and teach others to adopt standards.[340] However, the focal firm needs to find a supplier who has the potential to manage the chokepoints in the supply chain, as well as this supplier has the issue to manage multiple smelters or refiners due to the horizontal spread in mineral supply chains.[341] Moreover, well-executed monitoring and audits for the key supplier and the chokepoints are required to establish compliance.[342] Hence, a high level of spread in the horizontal supply chain requires the involvement of external parties to reduce the managerial workload.[343] Therefore this solution is not further considered.

2.5.5.3 High collaborative approaches are driven by high complexity and fitting partners

The high collaborative approach consists of the multi-stakeholder and the third-party approach which can be implemented in two ways.[344] The first solution is to outsource the responsibility to manage lower-tier suppliers to another organization, while the second approach is to create an alliance with firms from the same industry or other industries,

[333] See Tachizawa and Wong (2014, p. 651).
[334] See Tachizawa and Wong (2014, p. 651).
[335] See Koh, Gunasekaran, and Tseng (2012, p. 305); Tachizawa and Wong (2014, p. 351).
[336] See Mena et al. (2013, p. 72).
[337] See Mueller, Dos Santos, and Seuring (2009, p. 358).
[338] See Ciliberti, de Groot, de Haan, and Pontrandolfo (2009, p. 125); Prado (2013, p. 700); Tachizawa and Wong (2014, p. 651).
[339] See Tröster and Hiete (2019, p. 2).
[340] See (2009, p. 125); Pilbeam et al. (2012, p. 358); Tachizawa and Wong (2014, p. 651).
[341] See El Baz et al. (2020, p. 723); Sancha et al. (2019, p. 464); Van den Brink et al. (2019, p. 392).
[342] See Venkatesh, Zhang, Deakins, and Mani (2020, p. 668).
[343] See Wilhelm et al. (2016, p. 209).
[344] See OECD (2021, p. 39); (OECD, 2016, p. 42); Tachizawa and Wong (2014, p. 652).

NGOs, and other associations to manage lower-tier suppliers collectively.[345] These formed alliances execute assessments and exchange the results between the members.[346] Additionally, common standards and requirements are implemented by these alliances.[347] The successful implementation of standards and certification schemes is more likely via a multi-stakeholder approach as the critical mass of supporting stakeholders is easier to achieve and therefore pressure is increased on suppliers to adopt these standards and certification schemes.[348] The second approach is aligned with the multi-stakeholder solution of the OECD, as the OECD recommended relying on joint industry schemes.[349] These industry schemes are financed by a joint pool of funds or membership fees.[350] Furthermore, they can establish due diligence along a supply chain via the execution and management of third-party audits, supplier inspections, awareness-raising, stakeholder engagement, and training.[351] The main advantage of this approach is cost and time savings, for the focal firm as well as for the lower-tier suppliers.[352] To elaborate on this, the focal firm saves time and costs, as no single evaluation of each of the focal firm's suppliers has to be conducted.[353] On the other hand, the lower-tier supplier provides its products to several buyers which may execute evaluations for their suppliers. Hence the lower-tier supplier has to do several audits for the same purpose. With common industry schemes, the double workload can be avoided.[354] Moreover, a single focal firm cannot manage risks in its supply chain when the supply chain perspective is horizontally and vertically extended due to capacity problems. By following the multi-stakeholder and third-party approach this barrier can be mitigated as plenty of members manage the extended supply chain in form of an alliance or industry scheme.[355] Other advantages of these approaches are that the relative buyer power is increased through collaboration with other partners.[356] Moreover, collaboration with suppliers enables the focal firm to increase pressure on sub-suppliers, hence the sub-suppliers are more motivated to act responsibly.[357] For example, the purchasing volumes of single alli-

[345] See Tachizawa and Wong (2014, p. 652).
[346] See Lechler et al. (2019, p. 70).
[347] See Lechler et al. (2019, p. 70).
[348] See Tröster and Hiete (2019, p. 2).
[349] See OECD (2021, p. 39).
[350] See OECD (2021, p. 39).
[351] See OECD (2021, p. 39).
[352] See OECD (2021, p. 39).
[353] See OECD (2021, p. 39).
[354] See OECD (2021, p. 39).
[355] See Lechler et al. (2019, p. 72).
[356] See Hoejmose et al. (2013, p. 280).
[357] See Wilhelm et al. (2016, p. 198).

ance members can be pooled, and therefore the negotiation power increases.[358] Additionally, power asymmetries are reduced which is positively related to the development of trust and partnerships.[359] Collaboration allows the connection of knowledge and other resources.[360] Therefore, technical possibilities to create transparency and traceability increase, which could make the use of new technologies like the blockchain possible.[361] Moreover, the alliances are not only consisting of members which are operating on the same stage in the supply chain as the focal firm.[362] In case direct and indirect suppliers participate in the alliance, transparency and traceability are increased directly.[363] These suppliers can pass the principles of the alliance to their suppliers and therefore lower-tier suppliers can be reached.[364] To conclude, the barrier regarding the missing contractual relationship between the focal company and its lower-tier suppliers becomes less relevant.[365] Furthermore, alliances lead to learning effects along the supply chain due to the share of knowledge.[366] Therefore the knowledge gap regarding utility can be closed in the upstream supply chain (Chapter 2.5.5.2). Moreover, awareness is increased and a common goal is implemented while a sustainability culture is promoted along the supply chain.[367] Through this knowledge sharing, information asymmetry between the parties is reduced and lower-tier suppliers become more visible to the focal firm, as well as the willingness to establish the required standards of the alliance increase.[368] To conclude lower-tier suppliers can better be managed in collaboration with other firms in case the focal firm has access to the right partners to build such an alliance or industry schemes.[369]

2.5.5.4 The Copper Mark: partner and compensator for the missing dimensions of the OECD DD Guidance

[358] See Lechler et al. (2019, p. 71).
[359] See Hoejmose et al. (2013, p. 280).
[360] See Wilhelm et al. (2016, p. 198).
[361] See Tachizawa and Wong (2014, p. 657).
[362] See Lechler et al. (2019, p.71).
[363] See Lechler et al. (2019, p.71).
[364] See Lechler et al. (2019, p. 72).
[365] See Lechler et al. (2019, p. 72).
[366] See Hajmohammad and Vachon (2016, p. 54).
[367] See Hajmohammad and Vachon (2016, p. 54).
[368] See Lechler et al. (2019, p. 74).
[369] See Govindan et al. (2021, p. 10); Lechler et al. (2019, p. 74).

The Copper Mark was founded in 2019 by the International Copper Association as an industry-led initiative to develop and elaborate standards to contribute to sustainable development along the copper value chain on a global scale.[370] The Copper Mark is an independent entity that collaborates with companies and organizations across the copper industry to support them and understand the growing demands for independently verified and responsible production practices.[371] For implementation, the Copper Mark cooperates with its 19 partners across various industries which are: Applied Materials, Ford Motor Company, FLSmidth, Google, HALCOR Copper Tubes Division of ELVALHALCOR S.A., Hellenic Cables, Imperial Group LLC, Intel, MM Kembla, Mueller Industries Inc., Nanotec S.A., Nexans, ODDO BHF METALS, Revere Copper Products Inc., Siemens Energy, Southwire, Superior Essex, and Wieland Group.[372] Furthermore, formal and informal collaboration, partnerships, and cooperations with other organizations like the International Copper Association, RMI, or the London Metal Exchange are implemented to strengthen the multi-stakeholder approach toward responsible production use and reuse of natural resources.[373] The Joint Due Diligence Standard for Copper, Lead, Nickel, and Zinc was launched by the Copper Mark and is based on the OECD Guidance to reduce the barriers like costs and administration for multi-metal producers as well as to strengthen commonalities across these metals.[374] Furthermore, the Copper Mark is working on an extension of its minerals in scope, as the mineral molybdenum will be considered in the future as well.[375] Responsible practices are defined by the Copper Mark and the RMI jointly via 32 Criteria which focus on governance, labor rights, environment, community, and human rights.[376] These criteria for a sustainable supply chain are based on the Sustainable Development Goals of the UN and are listed in Appendix A2.[377] The Copper Mark Assurance process is for participants on-site level who produce copper (mines, smelters, refiners) and ensures that all 32 criteria are met.[378] Alternatively, copper-producing sites can be only assessed against the Joint Due Diligence Standard.[379] The Copper Mark Assurance Process consists of five steps, commitment (1), self assessment (2), independent assessment (3),

[370] See Copper Mark (2021a, p. 2).
[371] See Copper Mark (2022a).
[372] See Copper Mark (2022e).
[373] See Copper Mark (2021a, p. 2).
[374] See Copper Mark (2021a, p. 9).
[375] See Copper Mark (2022g, p. 11).
[376] See Copper Mark (2021a, p. 9).
[377] See Copper Mark (2021e, p. 2).
[378] See Copper Mark (2021b, p. 4-5).
[379] See Copper Mark (2021b, p. 10).

improvement plan (4), and re-assessment (5).[380] Firstly the copper-producing sites commit themselves to the assurance process in step 1 and participate in the self-assessment.[381] The self-assessment is voluntary for sites that are only assessed against the Joint Due Diligence Standard.[382] During step 3 (independent assessment), the sites absolve an independent assessment to prove that the 32 criteria are fully met, partially met, or not met.[383] In case some criteria are just partially or not met an improvement plan will be executed to ensure that all criteria are fully met within 24 months.[384] Sites that just have implemented the Joint Due Diligence Standard have only 12 months to be conform with the Joint Due Diligence Standard.[385] Step 4 (improvement plan) includes a plan to mitigate the identified risks during step 3.[386] This improvement plan is developed jointly.[387] Step 5 (re-assessment) consists of a re-assessment which is done every three years or in case significant incidents or operational changes are assessed.[388] Furthermore, the Copper Mark Assurance Process considers existing systems that are equivalent, not fully equivalent, and not applicable to strengthen responsible production and avoid redundancy across the copper industry.[389] For example, the Joint Due Diligence Standard is an extension of the OECD DD Guidance for downstream companies in the copper supply chain and this guidance is equivalent to the Aluminium Stewardship Initiative (Performance Standard V.2 2017), Initiative for Responsible Mining Assurance (Standard for Responsible Mining (2018), International Council for Mining and Metals (Performance Expactations 2019), London Bullion Market Association (Responsible Gold Guidance V8 2018), World Gold Council (Responsible Gold Mining Principles 2019).[390] Hence, smelters or refiners assessed against one of the equivalent standards for the mineral copper are automatically copper Mark conform.[391] Additionally, the Copper Mark analyzes all findings and supports the participants via training (process and criteria based), guidance, and capacity development.[392] To conclude the Copper Mark is the ideal multi-stakeholder initiative for Siemens Energy, as it provides

[380] See Copper Mark (2021b, p. 4).
[381] See Copper Mark (2021b, p. 10).
[382] See Copper Mark (2021b, p. 12).
[383] See Copper Mark (2021b, p. 11).
[384] See Copper Mark (2021b, p. 11).
[385] See Copper Mark (2021b, p. 12).
[386] See Copper Mark (2021b, p. 21).
[387] See Copper Mark (2021b, p. 21).
[388] See Copper Mark (2021b, p. 10).
[389] See Copper Mark (2021a, p. 11).
[390] See Copper Mark (2020).
[391] See Copper Mark (2020).
[392] See Copper Mark (2021a, p. 5-7).

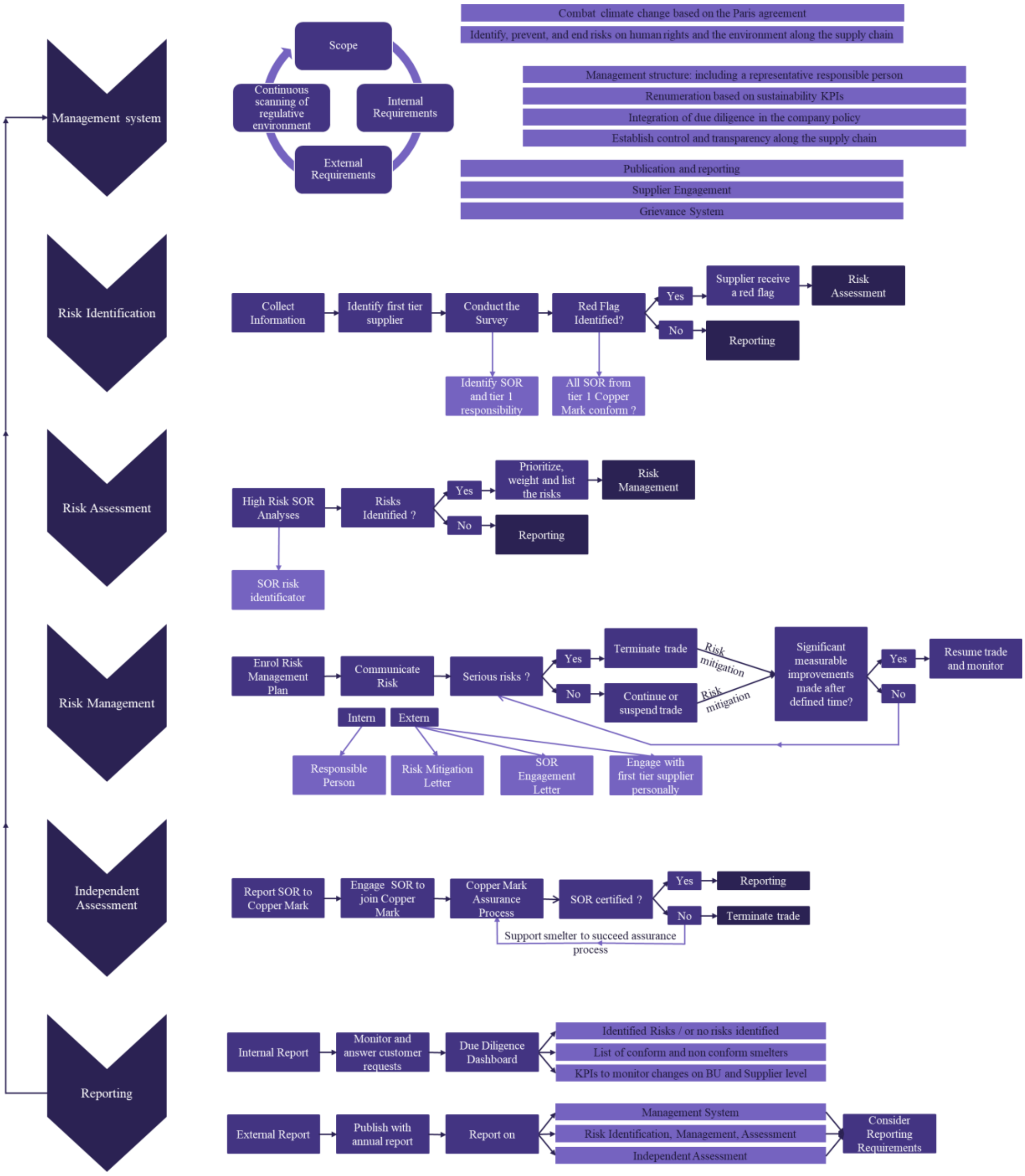
due diligence guidance for upstream companies, which fulfills all required standards of the OECD Guidance as well as the standards of the DFA, CMR, and even the SCDDA and partly the EU Directive 2019/1937 if the specific criteria of the Copper Mark are fulfilled (Chapter 2.2.1 - 2.2.3). The comparison of the specific copper Mark Criteria against the specific laws is provided in Appendix A2. Moreover, the Copper Mark is not solely focused on one mineral, as already four of the five main mined minerals are addressed, while molybdenum will be covered in the future (Chapter 1.2). Furthermore, the multi-stakeholder and third-party approach is recommended for complex supply chains like the supply chain of copper (Chapters 2.5.5.3). In addition, the Copper Mark offers common standards, requirements, and processes while it executes assessments, audits, and training. Additionally, cross-tier collaboration, the exchange of results, stakeholder engagement, and the exception of equivalent systems are given. Hence all advantages of the multi-stakeholder approach from chapter 2.5.5.3 are provided by the Copper Mark. As a result, Siemens Energy supports the engagement of the Copper Mark in the upstream copper supply chain.[393] Additionally, the adjusted OECD DD Guidance for downstream companies in relation to Siemens Energy and the mineral copper is developed and presented in chapter 2.6.

2.6 Model for responsible sourcing of copper for downstream companies

The extended version of the OECD DD Guidance by the Copper Mark is not applicable as the scope of this version is focused on upstream companies in kind of all copper producers like mines, traders, smelters, and refiners, while Siemens Energy is placed in the downstream supply chain.[394] Therefore the OECD DD Guidance is adjusted to the laws in scope. As the CMR and the DFA are already integrated into the OECD DD Guidance and do not cover copper, only the requirements of the SCDDA and the Directive 2019/1937 require additional consideration to be in alignment with the current and upcoming laws (Chapter 2.2). Based on the theoretical knowledge, best practices, the comparison of the OECD DD Guidance, the requirements of the SCDDA, and the Directive 2019/1937 a model is developed to enable due diligence in the copper supply chain at a multinational enterprise.

