FAIRPHONE

Fair Materials Sourcing Roadmap 2023

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This is a publication of Fairphone.
Fairphone is building a market for ethical phones and motivating the industry to act more responsibly.

With thanks and appreciation to the many experts who contributed to this research with their knowledge and insights; including Levin Sources, TDI Sustainability, the Responsible Minerals Initiative, the OECD, and other industry stakeholders. We encourage others to contact us for sharing insights, and encourage others to build upon what we have learned, so that together we can create a platform for taking action to improve material supply chains.

Executive Summary

Introduction

Smartphones contain dozens of different elements and materials, each with a different supply chain stemming from mined and/or recycled sources. The use of electronics has increased over the last decades, making the electronics sector a large consumer of metals. The electronics sector has a responsibility, as well as an opportunity, to address and catalyze social and environmental improvements throughout material chains, including in mining and recycling. Due to the complexity of mining and recycling chains, we need to prioritize which material supply chains we can effectively reach and positively impact. We researched the different materials in our products to better understand the challenges surrounding each one and identified the opportunities that exist to drive positive supply chain to material impact.

It starts with our long term vision: a world in which we are truly circular - where materials can be used, reused and recycled to their full extent and we would not need to mine new materials to meet our material demand. Moving to a circular economy requires multiple interventions. The need for longer lasting products, improved repairability, re-use, collection, and recyclability of products are some of the key areas that need to be addressed. At Fairphone, we focus on many of these aspects, for example, to design and support long-lasting products and incentivise improved collection of end-of-life post-consumer waste through our take-back and recycling programs. Yet the mining sector will remain a key supplier for decades to come. First of all, due to the demand for materials – as a result of population growth and economic development around the world – global materials use is projected to more than double from 2011 to 2060. This growth is exponential for certain minerals, especially those needed for our transition to a greener economy. But challenges also exist from a supply side of recycled materials: in 2019, only 17.4 % of generated e-waste was collected and recycled. And even when products are ready for recycling, not all materials can fully be recovered due to the complex combinations of materials in technological applications.

Creating a fair transition to a circular economy requires multiple interventions; including the sourcing of responsibly recycled materials, as well as -still- responsibly mined materials.

Recycling

E-waste has been defined as the worlds' fastest growing waste stream. While recycling is increasing steadily around the globe, end-of-life recycling rates are very low. This is due to relatively low efficiencies in the collection and processing of most metal-bearing discarded products, inherent limitations in recycling processes, and primary material is often relatively abundant and low-cost, thereby keeping down the price of scrap.

The sourcing strategies of companies could be an important factor, as increasing the demand for post-consumer recycled materials can incentivise collection and recycling. For some materials, this means developing scalable supply chains of materials used in post-consumer electronics, both by improving the application of recycled materials in products, as well as enabling an improved recovery of materials from the product through its design.

Another key area for improvement is the informal recycling sector. As the infrastructure for recycling is often underdeveloped or absent in developing countries, electronic waste frequently ends up in the informal sector, where it is often handled under inferior conditions, causing severe health effects to workers and the surrounding communities. Though coming with significant social and environmental challenges, the informal recycling sector provides a livelihood for many and as the amount of e-waste is increasing steadily, the informal sector is also growing.

Mining

The mining sector does not come without its problems. Both large scale mining (LSM) as well as artisanal and small scale (ASM) can be tainted by social and environmental challenges. LSM operations usually span very large areas of land and can cause significant damage to the environment including air, water and soil pollution. Conflicts with surrounding communities are also reported, due to pollution or over the use of limited resources such as land, forests and water. The ASM sector usually operates informally, charecterised by low to no mechanisation, dangerous working conditions, dismal incomes, high environmental pollution and child labor. Awareness surrounding social and environmental issues, especially in the mining sector, has been increasing steadily throughout the electronics industry over the last decades.

This awareness has led brands to apply due diligence practices on specific material supply chains to understand and mitigate key human rights risks in the mining sector. Special attention has been directed at mined minerals that were identified to directly support armed groups and were associated with high instances of child labor, the so-called conflict minerals.

These efforts are only now expanding to include other minerals. Similarly, while risk management increases the general awareness and transparency in the industries' supply chains, it does not always lead to improvements in the mining sector. The ASM sector is usually perceived as a high risk sector and therefore, with the adoption of risk management strategies of downstream brands, ASM supply is often banned from international supply chains. However, banning ASM material pushes the sector further into informality, reducing oversight and control of the sector, thus rendering the supply chains opaque with a high risk of leaking into formal global supply chains.

Although both LSM and ASM come with significant social and environmental challenges, they are also equipped with the ability to drive development and improve livelihoods in low and middle income countries. The mining sector is of key importance to developing economies and provides a livelihood for millions of people around the globe. The ASM sector employs over 44 million people worldwide and is showing a growing trend, indirectly supporting an estimated 150-200 million people. The LSM sector, although having low labor intensity, can have a large multiplier effect on surrounding sectors and job creation. One direct mining company employee may correspond to 3–5 employees elsewhere in the economy.

Opportunities for change

Many materials are lost because of a lack of reuse and recycling of post-consumer products. Similarly, many products end up in countries that lack an infrastructure to process post-consumer waste, and are recycled informally, risking health and safety as well as contributing to environmental pollution. Furthermore, the contribution of mining to national economies could be significant, but does not yet reach their full potential. And while this is obviously not a task for the private sector alone and needs to involve government and other stakeholders' efforts as well, there is a role for the mining sector to contribute further to local development. Therefore, the key selected *Thought Leadership* areas where we see more industry effort is needed and where we recognise we can drive a positive impact are to:

- Develop scalable post-consumer recycling chains: invest in and build scalable sourcing models for post-consumer recycled materials & (bio-based) plastic and improve recyclability by design;

- Develop fair urban mining solutions: design urban mining formalisation and improvement programs, build scalable sourcing models and create the infrastructure for funding & implementation by broader industry;

- Develop Fair ASM sourcing solutions: design ASM improvement programs, build scalable sourcing models, accept ASM in our supply chain, and create the infrastructure for increased demand of Fair ASM, funding & implementation by industry; and

- LSM engagement for community development: design and implement improvement programs that contribute to local development (i.e. benefit vulnerable LSM communities), build scalable sourcing solutions incentivising these best practises.

Focus Materials selection

To determine which material chain we believe we can influence, as Fairphone and the electronics industry at large, we developed a methodology in order to analyze opportunities and challenges in the different supply chains. The first analysis was the result of the following criteria;

- **Inventory of the materials used in our products and accessories**, as we can only exert supply chain influence on materials that are included in our products.

- The **consumer electronic industry's demand** for the different identified materials. The higher the industry demand, even if the material is only used in very small quantities in our products, the higher the responsibility, as well as opportunity of the electronic industry to drive change in that material supply chain.

- An estimation of the **criticality** of materials for the technical functionality of the device. When a material scores very low on this indicator, it means that it is relatively easy to substitute the material for other materials. Therefore, the lower the score, the less likely and relevant an opportunity to develop impact programs exists.

- The **social and environmental issues,** as well as the strength of **governance** structures in the 5 top producing countries measured by the strength of the rule of law as well as the level of corruption.

Consequently, we looked into the shortlisted materials and zoomed in on the key issues and determined whether they were either social or environmental and part of the mining or recycling sector. The assessment included:

- The **depletion rate** and the **rate of virgin materia**l consumption to assess the reliance on the mining sector and address the need and opportunity for advancing recycling; and

• The **demand outlook** for each focus material: when the demand for materials is likely to rise, this can add additional supply pressure to the mining and/ or recycling sector.

We also recognise that as a small electronics manufacturer we do not have the influence to tackle all of the social and environmental issues in the various supply chains. We therefore assessed the potential for Fairphone to drive impact on the key selected topics by evaluating whether the key issues in the material chains align with our areas of focus or *thought leadership* areas; and the expected feasibility of developing more sustainable sources, integrating those sources into our supply chain and identifying opportunities to scale impact across our industry.

Fair Materials Sourcing Roadmap 2023
Our analysis led to the identification and selection of a total of 14 focus materials: Aluminium, Cobalt, Copper, Gold, Indium, Lithium, Magnesium, Nickel, Plastics, Rare Earth metals, Silver, Tin, Tungsten and Zinc. While many of the materials analyzed had serious issues to consider, these 14 materials provide Fairphone with the most potential to make a significant impact and show the most urgent need for intervention.

It is important to note that we acknowledge that the 14 materials are contained in one or multiple components and that it is not realistic to have 100% of these materials sustainably sourced. We therefore will focus on those components with a high average content of our focus materials to set a scalable example.

Defining our roadmap and setting ambitious goals for Fair Materials is only the part of the journey. For all the materials included in our roadmap, more detailed trajectories need to be set out, defining the steps to develop each individual fair sourcing chain, following our Fair Sourcing Principles.

Our Fair Material Sourcing Roadmap is not only intended to help shape Fairphone's upcoming materials priorities, but contribute to improved transparency and consume awareness and inspire the rest of the industry to better understand the risks and opportunities associated with materials supply chains. We encourage others to build upon what we have learned, so that together we can create a platform for taking action to improve material supply chains.

Definitions

Artisanal Mining (ASM) The OECD Due Diligence Guidelines defines ASM as: "formal or informal mining operations with predominantly simplified forms of exploration, extraction, processing and transportation. ASM is normally low capital intensive and uses high labour-intensive technology."[1] "According to this definition, ASM can include men and women working on an individual basis as well as those working in family groups, in partnerships, or as members of cooperatives or other types of legal associations and enterprises involving hundreds or even thousands of miners. In some countries, a distinction is made between artisanal and small-scale mining, whereby 'artisanal' typically refers to pure manual mining while 'small-scale' may have fixed installations or use mechanised equipment. However, the diversity of ASM operations is vast and generalizations are easily contradicted. ASM can be carried out by men, women, youth and children."[2]

Large scale mining (LSM) refers to industrial mining operations that "use extraction and processing technologies that require high levels of investment and skills. Significant revenues, economies of scale and efficiencies result from these operations."[3]

Industrial Waste or Pre-Consumer Scrap is waste generated by industrial processes. As stated in a report of the United Nations Environmental Program (UNEP): "Pre-consumer scrap originates from a fabrication or manufacturing process and is mostly of high purity and value. Its recycling is generally economically beneficial and easy to accomplish although it becomes more difficult the closer one gets to finished products (e.g., rejected printed circuit boards)."[4]

Post-Consumer waste or Old scrap "is contained in products that have reached their end-of-life. The recovery of their materials requires more effort, particularly when the metal or material is a small part of a complex product."[5]

Urban Mining is the process of recovering raw materials from discarded electronic waste. An urban mine is usually referred to as the stockpile of electronic waste that exists in a society.

Virgin mining refers to the extraction of newly mined minerals from the earth.

End-of-life recycling rates is the percentage of a metal contained in discarded products that is actually recycled.

E-waste (electronic waste) refers to discarded electrical or electronic equipment.

1 OECD (2016)
2 EITI (2021)
3 OECD (2008) p. 136
4 UNEP (2011) p14
5 UNEP (2011) p14

Primary metals or primary production refers to the production of metals from ore.

Secondary metals or secondary production refers to the recovery of metals from scrap or waste.

Conflict minerals Conflict minerals are defined by law as minerals that directly or indirectly finance or benefit armed groups in the Democratic Republic of the Congo or an adjoining country.[6] Currently, four minerals and their derivatives are considered 'conflict minerals': tin (cassiterite), tantalum (tantalite), tungsten (wolframite) and gold, also referred to as the 3Ts and G or 3TG. The scope of the Dodd-Frank Act is limited to minerals originating from the Democratic Republic of the Congo and adjoining countries.

Thought Leader Fairphone has identified specific social and environmental improvement areas in material supply chains of electronics that remain largely unaddressed, but are within the electronics industry and Fairphone's capacity to influence and are crucial to solve to move closer to a fair and circular economy. These are defined as thought leadership areas. These areas are further analyzed and explained in chapter 3.

Frontrunner For materials in which the key problems in the supply chain do not fall into a key improvement area (thought leadership areas) within Fairphone's influence, or where initiatives exist that already address the key issues, we seek to integrate these existing sustainable materials into our products.

Attention materials are materials that we have not selected for our primary focus, as the share of electronics demand for these materials is low. Therefore, opportunities for the electronics industry to drive improvements in this supply chain are more limited. We will however keep monitoring and when more sustainable materials are available, we will seek to integrate these frontrunner materials into our supply chain.

Focus materials are defined as the materials that are ultimately selected as our primary focus materials and are included in our Fair Material Sourcing Roadmap until 2023, based on the results of our detailed assessment.

6 The Dodd-Frank Wall Street Reform and Consumer Protection Act, commonly called the Dodd-Frank Act)

1. Introduction

"By establishing a viable market for ethical consumer electronics, we motivate the entire industry to act more responsibly"

As a social enterprise, Fairphone's core mission is to develop a viable market for ethical consumer electronics. To achieve this, Fairphone seeks to create awareness around supply chain improvement needs and opportunities, set up sustainable supply chains, and collaborate with the wider consumer electronics industry in order to attain and scale impact.

Smartphones contain dozens of different elements and materials, each with a different supply chain stemming from mined and/or recycled sources. The mining sector has its share of social and environmental problems, ranging from dangerous working conditions and child labor to poor wages and pollution. Beyond issues at the mines themselves, we also need to recognize that many of the essential materials used in phones are a limited and dwindling resource. To increase sustainability, the industry needs to find alternatives to virgin mining and ways to conserve and reuse the materials already in circulation.
As a result one of the key impact areas of Fairphone is focused on increasingly sourcing fair materials.

With over 40 minerals and metals used in a smartphone, it is important to focus on those material supply chains in which we can generate most impact. We therefore researched the challenges within each material supply chain, and narrowed them down to a shortlist of focus materials with the highest opportunity to drive positive change as an electronics manufacturer, as well as by our industry at large. In our Fair Sourcing Policy we set out the due diligence steps we take to investigate, analyze, and address the risks, following the OECD due diligence guidance on responsible sourcing within these material supply chains.[7] Our impact strategy however goes beyond risk management, and is based on leveraging our industry buying power to incentivize and trigger the investments required for developing responsible mining and recycling practices.

This report is a follow up to our material research published in 2017, which informed our material roadmap until 2020. This report defines our fair material impact vision, the methodology we adopted to analyze material chains and on which materials we will place key focus, as well as the results defining our final 2023 fair material sourcing roadmap.

7 OECD (2016)

It is not only intended to help shape Fairphone's upcoming material priorities but contribute to improved transparency and consumer awareness, inspiring the rest of the industry to better understand the risks and opportunities associated with materials supply chains. We encourage others to build upon what we have learned, so that together we can create a platform for taking action to improve material supply chains.