[393] See Copper Mark (2021c).
[394] See Copper Mark (2022d, p. 8).

Figure 13: Model for responsible sourcing of copper for downstream companies



Source based on: the accumulated knowledge of this thesis.

Figure 13 represents the model for responsible sourcing of copper for downstream companies. The five-step framework of the OECD DD Guidance is presented in the left part of the model. The best practices illustrate that downstream companies focus on risk identification and assessment (step 2). Therefore this model divided these steps and consist of 6 main steps. The first step starts with the management system, which requires a continual scan of the scope of the legislative environment. Thereupon, the internal and external requirements of the management need to be identified and benchmarked against the current management system. In case gaps are identified the management system requires adjustments. The main requirements of the OECD DD Guidance SCDDA and the Directive 2019/1937 are given in the right part of the model, while the details are listed in appendix A5. After step 1 is completed, the risk identification is enrolled, therefore all necessary information on a corporate level are collected to identify significant first tier suppliers. An example is explained in chapter 3.1.2. Afterward, the survey in appendix A3 is conducted to identify smelters and refiners and the responsible sourcing behavior of tier one suppliers. Based on this information, red flags are identified according to chapter 3.1.4, while the exact requirements of the risk identification process are shown in Appendix A5. If risks are identified then they have to be assessed. Therefore the high risk smelter or refiner identificator (chapter 3.2.3) is applied and the identified risks are listed and weighted. This list is the basis for step 4 (risk management). Here the risks are communicated to the smelter or refiner, to the supplier (letter and personally), and the responsible person within the company. In case, serious risks are identified or the risk management plan does not show the desired results, the trade with the supplier has to be terminated, while the exact requirements are elaborated in appendix A.5. Step 5 contains an independent assessment enrolled by the Copper Mark, therefore the tier one supplier and smelter or refiner are reported to the Copper Mark. The Copper Mark engages then with the smelter or refiner to certify the smelter or refiner. The long-term target is that all smelters and refiners in the supply chain are certified and therefore no major sustainability risks are caused in the upstream supply chain. Hence, if a smelter or refiner does not get certified and the provided support by the focal company and its partners does not show success then a phase-out of the not-certified smelter or refiner is required. The last step requires internal and external reporting. The internal reporting is based on the response to customer requests and the KPIs presented in appendix A3, which are integrated into the due diligence dashboard. Therefore continuous improvement can be monitored. The external reporting is integrated into the annual report and based on the information in the right part of the model, while a detailed version is offered in Appendix A5. This model is implemented at Siemens Energy to test if the theoretical concept is applicable in the environment of a multinational enterprise. Therefore design science is chosen as a research methodology and elaborated on in the following chapter.

3 OECD DD Guidance: improvement of responsible sourcing of copper at Siemens Energy via design science

3.1 Design science in the context of responsible sourcing and mineral supply chains

3.1.1 Research Methodology: design science and its motivation at Siemens Energy

Design science serves as the research methodology, as it is a scientific approach for studying and creating artifacts.[395] These artifacts are applicable for researchers who want to solve practical problems, which can be known or unknown.[396] The artifact is described as an object which is applicable for practical problem solving through interaction with a specific context.[397] Hence, the artifact has the potential to shape the desired future as it solves the problem.[398] An advantage of design science is that it supports the understanding of the problem, as knowledge is systematically generated and applied to create a solution.[399] Therefore it is focused on normative, anticipatory, and actionable knowledge to solve the problem, while classical research targets to create descriptive knowledge to explain the problem.[400] Hence design science can close the gap between academic and practical knowledge.[401] In the second part of this thesis, the knowledge regarding the main problem "responsible sourcing of minerals in alignment with the continuously changing legislative environment" were systematically collected. Therefore secondary data were used and a systematic literature review was applied. The procedure of the systematic literature review is provided in Appendix B. The outcome illustrates that the current solution in form of the OECD DD Guidance is outdated as it is insufficient to fulfill current and upcoming regulations (Chapter 2.2.1). Contrary the general solution is still the industry standard regarding the basic entrenchment of due diligence and therefore responsible sourcing in multinational enterprises. Therefore the general solution is adjusted to control for lacking dimensions to be aligned with all legal requirements of chapter 2.2. Based on this knowledge a new artifact is created during the ideation process. The ideation process consists of the Krajic Ma-

[395] See Johannesson and Perjons (2021, p. 77).
[396] See Johannesson and Perjons (2021, p. 77).
[397] See Hevner, March, Park, and Ram (2004, p. 8).
[398] See Stange, Schiele, and Henseler (2022, p. 2).
[399] See Stange et al. (2022, p. 2).
[400] See Stange et al. (2022, p. 2).
[401] See Stange et al. (2022, p. 2).

trix which allows the development of specific strategies per item based on the market power and dependence of the buying and selling company. Therefore, possible solutions become visible and are evaluated which allows to systematically create the best solution for Siemens Energy. At the end of this process, the new artifact is presented in chapter 2.6 and tested at Siemens Energy to be able to evaluate its applicability, quality, pragmatic validity, efficacy, and utility. Therefore several primary and secondary data are gathered at Siemens Energy and its subsidiaries.

3.1.2 Siemens Energy and its subsidiaries as a sampling frame

Siemens Energy collaborates with several other companies (suppliers) to get access to external resources. Therefore Siemens Energy is classified as the population of the sample. The sampling frame is the corporate procurement database of Siemens Energy as it contains all first-tier suppliers. However, Siemens Energy has over 30.000 first-tier suppliers in 140 countries, while only some deliver copper or components.[402] To identify these suppliers the process shown in figure 14 has been developed.

Figure 14: Supplier selection process based on commodity codes

(Figure hidden for confidential reasons)
Source based on: Siemens Energy AG (2021a); Siemens Energy AG (2022c).

Figure 14 shows the selection of significant suppliers based on commodity codes. Firstly commodity codes have been analyzed to figure out which products contain copper. Therefore X commodity codes have been analyzed and X commodity codes are connected to copper. (Text hidden for confidential reasons). The subsidiaries contain around X relevant suppliers, while X suppliers of the largest subsidiary Siemens Gamesa have been identified as significant.

However, laws require an exclusive analysis of the entire supply chain (Chapter 2.2.2-2.2.3). As the scope of this paper is a master thesis this approach is not suitable given the time constraint, but it allows to illustrate if the created artifact is suitable to solve the problem at Siemens Energy. The suppliers in the scope of this thesis including their locations and purchasing volume can be found in table one.

[402] See Siemens Energy AG (2022j, p. 51).

The X suppliers are the unit of observation, as these are the objects which provide data about their supply chain.[403] These direct suppliers serve together with the indirect suppliers as the unit of analysis.[404] To identify the indirect suppliers (smelters or refiners), the X suppliers are requested to provide information regarding their smelters or refiners and due diligence approaches along their supply chains.

3.1.3 Questionaire is the data collection tool to estimate the current state of due diligence practices in the copper supply chain at Siemens Energy

The data collection focuses on information about the purchasing and due diligence approaches of the unit of analysis and observations. This information is related to the detection of the quality of specific things and is therefore classified as qualitative data.[405] The qualitative data are collected via a questionnaire and therefore primary data are gathered. The questionnaire itself is created with the program Microsoft Excel and contains five pages, while the first page serves as an instruction, as the scope and purpose of the document are determined. The second page provides an overview of the definitions to create a common understanding of the questionnaire. For example, smelters are defined as ”A smelter or refiner is a company that procures and processes mineral ore, slag and/or materials from recycled or scrap sources into refined metal or metal-containing intermediate products. The output can be pure (99.5% or greater) metals, powders, ingots, bars, grains, oxides, or salts. The terms "smelter", "refiner", and "processor" are used interchangeably throughout various publications[406] to ensure a common understanding. Additionally, the common understanding is supported by the design and wording of the questions, which are based on several reporting templates of the RMI.[407] The RMI provides well-established reporting templates for several minerals like the 3TG or mica which are applied across various industries.[408] Page three is the declaration which includes the company authentification, the sourcing of the relevant material copper, and the managerial approach of responsible minerals sourcing at the company itself. The reasoning for each question is elaborated in chapter 3.1.4. The fourth page consists of a predefined table where the suppliers are asked to

[403] See Napolitano and Saini (2014, p. 1).
[404] See Van Aken and Berends (2018, p. 131).
[405] See Van Aken and Berends (2018, p. 129).
[406] See RMI (2022a).
[407] See RMI (2022a); RMI (2022b); RMI (2022d); RMI (2022f).
[408] See RMI (2022e); RMI (2022h).

provide information about their smelters. This is required to identify the chokepoints in the supply chain of Siemens Energy and its subsidiaries. The last page serves as a smelter look-up, while all certified smelters or refiners by the Copper Mark and equivalent certification systems are listed there. The questionnaire is sent via email to the account executive on the supplier's side, while the CEO shall authorize the answers. The questionnaire is chosen as the data collection tool, as the suppliers are based in 16 different countries around the world. Moreover, it gives the suppliers the possibility to investigate the required information and allows high data accuracy via an excel analysis. To avoid unanswered questions, key questions are marked as mandatory fields. Especially since it is assumed that not all suppliers have sufficient information about their copper sources, time is provided to investigate the required information via a snowball system. Hence, other data collection tools like interviews are less suitable. Moreover, each question has a field for a closed and open answer. The open answer provides the data for content analysis, which is required for the visualization of the copper supply chain information of direct and indirect suppliers, as well as the related locations and policies. On the other hand, quantitative data in form of yes or no answers is mainly used for the red flag identification and the report, as the performance of the due diligence process is tracked and communicated with numerical key performance indicators (KPI).[409] To ensure the correct application from the user, the yes and no response field is predefined and the answers have to be selected, while the empty response fields request the elaboration of the answer. These KPIs are provided together with the questionnaire in Appendix A3. Additionally, secondary data are used for the plausibility checks. This is done via internet research, public data banks, and reports. Furthermore, secondary data are used to review audits and certifications on the SOR level, as there are plenty of different audits and certification schemes available, which are equivalent to the Copper Mark. After the data collection, the data are analyzed.

3.1.4 Data analysis: investigation of the current state of due diligence in the copper supply chain at Siemens Energy

The process of data analysis starts with the processing of questions 1-3 of the questionnaire to ensure that only relevant supplier data are analyzed. The second step is the identification of critical points which shall be marked with red flags, which are defined in collaboration

[409] See Van Aken and Berends (2018, p. 137).

with Siemens Energy and are set on the supplier level in case of high risks. Therefore questions 4-6 of the questionnaire are analyzed. A red flag is raised when a supplier has not responded, not all smelters in its supply chain are identified, or the supplier has reported to source from smelters that are not conform with the Copper Mark. Therefore the smelter list provided by the supplier is compared to the Copper Mark Conforment Smelter List to identify smelters that are non conformant. The change in the conceptualization of red flags is done to compensate for the missing environmental perspective of the OECD DD Guidance (Chapter 2.2.1). The OECD DD Guidance defines red flags based on the location (the mineral has its origin in a CAHRA or is transported via a CAHRA or the mineral originates from a location where minerals from CAHRA transit or the mineral originates from a country with limited reserves) and the suppliers (the supplier or other known upstream suppliers have shareholder interests in a CAHRA, or the supplier or other known upstream suppliers have sourced, or the supplier does not know if the used minerals originate or transit from a red flag location).[410] Additionally, the adopted concept is not limited to geographical risks, which is required by the SCDDA and the EU Directive 2019/1937 (Chapter 2.2.3). A red flag is set just in case of a finding that there could be a potential risk, while it does not need to confirm that the risk occurs. For suppliers and smelters or refiners which does not cause a red flag, there is no further investigation required. In case the smelter or refiner caused the red flag on the supplier level, the smelter or refiner is listed and analyzed if a high risk is caused by the smelter or refiner. As independent assessments can not be enrolled due to time constraints, the “smelter or refiner risk identificator” was developed. This tool allows analyzing if the smelter or refiner causes a low, medium, high or extreme risk based on internet research and other sources, like the internal data banks of Siemens Energy. Together with the content analysis, this information provides input to prioritize the engagement with suppliers, smelters, or refiners. Moreover, each supplier and smelter or refiner is listed and a possible risk type is identified and weighted. In case serious human rights violations are detected, risk mitigation strategies have to be enrolled which are described in chapter 3.2.4. The answers to questions A-F are used in step three. Here it is proven if the supplier source OECD conform. To source OECD conform, the supplier has to have a responsible minerals policy published on its website, as well as the supplier needs to illustrate its due diligence practices which cover at least all risks of Annex II of the OECD DD Guidance. Additionally, the supplier has to review its suppliers

[410] OECD (2016, p. 33-34); RMI (2022g, p. 21).

due diligence information against its expectations. In case these expectations are not fulfilled, the supplier has to have corrective action management. Suppliers which are not sourcing OECD conform do not receive a red flag based on this information. However, the supplier is requested to improve its sourcing behavior and to become OECD conform. This is required by Directive 2019/1937, as the directive demands an exclusive risk analysis of the supply chain. The process only focuses on the first tier supplier and the chokepoints in the supply chain. By controlling the sourcing behavior of the first tier supplier it can be evaluated if the first tier supplier sources conform or non-conform and raise therefore a risk. In case the Directive 2019/1937 enters into force, Siemens Energy can directly evaluate its first tier suppliers and use the data for red flag identification in the downstream supply chain. Question D is an exception, as it is used to evaluate the different possibilities of the ideation process. In the following, the adjusted OECD DD Guidance is implemented at Siemens Energy.

3.2 Implementation of the model for responsible sourcing of copper for downstream companies at Siemens Energy

3.2.1 Implementation of the management system at Siemens Energy

Firstly the management system was adjusted to the legal requirements. An overview of the exact requirements of the management system from the OECD DD Guidance, the SCDDA, and the Directive 2019/1937 are provided in Appendix A5. The requirements are based on six categories which are grouped into the scope, internal and external requirements.

<u>1. The scope and requirements of the policy</u>: responsible sourcing at Siemens Energy is going beyond the supply chain of minerals from CAHRA, while it also covers CAHRA specifically.[411] Furthermore, all risks in Annex II of the OECD DD Guidance are covered,[412] while additional risks are covered by the supplier code of conduct, including legal compliance, human rights, labor practices, and the environment.[413] (Text hidden for confidential reasons).[414] Direct suppliers commit themselves to comply with their suppliers with the code of conduct and indirect suppliers are in the scope as well. Moreover, the estab-

[411] See Siemens Energy AG (2022h, p. 1).
[412] See Siemens Energy AG (2022h, p. 1).
[413] See Siemens Energy AG (2021b, p. 5).
[414] See Schmitz (2022a).

lished risk management system regarding copper covers human rights and environmental risks via the Copper Mark Criteria which are described and compared to the requirements of the SCDDA and the Directive 2019/1937 in Appendix A3. Furthermore, it targets to identify, prevent and end these risks via on-site audits along the supply chain.[415] A plan of how climate change will be tackled via the reduction of emissions is presented, including targets and actions in alignment with Paris Agreement.[416]

2. Requirements for the structure: the management system integrates leadership with clear organizational roles including responsibilities and accountabilities in form of a governance structure for sustainability.[417] This structure consists of the CEO (name) who is also the chief sustainability officer.[418] The sustainability department (led by name) is integrated into the strategic functions at Siemens Energy which ensures that all measures and initiatives are integrated into the business operations, while the circular management system ensures the implementation of sustainability in all business activities in line with the Siemens Energy Strategy.[419] To conclude (Text is hidden for confidential reasons).

3. Control: the SCDDA and the Directive2019/1937 have no explicit requirements, while the OECD DD Guidance requires an establishment of a traceability system or the identification of upstream actors in the supply chain. Upstream actors are identified and managed with the Copper Mark. Furthermore, data was collected to prove the possibility to establish a traceability system in form of a chain of custody, (Text is hidden for confidential reasons).

4. Publication and communication: the management system ensures the adoption and communication to the suppliers and the public as it is published on the website of Siemens Energy.[420] This includes the integration of sustainability in the company's policy covering all three dimensions (Chapter 2.1) as well as a commitment to the Sustainable Development Goals s and the Paris Agreement to meet global warming of 1.5 degrees.[421] Furthermore, a sustainability report is published on an annual basis since 2020.[422]

5. Supplier engagement: is ensured via the code of conduct and through the conduction of supply chain due diligence (regular communication and reporting) with relevant suppliers.

[415] See Siemens Energy AG (2022h, p. 1).
[416] See Siemens Energy AG (2022j, p. 28).
[417] See Siemens Energy AG (2022j, p. 13-15).
[418] See Siemens Energy AG (2022j, p. 13); Siemens Energy AG (2021b, p. 1).
[419] See Siemens Energy AG (2022j, p. 14-15).
[420] See Siemens Energy AG (2022b).
[421] See Siemens Energy AG (2022j, p. 2 and 28).
[422] See Siemens Energy AG (2022b).