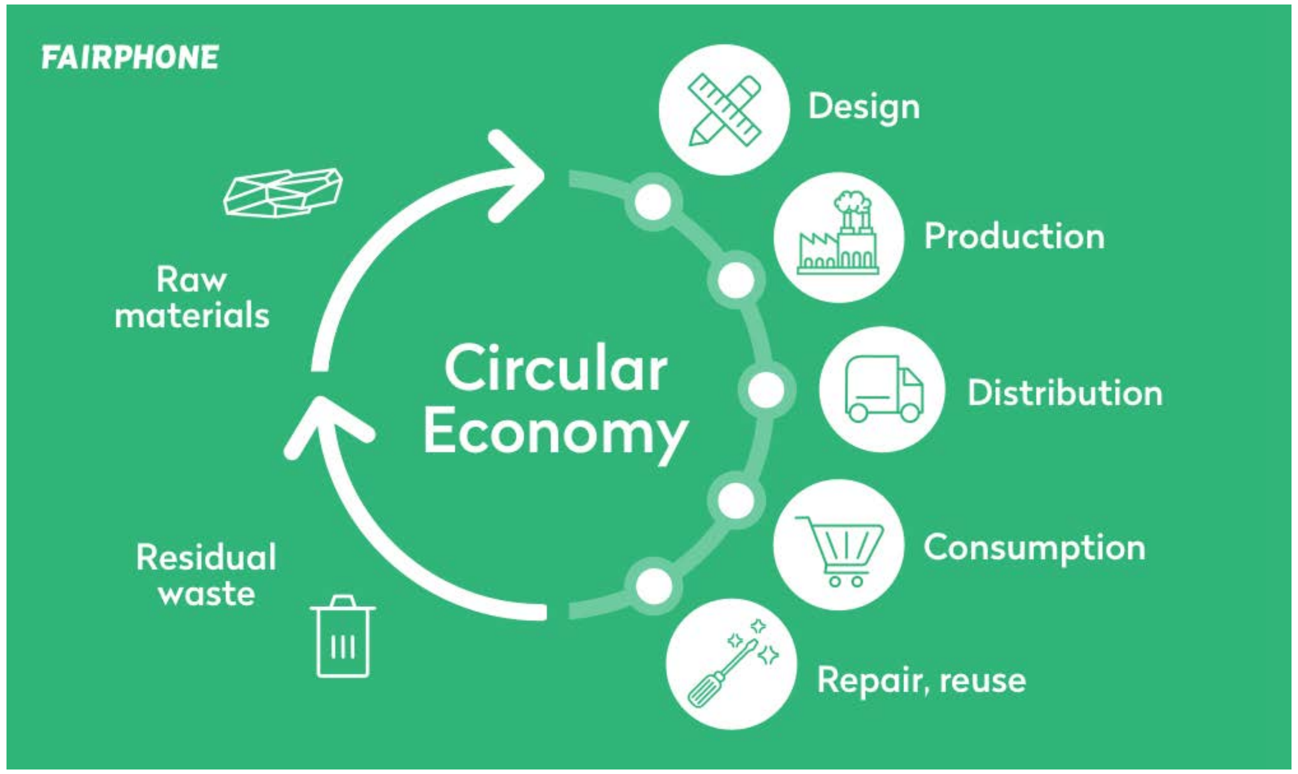
2. Fairphone Vision

We envision a world in which we are truly circular - where materials can be used, reused and recycled to their full extent and where we would not need to mine new materials to meet our material demand. Transitioning to a circular economy is key to minimise our environmental impact and efficiently make use of our finite resources. "A circular economy, unlike the traditional linear economic model based on a 'take-make-consume-throw away' pattern, is grounded in the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems."[8] A circular economy is "based on sharing, leasing, reuse, repair, refurbishment and recycling, in an (almost) closed loop, where products and the materials they contain are highly valued. In practice, it implies reducing waste to a minimum."[9]

In order to reach this long term vision, Fairphone focuses on longevity, reuse and recycling. Through Fairphone's modular design we focus on durable, upgradeable phones that are easy to repair. Furthermore, we encourage people to consume less and return their used phones for recycling, which all helps reduce e-waste.

Of course, circularity also includes the increasing use and sourcing of recycled materials. Yet, while we are increasingly recycling materials around the globe, for most materials it is expected the supply of recycled materials will not meet the growing demand, at least not in the coming decades. The mining sector will therefore remain crucial to meet our materials needs.

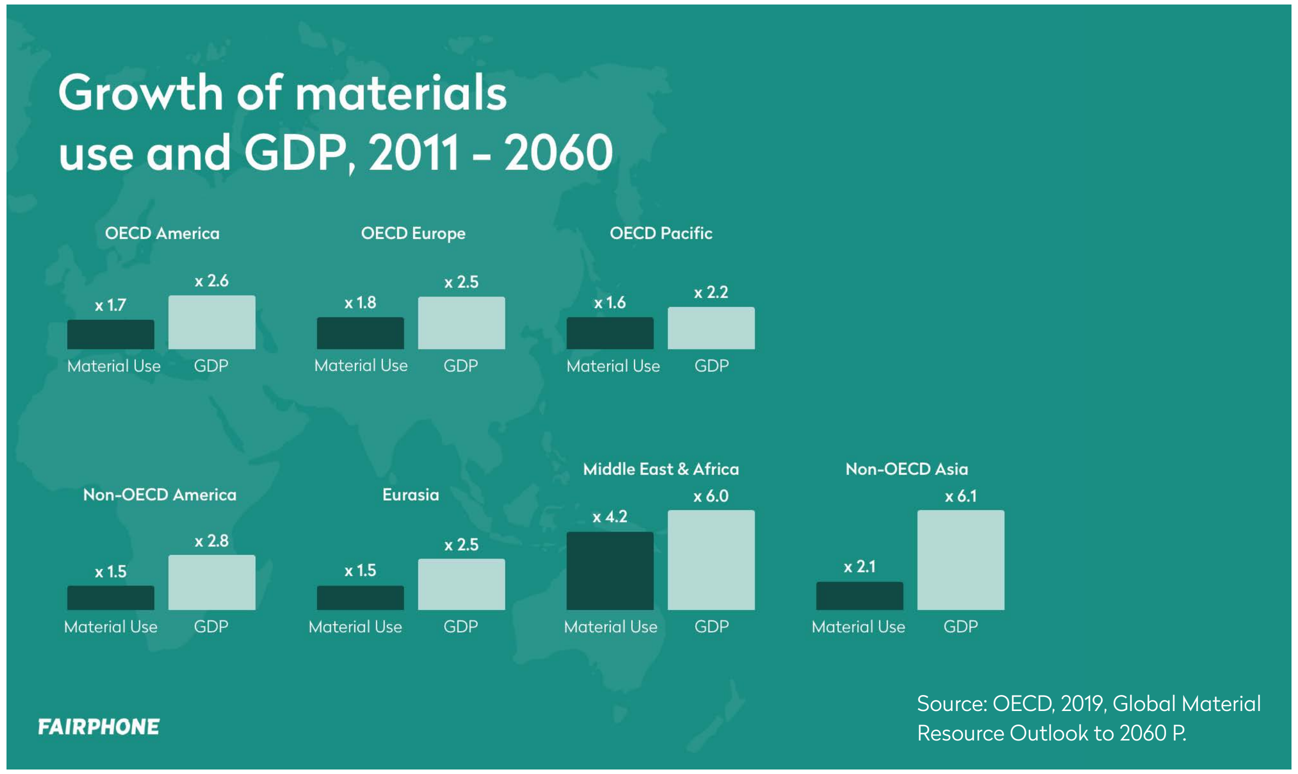
8 https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy
9 European Parliament (2016) p1



Mining vs recycling

Due to population growth and economic development around the world, the investments in infrastructure, construction and general production are rising and are expected to result in a sharp increase in demand for metals and non-metallic minerals.[10] Specifically, there is a strong link between economic growth and increased material use. As stated in a recent report published by the OECD, "the projected increase in population and tripling of global per capita income levels combine to a quadrupling of global GDP", causing "global materials use that is projected to more than double from 2011 to 2060."[11] While recycling among all metals is expected to grow at a higher relative rate than the mining sector, "the strong increase in demand implies that primary and secondary material use grow at roughly the same speed."[12]

10 OECD (2019), p15
11 OECD (2019), p18
12 OECD (2019), p16



Aside from general growth in demand for metals, the growth is exponential for certain minerals, especially those needed for our transition to a greener economy. This transition requires investment in and production of new technologies, such as solar or wind energy, which are more material intensive than fossil fuel based electricity generation technologies.[13] To meet the climate goals as set in the Paris agreement, the installation of greener technologies is necessary and will, therefore, significantly increase the material footprint for key materials. Some materials, such as graphite, lithium and cobalt, which are used in batteries, could increase by nearly 500% by 2050.[14] Even if end-of-life recycling rates increased to the maximum efficiency of 100%, the demand would greatly outstrip recycled supply. Furthermore, some materials can be used in applications for decades, thereby delaying these from being recycled, while other products, such as many smaller end-of-life electronic devices, do not reach recycling streams at all.

In 2019, only 17.4 % of the e-waste generated was collected and recycled.[15] As mentioned, even when products are ready for recycling, not all materials can fully be recovered due to the complex combinations of materials in technological applications.[16] While there is a forecasted rapid growth of recycling, the demand for materials cannot be met through only recycled supply, thereby leaving the mining sector as a key supplier for years to come.

13 The Worldbank Group (2020) p11
14 The Worldbank Group (2020) p11
15 UNU (2020) p14
16 This is explained further in the next section

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The mining sector, however, is not without its problems. It can be tainted by social and environmental challenges ranging from pollution, deforestation or the violation of human rights. Industrial mining operations, large scale mining (LSM), are often resource intensive, and conflicts with surrounding communities over land and water use have been reported. Surface mining can lead to pollution when waste is not managed properly. Similarly, the artisanal and small scale mining (ASM) sector comes with a different range of challenges. ASM mining practices are often informal and characterized by dangerous working conditions, dismal incomes, severe environmental pollution and instances of child labor.

In addition to the challenges, the mining sector is of key importance to developing economies and provides a livelihood for millions of people around the globe. Many of the poorest countries in the world rely on mining as the primary economic driver, yet over 80% of the world's most resource dependent countries are characterized by weak human development and governance scores.[17] The LSM sector, although having low labor intensity, can have a large multiplier effect on surrounding sectors and job creation.[18] The ASM sector employs over 44 million people worldwide and is showing a growing trend, indirectly creating employment in auxiliary sectors for 40 million people and supporting an additional estimated 150-200 million people.[19]

17 ICMM (2020) p7
18 ICMM (2013) p23
19 Delve database, Accessible at: https://delvedatabase.org/data

It is one of the biggest employment sectors in Africa, second only to farming. The mining sector therefore, provides a key opportunity to foster development and improve livelihoods in impoverished countries.

"The mining sector is a key sector for developing economies and provides a livelihood for millions of people around the globe"

Due to the importance of the mining sector, it is critical that the challenges and opportunities are not overlooked while we are fostering a fair transition to a circular economy. It is paramount that investments are not only made in the recycling of materials, but also in ensuring the mining sector operates more sustainably and drives lasting, diversified development in emerging economies.

The use of electronics has increased over the last decades, making the electronics sector a large consumer of metals. This sector has a responsibility as well as an opportunity to address and catalyze social and environmental improvements throughout material chains, including in mining and recycling. The sector has the ability to influence change in the supply chain, especially where material demand from the electronics sector is very high, through setting expectations and working with suppliers to address and improve upon social and environmental performance.

3. Challenges and Opportunities for Impact

Awareness surrounding social and environmental issues, especially in the mining sector, has been increasing steadily throughout the electronics industry over the last decades. This awareness has led brands to apply due diligence practices on specific material supply chains to understand and mitigate key human rights risks in the mining sector. At the same time, human rights violations in recycled supply chains have received less attention. While the implementation of due diligence practices provides a key mechanism to increase awareness of issues throughout supply chains, it does not always lead to improved practices to effectively solve the risk to human rights.

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Due diligence across different material supply chains

In recent years, there has been growing international awareness of human rights risks in virgin mined supply chains. Special attention has been directed at mined minerals that were identified to directly support armed groups and were associated with high instances of child labor. Following legislation on these 'conflict minerals' (i.e. Tin, Tungsten, Tantalum and Gold), and the development/publication of the 'OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas', schemes have been developed to ensure the mining of these minerals do not contribute to conflict or gross human rights violations. In the electronics sector, companies have widely adopted supply chain due diligence approaches to identify and manage the risk of these conflict minerals in their supply chains, which originate from the Democratic Republic of the Congo (DRC) and the surrounding countries. Industry audits are generally focused on these materials and this region, to ensure human rights violations are not present in end-users' supply chains. Due diligence practices are slowly being applied to other minerals as well, such as cobalt because of the assocation with high instances of child labor. In general, the progress of the electronics industry remains focused on these widely adopted compliance driven due diligence approaches, while efforts of engagement to positively impact on-the- ground communities remain limited.[20]

While due diligence requirements for recyclers are included in different guidelines and standards, in general, challenges and risks in the recycling chain have received less attention and are less documented than mining.

While risk management increases the general awareness and transparency in the industries' supply chains, it does not always lead to improvements in the mining sector. Various on the ground mechanisms to enable due diligence have been implemented and the mechanisms are highly focused on addressing linkages to conflict financing and do not usually address key social and environmental issues, such as health and safety or preventing mining pollution. In the DRC for example, a recent study by IPIS and Ulula found that indeed the presence of armed actors was significantly less at ASM sites that were included in due diligence schemes.[21] However, little difference was found between social and environmental practices of ASM that were covered by due diligence schemes versus mines that were not. For example, similar frequency of accidents (including fatal accidents) were reported in both types of ASM sites.[22] Additional efforts are therefore recommended to drive economic, social and environmental change and transformation through due diligence programs.[23]

20 Responsible Sourcing Network (RSN) (2019) p6
21 IPIS and Ulula (2019) p42
22 IPIS and Ulula (2019) p43
23 IPIS and Ulula (2019) p44

Similarly, as mentioned in a recent report by the German Environment Agency, "control instruments have achieved inadequate impacts or were associated with unintended impacts. For example, the Dodd Frank Act (section 1502) has led companies to switch to other production sites instead of optimising the transparency of supply chains in the Congo as intended".[24] As the responsibility for risk management lies with each individual end-user, and risks such as child labor or other malpracractices in the mining sector are systemic and complex to solve, the approach often leads end-users to disengage with the more high risk areas and/or mining entities. Solving these complex issues requires investment and engagement by the industry, in cooperation with other key stakeholders such as governments and NGOs, to incentivize and propel improvements - strategies that go beyond managing risks.

Standards and certifications

Several operating standards and certification systems on responsible mining have been developed and adopted by the industry. Some of these are sector-specific, such as the Copper Mark, the Aluminium Stewardship Initiative, the Responsible Jewellery Council, Fairtrade Gold Standard and Fairmined; while others are applicable across many commodities, such as the Initiative for Responsible Mining Assurance and the International Council for Mining and Metals Performance Expectations. These initiatives cover a broader scope than the narrower human-rights due diligence approaches, and include requirements to address a more comprehensive set of social, labor, corporate governance and environmental aspects.

The level of uptake by the industry and multi-stakeholder initiatives varies between the schemes, but generally is low, compared to the number of actors in each sector. There are multiple reasons for this, including the need for investments to reach these comprehensive standards as well as incentives for organizations to obtain these certifications, such as an increased demand for certified material (in some instances with a premium attached).[25]
In short, there has been an increase in efforts by the wider industry on analyzing and mitigating risks in specific material supply chains. However, these efforts have been mainly concentrated on key materials, starting with the four defined conflict minerals and are only now expanding to include other minerals. At the same time more material chains, including recycling chains, need attention that is currently outside of the scope and focus of the wider industry.

24 GEA (2019) p38
25 GEA (2019) p39

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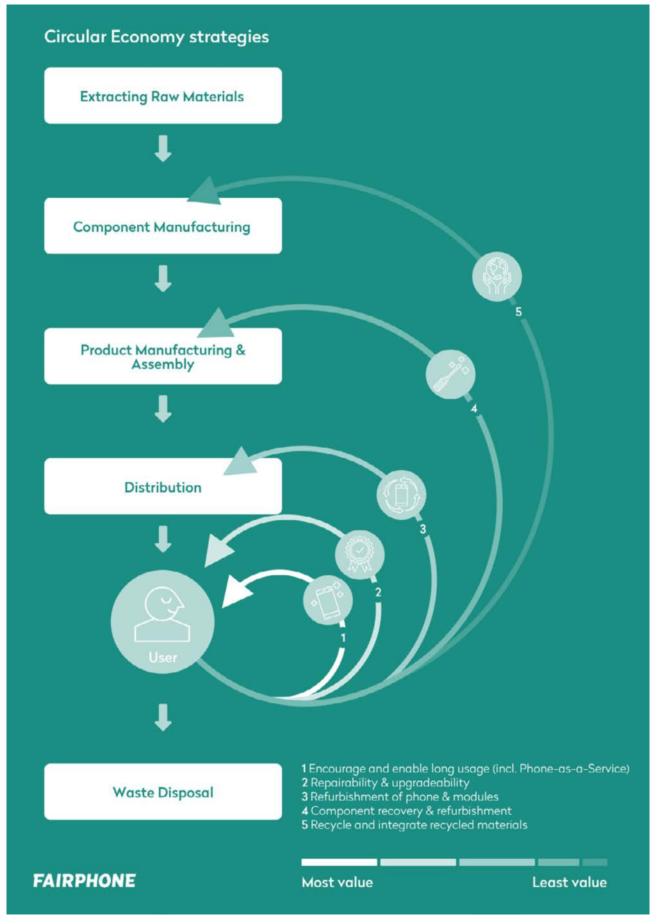
We recognise that risk management alone does not necessarily contribute to improved mining or recycling practices and that currently only very few mining entities are certified to reach high sustainability performance standards. Systemic problems in the mining sector are complex, cannot be addressed within short timeframes and need significant engagement and investments to solve. This often means that we need to recognize and accept that certain risks are a reality today, which require actively working together to find sustainable solutions. The electronics industry has a key role to play because of its capacity to influence markets through sourcing practices, as they can incentivise improvements through channeling demand to certain supply sources as well as set specific sourcing requirements.