6. Grievance system: on a company level, Siemens Energy has enrolled several channels to report on risks or violations of sustainability standards.[423] Particularly the whistle-blower hotline “Speak up” allows all persons or organizations to inform Siemens Energy about possible risks and violations.[424] Moreover, Copper Mark has an industry-wide grievance system in place which Siemens Energy is a part.[425] To conclude the management system of Siemens Energy fulfills all requirements of the OECD DD Guidance, the SCDDA, and part of the EU Directive 2019/1937. (Text is hidden for confidential reasons).

3.2.2 Risk identification at Siemens Energy

The next step requires the identification and assessment of risks in the copper supply chain. The risks are identified via a red flag identification based on a three-step approach. All smelters or refiners which are not conformant with the Copper Mark receives a red flag, while every supplier receives a red flag who sources at least from one of the smelter or refiner with a red flag or was not able to identify all its smelter or refiner. A broader version of the approach is described in chapter 3.1.4. Therefore, potential risks can be identified in alignment with the SCDDA and the OECD DD Guidance, while risks of Annex II no. 2 and 8 of the EU Directive 2019/1937 are not covered by Copper Mark Criteria and can therefore not be identified and managed via the Copper Mark. In case the law enters into force, additional criteria have to be enrolled to cover the aspects of Annex II no. 2 and 8 (Appendix A2). These risks are related to the import of specific chemicals, pesticides, and specimens. The import of hazardous chemicals and pesticides into the European Union is covered via Reach.[426] Reach is a regulation that targets to protect the environment and human health with the identification of intrinsic chemical substances.[427] Therefore importers and manufacturers have to register these chemical substances in a central data bank controlled by the European Chemical Agency.[428] To control this, Siemens Energy and its suppliers participate in Reach.[429] The trade of any species of wild fauna and flora is not in the scope of this thesis as the thesis is limited to the sourcing of minerals. Additionally, the

[423] See Siemens Energy AG (2022f).
[424] See Siemens Energy AG (2022k).
[425] See Copper Mark (2021d, p. 6).
[426] See European Comission (2022a); European Comission (2022b); European Comission (2022a); European Comission (2022c).
[427] See European Comission (2022d).
[428] See European Comission (2022d).
[429] See Siemens Energy AG (2022j, p. 46).

trade of any species of wild fauna and flora is not relevant for Siemens Energy as it has no demand for species.

Table 1: Red Flag identification of relevant Copper suppliers at Siemens Energy and Siemens Gamesa

(Table is hidden for confidential reasons).
Source based on: Own survey results; Siemens Energy AG (2022c); Siemens Gamesa (2022).

Table 1 shows that 27 out of 29 suppliers cause a red flag as they collaborate with smelters or refiners that are not conform with the Copper Mark, did not participate in the survey, or did not report all smelters or refiners in their supply chain. An additional review of the due diligence approach of the smelter or refiner allows prioritization of red flags supplier and to identify high or extreme-risk smelter or refiner via a risk assessment on the smelter or refiner level (Chapter 3.2.3). Therefore the external risk identification is aligned with the OECD DD Guidance and the laws in scope (Appendix A5).

3.2.3 Risk assessment on smelter or refiner level at Siemens Energy

The criteria regarding the risk assessment are visible in Appendix A5, while it is enrolled on the smelter or refiner level. Therefore all identified smelters or refiners within the supply chain of Siemens Energy have been evaluated based on the developed smelter or refiner risk identificator (table 2). This tool allows for separating high and extreme-risk smelters or refiners from others based on predefined criteria. For implementation, a structured cross-check of the information conducted in the survey is enrolled with secondary data in form of internet research. Moreover, risks can be identified, weighted, and listed. An on-site risk assessment is not required due to the target to source only from conformant smelters or refiners, which is elaborated in chapter 3.2.4. Therefore the due diligence practices of the smelter or refiner and the direct suppliers can be evaluated and the risk assessment is in alignment with the laws in scope and the OECD DD Guidance.

Table 2: Smelter or refiner risk identificator

No.	Question	Answer	Answer	Answer	Answer	Answer	Answer	Answer
1	smelter or refiner is eligible acc. to smelter or refiner database	Yes	Yes	Yes	No	Yes/No	Yes/No	Yes/No
2	smelter or refiner is part	Yes	Yes	Yes	Yes/No	No	Yes/No	Yes/No

	of Siemens Energy Supply Chain							
3	smelter or refiner is in operation	Yes	Yes	Yes	Yes/No	Yes/No	No	Yes/No
4	smelter or refiner is sourcing from CAHRAs or located in a high or extreme risk area and not participating in an accredited audit program	Yes/No	Yes/No	Yes	Yes/No	Yes/No	Yes/No	Yes/No
5	smelter or refiner is non conformant acc. to smelter or refiner database and did not successfully pass the Copper Mark Assurance Process or an equivalent process	Yes/No	Yes	Yes/No	Yes/No	Yes/No	Yes/No	No
6	smelter or refiner is not participating on an accredited audit program like the Copper Mark or an equivalent program and NGO and/or Media report smelter or refiner in connection to OECD DD G. Annex II risk or risks in the scope of the SCDDA or the Directive 2019/1937 within the last five years	Yes	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	No
	High Risk	**Yes**	**Yes**	**Yes**	**No**	**No**	**No**	**No**

Source based on: Siemens Energy AG (2016).

Table 2 shows the smelter or refiner risk identificator which allows the classification of smelter or refiner based on the mentioned criteria in the first column. These criteria have been jointly developed with Siemens Energy and are based on the OECD DD Guidance and the Copper Mark, while criteria four is used to weaken the geographical limitations of the OECD DD Guidance (Chapter 2.2.1; 2.2.5.1). Furthermore, environmental risks are not solely related to CAHRA. In case the smelter or refiner is certified by the Copper Mark or an equivalent system, a low risk is identified. In case of questions one to three are answered with yes, the medium risk is identified. When a single question from four to six is answered with yes, high risk is identified. In case more than two questions from this category are answered with yes, an extreme risk is identified. Smelters or refiners who cause an extreme risk are prioritized (group one), while smelters or refiners with high risks are in group two, and group three smelters or refiners cause a medium risk. Smelters or refiners of group four cause a low risk as these smelters or refiners are assessed by the Copper

Mark or an equivalent system. The result of this analysis is integrated into the internal reporting in chapter 3.2.5, while the assessed risks are listed, weighted, and prioritized in table 15 in Appendix A5.

3.2.4 Risk management and independent assessment at Siemens Energy

All risks are reported to the responsible person at Siemens Energy, as well as the risk management plan is enrolled. This risk management plan is based on a regular reporting of all relevant collected information regarding the identified and potential risks in the supply chain and reported to the management. Furthermore, the suppliers related to the identified and potential risks are informed via a risk mitigation letter. This risk mitigation letter informs the supplier about the identified red flag as well as each smelter or refiner who causes the red flag. Furthermore, it requests the supplier to intensify its engagement with its suppliers and to broaden its knowledge about the origin of its copper as well as ensure that all smelters or refiners are conformant with the Copper Mark or an equivalent certification system. Moreover, it is stated that Siemens Energy is working toward avoiding the use of copper, from smelters or refiners not certified by the Copper Mark or equivalent certification standards. During strategic talks with the supplier, Siemens Energy supports its suppliers collaboratively, to ensure that the requirements and objectives of the due diligence concept are realized. In case the risk mitigation efforts of the supplier do not show advancements or are not sufficiently implemented, a suspension of the use of the supplier will be enrolled. In case after the suspension, no significant advancement can be ascertained, permanent termination of the relationship with the supplier will be executed. In case, serious human rights abuses or the financing of armed groups is detected then the business relationship with the supplier will be terminated. Therefore all requirements regarding risk management, the OECD DD Guidance, and the laws in scope are fulfilled (Appendix A5). However, the smelter or refiners are motivated via a three-channel communication to get certified by the Copper Mark or an equivalent standard, which requires independent assessments on the site of the smelter or refiner.

At first, Siemens Energy concentrates its efforts on establishing internal leverage over its direct suppliers. Moreover, the suppliers are informed about their survey results. In case red flags are identified, a Risk Mitigation Letter (Appendix A6) informs the supplier about the red flag. To mitigate the red flags the suppliers should motivate their smelters or refiners to get certified. This is also addressed during regular meetings with the suppliers.

The second channel is the direct communication between Siemens Energy and its identified smelter or refiners. Therefore, Siemens Energy contacts its identified smelter or refiners with the engagement letter for the smelters or refiners. This letter includes a short description of the company and its motivations to establish a responsible supply chain via collaboration with the Copper Mark, or equivalent certification systems. Moreover, it is stated that Siemens Energy is working together with its suppliers toward avoiding the use of copper within its supply chain from smelters or refiners not certified by Copper Mark, or equivalent certification standards. Additionally, Siemens Energy offers support for the smelter or refiner to ensure that the smelter or refiner is able to register and complete the Copper Mark Assurance Framework. The Smelter or Refiner Engagement Letter is provided in Appendix A6.

In the third channel, all smelters or refiners not certified by Copper Mark are reported to Copper Mark. This is important as other partners of Copper Mark do the same. Therefore, the Copper Mark is able to gain deep insights into the smelter or refiner market. As a result, the Copper Mark and its members can build together leverage with the smelter or refiners. This leverage is then used to motivate the smelter or refiners to get certified via independent assessments.

The three-channel communication is enrolled in parallel. In case the smelter or refiner participates in the Copper Mark Assurance Framework, the results of the independent assessments based on each criterion are shared on the webpage of Copper Mark. Additionally, the Copper Mark offers assurance in alignment with the OECD DD Guidance for responsible sourcing.[430] The SCDDA does not require independent assessments, while the Directive 2019/1937 only requires "independent third-party verification"[431] by the contracting of suppliers to ensure compliance.[432] Hence a comparison of the OECD DD Guidance requirements on independent assessments of the Copper Mark and the laws in scope is not required. In case the target to solely source from certified smelters or refiners by the Copper Mark or an equivalent assessment system is realized, low risks regarding the laws in scope are raised and all relevant suppliers within the supply chain are accessed via on-site assessments. However, a switch to suppliers which solely source from certified smelters or

430 See Copper Mark (2022f).
431 European Commission (2022b, p. 55).
432 BMAS (2021, p. 1-23); European Commission (2022b, p. 55).

refiners is not a possibility at this stage of the project. The market is too small and the design maturity of copper related products is too high (Chapter 2.5.1). Nevertheless, in future the conformance with the laws in scope can be ensured.

3.2.5 Reporting at Siemens Energy

The reporting is differentiated between internal and external reporting. The external reporting is based on the OECD DD Guidance and includes a description of the management system, the data gathering and processing for red-flag identification, an explanation of how the due diligence efforts and the methodology are adopted, and a review of the results. The report will be published in the sustainability report 2022/2023 by Siemens Energy. (Text is hidden for confidential reasons).The results will be integrated into the existing reporting structure for responsible minerals sourcing published on page 54 in the sustainability report 2021 of Siemens Energy,[433] including external sustainability audits, agreed-upon improvement measures with suppliers, and accepted external sustainability audits. Furthermore, information will be uploaded on the website of Siemens Energy.[434] The list of certified smelters or refiners is published on the webpage of the RMI and the Copper Mark.[435] Internal reporting enables the monitoring of the due diligence process. Based on the yearly conduction of the due diligence execution at Siemens Energy changes in the supply chain can be identified and continuous improvement is ensured. For this reason, the KPIs developed in Chapter 3.1.4 are applied and the fundamentals of the calculation are provided in Appendix A3.

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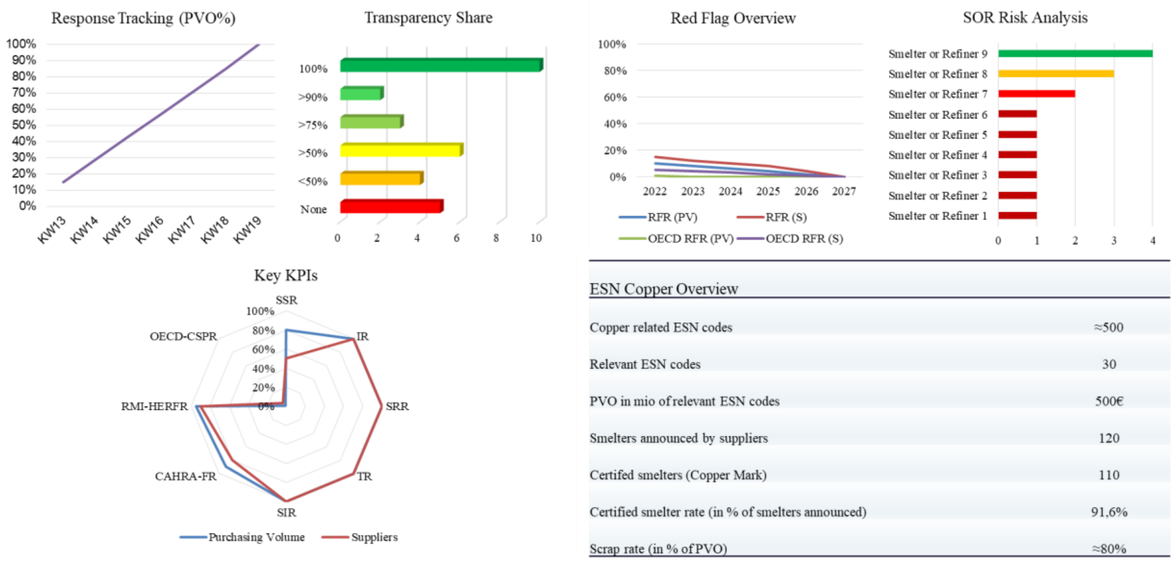
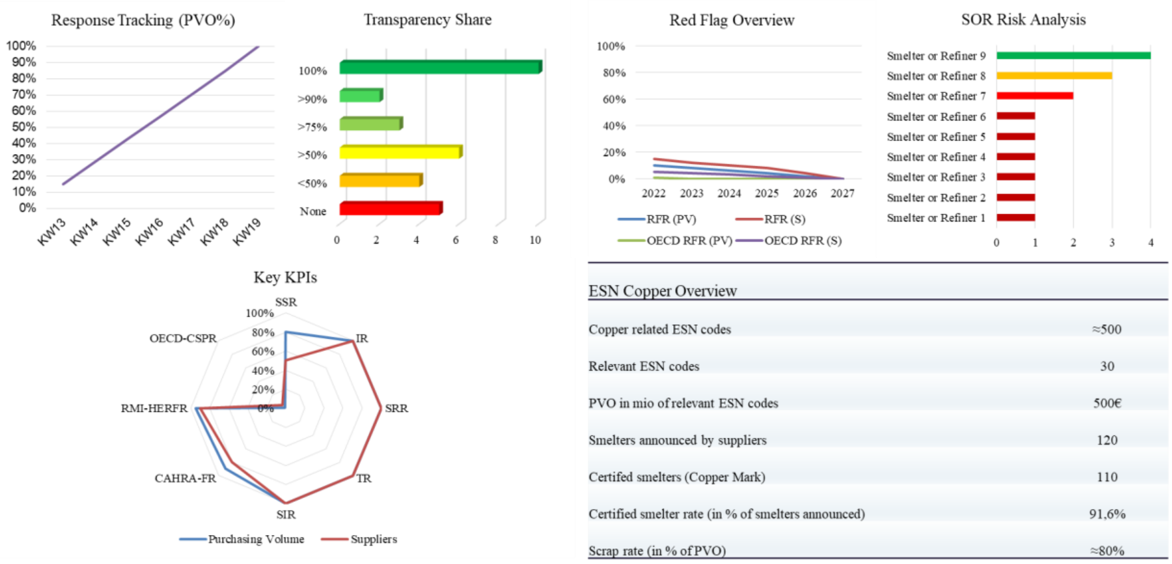
[433] See Siemens Energy AG (2022j, p. 54).
[434] Will be published on: Siemens Energy AG (2021b); Siemens Energy AG (2022i).
[435] See Copper Mark (2022b); RMI (2022c).

Figure 15: Due diligence dashboard for copper at Siemens Energy (fictive values)



Source: Survey results based on own survey results and secondary data analysis.

Figure 16: Due diligence dashboard for copper at Siemens Gamesa (fictive values)



Source: Survey results based on own survey results and secondary data analysis.

Figure 15 (Siemens Energy) and figure 16 show the results on the company level of the first survey regarding copper due diligence at Siemens Energy and Siemens Gamesa. The dashboard was designed to visualize changes in the data over time. In the future, the graphic response tracking will add a line for each year. The transparency share will be only visible in detail for the current year, while the red flag overview will indicate if the risk in general decreases or increases. The smelter or refiner risk analysis shows all smelters or refiners in the supply chain listed by the results of the risk assessment in the current year.