Below we analyze some key areas where systemic social and environmental issues persist and where the electronics sector, and thus Fairphone, can be a change agent for positive impact.

3.1 Sourcing recycled materials: Key bottlenecks to move to a circular economy

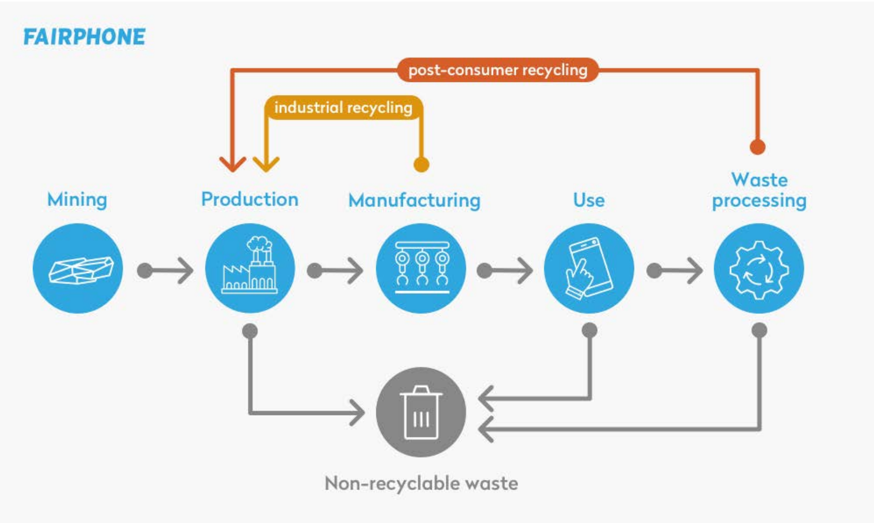


As mentioned, we envision a world in which we are truly circular - where materials can be used, reused and recycled to their full extent. Moving to this circular economy requires
multiple interventions, as shown in the picture on the right. The need for longer lasting products, improved repairability, re-use, collection, and recyclability of products are some of the key areas that need to be addressed.

At Fairphone, we focus on many of these aspects. We focus on longevity with our modular design that allows for easy repair and upgrades of modules without the need to replace the entire phone. Furthermore, modularity allows for reuse and refurbishment of the modules and usage as spare parts. However, not only physical longevity is needed to prevent a product from becoming obsolete. Software support of the core chip set is as important but usually not the focus of a phone manufacturer, but of chipset producers. Knowing that support is mostly limited to a few years, Fairphone takes on the responsibility and prolongs software support for our products. Furthermore, we aim to become e-waste neutral by incentivizing improved collection of end-of-life post-consumer waste through our take-back and recycling programs in Europe and Africa.

With regards to material sourcing strategies – the focus of this report – improving the recycling loop to recover and reuse materials to move to a circular economy is of key importance.

Generally we identify different types of recycled supply: post-consumer or end-of-life waste and pre-consumer or industrial waste.



The re-use of industrial waste is more common, as industrial processes are optimized to ensure a minimum loss in material value – the scrap produced is usually of high purity and value. However, the closer processes are to the manufacturing of finished products, the more complicated the products are and the more difficult they become to effectively recycle. While industrial waste recycling contributes to resource efficiency, a key opportunity to prevent negative impact, as well as leverage resource recovery lies in the effective recycling of post-consumer waste.

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End-of-life recycling

While recycling is increasing steadily around the globe, only a minor share of the products that reach end of life are effectively recycled. After its use, the generated electronic waste contains both valuable as well as hazardous materials, such as mercury, lead, cadmium or plastics, that can contain flame retardants. Therefore, if not disposed of safely and recycled properly, this hazardous waste presents major pollution and health risks. Despite this, end-of-life recycling rates of e-waste worldwide remain disproportionately low.

Electronic waste is made up of 30% plastics and more than 40% metals.[26] A research report published in 2017 estimated that of all the plastics produced until 2015, "only 9% had been recycled, 12% was incinerated, and 79% was accumulated in landfills or the natural environment".[27] Similarly, the recycling rate of products containing metals remains low. As stated in a UNEP report published in 2011, "because of relatively low efficiencies in the collection and processing of most metal-bearing discarded products, inherent limitations in recycling processes, and because primary material is often relatively abundant and low-cost (thereby keeping down the price of scrap), many end of life recycling rates (EOL-RRs) are very low."[28]

At the same time, waste from the electronics sector (electronic waste or e-waste), is growing very fast. In fact, it has been defined as the worlds' fastest growing waste stream. Driven by developing economies, the global consumption of electrical and electronic equipment (EEE) increases globally with an annual average rate of 2.5 million metric tons.[29] Where in 2015, 44 million metric tons of e-waste was produced, equal to around 6.4 kg per capita.[30] In 2019, over 50 million metric tons of e-waste was produced, amounting to 7.3 kg per capita. If this trend continues, it is expected that the total amount of e-waste produced annually will rise to almost 75 million metric tons in 2030, amounting to over 9 kg per capita.

"In 2019, only 17,4 % of e-waste was formally documented to be recycled"

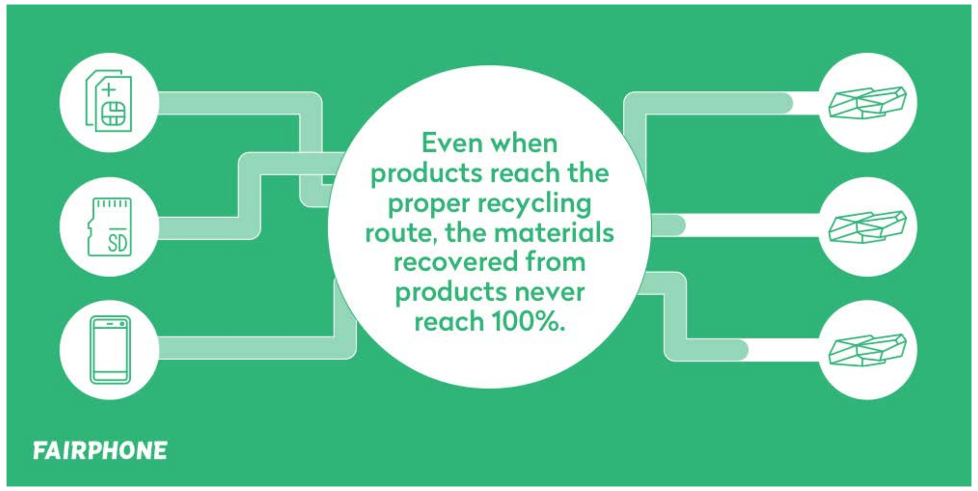
Unfortunately, the collection and recycling of e-waste is far behind. In 2019, only 17.4% of the e-waste generated was documented to be collected and recycled, leaving over 80% of the generated e-waste undocumented, and likely to be either not recycled or recycled under inferior conditions.[31] Therefore, a high percentage of e-waste remains unused. As e-waste contains numerous metals, there is potentially significant monetary value that can be generated from e-waste. In 2019, the total value of e-waste generated approximates USD$57 billion. With the current e-waste recycling rates, only USD$10 billion is recovered.[32]

26 Mary Senophiyah, Meenambal T. (2016) https://www.researchgate.net/publication/305895242_Inventorisation_of_E-Waste_and_Developing_a_Policy_-_Bulk_Consumer_Perspective
27 Roland Geyer, Jenna R. Jambeck, Kara Lavender Law (2017) p1
28 UNEP (2011) p9
29 UNU (2020) p13
30 UNU (2020) p23
31 UNU (2020) p14
32 UNU (2020) p15

This only takes into account the e-waste generated in 2019, not the previous decades nor the e-waste that has never reached any formal, or informal recycling route. Therefore, the potential value that can be generated by tapping into this urban mine could be very significant.

The lack of the collection and recycling stems from a myriad of factors, including the needed improvement in the collection of old electronics and the prevention of illegal export. The sourcing strategies of companies could be an important factor too, as increasing the demand for post-consumer recycled materials can incentivize collection and recycling. This includes increasing the use and application of recycled materials in products, as well as enabling an improved recovery of materials by design. As the recovery of materials from electronic products is complex, "the recycling sector is often confronted with high costs of recycling and challenges in recycling the materials. For instance, the recovery of some materials such as germanium and indium is challenging because of their dispersed use in products, and the products are neither designed nor assembled with recycling principles having been taken into account".[33]

Indeed, as indicated in the first recyclability study conducted by Fairphone, only 30% of the materials used in the Fairphone 2 can be recovered, even if the most optimal recycling routes are applied. Fairphone 3 shows an improvement to 45.1%. It should be noted this is more than many other products, but unfortunately the data can not yet be compared as few organizations have published recyclability studies. These examples show that, besides a pull factor to channel demand for post-consumer recycled materials and finding new applications in which to use these materials, more effort needs to be placed on the ease of their effective recovery from used products. As a result, effective and scalable supply chain models for post consumer recycled materials will be enabled.



33 UNU (2020) p58

Informal recycling
In 2019, more than 80% of the e-waste generated remained unaccounted for. From this undocumented electronic waste, it is estimated that 8% is discarded in waste bins, ending up in landfills or incinerated. Between 7-20% of the waste is likely to be exported as secondhand products or illegally exported to developing countries.[34] As the infrastructure for recycling is often underdeveloped or absent in these countries, electronic waste frequently ends up in the informal sector, where it "is often handled under inferior conditions, causing severe health effects to workers as well as to the children who often live, work and play near e-waste management activities".[35]

As such, as the amount of e-waste increases steadily, the informal sector is likely to be growing at a similar pace. In these informal recycling systems, a significant number of self employed people are typically engaged to collect end-of-life electronic products from households or other institutions and "sell it to be repaired, refurbished, or to be dismantled. Dismantlers manually break the equipment down into usable marketable components and materials. Recyclers burn, leach, and melt e-waste to convert it into secondary raw materials. This 'backyard recycling' causes severe damage to the environment and human health".[36] Furthermore, the work in general is characterised by dangerous working conditions and low pay, and child labor in this informal sector has been documented in multiple instances. In India, for example, it is estimated that in 2014 around 450,000 children were active in the sector.[37] The recycled materials that are produced and recovered in this sector end up in a variety of recycled supply chains.

At the same time, the sector provides a livelihood for many. In 2013, it was estimated that "of the 24 million people who work in recycling activities, about 80 per cent perform in the informal economy."[38] Given the rising volumes of electronics waste, the informal recycling sector could be much larger today. Therefore, it is an important sector to be taken into account when addressing key human rights issues, but more importantly, it presents an area where the livelihoods of millions of people could be positively impacted with the right engagement and investments.

Similarly, there is a growing amount of plastics that is left in the environment. It is estimated that "for every person born since the 1950s, one tonne of plastic has been produced and less than a tenth of this has been recycled. Around half the amount of plastic waste we produce globally is packaging that is used just once".[39] The production of plastics is rising, and estimated to double over the next ten to fifteen years.

34 UNU (2020) p14
35 UNU (2020) p14
36 UNU (2020) p41
37 ILO (2014) p15
38 Ibid p23
39 Tearfund (2019) p3

The growth and lack of recycling of plastics is the largest in developing countries, where there is a lack in the collection of recycling infrastructure that renders the vast majority of plastics to end up in a landfill or incinerated, causing severe environmental and health effects. It is estimated that developed economies can reach recycling rates of around 30% of plastics, while developing economies remain below 10%.[40] Plastics pollute entire landscapes, posing a health risk to people as well as to wildlife. “Piles of plastic pollution and waste release a toxic liquid runoff called leachate, which can contaminate soil and groundwater.”[41] The incineration of plastics wastecontributes to global emissions and not to mention the severe health risks as it releases toxic fumes when openly burned, polluting our food systems.[42]

As much of the plastic waste ends up in low- and middle-income countries, the informal sector plays a substantial role and provides a common livelihood for people who are poor and living in urban areas – about one percent of the global urban population (over 15 million people) earn their living in this way.[43]

To conclude, many materials are lost because of a lack of reuse and recycling of post-consumer products. Similarly, many products end up in countries lacking the infrastructure to process post-consumer waste, and are recycled informally, risking the health and safety of workers as well as contributing to environmental pollution.

Challenges of post-consumer recycling

As we have mentioned, more industry efforts are needed to scale the effective recycling of post-consumer waste and ensure that current recycling is done in a more responsible manner. First of all, there is a need to clearly differentiate between post-consumer and pre-consumer/industrial recycled sources. The channeling of demand for post-consumer recycled materials can incentivize increased recycling of those products. Simultaneously, the electronics industry is well positioned to enable higher material recovery rates through product design. Therefore, for certain key materials that lack efficient recycling pathways, we will explore options to enable the recovery of materials from our products, pilot and develop appropriate, scalable recycling routes and incentivize increased recycling rates by sourcing post-consumer recycled materials.

40 Woldemar d'Ambrières (2019) p14
41 Tearfund (2019) p19
42 Tearfund (2019) p49
43 It is estimated that in some areas the informal sector is responsible for an even higher percentage of waste collection 'for example in Lusaka, Zambia, this is over 30 per cent'. Tearfund (2019) p35

Furthermore, transparency is needed to determine the sources of recycled supply and its associated performance. This includes both the efficiency of recycling, as a maximum recovery of materials should be incentivized, as well as the social and environmental responsibility of the dismantling and recycling of electronic and plastic waste. While a significant focus of industry has been geared towards risk management in mined supply chains, the informal recycling sector has received much less attention.

Opportunities for impact

As described above, the informal sector comes with its challenges, however, it also provides a livelihood for many people, as well as a key potential source of unused electronics and plastic waste. Instead of putting a halt to the informal sector, there are opportunities to improve waste collection and recycling, while positively impacting the livelihood of many people by formalizing and professionalizing the sector.

Therefore, the key selected Thought Leadership ***areas*** where we see more industry efforts need to be geared towards and where we recognise the industry can drive a positive impact are to:

- Develop scalable post-consumer recycling chains: invest in and build scalable sourcing models for post-consumer recycled materials & (biobased) plastic and improve recyclability by design; and
- Develop fair urban mining solutions: design urban mining formalization and improvement programs, build scalable sourcing models and create the infrastructure for funding & implementation by broader industry.

3.2 Sourcing mined materials: Key social and environmental improvement needs

The vast majority of the world's mineral production stems from large scale, industrial mine sites (LSM), with fully mechanised operations. A minor part of the world supply stems from ASM. However, ASM has experienced explosive growth in recent years due to the rising value of mineral prices and the increasing relatively quick and high returns in comparison to agricultural activities. Currently, an estimated 44 million people are directly engaged in ASM, up from 30 million in 2014, 13 million in 1999 and 6 million in 1993.[44] That compares to only 7 million people working in LSM in 2013.[45] Both LSM operations and the ASM sector come with their own set of challenges.

LSM mining

Pollution of large scale mining through the release of harmful substances through waste water and solid waste, as well as air pollution or land erosion can cause high damage to the environment and surrounding communities. Mineral extraction is the world's largest waste producer, especially in case of the extraction of zinc, bauxite, and nickel mining. Waste is usually stored in tailings.[46] When not stored properly or storage facilities fail through other causes, tailings can spill thereby potentially causing acid mine drainage (AMD) and "hazardous substances to be released into the environment causing major environmental catastrophes. Effluent from mining tailing (particularly from coal, iron and uranium ore mines) is also potential sources of groundwater and soil pollution with heavy metals and radionuclide."[47] LSM could also have a direct as well as indirect impact on forests, where "around 10 percent of all forests are potentially influenced by operational large-scale mining projects."[48] Furthermore, the energy intensity of the extraction and processing of natural resources is very high. The extractive industry is a large user of fossil fuels, thereby having a very significant footprint and effect on climate change.[49] Conflicts with surrounding communities are also reported, due to pollution or over the use of limited resources such as land, forests and water. For example, conflict with surrounding communities may result over the use of water, as mining operations can be water intensive and create competition for other uses, such as with agriculture. "Copper for example, is estimated to require 1,600 litres of water to obtain 19 kgs of copper" and "70 % of mining operations of the six largest mining companies are located in water-stressed countries."[50]

44 Delve Database, Available at: https://delvedatabase.org/
45 IGF (2017) piv
46 "Tailings are the materials left over after wet processes used to separate the valuable fraction from the uneconomic fraction of an ore. The leftover slurry is referred to as tailings, and consists of fine particles and chemical reagents. Sometimes, it has high concentrations of toxic substances". IRP (2020). p136
47 IRP (2020). p139
48 Worldbank (2019)
49 IRP (2020) p143
50 Ibid. p134

"While a solid focus of the LSM industry has been on developing standards and certifications for mining operations, managing health and safety and reducing the aforementioned environmental risks, the potential for LSM to contribute to the diversification and the development of local economies remains underutilized."

Responsible mining can contribute to local growth because of linkages at the community level. For example, due to the fact that LSM operations can be active for decades, significant opportunities to spur economic growth are presented by procuring local resources, providing direct and indirect employment opportunities and investing in local development and

infrastructure. As noted in a report of the ICMM, "In more mature mining countries, the total GDP contributions – from mining per se but also in other linkage industries – can be quite significant. One dollar of economic activity in the mining sector can generate three dollars or more of economic activity elsewhere."[52] Similarly, while direct employment is relatively low, due to the low labor intensity of the operations, wages are usually high. The indirect employment can still be quite significant as "mining can also be a very influential source of income and spending power and hence a stimulus for new productive activities."[53]
For example, local procurement can indirectly benefit other sectors and jobs. "Taking all this into account, employment multiplier effects can often be significant. One direct mining company employee may correspond to 3–5 employees elsewhere in the economy."[54]
The above average multiplier effect of mining means that during its lifetime mining can make a significant contribution to local developing economies.

However, as of 2019, "the world's most mining dependent countries continue to rely on their natural resources as the primary driver of economic activity."[55] At the same time, "resources such as the Natural Resource Governance Institute's (NRGI) Resource Governance Index and the World Bank's Worldwide Governance Indicators (WGI), indicate that the governance of natural resources in 84% of these countries is weak, poor, or failing."[56] The absence of strong governance structures, leads to limited oversight and regulations to prevent pollution and human rights violations and thus requires strong governance structures of mining organizations to avoid harm. More so, the human development index of these countries is relatively low, suggesting that mining investments and revenues need to be managed carefully to reduce poverty and increase social improvements in host countries.[57]

52 ICMM (2013) p23
53 ICMM (2013) p24
54 ICMM (2013) p24
55 ICMM (2020) p7
56 ICMM (2020) p9
57 ICMM (2013) p20

In sum, the contribution of mining to national economies could be significant, but does not yet reach their full potential. And while this is obviously not a task for the private sector alone, and needs to involve government and other stakeholders' efforts as well, there is a role for mining companies to contribute further to local development and for the electronics industry, as a key user of certain metals, to incentivize and contribute to good practices.

ASM mining

The ASM sector provides a livelihood for many impoverished communities. People work in ASM when there are very little or no alternative income sources available and mining revenues are usually faster and higher.[58] If commodity prices rise, the share of ASM production is likely to expand. Higher prices are attractive for miners and ASM could provide a flexible source to fill the global supply gaps. "Recent years have seen an unprecedented and widespread shift from agrarian to informal mineral extractive economies. In 2016, the IIED estimated the number of people supported by ASM-related activities to be 100 million to 150 million and growing."[59] This is especially true in certain commodities such as ASM gold mining, which has steadily increased at an estimated 3.6% per year.[60]

The ASM sector usually operates informally, characterised by low to no mechanisation, dangerous working conditions, dismal incomes, high environmental pollution and child labor. ASM gold mining is responsible for around 30% of the world's mercury emissions, thereby highly polluting the environment and posing health and safety risks to workers and the surrounding communities. It is also estimated that around 1 million children are active in ASM gold mining.

The lack of mechanisation in ASM mines makes the production output and financial capacity of these mine sites very low. Similarly, in order to adopt more responsible and productive mining practices, capacity building and training is necessary. However, artisanal miners are often trapped in a cycle of poverty as the informal structures often lead to informal sales channels and an inability for miners to bargain for fair trading terms. Because of a lack of access to formal finance, miners need to resort to local investors, often against very high interest rates and/or unfavorable terms. All these factors contribute to consistently low incomes, low capacity and poor social and environmental practices at ASM mine sites, continuing the cycle of poverty.

58 Proportion fluctuates over time
59 IRP (2020), p 10; IIED (2016) p8
60 LBMA (2020)

Conflicts between ASM and LSM mining are occurring more frequently, leading to significant concerns of human rights violations: the presence of ASM sites can serve as an indicator for the presence of mineral reserves and becomes an area of interest for LSM exploration activities.[61] At the other end of the spectrum, LSM activities can cause an influx of artisanal miners searching for mining opportunities. However, as artisanal miners are usually seen as high risk for LSM companies, they are often forcefully evicted from LSM sites. Around the globe "security forces employed by either companies or governments to protect large-scale mining assets have been accused of human rights abuses against artisanal and smallscale miners, including gender-based violence and sexual assault."[62]

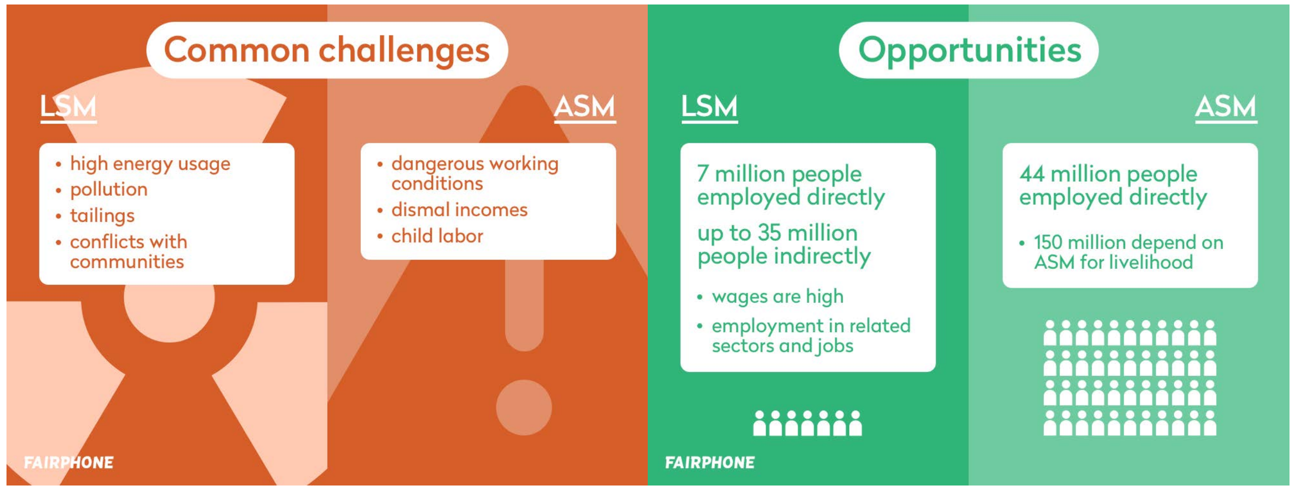
The ASM sector is usually perceived as a high risk sector and therefore, with the adoption of risk management strategies of downstream brands, ASM supply is often banned from international supply chains. In general, only artisanally mined production that is certified using high social and environmental standards, such as Fairtrade or Fairmined, are accepted by downstream companies and brands. However, few mines are certified against these standards, as they are expensive and time intensive to achieve. As a result, the vast majority of artisanally mined minerals do not have any access to formal markets.

However, banning ASM material pushes the sector further into informality, reducing oversight and control of the sector, thus rendering the supply chains opaque with a high risk of leaking into formal global supply chains. Furthermore, interventions that effectively reduce demand for artisanal mined output are likely to have a detrimental effect on the local livelihoods of the millions of dependent ASM miners. With access to informal markets only, or an inability to sell any artisanally mined materials, local incomes can be negatively effected, potentially driving more families into poverty and increasing the risk of child labor and dangerous working practices. Effectively, risk management strategies are not solving the key human rights issues that they are meant to address.

While the challenges in artisanal mining are substantive, it presents a tremendous opportunity to positively impact the livelihoods of millions of people.

To effectively address the issues surrounding artisanal mining, substantial investments and engagement are needed to improve mining performance. Multiple actors can play a role to improve the performance of ASM mines. For example, there is potential for LSM companies to increase capacity by providing expertise and support.

61 IRP (2020) p89
62 IRP (2020) p89



The electronics industry also has a role to play. Improvements of artisanal mining practices can be incentivized by companies consistently creating demand for ASM mines that are committed to and continuously demonstrating sustainability improvements. Only with access to formal supply chains can ASM sustainability performance be formulated and incentivized, and investments in the sector by corporate entities, as well as local governments, catalyze the change that is needed.

Opportunities for impact
While mining can be seen as intrinsically unsustainable and harmful to the planet, when managed properly it can become sustainable with significant power to influence local development. As mentioned, both LSM and ASM come with significant social and environmental challenges, but they are also equipped with the ability to drive development and increase livelihoods in low- and middle-income countries. Therefore, working with ASM mine sites that are committed to continuously improving their social and environmental performance and business practices is crucial.

In LSM there is an opportunity and need to ensure the benefits of mining are used to catalyze local development, while simultaneously protecting the surrounding communities. While existing industry efforts to ensure the mining operations adhere to social and environmental standards are crucial, the scope should be widened to ensure mining is met with the local economic resilience to foster continuous sustainable development. Similarly, the importance of the ASM sector to local livelihoods should not be overlooked.

Therefore, the key selected Thought Leadership areas where we see the need for more industry efforts and where we recognise the industry can drive positive impact:

- Develop Fair ASM sourcing solutions: design ASM improvement programs, build scalable sourcing models, accept ASM in our supply chain, and create the infrastructure for increased demand of Fair ASM, funding & implementation by industry; and
- LSM engagement for community development: design and implement improvement programs that contribute to local development (i.e. benefit vulnerable LSM communities), building scalable sourcing solutions incentivizing these best practises.

3.3 Our Fair Sourcing Principles: Thought Leadership and Frontrunner Opportunities

To address the complexity in both the mining and recycling sectors, scalable solutions that have a positive impact on these communities and contribute to the circular economy are needed. As described further in our policy, Fairphone sees responsible sourcing as beyond a risk management approach to making a positive impact. We see a crucial need for us and our industry to work together with suppliers, recyclers and mining entities to find innovative approaches that can be scaled to the rest of the industry. In the end, we envision a world where people working throughout the value chain work under fair conditions and that the planet's resources are sourced and consumed responsibly. Therefore, our approach to fair sourcing can be broken down into four main principles:

1. Use buying power as a catalyst for investments;
2. Address risks as opportunities: engage, build supply chain partnerships and co-invest where we identify hotspots;
3. Achieve continuous improvements and report on progress; and
4. Work towards systemic change with region-wide impact.

For materials where the electronics industry is an important user and thus has a significant share of the demand, there is an opportunity for this industry to drive such changes, especially with a focus on the key issues as described above, which remain largely unaddressed. In these areas we see an opportunity to influence and (co) develop new approaches to tackle systemic issues in the mining or recycling sector - and lead change by becoming a thought leader.

In some cases there may already be sustainable material sources available, developed by industry peers or other initiatives. In such cases, and where Fairphone does not have the capacity or sector influence, we intend to integrate these sustainable alternatives into our chain and join our industry as a frontrunner.

In the next chapter we analyze in which material supply chains there is an opportunity for Fairphone, and the electronics industry, to lead positive change.

4. Methodology and Outcomes

To determine which material chain we believe we can influence, as Fairphone and the electronics industry at large, we further developed a methodology based on our previous study, in order to analyze opportunities and challenges in the different supply chains. Firstly, we analyzed whether the material is present in our products, what share of demand can be attributed to the electronics industry for each material, the criticality in the functioning of our phones and the key social and environmental issues for these materials (analysis 1). This resulted in an initial list of materials, which we further analyzed to understand our impact potential and the urgency for change in each of the material chains. We based this list on the key identified challenges in the industry, the expected demand growth, as well as the feasibility of driving change in each particular material chain. This analysis included a possible deepening of our engagement for the eight materials we already had in scope until 2020, as well as broadening our scope to include new materials in our roadmap.[63] The final prioritisation informs our 2023 fair material sourcing roadmap.

The analysis is mainly based on existing public literature, as in-depth studies and comparisons have been implemented on social and environmental issues in different material chains, such as our own scoping study from 2017, the material change report developed by The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018) and the Environmental Criticality of Raw Materials by the German Environment Agency (2019).

63 The materials in scope of Fairphone's material roadmap until 2020 are tin, tungsten, gold, neodymium, copper, lithium, cobalt and plastics

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Furthermore, validation of the methodology and results have been held throughout the process by expert stakeholder interviews.

4.1 Analysis 1: Material Assessment

As we developed our fair material sourcing roadmap, a first step was to make an inventory of **the materials used** in our products and accessories. We analyzed literature on the elements reportedly used in consumer electronics, which resulted in a list of 55 materials.[64] Furthermore, we collected over 90% of full material declarations of Fairphone's components. Certain materials reported in the literature were not reported by our suppliers, which can be the case if the materials are not part of our design, are only used in trace amounts, or are a result of mistakes in the full material declaration. The cross reference with existing literature was helpful to track certain unreported materials, or confirm that they indeed were not used in our products.

Secondly, we analyzed the **consumer electronic industry's demand** for the different identified materials. The higher the industry demand, even if the material is only used in very small quantities in our products, the higher the responsibility, as well as opportunity of the electronic industry, to drive change in that material supply chain.

The first layer of our analysis also included an estimation of the **criticality of materials** for the technical functionality of the device. When a material scores very low on this indicator, it means that it is relatively easy to substitute the material for other materials. Therefore, the lower the score, the less likely and relevant an opportunity to develop impact programs exists and the higher the score the higher the opportunity to develop programs of influence.

Lastly, we analyzed the **social and environmental issues**, as well as the strength of **governance structures** in the 5 top producing countries, measured by the strength of the rule of law as well as the level of corruption.[65] As an analysis of each individual chain would require a high level of expertise and capacity, the analysis was mainly based on reviewing existing, in depth reports comparing different materials.[66]

64 Rubber, leather and paper were also included in the analysis. Even while these materials are not found in a smartphone, these were included to cover a broader scope of materials as accessories are also in scope of our fair material strategy. The scores of the different rare earths, namely praseodymium, neodymium and dysprosium, are summarized under 'Rare Earth'.

65 The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018) p112

66 Especially the Material Change report published by RMI and Drive sustainability, developed by the Dragonfly initiative (TDI Sustainability)