Therefore the identified smelter or refiners are grouped into categories according to the smelter or refiner risk identificator. The radar chart shows the key KPIs, which visualize the robustness of the data (SSR, IR, SRR, SIR, TR) and provide an overview of the risk related to specific regions (CAHRAFR, RMIHERFR) and if the supplier source OECD conform. In the following years, the development is visualized with further lines for each year, which enables a direct comparison of each KPI. The Commodity Code copper overview will show the rows per year to provide insights data basis. Hence, it can be evaluated if the implemented approach was sufficient or not. The data are gathered for Siemens Energy on the business unit level. This is important as different business units have different commodity managers and suppliers. Therefore competition between the business units can be created to motivate the responsible persons to achieve better results in risk mitigation. Moreover, the KPIs are reported on purchasing volume and supplier levels to ensure a non-exclusive approach. This follows the logic of a risk-based approach, as in the beginning large advancements are ensured via a focus on the purchasing volume, while it is required that all suppliers are conformant (Chapter 2.2.1). A single focus on suppliers will not be sufficient, as the theory argues that a focus on key suppliers promises larger success regarding the engagement with the supplier itself and its smelter or refiners. The data on the business unit level is provided in Appendix A5. After the model was implemented at Siemens Energy a reflection is provided to evaluate the model's applicability.

3.3 Evaluation, limitation, generalization, and contribution of the model: further research is required

3.3.1 Limitations: data quality, full risk management for downstream supply chain, and specific risks of the Directive 2019/1937

During the implementation stage of the project, several problems occurred. Firstly it was crucial to track the supplier response and to motivate the suppliers to respond. Furthermore, the quality of the answers varied a lot. Therefore it is time-consuming to get valid and reliable answers from the suppliers. Especially some suppliers have their key resources in their supply chain. As a result, these suppliers are not willing to share information regarding the supply chain or their key suppliers. This circumstance makes it difficult to identify all smelters and refiners in the supply chain. After the smelters or refiners are identified the confirmation or disclaimer of potential risks is difficult, especially without on-site assessments. Therefore it is key to get all smelters and refiners in the supply chain certified to ensure no risks are caused in the upstream supply chain. Another barrier in the model is the engagement with the smelter or refiner. Here it is difficult to identify the correct contact data in case the supplier did not provide it. Even more problematic is the motivation of the smelter or refiner to engage with the Copper Mark due to a lack of interest. Here a joint engagement with the supplier, the Copper Mark, and the focal firm is continuously required to motivate the smelter or refiner to get certified. Lastly, the commitment of the focal firm seems to be key for handling internal barriers. At Siemens Energy, this commitment was given, and therefore all issues during the implementation phase could be managed, and the engagement with the most direct suppliers where successful.

Itself, the model has the potential to answer the research question, as it enables a downstream company to establish due diligence to control the relevant risks. Moreover, it targets to broaden the market for responsible suppliers with a multi-stakeholder initiative, the Copper Mark. Therefore the multinational enterprise has in the future the possibility to solely source from suppliers which source from responsible smelters or refiners assessed from the Copper Mark which raises no risks regarding the laws in scope. The purchasing process for the mineral copper will be aligned with the legislative regulations. To conclude, the quality of the model has the potential to satisfy all relevant attributes in the future. This can be evaluated in the next years with the due diligence dashboard. Therefore long-term monitoring is required, as sustainable developments are only visible after a few years, due to the duration of the assessments on the smelter or refiner level. Here it will be interesting to review the amount of identified and successfully audited smelters or refiners. This can be evaluated and visualized with the due diligence dashboard year over year. In case the certified smelter rate will decrease significantly the model can be seen as valid. To be in alignment with Directive 2019/1937 the red flag rate has to be at zero till the directive enters into force.

Nevertheless, the model shows also limitations. The Directive 2019/1937 also requires an internal risk and impact identification and a reporting of the operations from companies in group one, where Siemens Energy counts too (Chapter 2.2.3).[436] This is not in the scope of this thesis, as the thesis is focused on a specific supply chain and not on the focal multina-

[436] See Siemens Energy AG (2022c. p. 59).

tional enterprise itself. To conclude it would not be sufficient to entrench this model in the purchasing strategy, as it does not consider internal operations or impact identification.

Another limitation is the fact that the risks (Annex II no. 2 and 8) of the Directive 2019/1937 are not considered by the Copper Mark and therefore these risks are not controlled. In case another company is connected to these risks another solution (may a different multi-stakeholder initiative has to be found for risk mitigation.

Moreover, the current version of the Directive requires a liability of all direct and indirect suppliers. The model only allows for the control of sub-supplier behavior in the upstream supply chain. In case a sub-supplier in the downstream supply chain breaches the law, no violations are detected with this model. Risks regarding violations in the downstream supply chain have been identified as low but cannot be excluded. In the future, the management system and risk identification could be supported by a blockchain, which would also allow to detection of risks in the downstream supply chain. As the risks are low in the downstream supply chain and the suppliers would be visible, the focal firm could directly engage with the specific sub-supplier.

Additionally, Directive 2019/1937 obligates companies to control their downstream supply chain (customers). This is out of the scope of this model and the thesis. In general, the model is limited to the copper supply chain, due to the partnership with the Copper Mark. This partnership is not only ideal for copper as the Copper Mark manages next to this mineral and also other main mined minerals. Hence, the model can be used for all minerals in the scope of the Copper Mark. The partnership with the Copper Mark shows that most of the risks can be managed at the smelter or refiner level in the upstream supply chain. Considering minerals, not in the scope of the Copper Mark, another partnership with a multi-stakeholder initiative is required. This partner can be investigated via tables 4 and 5 in Appendix A2 and is further discussed in chapter 3.3.2.

3.3.2 Generalization of the model: the main barrier is a possible lack of a matching partner

The model is limited to the copper supply chain (Chapter 3.3.1). However, the main approach can be extended to mineral supply chains in general. To elaborate on it, step 1 (management system) accounts for all mineral supply chains. In step 2 (risk identification) changes are required, as the Copper Mark only certifies smelters or refiners which are processing copper, lead, nickel, zinc, and in future molybdenum. Here other multi-stakeholder initiatives could solve the problem like the RMI. For example, the RMI assessment is equivalent to the Copper Mark assurance process (Chapter 2.5.5.4) and covers minerals like 3TG, cobalt, nickel, mica, and zinc. Nevertheless, the concept to identify the choke points in the supply chain and certifying them is adaptable to other mineral supply chains. Especially as the smelters and refiners are also the chokepoints in other mineral supply chains because after the ore is transformed no separation between conflict-affected and conflict-free ores is possible, smelters usually process more than one mineral, and major risks occur earlier in the supply chain. Therefore also step 3 can be transferred to other mineral supply chains, as the smelter or refiner risk identificator can be applied and risks can be confirmed, prioritized listed, and weighted. Step 4, risk management is also adaptable to other mineral supply chains, as the risk management plan remains the same. The confirmed or non-confirmed risks need to be reported and in case serious risks are identified the trade with the supplier has to be terminated till significant improvements are realized. The independent assessment (step 5) requires like step 2 another multi-stakeholder organization to certify the chokepoint in the supply chain to ensure that the chokepoint and its sub-suppliers are not violating the laws. Step 6 does not need major changes to be extendable to other mineral supply chains. Only the KPI regarding the multi-stakeholder initiative (Copper Mark Conformant smelter rate) needs to be changed to the multi-stakeholder initiative in lead.

The generalization to other supply chains, like to the forestry, fishery, aquaculture, food, and beverage supply chains is more difficult. However, step 1 can be adopted as a permanent scanning of the regulative environment is needed to update the requirements on the management system and to adjust it. The generalization is limited in step 2 as a new risk analysis has to be performed in the supply chain to identify in which stages the risks occur. Moreover, the concept of chokepoints can be adopted in case chokepoints are identified which have the potential to manage other suppliers. For example, the mines could be replaced by the vessels which catch fish.[437] The fish auction places or the wholesaler could have the potential to control their direct suppliers in form of the fishermen.[438] To conclude the fish auction places could be certified to ensure no violations in the upstream supply chain. However, multi-stakeholder organizations have to be identified to certify the chokepoints. Regarding risk assessment, a new process to identify risks is required, as the risk identificator was developed to identify risks in mineral supply chains and the risks in other

[437] See Widyaningrum and Masruroh (2012, p. 23).
[438] See Widyaningrum and Masruroh (2012, p. 23).

industries will most likely differ. The risk management would not require significant changes, as collaboration with uncertified suppliers should be avoided. Regarding the independent assessments, multi-stakeholder organizations have to be identified to enroll independent assessments on the sites. The reporting would not require changes, only some specific KPIs would be required to monitor the development of the due diligence process. In total the general concept of the model can be generalized across different industries and their supply chains, while the main barrier is the identification of a matching partnership in form of a multi-stakeholder organization and the identification of the required choke points. Moreover, the copper supply chain and mineral supply chains in general get more and more attention regarding responsible sourcing (chapter 1.2). This works as an enabler for this model as a critical mass is required to establish standards, and certification systems and to influence lower-tier behavior (chapter 2.5.5). Other industries may not have this attention and therefore a multi-stakeholder organization may not have the power to influence lower-tier behavior. Additionally, the focal firm could suffer from a lack of power as it may not find other matching partners to build leverage about the chokepoints in its supply chain. Therefore it becomes visible that further research is required while this is elaborated in chapter 3.3.4. Nevertheless, the thesis has the potential to close the knowledge gap in the academic world, while it provides meaningful managerial knowledge.

3.3.3 Actual knowledge is summarized and tested, while a model is provided to align the sourcing process with the current and upcoming regulations of the EU

The thesis closes the academic knowledge gap in the context of sustainability, multi-tier supply chain management, and high complex supply chains with the model presented in figure 13. This model connects the theoretical knowledge of the management of bottleneck items, multi-tier supply chain management, and sustainability in multi-tier supply chain management. Most studies are based on a triadic approach in less complex supply chains like the food or textile industry. Therefore no model was tested in complex supply chains which have a length of up to 20tiers.[439] To conclude, low comparability to prior studies is given as most studies have been conducted in supply chains with 3-4 lower tier suppliers. Therefore meaningful knowledge is generated as it can be evaluated if the multi-tier supply

[439] See Sauer (2021, p. 1); Van den Brink et al. (2019, p. 393); Sauer and Seuring (2018, p. 560).

chain management approach suggested by three scientific papers[440] shows success regarding the management of lower-tier suppliers and sustainability in high complex supply chains. Moreover, practical and academic knowledge has been connected with the design science approach. The result is a theoretical concept that was designed under practical conditions to ensure high applicability in downstream companies. This allows the validation of the high collaborative approach suggested by the authors[441] in high complex supply chains.
The practical solution in high complex supply chains is the OECD DD Guidance which is already outdated as significant elements are missing to be in alignment with the SCDDA or the upcoming directive of the EU. Therefore a practical solution is required to close this gap. The model of this thesis provides such a solution. It shows how due diligence in mineral supply chains can be established in alignment with the current and upcoming regulative requirements of the EU by downstream companies. Therefore managers can use the theoretical model to adjust the management system, risk identification, risk assessment, independent assessment, and reporting of the companies they are working in. This is meaningful as the managerial knowledge regarding the implementation of the SCDDA is just developing, while managerial knowledge regarding the Directive 2019/1937 is lacking. Moreover, all crucial elements of the two laws are summarized in tables. This allows managers to check the current state of their companies regarding the alignment of the sourcing process with the two laws. As the model is already successfully established at Siemens Energy the risk of failure is low, at least for the mineral copper. Furthermore, the regulative frameworks regarding due diligence and the sourcing of minerals are changing fast. This can be taken into consideration with the systematic approach to analyse laws by the six main steps of the model. Most likely, the responsible sourcing process based on these six steps can be adjusted to the requirements of new upcoming regulative frameworks.
Additionally, managers can use this thesis to have an overview of the issues in mineral sourcing and especially for copper. Moreover, diverse strategies to mitigate the barriers of multi-tier supply chain management in the context of sustainability in the mineral supply chains are explained and evaluated in relation to the environment of the focal firm. Therefore managers can evaluate which strategy fits best to the company they are responsible for. To conclude, this thesis supports managers to close the knowledge gap regarding the

[440] See Mena et al. (2013, p. 72); Tachizawa and Wong (2014, p. 656); Wilhelm et al. (2016, p. 197).
[441] See Mena et al. (2013, p. 72); Tachizawa and Wong (2014, p. 656); Wilhelm et al. (2016, p. 197).

fast-changing environment of responsible sourcing as well as to make their companies ready to contribute toward sustainability along the supply chain.

3.3.4 Research is required: downstream management of suppliers, internal processes, and the management of company’s downstream activities

Further research is required in three main areas. Firstly the current model excludes possible risks in the downstream supply chain between the tier one supplier and the chokepoint in the supply chain. Here it would be meaningful to do research that targets to monitor all suppliers in the supply chain, including suppliers which cause only low risks. As the interpretation of the Directive, 2019/1937 remains unclear regarding a risk based approach or a duty of success companies run into the risk that a risk based approach is may not sufficient. Hence, even if a company aligns its mineral supply chains with the provided model courts could potentially judge the company for violations even if the company controls and monitors its supply chains with its best efforts. Especially if a duty of success would be confirmed a focus on the chokepoints to mitigate risks in the upstream supply chain would cause a high risk as possible violations between the tier one supplier and the choke point could not be detected or mitigated.

Secondly, the current model does not consider the internal processes of the focal firm. Here it would be useful to analyze how the focal firm can adjust its internal processes and the processes of its subsidiaries with the current and upcoming regulative requirements. The last main field is the issue that Directive 2019/1937 holds the focal firm responsible for the entire value chain. Hence a model is required that not only controls the upstream supply chain, due to the responsibility of the focal firm for its customers. Therefore a model regarding the management of the downstream activities in alignment with the upcoming regulative requirements is highly demanded.

If research in all three fields would be aligned an overall model could be established which provides managers the knowledge to fully align the corporate activities with the upcoming directive.

Moreover, it would be meaningful to monitor the long term success of this model at Siemens Energy. Hence it could be proven if a long term success is established. This would validate the model and confirm the concept of a multi-stakeholder approach regarding multi-tier supplier management and high complex supply chains. Therefore the previously mentioned research gap (chapter 3.3.3) could be closed. This could be done by Siemens Energy as the company monitors the due diligence approach and could share its insights with the academic world.

4 Sustainability risks are mitigated and aligned with the current and upcoming regulative requirements of the EU can be achieved by the model

The analysis of the considered literature regarding multi-tier supply chain management offers several opportunities to strengthen the responsibility on the lower tier level, while the highly collaborative approach promises the largest success. Moreover, the best practices provide a similar result and illustrated that the OECD DD Guidance was a useful tool to establish responsible sourcing for the 3TG. However, the OECD DD Guidance does not fulfill current legislative requirements like the SCDDA or future requirements of the Directive 2019/1937 and cannot answer the research question. Furthermore, the main barrier to the highly collaborative approach is the engagement with a matching partner. Through the developed model and the establishment of a matching partnership at Siemens Energy, the research questions:

> "*How can a multinational downstream company ensure responsible sourcing along the supply chain of minerals with the current and upcoming regulative requirements?"*

> *"Which elements are required to reply to the upcoming regulative requirements of the EU of minerals?"*

laws?" can be answered. Research question one is answered by the model for responsible sourcing of copper for downstream companies presented in chapter 2.6. This model is based on the five-step framework of OECD DD Guidance. This guidance was adjusted via practical experiences of several multinational downstream companies, new regulative requirements of the SCDDA and the Directive 2019/1937, the theoretical knowledge of multi-tier supplier management, and the management of suppliers for bottleneck items. Furthermore, this model has been successfully implemented in a multinational downstream company to ensure a high level of applicability and to test its validity. The main barrier during the implementation of the model was the identification of the chokepoints in the supply chain and the motivation of these chokepoints to participate in independent assessments. The first barrier could be managed in future with the blockchain technology and the second barrier will be mitigated over time. This follows the logic that more chokepoints are willing to participate when the demand for certified chokepoints increases and more competitors of the chokepoints get certified. The main limitation of this model is that it is limited to the management of the upstream supply chain. In case, the Directive 2019/1937 enters into force with the current definition and liability of the supply chain, a system is required to detect and mitigate the risks in the downstream supply chain. This could potentially be done via a blockchain solution. However, the risks in the downstream supply chain are identified as low. The second research question is answered as all elements regarding responsible sourcing based on the SCDDA and the Directive 2019/1937 are given. Tables 4 and 5 show the risks in the scope of both relative frameworks. The obligations for fulfillment are provided based on the steps of the model: management system (table 16), risk identification (table 17) risk assessment (table 17), risk management (table 18), and reporting (table 19). Therefore this thesis enables other companies to establish responsible sourcing regarding copper and other main mined minerals under consideration of the current upcoming regulative requirements of the EU.