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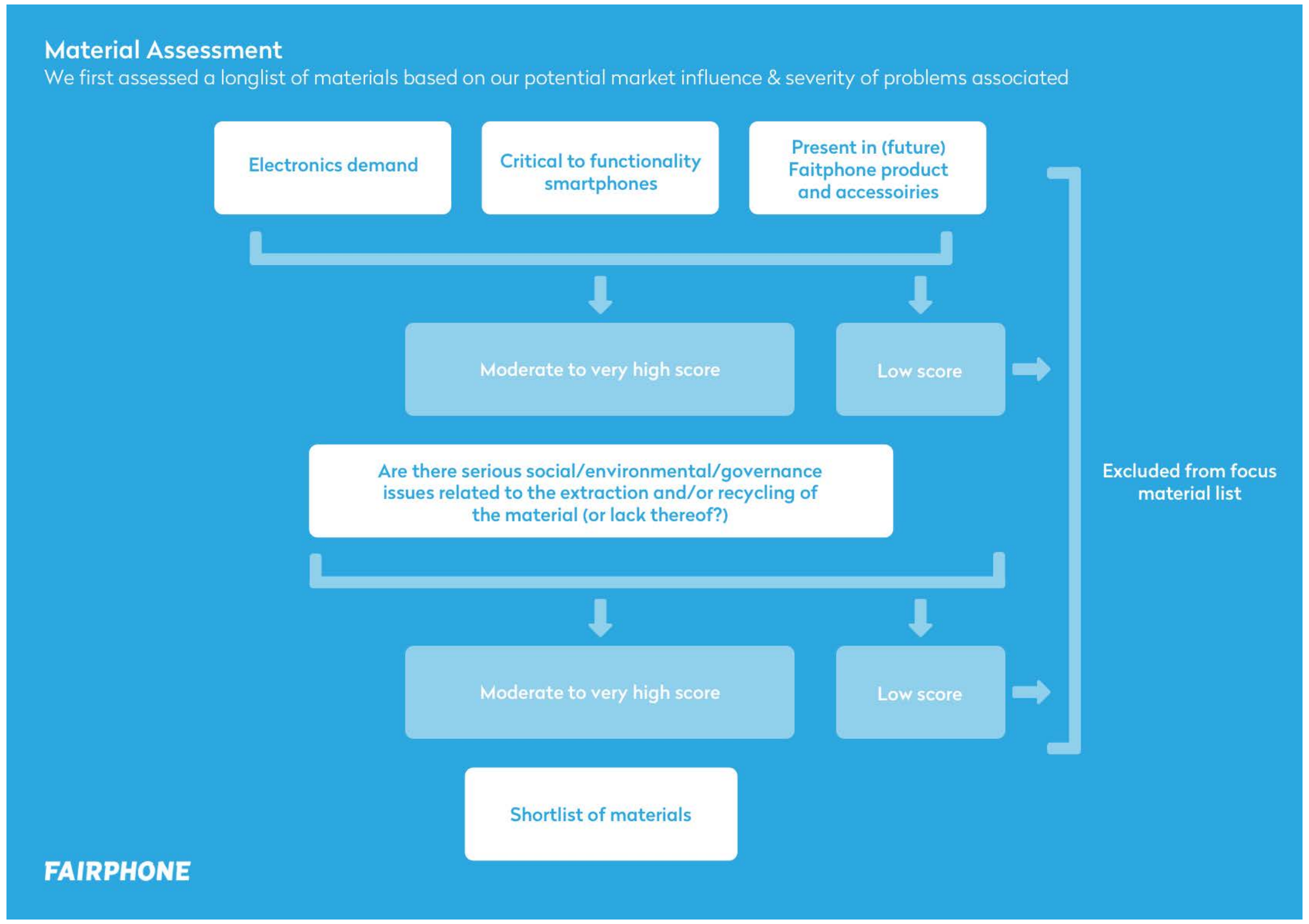
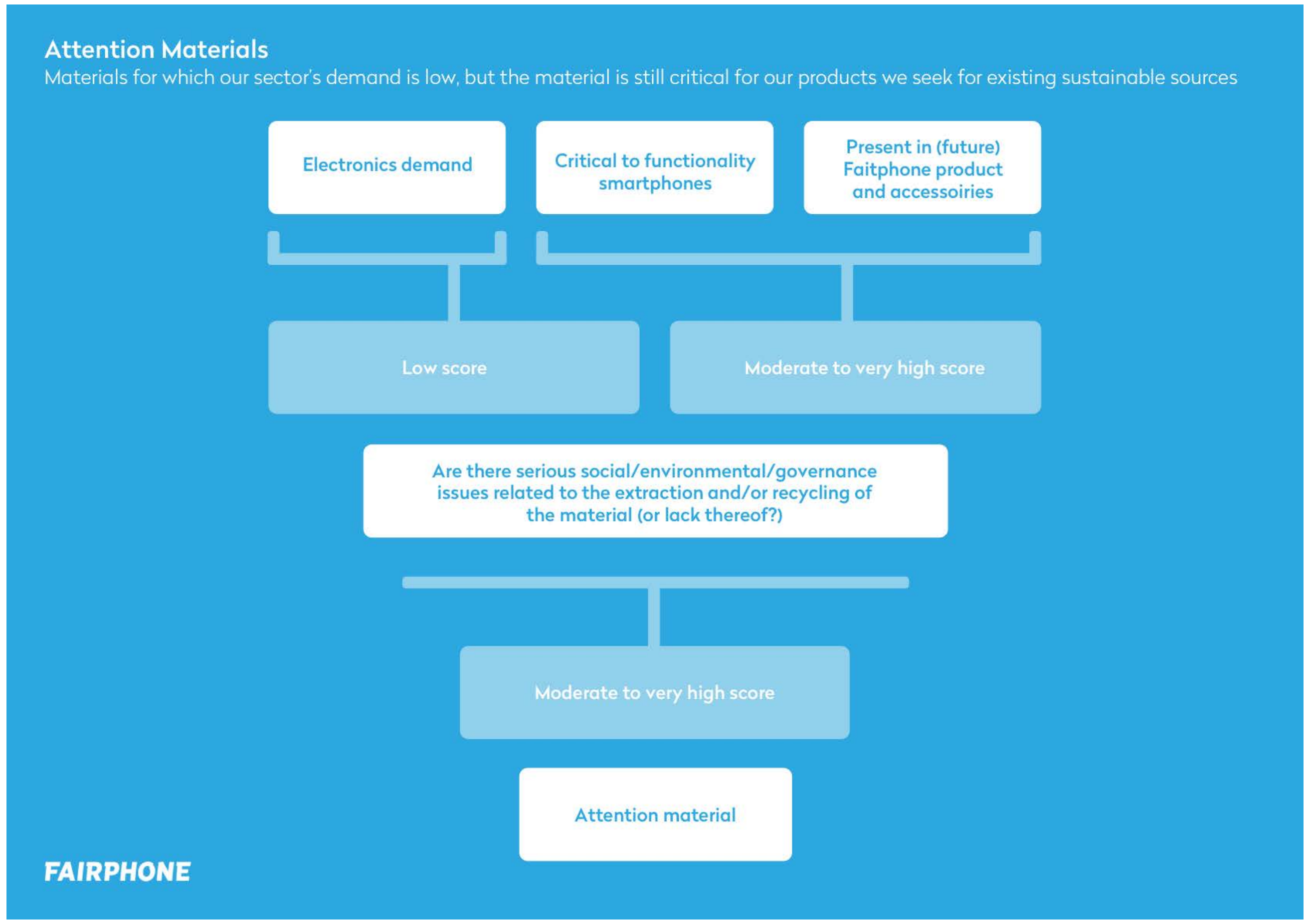


The analysis of these factors led to a list of 17 materials that are present in Fairphone products and could be included in our material sourcing roadmap (See Annex 1 for the full results and indicators used). These are materials where the electronics industry has a significant or leading role to play in order to improve on the relatively high social and environmental issues associated with each material supply chain.

There are many other materials that are critical to our products and have significant social and environmental challenges, but the demand for those materials from the electronics sector is low and therefore, the opportunity to drive change is limited. At the same time, should there be more sustainable alternatives for these materials, we would seek to source those. We will keep monitoring these '**attention materials**' and when a more sustainable alternative is developed we would seek to use these sources. A list of attention materials is included in Annex 2.



4.2 Analysis 2 : Defining our fair material sourcing roadmap

After defining a shortlist of 17 materials, we analyzed the potential for Fairphone to drive impact on the key selected topics around mining and recycling improvement.[67]
We recognize that as a small electronics manufacturer, we do not have the influence to tackle all of the social and environmental issues in the various supply chains. We therefore further analyzed the key social and environmental problems in the 17 material supply chains to assess:

- the urgency of improvement based on the forecasted demand, the dependency and expected pressure on the mining or recycling sector;
- whether these align with the defined thought leadership and our focus areas; and
- the expected feasibility of developing more sustainable sources, integrating more sustainable sources into our supply chain and identifying opportunities to scale impact across our industry.

67 Rare earth metals are counted as one metal, but in fact include dysprosium, praseodymium and neodymium in scope

Demand outlook and expected pressure on the mining or recycling sector
At Fairphone, our scope includes both improving mined as well as recycled supply. Based on previous scoring and in depth review of additional background literature, we looked into each of the 17 shortlisted materials, zoomed in on the key issues and determined whether they were either social or environmental and related to either the mining or recycling sector. Furthermore, we included the **depletion rate** and the **rate of virgin material consumption** to assess the reliance on the mining sector and address the need and opportunity for advancing recycling. For example, if there is a high depletion rate, recycling will be a necessity in the future, highlighting the need for advanced recycling solutions. If virgin material consumption is high, this indicates that reliance on the mining sector continues to be high, signalling a need for improvements in the mining sector, while further developing recycling streams in the longer term.

Furthermore, we considered the **demand outlook** for each material. When the demand for materials is likely to rise, this can add additional supply pressure to the mining and/ or recycling sector. Should demand rise exponentially, prices of materials can rise because of market shortages. Demand growth can lead to a swift expansion in supply, which can increase pressure on the mining or recycling sector, potentially leading to higher social and environmental issues, expansion of the ASM sector, or expansion of informal recycling practices. If the demand rises for a material with a high virgin mined consumption and high negative social impacts, it indicates that the mining sector will remain a key supplier, rendering improvements of the sustainability performance of the mining sector more urgent. In some cases, even when the virgin material consumption is low, indicating less than 70% of the material supply stems from the mining sector (and more than 30% stems from the recycling sector), the expected demand growth is exponential, and therefore the pressure on the mining sector is expected to be high in the coming decades. Strategies advancing responsible recycling practices could prove to be more urgent – where the key identified issues are mainly environmental or involve informal recycling chains, and there is an increased need for recycling because of the estimated depletion rate.

Lastly, the expected demand growth also provides an indication of the importance of that material in the coming decades, and the opportunities to collaborate with industry partners in the supply chain. In turn, when demand for a certain material is likely to decrease, that can result in a decrease of (informal) mining operations and recycling.

Thought leadership areas and feasibility
After analysing the prioritization of strategies for either mining or recycling improvements for the different materials, we further analyzed whether the main identified social and

environmental problems and needed strategies were aligned with the focus areas, or thought leadership areas, we identified in chapter 3:

- **Developing scalable post-consumer recycling chains**
- **Developing scalable fair urban mining sourcing solutions**
- **Developing scalable fair ASM sourcing solutions**
- **Developing scalable sourcing models that incentivize LSM engagement for community development**

When the key issues are in line with the selected thought leadership areas, and after the prioritization of the different materials, we further analyzed the feasibility of implementing supply chain improvements. For any sourcing program we develop, certain aspects need to be kept in mind to ensure it can reach the impact we aspire to achieve. To reach true impact, any sourcing solution we design needs to:

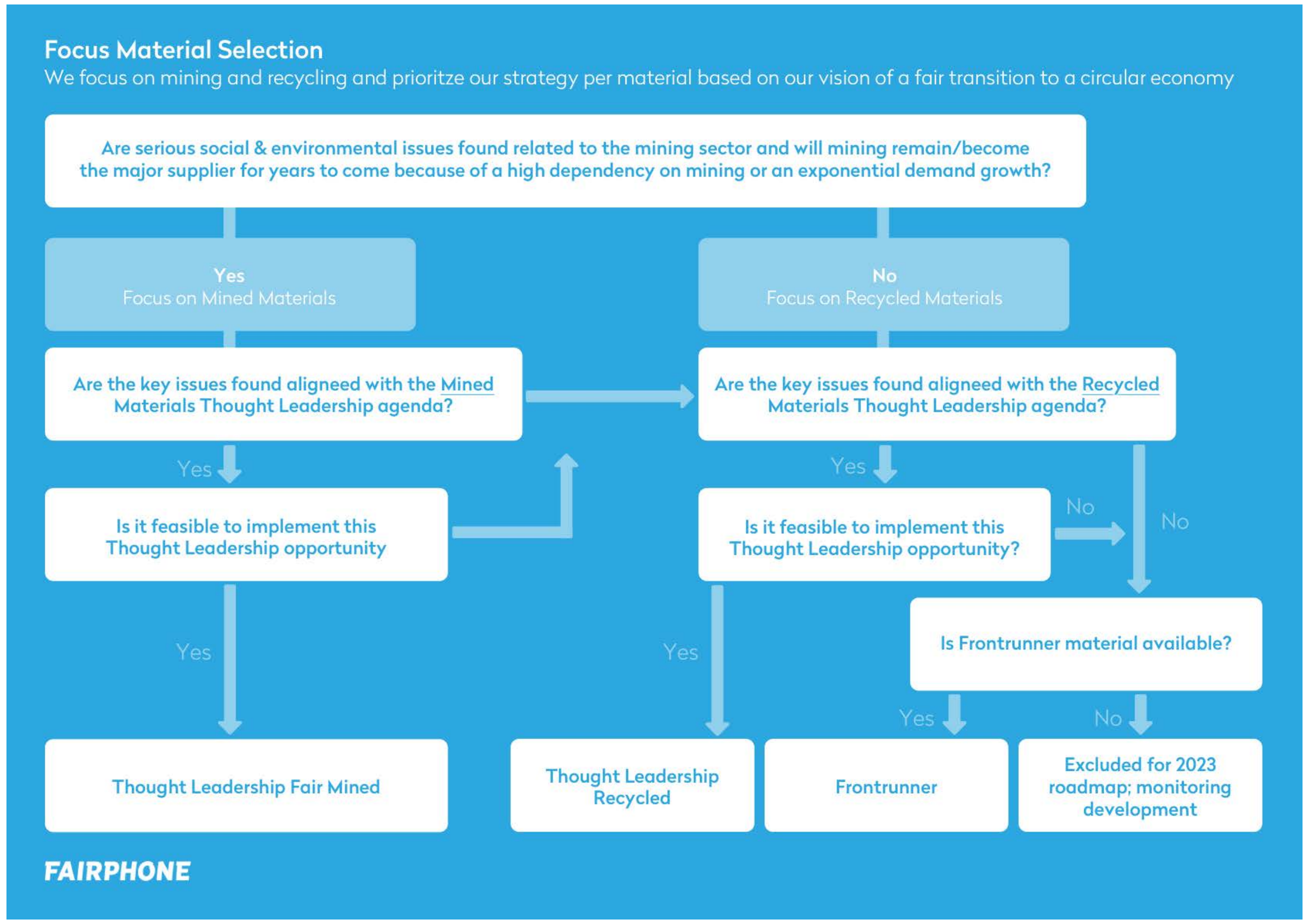
a) provide a solid case of increased fairness/ sustainability of the material;
b) be integrated into supply chains; and
c) be replicable by other industry actors.

Therefore, analyzing the improvement feasibility needs to take into account whether it would be feasible to develop more sustainable sources for the material where there are currently no such sources. For materials with a large artisanal sector, for example, this can entail developing multi-stakeholder programs with the relevant vertical supply chain actors, other industry peers, NGOs, service providers, and governments to improve the artisanal mining sector. However, for issues surrounding LSM, especially for materials of which the mining is concentrated, with a few large mining companies or in countries with a high degree of nationalization, this might be beyond Fairphone's ability to influence. In these cases, larger industry coalitions are necessary to exert influence. This may propel our shorter term strategy to use more sustainable materials that are already available (for example, recycled materials), while researching options for mining improvements and advocating for these coalitions to form.

Secondly, we analyze our supply chain on the feasibility to potentially use different material sources, or work with suppliers to improve existing sources. If a material is used in low quantities in many different parts of our products, it becomes more difficult to interest suppliers to change their material sources - unless it is a crucial material for that component. Also, materials are often used in specific combinations, for example in alloys. Aiming to change one of these materials for recycled sources is only feasible when that material is available to source in its pure form. However, recycling loops are usually determined by the specific products that are being recycled, and elements are not always recycled back to 100% purity when the main purpose is to reuse the elements for the same composite material or product. As a result, options to change supply chains to source post-consumer recycled material are sometimes limited, which can favor a short term strategy of sourcing from industrial waste or more responsible, certified mined materials while researching and developing scalable post-consumer recycling options.

Lastly, any solution that we develop needs to be replicable so impact can be scaled. Therefore, we analyzed the actions that are already undertaken by key industry actors on these materials to understand where efforts are already being made, which we could possibly join, or where there is still a need to develop solutions that could be replicated by industry peers.

When the issues related to the materials are in line with the defined thought leadership areas, and where we estimate the implementation to be feasible, we include the material in our 2023 roadmap. If not, we look for opportunities to include materials that at least are more sustainable: what we call 'frontrunner materials'.



Feasibility of frontrunner materials
For materials in which the key problems in the supply chain do not fall into a key improvement area within Fairphone's influence, or where initiatives exist that already address the key issues, we seek to integrate these existing sustainable materials into our products. For example, where the development of post-consumer recycled chains seems unfeasible, we could opt for using available pre-consumer recycled materials. Similarly, when certified mined materials are available, we would seek to integrate this material into our chain when there are no opportunities to set up LSM community development programs.

If materials are not included in the first selection of thought leadership materials, nor are there frontrunner materials available, we will not include the material in our roadmap until 2023. We will continuously research and monitor developments around the materials, and likely include these into future material roadmaps (see Annex 3 for the full analysis 2).

Feasibility attention materials
As mentioned earlier, certain material chains have relatively high social and environmental issues, but a low share of the electronics industry demand and as a result, the opportunity to drive changes by our industry are limited. We also analyzed whether sustainable, frontrunner, sources were already available for these **attention materials**, as well as the estimated feasibility of integrating these sources into our supply chain. At the moment these materials are not part of our focus material list.

Conclusion and target setting
The final analysis led to the identification and selection of a total of 14 focus materials. This list includes: Aluminium, Cobalt, Copper, Gold, Indium, Lithium, Magnesium, Nickel, Plastics, Rare Earth metals, Silver, Tin, Tungsten and Zinc and is shown in Annex 4.[68] We acknowledge that the 14 materials are contained in one or multiple components and that it is not realistic to have 100% of these materials sustainably sourced.