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Appendix

A1: Critical Minerals: mining and their application

Table 3: Critical Minerals based on the EU and USA and their industrial application in 2020

Critical mineral	associated main mineral	Stage	Application
Antimony	Lead, Copper	Extraction	Flame retardants, defence applications, lead-acid batteries
Barite	Lead, Zinc, Iron,	Extraction	Medical applications, radiation protection, chemical applications
Beryllium	Copper, Tantalum	Extraction	Electronic and communications, equipment, automotive, aerospace and defence components
Bismuth	Lead	Processing	Pharmaceutical and animal feed industries, medical applications, low-melting-point alloys
Cobalt	Copper, Nickel	Extraction	Batteries, superalloys, catalysts, magnets
Fluorspar	Lead, Copper, Zinc	Extraction	Steel and iron making, refrigeration and air-conditioning, aluminium making, and other metallurgy
Gallium	Copper, Lead, Zinc	Processing	Semiconductors, photovoltaic cells
Germanium	Zinc, Lead, Copper	Processing	Optical fibres, infrared optics, satellite solar cells, polymerisation catalysts
Hafnium	Nickel	Processing	Superalloys, nuclear control rods, refractory ceramics
Indium	Copper, Zinc, Lead	Processing	Flat-panel displays, photovoltaic cells, photonics solders
Lithium	only mined next to other critical minerals	Processing	Batteries, glass, ceramics, steel and aluminium, metallurgy
Magnesium	only mined next to other critical minerals	Processing	Lightweight alloys for automotive, electronics, packaging, construction, desulphurisation agent in steelmaking
Natural Graphite	Copper, Lead	Processing	Batteries, Refractories for steelmaking
Niobium	only mined next to other critical minerals	Processing	High-strength steel and superalloys for transportation and infrastructure, high-tech applications like capacitors,
Tantalum	only mined next to other critical minerals	Extraction	Capacitors for electronic devices and superalloys
Titanium	Copper	Processing	Lightweight high-strength alloys for, aeronautics, space, defence, medical applications
Tungsten	Lead, Copper	Processing	Alloys for aeronautics, space, defence, electrical, technology. Also used for a mill, cutting and mining tools
Vanadium	Molybdenum, Copper, Zinc	Processing	High-strength-low- alloys e.g. aeronautics, space, nuclear reactors, chemical catalysts
Scandium	only mined next to other critical minerals	Processing	Solid oxide fuel cells, lightweight alloys
Strontium	Molybdenum, Copper, Lead	Extraction	Ceramic magnets, aluminium alloys, medical applications, pyrotechnics
Rare Earth Elements	Copper, Nickel, Zinc, Lead, Molybdenum	Processing	Permanent magnets for electric motors and electricity generators, lighting phosphors, catalysts, batteries, glass and ceramics

Source based on: Department of the Interior (2021, p. 62201-62202); Ebunu, Olanrewaju, Ogolo, Adetunji, and Onwualu (2021, p. 6-7); European Commission (2020a, p. 18-20); (2022a); Mine data (2022b); Mine data (2022c); Mine data (2022d); Mine data (2022e); Mine data (2022f); Mine data (2022g); Mine data (2022h); Mine data (2022i); Mine data (2022j); Mine data (2022k): Mine data (2022l); Mine data (2022m); Mine data (2022n); Mine data (2022o); Mine data (2022p); Mine data (2022q): Mine data (2022r); Mine data (2022s); Mine data (2022t).

Table 3 shows the name of critical minerals, the associated main minerals, their production stage, and the application of the critical mineral. The column main mineral shows only the main minerals associated with the critical mineral, which are usually mined as by minerals. For example, lead deposits contain also antimony. Associated by minerals are not listed, for example, gallium deposits contain also germanium.[442]

A2: Comparison: Copper Mark Criteria fulfill current and future laws

Table 4: Comparison of the SCDDA requirements and the Copper Mark Criteria regarding human and environmental rights

Row Number	SCDDA	SCDDA Page	Fulfilled/overachieved by Copper Mark Criteria
1	International Labor Organization Convention No. 29 (forced labor)	p. 20	No. 6, p. 4
2	International Labor Organization Convention No. 87 (Freedom of Association and Protection of the Right to Organise)	p. 20	No. 7, p. 4
3	International Labor Organization Convention No. 98 (Right to Organise and Collectively Bargain)	p. 20	No. 7, p. 4
4	International Labor Organization Convention No. 100 (Equal Remuneration)	p. 20	No. 8, p. 4
5	International Labor Organization Convention No. 105 (Abolition of Forced Labour)	p. 20	No. 6, p. 4
6	International Labor Organization Convention No. 111 (Discrimination)	p. 20	No. 8, p. 4
7	International Labor Organization Convention No. 138 (Minimum Age Convention)	p. 20	No. 5, p. 3

[442] See Mine data (2022d); Mine data (2022e).

8	International Labor Organization Convention No. 182 (Worst Forms of Child Labour)	p. 20	No. 5, p. 3
9	International Covenant on Economic, Social, and Cultural Rights	United Nations (1966, p. 1-8)	Covered in rows 14-19
10	Minamata Convention (prohibition to produce mercury-added products and treatment of waste)	p. 20	No. 18, 19, p. 4
11	Stockholm Convention (biodiversity and organic pollutants)	p. 20	No. 21, p. 5
12	Basel Convention (export of hazardous waste)	p. 20	No. 18, p. 4
13	International Covenant on Civil and Political Rights	p. 20	(Covered in rows 14-19)
14	Prohibition of any forms of slavery	p. 3	No. 5, 6, p. 3
15	Safety standards, maintenance of workplace, measure and avoid exposure to chemical physical and biological substances	p. 2	No. 12, p. 4
16	Prevent physical and mental fatigue like to avoid inadequate training and instructions, providing breaks and reasonable working hours	p. 2	No. 10, p. 4
17	Prohibition of disregarding freedom to join trade unions, trade unions are free to operate including the right to strike and collective bargaining	p. 3	No. 7, p. 4
18	Prohibition of unequal treatment, adequate living wage	p. 3	No. 9, 11, p. 4
19	Prohibition of causing harmful soil change, water or air pollution, noises or excessive water consumption	p. 4	No. 16, 17 p. 4, no. 19, 20, p. 5
20	Prohibition of unlawful eviction or taking of land, water, or forests	p. 4	No. 28, 29, 30, p. 5

21	Prohibition of using or hiring private or public security services to protect the enterprise or its project due to a lack of control or instruction	p. 4	No. 27, p. 5

Source based on: BMAS (2021, p. 1-20); Copper Mark (2021e, p. 1-6), United Nations (1966, p. 1-8).

The scope of table 4 is to prove if all requirements regarding human and environmental risks of the SCDDA are covered by the Copper Mark Criteria. The Copper Mark Criteria are requirements that are independently proved by on-site assessments. To conclude, if a supplier is successfully assessed against the specific Copper Mark Criteria, this supplier fulfills or overachieves the specific risk covered in the SCDDA. Therefore the legal requirements of the SCDDA are numbered and cited in the first and second columns, while the exact page number is given in column three. The fourth column provides the specific Copper Mark criteria in case it fulfills or overachieves the requirements of the SCDDA. As a result, it becomes visible that all legal requirements regarding human and environmental rights are covered by Copper Mark. Hence, a company that is fulfilling certain criteria is causing low risks regarding the certain requirements of the SCDDA.

Table 5: Benchmark of the Directive 2019/1937 requirements against the Copper Mark Criteria regarding human and environmental rights

Number	Directive 2019/1937 Annex I, II and Article 15	Page	Fulfilled/overachieved by Copper Mark Criteria
Annex I no. 1	Violation of the people's right to dispose of a land's natural resources and to not be deprived of means of subsistence in accordance with Article 1 of the International Covenant on Civil and Political Rights.	1	No. 6, p. 4
Annex I no. 2	Violation of the right to life and security in accordance with Article 3 of the Universal Declaration on Human rights.	1	No. 26, 27 p. 5
Annex I no. 3	Violation of the prohibition of torture, cruel, inhuman or degrading treatment in accordance with Article 5 of the Universal Declaration of Human Rights.	1	No. 26, p. 5

Annex I no. 4	Violation of the right to liberty and security in accordance with Article 9 of the Universal Declaration of Human Rights.	1	No. 26, 27, p. 5
Annex I no. 5	Violation of the prohibition of arbitrary or unlawful interference with a person's privacy, family, home, or correspondence and attacks on their reputation, in accordance with Article 17 of the Universal Declaration of Human. .Rights	1	No. 26, 27 p. 5
Annex I no. 6	Violation of the prohibition of interference with the freedom of thought, conscience, and religion in accordance with Article 18 of the Universal Declaration of Human Rights.	1	No. 8 p. 4, no. 26, p. 5
Annex I no. 7	Violation of the right to enjoy just and favorable conditions of work including a fair wage, a decent living, safe and healthy working conditions and reasonable limitation of working hours in accordance with Article 7 of the International Covenant on Economic, Social and Cultural Rights.	1	No. 5, 6, p. 3 no. 7, 9, 11, 12, p. 4
Annex I no. 8	Violation of the prohibition to restrict workers' access to adequate housing, if the workforce is housed in accommodation provided by the company, and to restrict workers' access to adequate food, clothing, and water and sanitation in the workplace in accordance with Article 11 of the International Covenant on Economic, Social and Cultural Rights.	1	No. 5, 6, p. 3 no. 7, 9, 11, 12, p. 5

Annex I no. 9	Violation of the right of the child to have his or her best interests given primary consideration in all decisions and actions that affect children in accordance with Article 3 of the Convention of the Rights of the Child; violation of the right of the child to develop to his or her full potential in accordance with Article 6 of the Convention of the Rights of the Child; violation of the right of the child to the highest attainable standard of health in accordance with Article 24 of the Convention on the Rights of the Child; violation of the right to social security and an adequate standard of living in accordance with Article 26 and 27 of the Convention on the Rights of the Child; violation of the right to education in accordance with Article 28 of the Convention on the Rights of the Child; violation of the right of the child to be protected from all forms of sexual exploitation and sexual abuse and to be protected from being abducted, sold or moved illegally to a different place in or outside their country for the purpose of exploitation, in accordance with Articles 34 and 35 of the Convention of the Rights of the Child.	1	No. 5, p. 3, no. 6, p. 4
Annex I no. 10	Violation of the prohibition of the employment of a child under the age at which compulsory schooling is completed and, in any case, is not less than 15 years, except where the law of the place of	2	No. 5, p. 3

	employment so provides in accordance with Article 2 (4) and Articles 4 to 8 of the International Labour Organization Minimum Age Convention, 1973 (No. 138).		
Annex I no. 11	Violation of the prohibition of child labour pursuant to Article 32 of the Convention on the Rights of the Child, including the worst forms of child labour for children (persons below the age of 18 years) in accordance with Article 3 of the of the International Labour Organization Worst Forms of Child Labour Convention, 1999 (No. 182). This includes:	2	No. 5, p. 3
Annex I no. 11a	All forms of slavery or practices similar to slavery, such as the sale and trafficking of children, debt bondage and serfdom, as well as forced or compulsory labour, including the forced or compulsory recruitment of children for use in armed conflicts.	2	No. 6, p. 4
Annex I no. 11b	The use, procuring or offering of a child for prostitution, for the production of pornography or for pornographic performances.	2	No. 5, p. 3
Annex I no. 11c	The use, procuring or offering of a child for illicit activities, in particular for the production of or trafficking in drugs.	2	No. 5, p. 3
Annex I no. 11d	Work which, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety or morals of children.	2	No. 5, p. 3

Annex I no. 12	Violation of the prohibition of forced labour; this includes all work or service that is exacted from any person under the menace of any penalty and for which the said person has not offered himself or herself voluntarily, for example as a result of debt bondage or trafficking in human beings; excluded from forced labour are any work or services that comply with Article 2 (2) of International Labour Organization Forced Labour Convention, 1930 (No. 29) or with Article 8 (3) (b) and (c) of the International Covenant on Civil and Political Rights.	2	No. 6, p. 4
Annex I no. 13	Violation of the prohibition of all forms of slavery, practices akin to slavery, serfdom or other forms of domination or oppression in the workplace, such as extreme economic or sexual exploitation and humiliation in accordance with Article 4 of the Universal Declaration of Human Rights and Art. 8 of the International Covenant on Civil and Political Rights.	2	No. 6, p. 4
Annex I no. 14	Violation of the prohibition of human trafficking in accordance with Article 3 of the Palermo Protocol to Prevent, Suppress and Punish Trafficking in Persons Especially Women and Children, supplementing the United Nations Convention against Transnational Organized Crime.	2	No. 6, p. 4

Annex I no. 15	Violation of the right to freedom of association, assembly, the rights to organise and collective bargaining in accordance with Article 20 of the Universal Declaration of Human Rights, Articles 21 and 22 of the International Covenant on Civil and Political Rights Article 8 of the International Covenant on Economic, Social and Cultural Rights, the International Labour Organization Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87) and the International Labour Organization Right to Organise and Collective Bargaining Convention, 1949 (No. 98), including the following rights:	2	No. 7, p. 4
Annex I no. 15a	Workers are free to form or join trade unions	2	No. 7, p. 4
Annex I no. 15b	The formation, joining and membership of a trade union must not be used as a reason for unjustified discrimination or retaliation	3	No. 7, p. 4
Annex I no. 15c	Workers' organisations are free to operate in accordance with applicable in line with their constitutions and rules without interference from the authorities	3	No. 7, p. 4
Annex I no. 15d	The right to strike and the right to collective bargaining.	3	No. 7, p. 4

Annex I no. 16	Violation of the prohibition of unequal treatment in employment, unless this is justified by the requirements of the employment in accordance with Article 2 and Article 3 of the International Labour Organisation Equal Remuneration Convention, 1951 (No. 100), Article 1 and Article 2 of the International Labour Organisation Discrimination (Employment and Occupation) Convention, 1958 (No. 111) and Article 7 of the International Covenant on Economic, Social and Cultural Rights; unequal treatment includes, in particular, the payment of unequal remuneration for work of equal value.	3	No. 8, 9 p. 4
Annex I no. 17	Violation of the prohibition of withholding an adequate living wage in accordance with Article 7 of the International Covenant on Economic, Social and Cultural Rights.	3	No. 11, p. 4
Annex I no. 18	Violation of the prohibition of causing any measurable environmental degradation, such as harmful soil change, water or air pollution, harmful emissions or excessive water consumption or other impact on natural resources, that: a, b, c, and d in accordance with Article 3 of the Universal Declaration of Human Rights, Article 5 of the International Covenant on Civil and Political Rights and Article 12 of the International Covenant on Economic, Social and Cultural Rights.	3	No. 16, 17, 18 p. 4, no. 19, 20, 21, 23, 29 p. 5
Annex I no. 18a	Impairs the natural bases for the preservation and production of food or	3	No. 23 p. 5

Annex I no. 18b	Denies a person access to safe and clean drinking water or	3	No. 23, p. 5
Annex I no. 18c	Makes it difficult for a person to access sanitary facilities or destroys them or	3	No. 23, p. 5
Annex I no. 18d	Harms the health, safety, the normal use of property or land or the normal conduct of economic activity of a person or	3	No. 29, p. 5
Annex I no. 18e	Affects ecological integrity, such as deforestation.	3	No. 21, p. 5
Annex I no. 19	Violation of the prohibition to unlawfully evict or take land, forests and waters when acquiring, developing or otherwise use land, forests and waters, including by deforestation, the use of which secures the livelihood of a person in accordance with Article 11 of the International Covenant on Economic, Social and Cultural Rights.	3	No. 29, p. 5
Annex I no. 20	Violation of the indigenous peoples' right to the lands, territories and resources which they have traditionally owned, occupied or otherwise used or acquired in accordance with Article 25, 26 (1) and (2), 27, and 29 (2) of the United Nations Declaration on the Rights of Indigenous Peoples.	3	No. 28, p. 5
Annex I no. 21	Violation of a prohibition or right not covered by points 1 to 20 above but included in the human rights agreements listed in Section 2 of this Part, which directly impairs a legal interest protected in those agreements, provided that the company concerned could have reasonably established the risk of such impairment and any appropriate measures to be taken in	3	No. 26, p. 5

	order to comply with the obligations referred to in Article 4 of this Directive taking into account all relevant circumstances of their operations, such as the sector and operational context.		
Annex II no. 1	Violation of the obligation to take the necessary measures related to the use of biological resources in order to avoid or minimize adverse impacts on biological diversity, in line with Article 10 (b) of the 1992 Convention on Biological Diversity and [taking into account possible amendments following the post 2020 UN Convention on Biological Diversity], including the obligations of the Cartagena Protocol on the development, handling, transport, use, transfer and release of living modified organisms and of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity of 12 October 2014.	5	No. 21, p. 5
Annex II no. 2	Violation of the prohibition to import or export any specimen included in an Appendix of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) of 3 March 1973 without a permit, pursuant to Articles III, IV and V.	5	Not covered
Annex II no. 3	Violation of the prohibition of the manufacture of mercury-added products pursuant to Article 4 (1) and Annex A Part I	5	No. 19, p. 4, no. 20, p. 5

	of the Minamata Convention on Mercury of 10 October 2013 (Minamata Convention).		
Annex II no. 4	Violation of the prohibition of the use of mercury and mercury compounds in manufacturing processes within the meaning of Article 5 (2) and Annex B Part I of the Minamata Convention from the phase-out date specified in the Convention for the respective products and processes.	5	No. 19, p. 4, no. 20, p. 5
Annex II no. 5	Violation of the prohibition of the treatment of mercury waste contrary to the provisions of Article 11 (3) of the Minamata Convention.	5	No. 18, p. 4
Annex II no. 6	Violation of the prohibition of the production and use of chemicals pursuant to Article 3 (1) (a) (i) and Annex A of the Stockholm Convention of 22 May 2001 on Persistent Organic Pollutants (POPs Convention), in the version of Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants (OJ L 169 of 25 June 2019 pp. 45-78.	5	No. 19, p. 4, no. 20, p. 5
Annex II no. 7	Violation of the prohibition of the handling, collection, storage, and disposal of waste in a manner that is not environmentally sound in accordance with the regulations in force in the applicable jurisdiction under the provisions of Article 6 (1) (d) (i) and (ii) of the POPs Convention.	5	No. 18, p. 4

Annex II no. 8	Violation of the prohibition of importing a chemical listed in Annex III of the Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (UNEP/FAO), adopted on 10 September 1998, as indicated by the importing Party to the Convention in line with the Prior Informed Consent (PIC) Procedure.	5	Not covered
Annex II no. 9	Violation of the prohibition of the production and consumption of specific substances that deplete the ozone layer (i.e., CFCs, Halons, CTC, TCA, BCM, MB, HBFCs and HCFCs) after their phase-out pursuant to the Vienna Convention for the protection of the Ozone Layer and its Montreal Protocol on substances that deplete the Ozone Layer.	5-6	No. 20 p.70
Annex II no. 10	Violation of the prohibition of exports of hazardous waste within the meaning of Article 1 (1) and other wastes within the meaning of Article 1 (2) of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal of 22 March 1989 (Basel Convention) and within the meaning of Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190 of 12 July 2006 pp. 1-98) (Regulation (EC) No 1013/2006), as last amended by Commission Delegated Regulation (EU) 2020/2174 of 19 October	6	No. 18, p. 4

	2020 (OJ L 433 of 22 December 2020 pp. 11-19).		
Annex II no. 11	Violation of the prohibition of the export of hazardous wastes from countries listed in Annex VII to the Basel Convention to countries not listed in Annex VII (Article 4A of the Basel Convention, Article 36 of Regulation (EC) No 1013/2006).	6	No. 18, p. 4
Annex II no. 12	Violation of the prohibition of the import of hazardous wastes and other wastes from a non-party to the Basel Convention (Article 4 (5) of the Basel Convention).	6	No. 18, p. 4
Article 15	Combating climate change: plan to reduce emissions, plan to ensure that the business model and strategy of the company are compatible with the transition to a sustainable economy and with the limiting of global warming to 1.5 °C in line with the Paris Agreement.	60	No. 15, p. 4

Source based on: Copper Mark (2021e); European Commission (2022a); European Commission (2022b).