We therefore, will focus on those components with a high average content of our focus materials to set a scalable example.

Our Fair Material target therefore is an average percentage of 70% for these 14 materials [in weight] that we aim to source more sustainably by 2023, defined as one of our key performance indicators.

68 Rare earth metals include dysprosium, praseodymium and neodymium

The 8 materials that were a part of our 2020 strategy are still included in this roadmap. What we found is that for many of these materials we use more sustainable materials. For some of these materials, Fairphone created innovative scalable solutions in line with our Fair Sourcing strategy, e.g. post-consumer recycled plastic and Fairtrade certified Gold. At the same time, we recognize that for some materials we use sustainable sources, but a deepening of the strategy is needed to further improve the material sources to fully live up to our Fair Sourcing Policy, i.e. with the notion that continuous improvement is still needed (e.g. 'beyond conflict free' tin).

Accessories
While the above mentioned fair sourcing roadmap applies to our smartphone, our accessories are included as well. For our branded accessories we aim for at least two of the materials included in our roadmap to be fairly sourced for each of our accessories, with the exception of accessories that do not contain two focus materials. As plastics are used throughout almost all of the accessories, this is one of the key materials to be sustainably sourced to the highest possible percentage. If other materials are also included in the accessory, at least one additional material will be taken into scope to fairly source.

5. Material roadmap next steps

For all the materials included in our roadmap, more detailed trajectories need to be set out, defining the steps to develop each individual fair sourcing chain, following our fair sourcing principles. In general, developing a fair material supply chain includes the following steps:[69]

1. Implement research on the social and environmental issues per material chain
2. Supply chain mapping
3. Partner and supplier engagement
4. Program design
5. Program implementation
6. Supply chain integration of Fair Material
7. Continuous collaboration and monitoring of improvements

In order to determine the social and environmental issues and feasibility of developing a fair chain, a high level first screen was performed to develop our final list of materials. For some materials, we already have a deeper understanding of the potential to develop or integrate more sustainable sources because of our previous work and efforts.

For other materials, further research is needed to inform a detailed strategy. Similarly, each material has its own set of supply chain stakeholders and technical characteristics. Therefore, it is important to map our supply chain in more detail to better understand potential partnerships, as well as the feasibility of adapting certain material supply chains. Once (supply chain) partners are eventually on board, material sustainability or an improvement program needs to be (co) developed. Usually, this includes cost-sharing arrangements, as well as potentially fundraising for larger multi-stakeholder programs. After programs are taking off, the sustainable material can be integrated into our supply chain. However, the work obviously does not end there - improvement of complex social and environmental issues does not happen overnight. Continuous monitoring and collaboration together with partners to ensure impact goals are being reached, is what it is all about. We will keep monitoring and communicating about our progress, with our partners, to reach step by step improvements throughout our material chains.

69 For more information please see Fairphone's Fair Sourcing Policy [available later]

Annex 1: Analysis 1

In our first analysis, we assessed 56 materials, to determine which material chain we believe we, and the electronics industry at large, can and should influence.

We analyzed opportunities and challenges in the different supply chains:

1. The electronics industry demand, in order to understand the potential influence of our sector in the specific material chain;
2. Whether the material can easily be substituted;
3. If material is present in our phone; and
4. The social, environmental and governance issues associated with the specific material chain.

Legend

- Very High
- High
- Moderate
- Low

Focus Material

- MD Missing Data
- NR Not Reported
- NA Non Applicable

	Demand of electronics sector	Critical for functionality	Presence in phone	Weak governance structures	Scoring Social Challenges	Scoring Environmental Challenges
Aluminium (Bauxite)	Moderate	Moderate	Moderate	High	Moderate	High
Antimony	High	High	Moderate	Very High	Low	Very High
Arsenic	Low	Low	Low	MD	Low	Low
Barium	MD	Low	Moderate	MD	Moderate	Low
Beryllium	High	Very High	Moderate	Moderate	Low	High
Bismuth	High	Moderate	Low	Very High	Low	High
Boron	Moderate	Low	Low	MD	Low	Moderate
Chromium (Chromite)	Low	Very High	Moderate	Moderate	Moderate	Moderate
Cobalt	High	Moderate	High	Very High	High	High
Copper	High	Very High	Very High	Moderate	Moderate	Very High
Gallium	High	High	Low	MD	Moderate	High
Germanium	High	Moderate	Low	High	Low	MD
Gold	Moderate	Moderate	Moderate	High	High	Very High
Graphite	Low	High	Moderate	High	Moderate	Low

Aluminium

Bauxite

Aluminium mining has a high association with environmental impact and as there is a high risk of corruption and weak rule of law in the main producing countries, the probability of negative environmental impacts occuring are heightened. Recycling only uses 5% of the energy that is needed to produce aluminium. Informality and poor health & safety practices are documented in recycling chains. Other key sectors using aluminium are: building and transport

Antimony

Antimony mining comes with very high environmental impacts, such as acid mine drainage and radioactive waste potential. As governance structures are scored to be very weak in main antimony extraction countries, negative impacts of mining are more likely to occur. A number of product restrictions apply on Antimony, based on its known emetic and gastric irritation properties

Arsenic

Due to its toxic and carcinogenic properties, restrictions to arsenic use in several applications apply.

Barium

Barium is produced with a large share of small scale mining, due to the small deposit size (60%, while often semi-mechanised) potentially forming health, safety & environmental risks. Barium is almost never recycled.

Beryllium

Beryllium has some potential for environmental hazards in the mining phase. However, almost 90% of beryllium supply comes from a single mine in the US. Beryllium can cause lung problems for workers that handle it. Protecting workers in the processing phase, or designing products without beryllium can effectively curb this risk. Beryllium is not restricted in products.

Bismuth

Bismuth mining can cause environmental harm because of acid mine drainage and association with heavy metals, which have an increased likelihood to occur as the main countries of bismuth exctraction are characterised by weaker governance structures. Because of its non-toxicity bismuth substitutes other materials in many applications. Recycling of bismuth is almost non existent. Other key sectors using bismuth are: Pharmaceutical & Animal - Feed

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Boron

Boron has a moderate environmental impact, mainly associated with high CO2 emissions and association with radioactive waste and biodiversity threats in the mining phase. Key sectors using boron are: Household & commercial products (as fiberglass, detergents, soaps, ceramics)

Chromium

Chromite

Chromium has a moderate to high association with health and safety risks as it has a (small) share of ASM production and the top producing countries are characterised by weaker governance scores. Chromium mining can also pose environmental risks because of its potential for pollution from harmful chemicals. Key sector using chromium is: stainless steel

Cobalt

Cobalt has a high to very high association with social issues, with a high potential for health and safety risks and risks of child labour, among others. ASM is a significant share of worldwide production (estimates go up to 20%), often associated with the aforementioned risks whilst at the same time, providing a livelihood for many. Similarly, the environmental risks of cobalt mining are very significant with a potential for acide discharge, overlap with conservation areas and heavy metal pollution. As the extraction of cobalt is done mainly in countries with a high risk of corruption and weak rule of law, there is a high likelihood of these negative impacts to occur. Other key sector using cobalt is: Electric vehicles

Copper

Copper mining can have a very high environmental impact. LSM Mining has high pollution risks and legacies, while recycling can save between 65% up to 90% CO2 emissions. Informal urban mining of copper has been frequently documented as it is often easy to reclaim copper from scrap/ cables, causing high health & safety risks and pollution.

Gallium

Gallium has a high association with environmental impacts mainly because of its CO2 impacts, acid discharge potential and radioactive waste potential

Germanium

As germanium is extracted mainly as byproduct of copper and zinc, significant risks of environmental pollution exists. Germanium is often extracted in countries with a weaker rule of law and higher corruption. Other key sectors using germanium are: Infrared & Optics

Gold

Gold is currently the main product mined by ASM worldwide providing a livelihood for millions of people, and simultaneously coming with high health and safety and pollution risks. Global ASM gold production is estimated between 10-25%. Gold mining is also very CO2 intensive, as well as comes with high environmental issues such as risks of mercury pollution, deforestation, acid discharge, and radioactive waste. The main gold producing countries are characterised with a high risk of corruption and weak rule of law. Key sectors using gold are: Financial investment (30%) & jewellery (50%)

Graphite

Graphite mining mainly stems from China, where pollution on surrounding communities has been documented. Also, graphite mining is mostly done on a small but mechanised scale with associated health & safety and environmental risks. Risks are more likely to occur because of a weaker rule of law and risks of corruption in main producing countries. Key sector using graphite is: Steel making (52%)

	Demand of electronics sector	Critical for functionality	Presence in phone	Weak governance structures	Scoring Social Challenges	Scoring Environmental Challenges

Indium

Indium is extracted as a byproduct of other supply chains (such as zinc, lead), with recorded environmental impacts because of its acid discharge potential, radioactive waste potential and heavy metal pollution risks. As the main countries extracting indium are characterised by a weaker rule of law and higher corruption levels there is a heightened risk of these impacts to occur. CO2 impacts of indium are high, and recycling rates very low (below 1%).

Iron

The production of steel has a large CO2 impact and environmental risks such as a very high potential for radioactive materials in tailings. As the extraction of iron is mainly done in countries that are associated with weaker goivernance structures, environmental effects are more likely to occur. The smelting & production can be dangerous to workers (one of the most hazardous work environments because of toxic fumes, chemicals and flying objects in smelting), and informal export from war zones has been documented. Key sector using iron is: Steel

Lead

Lead has a high potential for environmental impact because of overlap with conservation areas, potential for acid discharge and can pose a health risks because of the risk of harmful chemicals. These risks are more likely to materialze because of weak governance structures in main countries of lead extraction. Key sector using lead is: Lead acid Batteries (85%)

Leather

NA NA NA

Leather has a moderate association with child labour, especially in India's leather industry. Also animal welfare is of high concern. Key sectors using leather are: Automotive, fashion, accessoiries & furniture

Lithium

Lithium mining has been associated with incidences of community conflicts over water and other community impacts. Recycling rates of lithium are very low.

Magnesium

Magnesium has a moderate to high risk of environmental impacts because of high CO2 emissions, risk of acid discharge and a high water stress risk. These risks have a high likelihood to occur as magnesium is often extracted in countries with high level of corruption and a weak rule of law. Other key sectors using magnesium are: in alloys for automotive (58%)

Manganese

A significant part of manganese mining is coming from ASM with key health and safety as well as environmental risks. Environmental risks of manganese mining are around the potential for acid discharge and harmful chemicals, posing a threat to health and safety of workers and communities. Moreover, risks are more likely to occur as maganese is often extracted in countries with weak governance structures. Key sector using manganese is: Steel making (87%)

Mica

NR

Mica has a moderate to high association with negative social impacts. As the extraction of Mica is mainly done in countries with high levels of corruption and weak rule of law, these negative impacts are more likely to occur. ASM mining in the mica sector in especially India and Madagascar is rampant, with associated poor health and safety practices, incidences of child labour and environmental pollution. At the same time, ASM mica mining provides a livelihood for many and is an important sector to improve. Key sectors using mica are: electronics, automotive, paint and coatings

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	Demand of electronics sector	Critical for functionality	Presence in phone	Weak governance structures	Scoring Social Challenges	Scoring Environmental Challenges

Molybdenum

Molybdenum has very high environmental impact, including acid mine discharge and heavy metal pollution. Molybdenum extraction is often ocurring in countries with weaker governance structures. Recycling is already being done from steel, which could provide a viable alternative to mined Molybdenum. Key sectors using molybdenum are: in alloys such as stainless steel

Nickel

Nickel mining can be highly polluting, with risks of heavy metal induced diseases (like respiratory illnesses), association with acid discharge and hazardous chemicals. Polluting tailings of nickel are very concerning. A high percentage of nickel production comes from high risk countries with a weak rule of law and high levels of corruption, and conflicts with indigenous people have been recorded. Key sector using nickel is: Stainless steel (65%)

Niobium

Niobium mining has a potential to negative environmental impacts as it is associated with radioactive waste. Niobium extraction is mainly happening in countries with a weak rule of law and high incidence of corruption, thereby enlarging the risk for negative impacts. Key sector using niobium is: Manufacture of HSLA steels (86%)

Palladium

Palladium mining seems to have potential negative social impacts, but more research is needed to validate this. Environmental impacts range from acid mine drainage to heavy metal pollution. A significant share of extraction of palladium comes from countries with a higher risk of corruption and a weak rule of law. Other key sectors using palladium are: Automotive catalytic converters (72%)

Phosphorous

MD MD MD

Phosphorus mining has a high environmental impact, as it is mainly surface mining and highly associated with heavy metals and radioactive pollution. Limited information is available on the social impacts of phosphate mining. Key sector using phosphorous is: Agriculture (95%)

Plastics

Packaging

MD MD MD

While data on the social and environmental impact of plastics comparable to the other materials scoped is largely missing, both social and environmental impacts of plastics are estimated to be high to very high. The enormous amount of plastics ending up on land and in oceans threatens wildlife and causes high environmental pollution. In low-income countries about 93 per cent of waste is burned or discarded on roads, open land, or waterways leading to severe health effects and pollution.

Platinum

NR

Platinum has a high CO2 intensity, and social & environmental issues around platinum mining are reported. Platinum extraction is often ocurring in countries with weaker governance structures. Key sectors using platinum are: Automotive catalst & jewellery

Rare earth

praesodymium, neodymium, dysprosium

Rare earths have a high pollution potential because of their association with radioactive substances. To date, recycling is almost non existent (while it would reduce CO2 by around 50%). Also, 10-40% of rare earth mining is linked to illegal and informal production, which poses severe health and safety risks to workers, as well as pollution risks. As the main production of rare earth comes from countries with high corruption levels and a weak rule of law, the negative impacts are more likely to occur.

	Demand of electronics sector	Critical for functionality	Presence in phone	Weak governance structures	Scoring Social Challenges	Scoring Environmental Challenges
Rhenium			NR	MD		
Rhodium			NR	MD		
Ruthenium		MD		MD		
Rubber	NA	NA	NA			
Scandium	MD	MD	NR	MD		
Silica sand (Glass)						
Silver						
Strontium	MD	MD		MD		

Rhenium

Rhenium is a by-product of molybdenum and can be associated with acid mine drainage and potential water and soil pollution as well as biodiversity threats. Key sectors using rhenium are: Superalloys used in aerospace applicaitons and petrochemical catalysts

Rhodium

Rhodium mining has a very high risk of acid discharge, accidents because of flooding and heavy metal pollution. Other key sector using rhodium is: Automotive

Ruthenium

Ruthenium has a very high potential for acid discharge and moderate potential for hazardous chemicals

Rubber

Rubber has a high percentage of production from smallholders with a high risks of poor labour conditions, child labour and pollution. However, about 6 million people are dependent on this sector for their livelihoods. Rubber production shows overlap with conservation areas and has been reported to lead to illegal deforestation and loss of biodiversity, as well as conflicts with indigenous peoples. A large share of rubber production stems from countries with a weak rule of law. Key sectors using rubber are: Automotive, latex, footwear and adhesives

Scandium

Scandium is a by product of REEs, uranium and titanium, and has a high association with radioactive waste. Scandium is mainly mined open pit with risks of accidents, floods and spreading pollution. Recycling of scandium is very low to non-existent. Key usage of scandium is for Solid Oxide Fuel Cells used to generate power for automotive and other applications

Silica sand

Glass

Silica sand mining can have an association with risks of floods and accidents, as well as overlap with protected areas. Mining of silica sand has some association with countries experiencing corruption and a weak rule of law. Sand mining for the construction industry has other social risks attached, such as a large informal sector. This does not seem to apply to silica sand mining. Key sector using silica sand is: Construction industry

Silver

Silver is often mined as a by-product of gold, lead, copper and zinc, only 25% of silver production is mined in silver mines. It seems a significant share of silver is mined artisanally (estimates range from 6-10 %) with associated risks of poor health and safety practices, child labour and environmental pollution. Silver extraction can use a high amount of mercury. Silver mining is associated with heavy metals and potential pollution thereof and has a high CO2 impact, making recycling also important and frequently pursued by the jewelry sector. A high share of silver mining stems from countries with a weak rule of law and high levels of corruption, thereby potentially excacerbating the risks of social and environmental negative impacts from mining. Other key sectors using silver are: Coins, silverware and jewellery

Strontium

Strontium mining seems to score low on both social and environmental issues. However, little data is available, therefore more research is needed to confirm the impacts of strontium mining.

	Demand of electronics sector	Critical for functionality	Presence in phone	Weak governance structures	Scoring Social Challenges	Scoring Environmental Challenges
Tantalum						
Tin						
Titanium						
Tungsten						
Vanadium	NA	NA	NR			
Zinc						

Tantalum

A high share of tantalum is mined artisanally (estimates are between 20 and 26%), and is prone to poor health and safety practices, child labour, environmental pollution and conflict financing. Environmental issues in tantalum mining range from overlap with conservation areas, risk of acid mine discharge and association with radioactive materials. As the main countries of extraction of tantalum are characterised by a weak rule of law and high incidence of corruption, negative impacts of mining have a heightened chance to occur.

Tin

An estimated 20+ % of tin is mined artisanally. Tin is mined artisanally in certain producer countries, such as Bolivia and the DRC and Indonesia, contributing greatly to livelihoods but carrying very high environmental and health and safety risks. Environmental issues in tin mining range from overlap with conservation areas, risk of acid mine discharge and association with radioactive materials. As the main countries of extraction of tin are characterised by very weak governance structures, negative impacts of mining are more likely to occur.

Titanium

Titanium has a low to moderate association with social and environmental impacts. A large share of titanium is mined in countries with a weak governance structure and incidences of corruption. Furthermore, titanium mining is associated with radioactive waste. Key usage of titanium is: As inorganic pigment, mainly for paints

Tungsten

Tungsten has a significant share of ASM production, and it is estimated that 86% of tungsten is produced in countries in which ASM is occuring, and countries with a weak rule of law and high incidence of corruption. ASM can be characterised with poor health and safety practices, child labour and environmental pollution. Tungsten ASM mining has also been associated with conflict financing. Tungsten mining has some association with environmental impacts, such association with radioactive substances, but are generally scored relatively low. Tungsten has a moderate depletion rate as it is estimated to be depleted within 360 years after 2050. Other key sectors using tungsten are: Hardmetals in tools (for cutting, milling, mining and construction)

Vanadium

Mining of vanadium shows a high association with heavy metals, radioactive substances and waste risks. These negative impacts of mining are more likely to occur as the main countries of extraction are characterised by a weak rule of law and high incidence of corruption.

Zinc

The environmental risks of zinc mining are scored very high. As zinc is mined as a byproduct of lead, copper and iron mining, similar environmental risks exists. Main risks are related to the overlap of mining with conservation areas, a very high risk of acid discharge and a very high risk of radioactive material in tailings and a risk of heavy metal pollution. Some zinc is mined artisanally, which seems to be a low share of production. As a significant share of zinc production stems from countries with a weak rule of law and high incidence of corruption, these negative impacts have a higher chance to occur. Other key sector using zinc is: Steel (galvanizing)

Note
the following materials (9) were also investigated but not included in the overview given the missing (comparable) data:
Calcium, Iridium, Mercury, Paper/Carton (packaging), Sodium, Sulphur, Terbium, Yttrium, Zirconium

Analysis 1

This first analysis was based on the 2017 Fairphone scoping report, the 2018 Material Change report by The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative and Fairphone specific information on design and component composition. From this, information was added on the different indicators of the recent report on the Environmental Criticality of Raw Materials published by the German Environment Agency in 2020, and cross checked with other available information per material to validate the results.

Methodology for selection of focus materials:
A material is included in the first selection where the demand of the electronics sector as well as the criticality scores are moderate to very high. If the material is either not used, used only in trace or very low amounts the material is excluded from scope. However, an exception was made when both the demand and the criticality of a material are high: even when used in very low amounts (such as Gallium and Indium). Some of the materials, such as Beryllium and Antimony, were selected but efforts are being made to phase out the material from our products.

In case the demand and usage of a material is significant for the electronics sector as well as another key sector, this informs us where to find potential partners. In cases where demand from electronics is low, the responsibility and opportunity to lead improvements lies with the sectors responsible for its main usage.

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Indicators

Weak governance structures
• Countries with weak rule of law
• Countries experiencing conflict and corruption

Social challenges
• Artisanal and small scale mining
• Child labor and forced labor
• Countries experiencing high intensity conflict
• Incidences of conflict with indigenous peoples
• Potential for harm from hazardous materials and chemicals
• Association with conflict *

Environmental challenges
• High CO2 emissions
• Overlap with conservation areas
• Potential for acid mine discharge
• Pre-condition for radioactive materials

** Added indicator from Fairphone and the Dragonfly Initiative (TDI) (2017). Scoping study: Guide to the material scoping study.*

Sources used
• The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018). • Material change: A study of risks and 10 opportunities for collective action in the materials supply chains of the automotive and electronics industries.
• Fairphone and the Dragonfly Initiative (TDI Sustainability) (2017). Scoping study: smartphone material profiles. Opportunities for improvement in ten supply chains. Available at: https://www.fairphone.com/nl/research-resources/

Electronics demand: This indicator is defined as “Industry consumption % of total global consumption by electronics industry”.[70]

Low: less than 5%
Moderate: from 5% to 10%
High: from 10% to 30%
Very high: more than 30%

70 The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018) p108

This criterion measures the proportion of the total global consumption of a specific material that can be attributed to the electronics industry – specifically consumer electronics where data is available. This criterion helps Fairphone understand the potential influence and responsibility of the electronics industry to take action in a supply chain. Where the electronics industry is a major consumer of a material, there is potential to collaborate with brands and business partners to collectively influence the supply chain to make the necessary improvements. Where the electronics industry is only a minor consumer, other industries could be better positioned to address the issues in this particular material supply chain.

Sources used

- The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018). Material change: A study of risks and 10 opportunities for collective action in the materials supply chains of the automotive and electronics industries.
- Fairphone and the Dragonfly Initiative (TDI Sustainability) (2017). Scoping study: Guide to the material scoping study.
- USGS mineral Yearbooks and Fact sheets.
- German Environment Agency (2019) Environmental Criticality of Raw Materials An assessment of environmental hazard potentials of raw materials from mining and recommendations for an ecological raw materials policy. Günter Dehoust, Andreas Manhart, Peter Dolega Öko-Institut e.V. Regine Vogt, Claudia Kemper, Andreas Auberger ifeu – Institut für Energie- und Umweltforschung Fiona Becker, Christine Scholl adelphi Dr. Aissa Rechlin, Dr. Michael Priester Projekt Consult GmbH.

Criticality - Substitutability Score - a score of 1-100 where: 1 = substitutable, and 100 = not substitutable (unacceptable compromise to performance quality).

Low: score lower than 41
Moderate: score from 41 to 54
High: score from 54 to 68
Very high: score more than 68

This criterion describes the likelihood that a substitute can be found for a specific material without compromising performance quality. If there is no likely viable substitute the material is considered critical to smartphone functionality. This criterion helps Fairphone understand how critical the material is for the smartphone's functionality, and if opportunities exist to substitute for another less harmful, more sustainably produced, or more abundant material. This is particularly important if the material is associated with many issues and/or is scarce

in supply. Note that while some materials achieve a low score according to their general substitutability, when considered in relation to their use within microelectronics many of these scores increase due to the highly specialized functions that they perform.

- The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018). Material change: A study of risks and 10 opportunities for collective action in the materials supply chains of the automotive and electronics industries.
- Fairphone and the Dragonfly Initiative (TDI) (2017). Scoping study: Guide to the material scoping study.
- German Environment Agency (2019) Environmental Criticality of Raw Materials An assessment of environmental hazard potentials of raw materials from mining and recommendations for an ecological raw materials policy. Günter Dehoust, Andreas Manhart, Peter Dolega Öko-Institut e.V. Regine Vogt, Claudia Kemper, Andreas Auberger ifeu – Institut für Energie- und Umweltforschung Fiona Becker, Christine Scholl adelphi Dr. Aissa Rechlin, Dr. Michael Priester Projekt Consult GmbH.

In some instances, the indicator value was changed from the original source information because of internal information on the usage and need of a certain material, stemming from specific Fairphone design aspects.

In product - this criterion indicates whether the material can be found in Fairphone's latest smartphone model, based on inquiries with suppliers.

Not reported - indicates the material has not been found to be present in the product
Low: indicates a trace or very low weight with a score lower than 0,025 grams
Moderate: indicates a low to moderate weight with a score from 0,025 - 5 gram
High: indicates a moderate to high weight with a score from 5 - 10 grams
Very high: indicates a low to moderate weight with a score above 10 grams

This criterion measures the proportion of the total weight of a material contained in the smartphone. This criterion helps Fairphone understand the potential influence to take action in a specific material supply chain. When the material content represented is low, the materials were usually excluded from scope. An exception was made when both the demand and the criticality of a material were high, even when only used in very low amounts, the material was included as the electronics sector remains a key influencer.

Materials that represent a significant part of the smartphone's composition could also present opportunities to collaborate with other consumer electronics manufacturers to bring about positive change.

Sources used

- Fairphone proprietary data collected from component suppliers.
- The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018). Material change: A study of risks and 10 opportunities for collective action in the materials supply chains of the automotive and electronics industries.
- Fairphone and the Dragonfly Initiative (TDI Sustainability) (2017). Scoping study: Guide to the material scoping study.
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- Apple (2019) Material Impact Profiles Which materials to prioritize for a 100 percent recycled and renewable supply chain.

Weak governance structures - this criterion measures the aggregate scores of weak rule of law and level of corruption in the 5 main producer countries of the specific material.

Low: 0 -1.4
Moderate: 1.5-2.4
High: 2.5-3.4
Very high: 3.5 and more

This criterion presents the aggregate score of the strength of the rule of law and the association with corruption of the 5 main producing countries of the material.
This information helps inform Fairphone of the likelihood of negative social and environmental impacts to occur, as the absence of strong governance structures limits control and oversight of responsible mining practices. For more information on the measurement and sources used for this criterion, please see the Material change report published by The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative.

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Sources used

- The Dragonfly Initiative, Drive Sustainability and the Responsible Minerals Initiative (2018). Material change: A study of risks and 10 opportunities for collective action in the materials supply chains of the automotive and electronics industries.

Social and Environmental issues- this criterion measures the aggregate score of social and environmental issues associated with the extraction of each specific material as indicated in different comparable studies.

Low: 0 -1.4
Moderate: 1.5-2.4
High: 2.5-3.4
Very high: 3.5 and more

Social and environmental scores are only scored when sufficient data points are available. In case the majority of the indicators were missing the relevant data and no additions could be found based on existing literature, the score was indicated as 'missing data'. The scoring takes into account social aspects such as the volume produced by artisanal and small scale mining, association with conflict, incidence of child and forced labor as well as incidences of conflict with indigenous peoples and health hazards. Environmental issues include indicators related to the height of CO2 emissions, overlap with conservation areas, and risks of acid discharge and radioactive pollution.

Sources used

- The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018). Material change: A study of risks and 10 opportunities for collective action in the materials supply chains of the automotive and electronics industries.
- Fairphone and the Dragonfly Initiative (TDI Sustainability) (2017). Scoping study: Guide to the material scoping study.
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Beyond the aforementioned sources, information and scoring have been compared with available reports on specific materials, internal information, and interviews with experts in order to validate and/ or slightly correct information contained in the main reports.

Annex 2: Attention materials

"Attention materials" are materials where we are not the leading industry but where we could be more sustainable when the opportunity arises.

Chromium, Graphite, Iron, Manganese, Molybdenum, Niobium, Titanium, Paper, Rubber, Leather, Palladium

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Annex 3: Analysis 2

Legend

Focus Material

Very High

High

Moderate

Low

MD Missing Data

NR Not Reported

NA Non Applicable

	Weak governance structures	Scoring Social Challenges	Scoring Environmental Challenges	Demand Growth	Depletion	Virgin Material Consumption
Aluminium Bauxite	High	Moderate	High	High	Low	Moderate
Antimony	Very High	Low	Very High	MD	Very High	Moderate
Beryllium	High	Moderate	Low	MD	Low	Very High
Cobalt	Very High	High	High	Very High *	Low	Low
Copper	Moderate	Moderate	Very High	High	Moderate	Moderate
Gallium	MD	Moderate	High	MD	Low	Very High

Aluminium – Problem statement: Aluminium mining has a high environmental impact. The demand growth is estimated to be around 240% until 2060, thereby potentially exacerbating social and environmental impacts. Recycling saves considerable energy (95%). However, virgin mined consumption is still moderate and above 70% of the total material input. Next to enhancing sustainability in mining, improvements in recycled supply seem key.

Antimony – Problem statement: Antimony depletion is very high and is associated with very high environmental risks in the mining phase. Recycling is therefore increasingly important. At the same time, antimony use is increasingly being restricted in products. Phasing out the use of antimony is therefore a potential strategy to be pursued.

Beryllium – Problem statement: Beryllium has a high potential for environmental hazards in the mining phase. Furthermore, beryllium can pose a risk to workers handling it as it can cause chronic lung diseases. Beryllium is never recovered from old scrap. Ensuring accurate protection for workers, or restricting the use of beryllium in products, which is increasingly being done by industry, therefore seem viable strategies.

Cobalt – Problem statement: Cobalt mining scores very high on social indicators, with a large share and livelihood dependency on ASM mining, high risks of poor health and safety practices, child labour, and heavy metal induced diseases. Environmental impacts of cobalt mining are also very significant. With an exponential expected rise of demand up to 450+% from green technologies only, pressure on the mining sector is likely to grow to meet increased supply needs. As the extraction of cobalt is done mainly in countries with a high risk of corruption and weak rule of law, there is a high likelihood of these negative impacts to occur. The share of artisanal production and associated issues are in turn, also likely to persist or grow. Therefore, the need for improvement of the ASM sector is paramount.

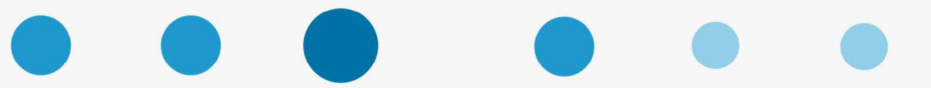
Copper – Problem statement: Copper mining can give a very high environmental impact. As the demand growth until 2060 is expected to be high (220%) the consumption of virgin mined copper remains moderate (above 70%) social and environmental effects of copper mining are expected to persist. The depletion of copper is also higher than average. Informal urban mining of copper has been widely documented as copper is often reclaimed from electronic scrap and cables, causing high health and safety risks and pollution. Responsible recycling seems therefore key to improve the copper chain.

Gallium – Problem statement: Gallium mining has a very high association with environmental impacts. As CO2 impacts are higher than average, virgin material consumption of gallium is very high, and recycling from electronics is very limited to non existent, innovations to drive the effective recycling of gallium deserves further efforts.

FAIRPHONE

Weak governance structures | Scoring Social Challenges | Scoring Environmental Challenges | Demand Growth | Depletion | Virgin Material Consumption

Gold

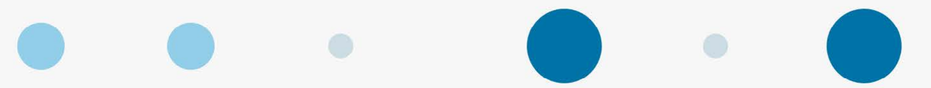


Problem statement: Both the social and environmental risks of gold extraction are high to very high and malpractices in gold recycling chains have been documented as well. The demand for gold is expected to rise steadily and as the main gold producing countries are characterised with a high risk of corruption and weak rule of law, negative effects of mining are more likely to occur. Gold has a moderate depletion rate. Over 70% of the material consumption still stems from mining and a very significant part of mined gold stems from the artisanal mining sector. An estimated 8 million people are active in, and 25 million people are indirectly dependent on the ASM gold sector. This sector is likely to persist and has shown a growth of 3,6% per year, a growth higher than the growth of average global gold mine production. At the same time, ASM gold mining comes with many health and safety risks, child labour and huge pollution because of mercury use. Improving ASM practices therefore is key.

Indium

Problem statement: Indium demand from the electronics industry is very high, and demand is expected to rise over 200% from demand for green technologies alone. Indium is extracted as a byproduct of other supply chains, with recorded environmental impacts (such as zinc, lead). As the main countries extracting indium are characterised by a weak rule of law and high corruption levels there is a heightened risk of these negative impacts to occur. Very little Indium is being recycled which is key as its supply is insecure and as CO2 impacts are higher than average.

Lithium

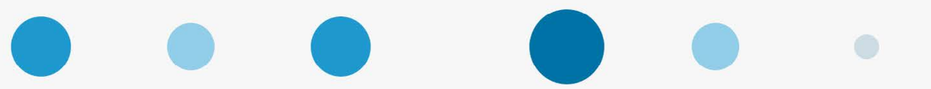


Problem statement: Lithium demand of the electronics sector is high and the overall demand growth for the transition to green technologies is estimated to reach up to 500% until 2050. This exponential demand growth is likely to lead to a potential heightening of impacts in the mining sector as recycling rates of lithium are very low, and dependency on virgin mined material remains very high. Therefore, ensuring more sustainable mining practices seems an urgent priority.