The scope of table 5 is to prove if all requirements regarding human and environmental risks of the Directive 2019/1934 are covered by the Copper Mark Criteria. Therefore these legal requirements of the Directive 2019/1934 are provided in the first column via a direct citation and benchmarked against the Copper Mark Criteria. In case the Copper Mark Criteria are equal or extend the specific legal aspect, the specific Copper Mark Criteria is cited to visualize which legal requirements regarding environmental and human rights are covered. To conclude, a company that is fulfilling the certain Copper Mark Criteria does not raise risks regarding the certain human or environmental risk dimension of the Directive 2019/1937. However, companies have to be proofed separately to ensure that no risks regarding Annex II no. 2, and 8 occur in the supply chain, as these aspects are not covered by the Copper Mark. However, a company that is fulfilling certain criteria is causing no risks regarding the certain requirements of Directive 2019/1937.

A3 Questionnaire and KPIs

Applied questionnaire at Siemens Energy

The applied questionnaire is similar to the reporting templates of the RMI. The RMI is a well-established multi-stakeholder initiative, a partner of Siemens Energy, and through the collaboration with various companies in the upstream mineral supply chain, the reporting templates are well known in the up and downstream supply chain of minerals. However, the RMI does not provide a reporting template for copper, as well as the RMI is not very active in the copper supply chain (only one not successfully assessed smelter). As a result, this questionnaire was developed based on other reporting templates of the RMI to ensure a common understanding.

Table 6: Questionnaire page one: instruction

SIEMENS energy	Siemens Energy reporting template for copper
The purpose of this document is to collect sourcing information on copper	
Mandatory fields are noted with an asterisk (*).	
What to do	
Answer at least all mandatory questions.	
Answer with yes or no in the provided field 'answer' which is marked yellow, question 3 and 5 are exceptions. Select a procentual value here.	
Provide evidence of your answers in the field comments.	
Instructions for completing the Smelter List Tab.	
This template allows for the identification of smelters, refiners, mines or processors using the Smelter Look-up. Please look at first if your smelter is listed there, if yes please use the provided information in the smelter look up and copy them into the smelter list.	
Use a separate line for each smelter/country combination.	
Select a type of operation from the drop-down fitting to the smelter. If no possibility is fitting, select "other, see comments" and provide the type of operations in the comment.	
Send the questionaire back to Siemens Energy via email: marc.jacke@siemens-energy.com	

Table 6 shows the first page of the questionnaire. Hence the instruction is provided, which explains how the supplier should use the questionnaire. The instruction is similar to the reporting templates of the RMI.[443]

[443] See RMI (2022a); RMI (2022b); RMI (2022d); RMI (2022f).

Table 7: Questionnaire page two: definition of items

ITEM	DEFINITION
Authorizer	This field identifies the person responsible for the content of the declaration. The authorizer may be a different individual from the contact person. It is not correct to use the words ''same'' or similar identification to provide the name of the authorizer.
Conflict-Affected and High-Risk Areas (CAHRA)	Conflict-Affected and High-Risk Areas (CAHRA) are defined by the OECD Due Diligence Guidance as "areas identified by the presence of armed conflict, widespread violence or other risks of harm to people. Armed conflict may take a variety of forms, such as a conflict of international or non-international character, which may involve two or more states, or may consist of wars of liberation, or insurgencies, civil wars, etc. High-risk areas may include areas of political instability or repression, institutional weakness, insecurity, collapse of civil infrastructure and widespread violence. Such areas are often characterised by widespread human right abuses and violations of national or international law."
Copper	Copper is a chemical element with the symbol Cu and atomic number 29.
Declaration of Scope or Class	For the purposes of this template, "scope" describes the applicability of the information provided by the reporting company. The scope may encompass the entirety of a company's services and/or products, or at a company's discretion, the template may be used to report on a specific product (or products), or, be 'User defined'. The 'User defined' scope selection or class may be used to describe any subset of a company's operation or product portfolio
Due Diligence	The OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-affected and High-risk Areas (OECD Guidance) defines "Due Diligence" as "an on-going, proactive and reactive process through which companies can ensure that they respect human rights and do not contribute to conflict". More information is available at http://www.responsiblemineralsinitiative.org/training-and-resources/conflict-affected-and-high-risk-areas/.
OECD	Organisation for Economic Co-operation and Development. The OECD has developed the OECD Due Diligence Guidance for Responsible Supply Chains. The OECD Due Diligence Guidance provides detailed recommendations to help companies respect human rights and avoid contributing to conflict through their mineral purchasing decisions and practices and uses a reasonableness approach. This Guidance is for use by any company potentially sourcing minerals or metals from conflict-affected and high-risk areas. The OECD Guidance is global in scope, and applies to all mineral supply chains. (http://mneguidelines.oecd.org/mining.htm)
Recycled or Scrap Sources	Recycled or scrap sources are recycled cobalt that are reclaimed end-user or post-consumer products, or scrap processed cobalt created during product manufacturing. Recycled copper includes excess, obsolete, defective, and scrap copper materials that contain refined or processed metals that are appropriate to recycle in the production of such metals. Minerals partially processed, unprocessed or byproducts from other ores are not included in the definition of recycled copper.
Smelter	A smelter or refiner is a company that procures and processes mineral ore, slag and/or materials from recycled or scrap sources into refined metal or metal containing intermediate products. The output can be pure (99.5% or greater) metals, powders, ingots, bars, grains, oxides or salts. The terms "smelter", "refiner", and "processor" are used interchangeably throughout various publications.
Smelter Identification Number	A unique identification number the Copper Mark assigns to companies that have been reported by members of the supply chain as smelters or refiners, whether or not they have been verified to meet the characteristics of smelters or refiners as defined in the Copper Mark audit protocols or other applicable audit programs.

Table 7 shows the second page of the questionnaire. Here the items applied in the questionnaire are defined to ensure a common understanding between the participants. For example in theory crude refiners, smelters, and refiners are distinguishable. However in practice, these companies are often vertically integrated, and in various publications, the words smelter, processor, and refiner are used interchangeably. All definitions are taken from other reporting templates of the RMI to ensure a common understanding based on integrated industry standards.[444] An exception is the definition of copper, which is just similar to the definition of other minerals.[445]

Table 8: Questionnaire page three: declaration

SIEMENS energy

Mineral Reporting Template for Copper

The purpose of this document is to collect sourcing information on copper — 01.03.2022

	Criteria	Company Information	Comments
A1	Company Name (*):		
A2	Declaration Scope or Class (*):	Company-wide	
A3	Description of Scope:		
A4	Company Unique ID (DUNS):		
A5	Company Unique ID Authority:		
A6	Address:		
A7	Contact Name (*):		
A8	Email – Contact (*):		
A9	Phone – Contact (*):		
A10	Authorizer (Company CEO)(*):		
A11	Title - Authorizer:		
A12	Email - Authorizer (*):		
A13	Phone - Authorizer (*):		
A14	Effective Date (*):		

Answer the following questions 1 - 6 based on the declaration scope indicated above

	Question: Relevance	Answer (Select "Yes" or "No")	Comment (Reasoning and source)
1	Is any copper intentionally added or used in the product(s) or in the production process?(*)		
2	Does any copper remain in the product(s)?(*)		
3	What is the share of recycled/scrap vs. mined copper used?(*)		
	In case questions 1 and 2 are answered with no, stop here.		
	Question: Red flag identification		
4	Do any of the smelters in your supply chain source the copper from conflict-affected and high-risk areas? (*)		
5	What percentage of relevant suppliers have provided a response to your supply chain survey? (*)		
6	Have you identified all of the smelters supplying the copper to your supply chain? (*)		
	Answer the Following Questions at a Company Level		
A	Have you established a responsible minerals sourcing policy in relation to copper? (*)		
B	Is your responsible minerals sourcing policy publicly available on your website? (Note – If yes, the user shall specify the URL in the comment field.) (*)		
C	Do you require suppliers' due diligence practices to cover, at a minimum, all risks in the OECD Due Diligence Guidance Annex II Model Policy, as well as the worst forms of child labor? (*)		
D	In your production, do you implement documentation and processes to be able to track back to the exact copper material lot and its supplier? (*)		
E	Do you review due diligence information received from your suppliers against your company's expectations? (*)		
F	Does your review process include corrective action management? (*)		

[444] See RMI (2022a); RMI (2022b); RMI (2022d); RMI (2022f).
[445] See RMI (2022a); RMI (2022b); RMI (2022d); RMI (2022f).

Table 8 shows the third page of the questionnaire. Here the supplier is requested to fill in their answers. The first column contains a drop-down menu where the supplier could select yes or no. Exceptions are questions three and five, here the supplier has to select a value (100%, >90%, >75%, >50%, <50% or 0%). The second column contains an empty field which gives the supplier the possibility to explain its answers. Questions A1-A14 are required to register the information about the company according to an industry standard. These questions are identical to the questions of other reporting templates of the RMI.[446] To ensure that only relevant suppliers answer the questionnaire, questions one, two, and three are integrated. In case a supplier answers this question with no then the supplier has not to answer the questionnaire. This was implemented to ensure that possible remaining errors from the data cleaning could be identified. After the analysis, it turned out that all inquired suppliers have been relevant due to their activities in the supply chain of Siemens Energy.

Questions four, five, and six serve for the red flag identification based on the OECD DD Guidance and are similar to the other reporting templates of the RMI. The questions A-F are also similar to the other reporting templates of the RMI. However, not all questions are used to avoid double questions and to shorten the questionnaire. An exception is question D. This question was asked to get information about current tracking systems in the supply chain and therefore to prove if a tracking system could be a solution for a downstream company.

Table 9: Questionnaire page four: smelter list

Smelter Name (*)	Smelter Country (*)	Smelter ID	Source of Smelter Identification Number	Smelter Street	Smelter City	Smelter Facility Location: State / Province	Smelter Contact Name	Smelter Contact Email	Types of operation	Name of Mine(s) or if recycled or scrap sourced, enter "recycled" or "scrap"	Location (Country) of Mine(s) or if recycled or scrap sourced, enter "recycled" or "scrap"	Does 100% of the smelter's feedstock originate from recycled or scrap sources?	Comments

Table 9 shows the fourth page of the questionnaire. Here the supplier is requested to provide information regarding the smelters in its supply chain. The categories in the first column are in alignment with the reporting templates of the RMI. An exception is column nine “types of operation”. This information is required due to the lack of transparency in the copper market regarding the classification of the company operating as a crude refiner,

[446] See RMI (2022a); RMI (2022b); RMI (2022d); RMI (2022f).

smelter, or refiner (Chapter 2.4.2). The supplier has to select the type of operation from a predefined dropdown menu. The dropdown menu contains all possible combinations of operations, which are given in table 9.

Table 10: Questionnaire page five: smelter look-up

Smelter Look-up (*)	Company Name	Site Name	Smelter Facility Location: Country	Smelter ID	Smelter City	Smelter Facility Location: State / Province	Smelter Street	Types of Operations	Source of Smelter Identification Number	Certification
Compañia Minera Zaldivar SpA	Antofagasta	Compañia Minera Zaldivar SpA	Chile	P0016	Antofagasta	Antofagasta	Avenida Grecia 750	mining, solvent extraction and electrowinning	Copper Mark	Copper Mark Criterita
Minera Centinela	Antofagasta	Minera Centinela	Chile	P0015	Sierra Gorda	Antofagasta	30 Km East of Sierra Gorda	mining, solvent extraction and electrowinning	Copper Mark	Copper Mark Criterita
Aurubis Bulgaria AD	Aurubis AD	Aurubis Bulgaria AD	Bulgaria	P0009	City of Pirdop	Sofia Province	2070, Industrial Zone	blending, smelting, refining	Copper Mark	Copper Mark Criterita
Olympic Dam	BHP	BHP Olympic Dam Corporation Pty Ltd	Australia	P0014	Olympic Dam	South Australia	Olympic Way	mining, blending, solvent extraction and electrowinning, smelting, refining	Copper Mark	Copper Mark Criterita
Minera Escondida Limitada	BHP	Minera Escondida Limitada	Chile	P0012	Antofagasta	Antofagasta	Av. De la Minería	mining, blending, solvent extraction and electrowinning	Copper Mark	Copper Mark Criterita
Minera Spence Limitada	BHP	Minera Spence Limitada	Chile	P0013	Santiago	Región Metropolitana	Cerro El Plomo 6000	mining, blending, solvent extraction and electrowinning	Copper Mark	Copper Mark Criterita
Miami Smelter & Mine	Freeport-McMoRan Inc	Miami Smelter & Mine	USA	P0007	Claypool	Arizona	5701 New St. 237	mining, blending, solvent extraction and electrowinning, smelting	Copper Mark	Copper Mark Criterita
Atlantic Copper Smelter & Refinery	Freeport-McMoRan Inc	Atlantic Copper Smelter & Refinery	Spain	P0005	Huelva	Andalusia	Avenida Francisco Montenegro	blending, smelting, refining	Copper Mark	Copper Mark Criterita
Sociedad Contractual Minera El Abra	Freeport-McMoRan Inc	Sociedad Contractual Minera El Abra	Chile	P0004	Calama	Antofagasta	Camino a Conchi Viejo Km 75	mining, solvent extraction and electrowinning	Copper Mark	Copper Mark Criterita
Sociedad Minera Cerro Verde S.A.A	Freeport-McMoRan Inc	Sociedad Minera Cerro Verde S.A.A.	Peru	P0003	Arequipa	Arequipa	Asiento Minero Cerro Verde Uchumayo	mining, blending, solvent extraction and electrowinning	Copper Mark	Copper Mark Criterita
Bagdad	Freeport-McMoRan Inc	Bagdad	USA	P0018	Bagdad	Arizona	104 Main Street	mining, blending, solvent extraction and electrowinning	Copper Mark	Copper Mark Criterita
Morenci Mine	Freeport-McMoRan Inc	Morenci Mine	USA	P0006	Morenci	Arizona	4521 N US Highway 19	mining, blending, solvent extraction and electrowinning	Copper Mark	Copper Mark Criterita
El Paso Refinery	Freeport-McMoRan Inc	El Paso Refinery	USA	P0008	El Paso	Texas	897 Hawkins Blvd	refining	Copper Mark	Copper Mark Criterita
Glogów	KGHM Polska Miedź S.A. Oddzial Huta Miedz	KGHM Polska Miedź S.A. Oddzial Huta Miedzi, Glogów	Poland	P0010		Silesian Voivodeship	ul. Źukowicka Glogów	smelting, refining	Copper Mark	Copper Mark Criterita
Legnica	KGHM Polska Miedź S.A. Oddzial Huta Miedz	KGHM Polska Miedź S.A. Oddzial Huta Miedzi, Legnica	Poland	P0011	Legnica	Lower Silesia	ul. Złotoryjska 59	smelting, refining	Copper Mark	Copper Mark Criterita
Oyu Tolgoi	Rio Tinto	Oyu Tolgoi	Mongolia	P0002	Sukhbaatar	Ulaanbaatar	Monnis Tower, Chinggis Avenue 15	mining	Copper Mark	Copper Mark Criterita
Kennecott Utah Copper LLC	Rio Tinto	Kennecott Utah Copper LLC	USA	P0001	South Jordan	Utah	Rio Tinto Regional Center	mining, blending, solvent extraction and electrowinning, smelting, refining	Copper Mark	Copper Mark Criterita
Onsan Smelter & Refinery	LS Nikko Copper	Onsan Smelter & Refinery (Onsan I and II)	South Korea	P0017	Ulju-gun	Ulsan	148 Sanam-ro, Onsan-eup	smelting, refining	Copper Mark	Copper Mark Criterita
Los Bronces	Anglo American	Los Bronces	Chile	P0027	Las Condes	Región Metropolitana	2800 Isidora Goyenechea	mining, solvent extraction and electrowinning,	Copper Mark	Copper Mark Criterita
El Soldado	Anglo American	El Soldado	Chile	P0028	Las Condes	Región Metropolitana	2800 Isidora Goyenechea	mining	Copper Mark	Copper Mark Criterita
Chagres	Anglo American	Chagres	Chile	P0029	Las Condes	Región Metropolitana	2801 Isidora Goyenechea	smelting, refining	Copper Mark	Copper Mark Criterita
Chino	Freeport-McMoRan Inc	Chino	USA	P0019	Vanadium	New Mexico	99 Santa Rita Mine Road	mining, solvent extraction and electrowinning,	Copper Mark	Copper Mark Criterita
Tyrone	Freeport-McMoRan Inc	Tyrone	USA	P0020	Tyrone	New Mexico	Highway 90 SouthTyrone Mine Rd	mining, solvent extraction and electrowinning,	Copper Mark	Copper Mark Criterita
Highland Valley Copper	Teck Resources Limited	Highland Valley Copper	Canada	P0026	Logan Lake	British Columbia	Highway 97C	mining	Copper Mark	Copper Mark Criterita
Safford	Freeport-McMoRan Inc	Safford	USA	P0022	Safford	Arizona	8500 N. Freeport-McMoRan Rd.	mining, solvent extraction and electrowinning,	Copper Mark	Copper Mark Criterita
Sierrita	Freeport-McMoRan Inc	Sierrita	USA	P0021	Green Valley	Arizona	6200 W Duval Mine Rd	mining, solvent extraction and electrowinning,	Copper Mark	Copper Mark Criterita

Table 10 illustrates the last page of the questionnaire, which contains the smelter look-up. The smelter look-up consists of all smelters which are certified by the Copper Mark or the RMI. Suppliers can select these smelters if they are sourcing from these smelters.

Table 11: KPIs to report due diligence performance at Siemens Energy

(Table is hidden for confidential reasons).

Table 11 shows the KPIs and the specific definition of the KPIs. Moreover, a separation in volume and supplier was implemented to ensure continuous improvement over time. This is necessary as the laws (Chapter 2.2.2) require an exclusive view of the supply chain and improvement. Hence, the entire PV has to be covered in the future as well as each supplier. Moreover, in the beginning, it is easier to generate meaningful rates through the focus on large suppliers, while later on only small suppliers require attention. Through the focus on suppliers and PV, this can be taken into account. The KPIs have been identified and defined in collaboration with Siemens Energy and are based on the industrial standards of the RMI.

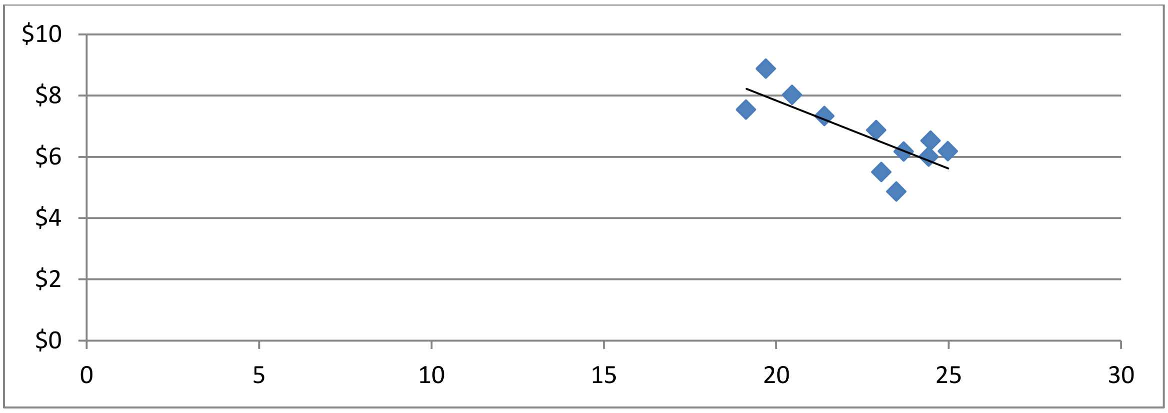
Table 12: KPIs aligned with OECD

(Table is hidden for confidential reasons).

Table 12 shows the KPIs defined by the OECD. The red flag definition by the OECD DD Guidance and Siemens Energy differ. The numerical difference is shown in chapter 3.3.5.

A4 Copper: price elasticity, copper smelter market, and copper purchasing stage

Figure 17: Supply-Demand ratio in thousand mt of copper anode versus the average price per year per mt in thousand US Dollar between 2010 and 2020



Source: Statista (2022a); Statista (2022f); Statista (2022h); Statista (2022p); Statista (2022aa).

Figure 17 shows the copper price in thousands of US Dollars for an mt of a copper anode. in thousand mt between 2010 and 2020. The data is visualized in the form of a scatterplot to estimate a correlation via the Pearson r correlation test. Pearson r shows a moderate negative linear correlation (-0,68) between the independent variable (supply-demand) and the dependent variable (Price in US Dollar). However, the r^2 is 0,4623 which means that 46,23% of the variability in the price is explained by supply-demand. No outliers are visible. Price elasticity is defined as a significant change in price in case the ratio in supply and demand changes.[447] Therefore a moderate price elasticity is estimated, as the supply-demand has a negative effect on the price. Hence, if the supply-demand is decreasing, the price increases. To the same conclusion comes the Inter-American Development Bank.[448]

Table 13: Copper smelter or refiner market of 2020 based on the 20th largest smelters and refiners

Country	Owner	Volume in 1000 mt	Value in bn USD	Value in bn €	market share

[447] See FVPR052 Portfolio Analysis Criteria (2022, p. 6).
[448] See Inter-American Development Bank (2021, p. 4).

China	Jiangxi Copper Corp	950	5.87€	5.15€	4.52%
Chile	Codelco	850	5.25€	4.61€	4.05%
Germany	Aurubis	810	5.01€	4.39€	3.86%
China	Tongling Non-Ferrous Metals Group	750	4.64€	4.07€	3.57%
India	Birla Group (Hidalco)	500	3.09€	2.71€	2.38%
China	Jinchuan Non-Ferrous Metal Co.	450	2.78€	2.44€	2.14%
Japan	Sumitomo Metal Mining Co. Ltd	450	2.78€	2.44€	2.14%
Japan	JX Nippon Mining & Metals Co., Ltd	450	2.78€	2.44€	2.14%
China	Chifeng Jinfeng	400	2.47€	2.17€	1.90%
China	Chinalco	400	2.47€	2.17€	1.90%
China	Yanggu Xiangguang Copper Co	400	2.47€	2.17€	1.90%
India	Vedanta	400	2.47€	2.17€	1.90%
Russia	Norilsk Nickel	400	2.47€	2.17€	1.90%
Peru	Southern Copper Corp	360	2.23€	1.95€	1.71%
Japan	Mitsubishi Materials Corp	354	2.19€	1.92€	1.69%
Iran	National Iranian Copper Industry Co.	350	2.16€	1.90€	1.67%
All other	All other	12726	78.66€	69.00€	60.60 %
World-wide	All	21000	129.80€	113.86€	100%

Source based on: ICGS (2021, p. 21); Statista (2022a); Statista (2022v).

Table 13 illustrates the copper smelter or refiner market based on the 20th largest copper smelter or refiners. Therefore it becomes visible that these smelters or refiners are operated by 16 different companies, while the three largest operators have a market share of 12,43%. Furthermore, 40,5 % of the generated copper value by the 20th largest smelter or refiners in 2020 has Chinese ownership. In 2020, the average exchange rate between the US Dollar and Euro was 1.14 Euro/US Dollar,[449] while the average price per metric ton of copper was 6.181 US Dollar.[450] This data was used to estimate the amount in Euro, as the initial values were given in mt and US Dollar.

Table 14: Relevant copper commodities and the purchasing volume in 2021 at Siemens Energy

(Table is hidden for confidential reasons).
Source based on: Siemens Energy AG (2022c).

[449] See Statista (2022v).
[450] See Statista (2022a).

Table 14 shows the Commodity Code, the description, and the related PV at Siemens Energy. 50% of the PV was used to purchase “Copper Raw Materials” (Chapter 2.4.2.1) in 2021.

A5 Requirments: management systems, risk identification and assessment, risk management, independent assessment, and reporting based on the laws and regulations in the scope

Table 15: Results of the smelter or refiner Risk Identificator

Smelter Name	Smelter Country	Smelter ID	Kind of Risk	Source of Smelter Risk	Identified Risk Category
LAFARGA	Spain				3
CUNEXT	Spain				3
Shituru Mining Corporation	Congo				2
Sicomines copper	Congo		Dumping of chemical substances into the Luilu river by Sicomines	AFREWATCH (2017)	1
Kansanshi Copper Mine	Zambia				2
Shalina	Congo				2
Ruashi Mine	Congo				2
Konkola Copper Mines Plc	Zambia		violence against demonstrators	Diggers (2021)	1
Congo Dongfang International Mining (CDM) Sprl	Congo		child labor	LG Chem (2018, p. 28)	1
ETI-Bakier	Turkey				2
Amalia & DOS	Chile				2
Sino-Metals Leach Zambia Ltd	Zambia				2
Huachin	Congo		restraint on acces to water, beatings and arbitrary by private armed groups, untransparent sources	Bwenda (2018, p. 31)	1
Chambishi	Zambia				2
Jinlong Copper Co., Ltd.	China				2
MOOK	Kazakhstan				2
Sx/EW Mopani	Zambia				2
Nkana	Zambia				2
Palabora	Congo				2
Huachin Likasi	Congo				2
Kaipeng Minning (KPM)	Congo				2
CMCEQ	Zambia				2
KCC (Kamoto Copper Company)	Congo	CID003261			2
Mabende	Congo		restraint on acces to water, beatings and arbitrary by private armed groups	Bwenda (2018, p. 31)	1
Panda (Likasi Mine)	Congo				2
Chengtun	Congo				2
Commus	Congo		mistreatment of miners	Boko (2021)	1
Mikas (Kasombo)	Congo				2
Comilu (Compagnie Minière de Luisha)	Congo				2
MMG (Kinsevere)	Congo				2
Roan Tailings Reclamation	Congo				2
KABWE(BRAEMORE)	Zambia				2
KIMIN (Kilo-Moto Mining International)	Congo				2
MJM	Congo				2
EXCELLEN MINING	Congo				2
HAN RUI	Congo				2
METAL MINES	Congo				2
GAR	Congo				2
COMIKA	Congo				2
MJM	Congo				2
HMC	Congo				2
LUPOTO	Congo				2
Jiangxi Copper Corporation	China				2
Tongling Nonferrous Metals Group Co., Ltd.	China				2
Shandong Fangyuan Nonferrous Metals Group	China				2
Yunnan Copper Co., LTD	China				2
Sociedad Contractual Minera El Abra	Chile	P0004			4
BIRLA COPPER	India		soil pollution caused on account of dumping of copper slag	India Environmental Portal (2022)	1
ZAMBIA CONSOLIDATED COPPER MINES	Zambia				2
PHILLIPINE ASSOCIATED SMELTING (PASAR)	Philippines				2
SUMITOMO METAL MINING	Japan				3
NITTETSU MINING	Japan				3
ASARCO	Mexico				2
MOUNT ISA	Australia				3
OMAN MINING	Oman				3
ONAHAMA SMELTING	Japan				3
JINCHUAN GROUP CO .,LTD	China				2
Corporacion nacional del cobre de chile	Chile				3
COMARCO (SPCC - ILO)	Peru				2
CODELCO	Chile				3
Olympic Dam	Australia	P0014			4
Minera Escondida Limitada	Chile	P0012			4
Minera Spence Limitada	Chile	P0013			4
Compañia Minera Zaldivar SpA	Chile	P0016			4
Onsan Smelter & Refinery	South Korea	P0017			4
Aurubis Olen	Belgium				3
KGHM Polska Miedź S.A. Oddzial Huta Miedzi, Glogów	Poland	P0010			4
KGHM Polska Miedź S.A. Oddzial Huta Miedzi, Legnica	Poland	P0011			4
Atlantic Copper Smelter & Refinery	Spain	P0005			4
Aurubis AD	Bulgaria	P0009			4
Jiangxi Copper Corporation Limited company Guixi Smelters	China				2

Source based on: smelter or refiner risk identificator analysis; AFREWATCH (2017); Boko (2021); Bwenda (2018, p. 31), Diggers (2021); India Environmental Portal (2022); LG Chem (2018, p. 28).

Table 15 shows the results of the smelter or refiner risk identificator. Therefore smelters or refiners that cause high or extreme risk are identified and can be prioritized to mitigate these risks at first. The risk classification is based on categories one to four, while one indicates an extreme risk, two a high risk, three a medium risk, and four a low risk.

Table 16: Requirements for a Management System based on the OECD DD Guidance, SCDDA, and Directive 2019/1937

Source: Category	OECD DD Guidance (p. 17)	SCDDA	Directive 2019/1937
Scope of the policy and therefore on the management system.	policy covering the supply chain of minerals from CAHRA.	establishment of a risk management system aligns with the due diligence obligations across all business processes (p. 7). Preventing and ending violations in the own business area (p. 7). Mitigating violations in the business area of direct suppliers (p. 7).	Identifying, preventing, and ending actual and potential adverse impacts on human rights and the environment (p. 54-57).
Requirements on policy and therefore on the management system.	Due diligence is required for all risks mentioned in Annex II along the supply chain.	Risk analysis to identify environmental and human rights-related risks (p. 7).	Combating climate change via a plan (including targets to reduce emissions) to ensure the 1.5 °C targets of the Paris agreement (p. 60).
		Risk analysis and monitoring are required internally and for direct suppliers (p. 7).	Periodic monitoring informs of assessments, internal on-site level, and external along the value chain (p. 58).
		Mitigate violations in case the company has substantiated knowledge about violations from an indirect supplier (p.10).	

Requirements for the structure of the management system.	Supply chain due diligence needs to be supported by the structure of the internal management.	A person who is responsible for the monitoring (p. 7).	An authorized representative (p. 60).
		Risk analysis and the results must be communicated to the decision-makers at least once a year (p. 7).	Variable remuneration is based on long-term interests, business strategy, and sustainability (p. 60).
Publication and communication.	Adopt the policy.	Issue and adopt a policy statement on the human rights strategy (p. 8). Requirements for the policy are listed in the reporting section.	Integration of due diligence in the company policy (p. 54).
	Communicate the policy clearly to the public and the suppliers.	Reporting on the company's website including an annual report (p. 11).	Reporting on the company's website including an annual statement (p. 59).
Control	A system of controls and transparency needs to be developed and implemented to establish control over the mineral supply chain. This can be implemented via a chain of custody, traceability schemes, or the identification of the upstream actors within the supply chain. Participation in industry-driven programs is a solution for the implementation.		

Engagement and relationships	The company should strengthen its engagement with suppliers.		
Grievance mechanism	The company should establish a grievance mechanism in form of an early-warning risk-awareness system on a company, or industry level.	Complaints procedure enables persons to report on risks (human rights and environment) in their own business area and direct and indirect suppliers side (p. 10).	Complaints procedure for affected persons, trade unions, and the civil society (p. 58).

Source based on: BMAS (2021, p. 7-11); European Commission (2022b, p. 54-30); OECD (2016, p. 17).

Table 16 shows the requirements for Management System by the OECD DD Guidance in comparison to the SCDDA and the Directive 2019/1937, while the specific text sections are given. Therefore it can be illustrated which criteria the management system has to fulfill to be in alignment with the OECD DD Guidance, SCDDA, and Directive 2019/1937 and regulation. Chapter 3.5.1. shows which parts of the management system of Siemens Energy fulfill or overachieves the requirements and which parts require improvement to be in alignment with the laws and regulations in scope.

Table 17: Requirements for risk identification and assessment based on the OECD DD Guidance, SCDDA, and Directive 2019/1937

Category	OECD DD Guidance	SCDDA	Directive 2019/1937
Source	p. 44	p. 7	p. 55-62
Risk identification	Identify the smelters and refiners within the supply chain.	Appropriate and effective identification of all risks regarding the due diligence obligations in own business and direct suppliers. The risk identification has to be done once a year.	Identify actual and potential adverse impacts within the value chain (p. 54). Companies from group b have only to identify these impacts within their business sector (p. 54).