Magnesium

Problem statement: Magnesium mining has a moderate to high risk of environmental impacts given high CO2 emissions, among others, and a high rate of virgin material consumption. Mining risks have a high likelihood to occur as magnesium is often extracted in countries with higher levels of corruption and a weaker rule of law. As virgin material consumption is still very high, fostering more recycling of magnesium seems key.

Nickel



Problem statement: Nickel mining can be highly polluting (especially the tailings). A significant growth in demand because of the transition to green technologies, and a very high overall estimated demand rise, could amplify the environmental effects of nickel mining (especially as the main countries of extraction are characterised by a weak rule of law and higher levels of corruption). Moreover, nickel has a moderate depletion rate and recycling nickel can save 90% of CO2 footprint, thereby making recycling also highly needed and a viable option to pursue.

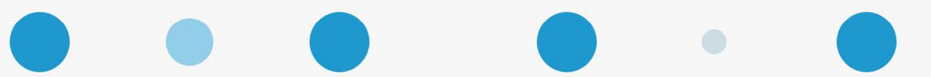
Plastics

Packaging

Problem statement: The growth of plastics use and production is expected to at least double in the coming 15 years and the annual volume of plastic entering the ocean will almost triple, potentially leading to more plastics in the ocean than fish. As the actual recycling rates of plastics continue to be relatively low, there is an urgent need to increase the amounts of plastic that are being recycled properly. Moreover, informal plastics recycling comes with very high health and pollution risks, while providing a livelihood for many people in developing countries. Ensuring the proper collection and handling of plastic waste could provide an opportunity to positively benefit millions of people while increasing plastics recycling rates.

Rare earth

praesodymium, neodymium, dysprosium



Problem statement: Rare earths are critical to electronics, and demand is likely to rise quite significantly because of usage in greener technologies (expected to rise with 200% until 2030). Both social and environmental issues are persistent in rare earth mining, ranging from radioactive pollution to informal mining. As the main production of rare earth comes from countries with high corruption levels and a weak rule of law, the negative impacts are more likely to occur. Up to date, recycling is almost non existent (while it would reduce CO2 by around 50%) making innovations in recycling a key need.

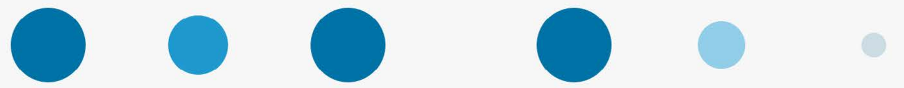
FAIRPHONE

Weak governance structures | Scoring Social Challenges | Scoring Environmental Challenges | Demand Growth | Depletion | Virgin Material Consumption

Silver

Problem statement: The demand for silver is expected to rise with at least 50% from the transition to green technologies and with an overall estimated rise in demand of 190% until 2060. Silver has high association with social impacts such as poor health and safety practices and child labour, as well as with environmental issues. A high share of silver mining stems from countries with a weak rule of law and high levels of corruption, thereby potentially exacerbating the risks of social and environmental negative impacts from mining. A significant share of silver is likely to originate from ASM production. Rising prices because of growing demand could expand ASM production and exacerbate the associated impacts, rendering improvements in the ASM sector of high importance. Silver also has a moderate depletion rate and a high CO2 impact, making recycling also important and frequently pursued by the jewelry sector.

Tin

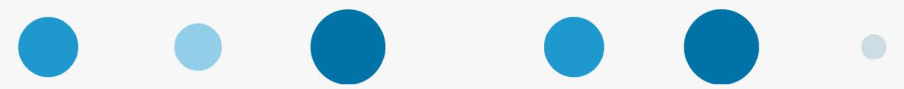


Problem statement: Tin mining is associated with high social and environmental impacts. With a very high expected rise in demand until 2060, of 320%, pressure on both the supply of mined as well as recycled tin will grow, thereby heightening associated social and environmental issues. An estimated 20+ % of tin is mined artisanally, contributing greatly to livelihoods but carrying very high environmental and health and safety risks. Improvement of the sector is therefore of key importance. At the same time, tin is depleting according to certain sources, which makes the supply of recycled material increasingly critical.

Tungsten

Problem statement: Social issues around tungsten mining score higher than environmental risks and tungsten mining has a significant share of ASM mining. The main countries of extraction are characterised with weak governance structures. ASM contributes significantly to local livelihoods in developing countries. At the same time, depletion is moderate (within 360 yrs), recycled supply is present but mainly coming from the larger tungsten industries (tungsten tools) while recovery from electronics is still very low because of dismantling difficulties.

Zinc



Problem statement: Zinc mining has significant environmental risks. Zinc demand can rise up to 200% until 2060. As a significant share of zinc production stems from countries with a weak governance structures, these negative environmental impacts have a higher chance to occur. At the same time, zinc is estimated to be depleted within 100 years, making zinc recycling a necessity.

* As these minerals are only used in one specific energy solution, technical developments might change the demand scenario significantly

** Given that seawater is a viable source of magnesium, the supply is potentially inexhaustible

Indicators

Demand growth
Low: below 100%
Moderate: 100%> 200%
High: 200%> 300%
Very high: > 300%

This indicator reflects the estimated demand growth based on studies that provide estimates on the expected demand growth of multiple materials until 2050/2060. Most notably, the study of the Worldbank group (2020) estimating key mineral needs for a transition to a low carbon future untill 2050, and the OECD study (2019), analysing an outlook for global materials use untill 2060 for 60 different materials (including metals, non-metallic minerals, fossil fuels and biomass), were used. The estimated demand growth for materials is always based on assumptions and projections, and therefore should be interpreted as current estimations subject to possible future changes. For example, if technological applications improve or change, especially with regards to technology needed for the transition to a greener economy, this can significatly change the material compsoition and consequently the demand for specific materials in the future.

Sources used
- OECD (2019), Global Material Resources Outlook to 2060: Economic Drivers and Environmental Consequences, OECD Publishing, Paris.
- The Worldbank Group (2020) Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition. CLIMATE-SMART MINING FACILITY Kirsten Hund, Daniele La Porta, Thao P. Fabregas, Tim Laing, John Drexhage.

Depletion
Low: depletes > 1000 years from 2050
Moderate/ High : depletes 100-1000 years from 2050
Very High: depletes < 1000 years from 2050

This criterion describes if the material is likely to become unavailable from mining in the coming years. This criterion helps Fairphone to better understand where improving recycling rates and promoting a circular economy is most urgent and could have the most immediate impact. Note that this depletion rate is primarily determined by economic scarcity since very few materials can be considered truly scarce in the physical sense.

Sources used
- The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018). Material change: A study of risks and 10 opportunities for collective action in the materials supply chains of the automotive and electronics industries.
- Fairphone and the Dragonfly Initiative (TDI Sustainability) (2017). Scoping study: Guide to the material scoping study.

Virgin material consumption Virgin material consumption input to production that is newly mined, extracted or produced:

Low: less than 70% newly mined (more than 30% from recycled material)
Moderate: from 70% to 90% newly mined
High: from 90% to 99% newly mined
Very high: more than 99% newly mined (less than 1% of from recycled material)

This criterion is defined by the Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018), as "the material input that is not derived from recycled material and which is therefore assumed to be newly mined, extracted or produced. This criterion can be used to measure the circular use of materials by how much (%) of the total material input into the production system comes from virgin sources as opposed to recycled scrap. It is important to note that the criterion draws on the European Commission's Critical Raw Metals (CRM) report. The CRM report calculates at the industry level the EOL Recycling Input Rate using the values from primary material input, recycled end-of-life material, scrap used in fabrication (new and old scrap) and scrap used in production (new and old scrap). Although several critical raw materials (CRMs) have high recycling potential, the consumption of EOL recycled material is low, and therefore the use of virgin material is generally high. This can be explained by several factors: sorting and recycling technologies for many CRMs are not yet available at competitive costs; it is impossible to recover materials which are in-use dissipated; many CRM EOL resources are currently found in long-life hard assets, which implies delays between manufacturing and scrapping and the recycling input rate; demand for many CRMs is growing in several industry sectors and the availability of EOL material is largely insufficient to meet demand".[71]

71 The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018) p110

Fairphones' recyclability study has been taken into account to validate the scores and understand the potential, or difficulty, to recover materials from electronic waste.

Sources used

- The Dragonfly Initiative (TDI Sustainability), Drive Sustainability and the Responsible Minerals Initiative (2018).
  Material change: A study of risks and 10 opportunities for collective action in the materials supply chains of the automotive and electronics industries.
- Fairphone (2017) Fairphone's Report on Recyclability. Does modularity contribute to better recovery of materials? Available at:

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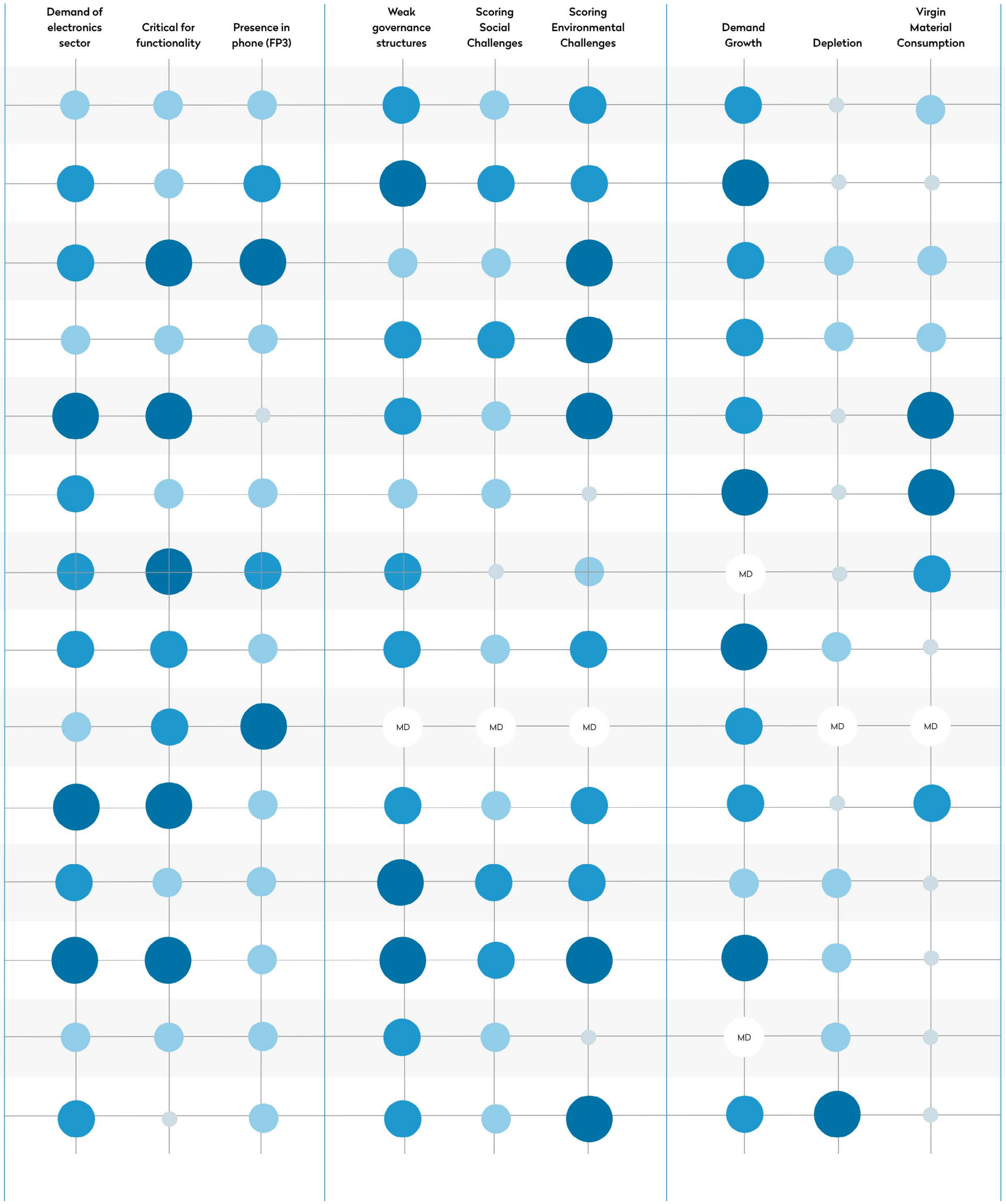
Annex 4: Focus Materials



Aluminium
Bauxiet

Aluminium mining has a high environmental impact and demand is forecasted to grow with 240% until 2060. Recycling saves considerable energy (95%), yet virgin mined consumption is still over 70%. Informality and poor EHS practices are documented in recycling chains. Enhancing sustainability in mining and recycled supply seems key.

Cobalt

Extraction of cobalt occurs mainly in countries with weak governance structures, resulting in a high likelihood of the very high social & environmental challenges of mining to occur. There is a large livelihood dependency on ASM cobalt mining. With an expected exponential rise of demand, pressure on the mining sector is likely to grow.

Copper

Copper mining has a very high environmental impact. Informal urban mining with high health & safety risks is frequently reported. With a high expected demand growth and virgin material consumption, environmental effects of mining are expected to continue. Depletion is above average; recycling can save up to 90% CO2 emissions making responsible recycling key.

Gold

Social & environmental risks of gold extraction are high to very high. Over 70% of gold supply stems from mining, usually in high-risk countries, with the ASM sector being a significant supplier, characterised by numerous ESG risks but providing a livelihood for millions. Malpractices in gold recycling chains have been documented as well.

Indium

Indium is extracted as a byproduct of other supply chains (such as zinc, lead), with recorded environmental impacts including high CO2 impacts. Indium demand from the electronics industry is very high, and demand is expected to rise over 200% from demand for green technologies alone. Since very little Indium is being recycled (<1%), recycling becomes increasingly important.

Lithium

Community conflict incidents are recorded around lithium mining. Demand for lithium from electronics is high; demand from green technologies is estimated to rise up to 500% by 2050. This likely leads to heightened impacts in mining as recycling rates of lithium are very low. With a very high dependency on virgin mined material, ensuring sustainable mining practices is urgent.

Magnesium

Magnesium has a moderate to high risk of environmental impacts and high CO2 emissions. These risks have a high likelihood to occur as magnesium is often extracted in countries with weak governance structures. As virgin material consumption is still high, fostering recycling of magnesium is key.

Nickel

Nickel mining can be highly polluting and is often extracted in high risk countries. Conflicts with indigenous people have been recorded. Significant growth in demand could enlarge the negative mining impacts. As recycling nickel can save 90% of CO2 emissions and its depletion rate is moderate, increasing recycled supply is also key.

Plastics
Packaging

Plastics ending up on land and in oceans threaten wildlife and cause high environmental pollution. Informal plastics recycling comes with very high health and pollution risks, while providing a livelihood for many. The growth of plastic use is expected to double in the coming 15 years. Ensuring proper collection and increasing recycling rates is key.

Rare earth
praesodymium, neodymium, dysprosium

Social & environmental issues are persistent in rare earth mining, including radioactive pollution and informal mining. Rare earths are critical to electronics, and demand is likely to rise significantly. To date, recycling is almost non-existent (while it would reduce CO2 by around 50%), making innovations in recycling key.

Silver

Silver is often mined as a by-product and an estimated 6-10% of silver comes from ASM. Demand is expected to rise 190% until 2060; potentially resulting in rising prices that could expand ASM production and exacerbate the associated impacts. Silver has a moderate depletion rate and mining a high CO2 impact, making recycling also critical.

Tin

Appoximately 20% of tin comes from ASM, contributing greatly to livelihoods but carrying very high environmental & social risks that are likely to occur as the main countries of extraction have weak governance structures. With demand projected to rise up to 320% until 2060, pressure on supply will grow. Recycled tin is also increasingy critical as tin might be depleting.

Tungsten

The majority of tungsten is produced in countries with a large ASM sector and weak governance structures. ASM contributes to local livelihoods in these countries but ASM tungsten is also associated with social and environmental risks, including conflict financing. Depletion is moderate and eventhough recycled supply is present, recovery from electronics is still very low.

Zinc

The environmental risks of zinc mining are scored very high. Zinc demand can rise up to 200% until 2060. As a significant share of zinc production stems from countries with weak governance sturcutres, the negative impacts of mining might expand. At the same time, zinc is estimated to be depleted within 100 years, making zinc recycling a necessity.

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