			Companies from group b that provide financial services have only to identify the risks before the service is offered (p. 54).
			Companies from group a have to identify risks and impacts of the company's operations toward global warming limits to 1.5 °C (p. 62).
Risk assessment	Identify the origin, transit, and transportation routes of the ores. Gain evidence on the smelters and refiners' due diligence practices review the information cross-check the gained information engage with smelter and refiner to mitigate risks, build capacity, and strengthen due diligence practices jointly On-site assessments on smelter and refiner levels are required when necessary	Identified risks must be prioritized, weighted, and listed.	

Source based on: BMAS (2021, p. 7); European Commission (2022b, p. 55-62); OECD (2016, p. 44).

Table 17 shows the requirements for the risk identification and assessment by the OECD DD Guidance in comparison to the SCDDA and the Directive 2019/1937, while the specific text sections are given. Therefore it can be illustrated which criteria the risk identification and assessment have to fulfill to be in alignment with the OECD DD Guidance, SCDDA, and Directive 2019/1937 and regulation. Chapter 3.3.2 shows the implementation at Siemens Energy.

Table 18: Requirements for risk management based on the OECD DD Guidance, SCDDA, and Directive 2019/1937

Category Source	OECD DD Guidance p. 45-46	SCDDA p. 7	Directive 2019/1937 p. 55-58
Risk management	Communicate the identified risks to the decision-makers	Communicate the identified risks to the decision-makers	Communicate the identified risks to the decision-makers (p.55)
	A risk management plan has to mitigate the risks via continuing, suspending, or terminating the business relationship	Identification and minimization of risks related to human rights or the environment within the supply chain	Identification, prevention, and minimization of risks related to human rights or the environment within the value chain (p. 55)
	Train suppliers jointly with NGOs stakeholders and other organizations to implement due diligence	Prevention, identification, and minimization of risks related to human rights or the environment within the enterprise	Risk management actions have to be developed in consultation with the affected stakeholders (p. 55)
	Improvement has to be measured per direct and indirect supplier and performance objectives have to be given, including a timeframe for improvement via qualitative and or quantitative indicators	Risk management actions have to consider the interests of employees within the enterprise and the supply chain and other directly affected people by the business activities of the enterprise or enterprises within the supply chain	develop and implement an action plan, including a reasonable timeframe and qualitative and or quantitative indicators to measure improvement (p. 55)
	Continuous monitoring		the focal company has to seek assurance from its direct business partners via a contract that these partners ensure the code of conduct (p. 55)

			support small and medium sized enterprises to avoid that the code of conduct and the action plan will jeopardize the viability of these companies (p. 55)
			In case actual and potential adverse impacts cannot be prevented or mitigated the focal firm has to conclude a contract with this firm to verify compliance (p. 55)
			In case compliance is verified via third-party verifications at a small and medium sized enterprise the focal firm should bear the costs, while terms should be fair reasonable, and nondiscriminatory (p. 55)
			The risk management plan has to mitigate the risks via continuing, suspending, or terminating the business relationship (p. 55)
			Continuous monitoring (p. 58)

Source based on: BMAS (2021, p. 7); European Commission (2022b, p. 55-58); OECD (2016, p. 45-46).

Table 18 shows the requirements for risk management by the OECD DD Guidance in comparison to the SCDDA and the Directive 2019/1937, while the specific text sections are given. Therefore it can be illustrated which criteria the risk identification and assessment has to fulfill to be in alignment with the specific law and regulation. Chapter 3.3.3 shows the implementation at Siemens Energy.

Table 19: Requirements for the reporting based on the OECD DD Guidance, SCDDA and Directive 2019/1937

Category	OECD DD Guidance	SCDDA	Directive 2019/1937
Source	p. 53	p. 11	p. 59
Company Management Systems	Implementation of the management system	documentation of management system, responsible person, regular risk analysis, policy statement, preventive measures of own business, remedial actions, complaints procedure	specifying information on the description of due diligence
	the due diligence policy	report the fulfillment of due diligence obligations on the website, free of charge, and in a comprehensible manner	an annual statement by the 30th of April for the last calendar year
	responsible person	elements of its policy statements (the procedure of how the companies fulfill their due diligence, the identified risks, the environmental and human rights expectations based on its employees and suppliers p. 8).	
	report on the way due diligence has been strengthened	the report must be available no later than four-month after the financial year has ended	
		documentation must be available for 7 years	
Risk assessment and management and independent assessment	steps to identify smelters and refiners	impact and effectiveness and conclusion of its measures	potential and actual adverse impacts
	assessment of their due diligence practices	report the identified risks	actions to mitigate these impacts
	publish a list of conforming smelters and refiners	if no risks are identified this has to be explained	

	description of the steps to manage the risks
	publish the audit reports

Source based on: BMAS (2021, p. 11); European Commission (2022b, p. 59); OECD (2016, p. 53).

Table 19 shows the requirements for the risk reporting by the OECD DD Guidance in comparison to the SCDDA and the Directive 2019/1937, while it is referred to the text sections in the specific laws. Therefore it can be illustrated which criteria the risk identification and assessment has to fulfill to be in alignment with the specific law and regulation. Chapter 3.3.4 shows the implementation at Siemens Energy.

Table 20: KPI of first-tier suppliers for due diligence dashboard based on fictive data

KPI	Supplier in scope rate		Inquiry rate		Supplier response rate		Red flag rate		CAHRA free rate		RMI high + extreme risk free rate		Transparency rate		OECD sourcing policy rate		OECD red flag rate	
Entity	Supplier	Volume	Supplier	Volume	Supplier	Volume	Supplier	Volume	Supplier	Volume	Supplier	Volume	Supplier	Volume	Supplier	Volume	Supplier	Volume
All	50%	80%	100%	100%	100%	100%	15%	10%	80%	90%	90%	95%	80%	95%	95%	99%	5%	1%
Focal Company	50%	80%	100%	100%	100%	100%	15%	10%	80%	90%	90%	95%	80%	95%	95%	99%	5%	1%
Business Unit 1	50%	80%	100%	100%	100%	100%	15%	10%	80%	90%	90%	95%	80%	95%	95%	99%	5%	1%
Business Unit 2	50%	80%	100%	100%	100%	100%	15%	10%	80%	90%	90%	95%	80%	95%	95%	99%	5%	1%
Subsidiary	50%	80%	100%	100%	100%	100%	15%	10%	80%	90%	90%	95%	80%	95%	95%	99%	5%	1%

Source based on: Own survey results

Table 20 provides the result of the survey based on the KPIs of the direct suppliers at the business unit level. This data can be selected and visualized in the due diligence dashboard provided in chapter 3.3.5.

Table 21: KPI of smelters for due diligence dashboard based on fictive data

KPI	Smelters announced by suppliers	Copper Mark Conforment Smelter Rate		Smelter identification rate	
Entity		Smelters	Volume	Supplier	Volume
All	120	90%	95%	100%	100%
Focal Company	110	90%	95%	100%	100%
Business Unit 1	70	90%	95%	100%	100%
Business Unit 2	40	90%	95%	100%	100%
Subsidiary	10	90%	95%	100%	100%

Source: Own survey results

Table 21 provides the result of the survey based on the KPIs of the supplier's smelters at the business unit level. This data can be selected and visualized in the due diligence dash-board provided in chapter 3.3.5.

A6 Risk mitigation and smelter or refiner engagement letter

A6.1 Risk Mitigation Letter

Dear Siemens Energy Supplier,

Thank you for providing us with your Copper information upon our recent request.

As part of our additional due diligence and risk mitigation, we have analyzed your response and identified at least one of the following remarks:

- You identified the smelter/refiner but the smelter/refiner is not on the Responsible Minerals Initiative (RMI) or on the Copper Mark or an equivalent published list of conformant (certified) smelters/refiners for the mineral copper

- You have not all smelters identified and therefore there is a potential that some missing smelters are not conform

Therefore, Siemens Energy requests you to intensify your engagement until our next inquiry in 2023 for the calendar year 2022 the latest. To broaden your knowledge about the origin and chain of custody of Copper in your own supply chain we suggest the use of the Copper Reporting Template which we used for our inquiry. This template is attached to the email. Alternatively, the RMI will publish a Mineral Reporting Template including Copper next to other minerals during the year: https://www.responsiblemineralsinitiative.org/.

We are working toward avoiding the use of copper, within our supply chain from smelters not certified by the RMI, Copper Mark or equivalent certification standards. The additional certification standards equivalent to the RMI and the Copper Mark are listed on the website of the Copper Mark: https://coppermark.org/wp-content/uploads/2021/01/RRA-Copper-Mark-Equivalence-Matrix REV18Dec2020v2.pdf. Therefore Siemens Energy encourages its suppliers and the identified smelters in our supply chain to support our approach.

For additional information please visit the website www.siemens-energy.com/responsibleminerals where you can also find the Siemens Energy approach to avoid the use of conflict affected minerals.

Sincerely yours,

Christian Holzer
Head of Siemens Energy Procurement

A6.2 smelter or refiner Engagement Letter

Dear Name of the smelter or refiner,

We are Siemens Energy and have the mission to empower our customers to meet the growing global demand for energy while transitioning to a more sustainable world. How? Our innovative technologies, extensive energy experience, and an ambitious strategy to decarbonize global energy systems are all central to our efforts to be the partner and driver of the energy transition. Our top focus areas in ESG, innovation, and transformation share how we're making the future of tomorrow different today, for both our partners - and our people.

Together as one team across 90 countries, we are committed to making sustainable, reliable, and affordable energy possible.

With reference to our responsible minerals sourcing policy (https://www.siemens-energy.com/global/en/company/about/supply-chain-management/sustainability-in-the-supply-chain/responsible-minerals.html), we have rolled out a uniform and enterprise-wide process to determine the use, source and origin of the relevant minerals in our supply chain which is not limited to Tin, Tungsten, Tanatalum and Gold (3TG). The mineral copper has been added to our due diligence process this year.

As a part of this due diligence, we have analyzed the responses of our direct suppliers and we identified you as a copper smelter in our supply chain. Initiatives like the **Responsible Mineral Initiative (RMI)** and the **Copper Mark** support us on the road towards a social and environmental responsible operating practices.

As you are part of our supply chain we encourage you to engage with these above mentioned initiatives and become conformant to their due diligence standards.

For any questions, please do not hesitate to contact us.

For additional information please visit the website www.siemens-energy.com/responsibleminerals where you can also find the Siemens Energy approach to avoid the use of conflict affected minerals.

Sincerely yours

Marc Jacke

Appendix B: Applied approach of the literature research

To get an overview of the topic "responsible sourcing along the supply chain of minerals beyond laws" the related laws regarding the sourcing of minerals have been identified with the case company and the advising professor Prof. Dr. Holger Schiele. Furthermore, the mineral supply chain and the copper supply chain have been analyzed regarding their shape and the related risks, which occur far away from the focal firm. Therefore the key problem was identified and the "Grounded Theory Literature Review Method" [451] from Joost F Wolfswinkel, Elfi Furtmueller, and Celeste P M Wilderom has been applied to review the literature regarding the key problem: "the management of suppliers regarding sustainability which are out of the visible horizon of the focal firm". Therefore all five stages: Define, Search, Select, Analyse, and Present stages have been assessed.[452] In the define stage, keywords were defined and the research fields have been identified. Moreover, fitting sources have been determined as well as a search string has been created.[453] The keywords, initial hits, relevant subject areas, usable and assessed papers, and the search string can be seen in table 22. Scopus has been chosen as the database.

Table 22: Open keyword research and results

Keywords	Initial hits	Hits in relevant subject areas	Usable and assessed papers	Search key Scopus
Multitier supply chain management Multi-tier supply chain management Lower-tier management Lower tier management	114	88	22	EXACTSRCTITLE(Journal of Purchasing and Supply Management) OR EXACTSRCTITLE(Journal of Operations Management) OR EXACTSRCTITLE(International Journal of Physical Distribution and Logistics Management) OR EXACTSRCTITLE(Supply Chain Management: An international journal) OR EXACTSRCTITLE(International Journal of Production and Operations Management) OR EXACTSRCTITLE(Industrial Marketing Management) OR EXACTSRCTITLE(Journal of Supply Chain Management) OR EXACTSRCTITLE(International Journal of Procurement

[451] See Wolfswinkel, Furtmueller, and Wilderom (2013, p. 46).
[452] See Wolfswinkel et al. (2013, p. 47).
[453] See Wolfswinkel et al. (2013, p. 47).

Sub-supplier management Sub supplier management Mineral supply chain management Copper supply chain management Sustainable mineral governance Supply chain due diligence Responsible sourcing Green supply chain management Sustainable supply chain Sustainable supply chain management Sustainable procurement Sustainable purchasing Sustainable supply chain management				Management) OR EXACTSRCTITLE(International Journal of Integrated Supply Management) OR EXACTSRCTITLE(Journal of Public Procurement) OR EXACTSRCTITLE(Journal of Global Operations and Strategic Sourcing) KEY(Multitier supply chain management) OR KEY(Multi-tier supply chain management) OR KEY(Lower-tier management) OR KEY(Lower tier management) OR KEY(Sub-supplier management) OR KEY(Sub supplier management) OR KEY(Mineral supply chain management) OR KEY(Copper supply chain management) OR KEY(Sustainable mineral governance) OR KEY(Supply chain due diligence) OR KEY(Responsible sourcing) OR KEY(Green supply chain management) OR KEY(Sustainable supply chain) OR KEY(Sustainable purchasing) OR KEY(Sustainable supply chain management) AND (LIMIT-TO (DOCTYPE,"ar")) AND (LIMIT-TO (EXACTSRCTITLE,"Journal Of Operations Management") OR LIMIT-TO (EXACTSRCTITLE,"Industrial Marketing Management") OR LIMIT-TO (EXACTSRCTITLE,"International Journal Of Operations And Production Management") OR LIMIT-TO (EXACTSRCTITLE,"Journal Of Purchasing And Supply Management") OR LIMIT-TO (EXACTSRCTITLE,"Journal Of Supply Chain Management") OR LIMIT-TO (EXACTSRCTITLE,"International Journal Of Physical Distribution And Logistics Management") OR LIMIT-TO (EXACTSRCTITLE,"International Journal Of Integrated Supply Management") OR LIMIT-TO (EXACTSRCTITLE,"Supply Chain Management An International Journal") OR LIMIT-TO (EXACTSRCTITLE,"Journal Of Global Operations And Strategic Sourcing"))

The relevant research fields are Business, Management, Accounting, Economics, Finance, Social Sciences, and Econometrics. This selection is justified, as the research question is

"How can a multinational downstream company ensure responsible sourcing along the supply chain of minerals beyond laws ". This topic has relevance in Business, Management, Accounting, and Finance due to its economic background. Social Sciences are chosen as a relevant field, as in supply chain management different people across the world, organizations, cultures, and teams work together. Fitting sources are defined as the most recent journals of purchasing and supply management. This limitation was done to ensure that the most recent papers regarding the topic are considered in the analyses of the key problem. Table 23 of the appendix illustrates these journals, while it provides information about the age group of the paper, and the relevance of the paper based on the abstract, while all keywords from the previous table have been applied.

Table 23: Literature analysis based on well-established journals

Journal	Papers between 2000-2020	Papers relevant according to abstract	Usable and assessed papers
Journal of Purchasing and Supply Management	9	6	4
Journal of Operations Management	26	3	1
International Journal of Physical Distribution and Logistics Management	20	4	2
Supply Chain Management: An international journal	4	12	8
International Journal of Production and Operations Management	26	3	1
Industrial Marketing Management	7	1	1
Journal of Supply Chain Management	16	6	5
International Journal of Procurement Management	0	0	0
International Journal of Integrated Supply Management	5	0	0
Journal of Public Procurement	0	0	0
Journal of Global Operations and Strategic Sourcing	1	0	0
Total	113	35	22

Table 23 lists the most recent journals of purchasing, which have been provided by Prof. Dr. H. Schiele and R. Siebelink during the lectures of the course „Supply Chain Management and Innovation" at the University of Twente. In the second stage, the search string was applied and 113 fitting papers have been identified. Next, the sample was refined to 35 relevant papers via the reading of the abstract. These papers have been analyzed, via selective coding. The key models were listed in a table, as well as the identified barriers and enablers. Therefore the outcomes of the papers became comparable. In total 22 papers contributed to this analysis. Moreover, additional relevant topics have been identified and summarized. For example, the Kraljic matrix concerning sustainability has been identified as an additional topic, which provides different solution concepts next to multi-tier supplier management, like the vertical integration of supply chains and traceability in supply chains. Hence, the literature regarding these topics has been additionally considered, without any limitations to specific journals. To consider practical solutions, best practices from the industry and solutions of the OECD have been reviewed via internet research. In the last stage, the content was structured and recommendations of the advising professors Prof. Dr. Holger Schiele and Dr. Frederik Vos were integrated. After the literature has been reviewed, the theoretical part of this thesis was conducted.