TRACEABILITY OF SUSTAINABLE METALS – a blockchain-based solution

SveMin

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"Traceability – for sustainable metals and minerals" is a project initiated by Svemin and financed by the strategic innovation program STRIM, *Strategic Innovation Program for the Swedish mining and metal extraction industry*. A part of Vinnova's, the Swedish Energy Agency's and Forma's investment in strategic innovation areas (SIP). The project is a joint project between Svemin, RISE, Boliden and LKAB and was carried out within the framework of the Svemin sustainability initiative, #Mineralbidraget.

Svemin, Swedish Association of Mines, Mineral and Metal Producers. Svemin has more than 40 member companies active throughout Sweden. Members include mining companies, prospecting an explorative companies, limestone and cement companies and various equipment and service providers.

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Foreword

An important step towards an ”eco-label”

Making it possible to put an “eco-label” on metals has been on the wish-list of mining companies with high environmental standards for decades. However, due to the way metals are traded on the global metal market, this has been considered an unrealistic fantasy.

In the last few years things have started to change. Certification initiatives are taken by governments, NGOs, mining companies and others. Introduction of legislation regarding “conflict minerals” has led to the development of new chain of custody models. The development of block chain technology has provided new potential tools for tracking goods or information.

The need for metals and minerals will grow substantially as a result of a growing world population, increasing living standards and, not least, the transition to a climate neutral society. In this context, certification of metals and minerals could contribute to meet sustainability challenges of increased resource use.

The Swedish mining and metals sector welcomes development of markets that favor responsible producers and sustainable production.

In any system for sustainability certification of metals, two main components are needed:

- Agreed criteria, i.e. what is “sustainable”
- A tool for traceability

Different sets of criteria have been developed, and are being developed, by different actors. In this project, we decided to stay out of the debate on what sets of criteria ought to be used. Instead, we have focused on making a contribution in the evaluation and development of different chain of custody models. The project has, among other things, included a market analysis based on the value chains for copper, as well as a conceptual development of a block chain solution.

In the wake of this Svemin study, we are pleased to have inspired the initiation of a government assignment on the same issue. Tillväxtanalys presented their result in April, 2019. We have been fortunate to have taken active part in each other’s projects.

As a next step, we are planning to take this concept further by creating and implementing a pilot block chain covering a “real world” value chain.

We are looking forward to contributing to the possibility of finally putting an “eco-label” on metals.

Per Ahl
Vd, Svemin

> Certification of metals and minerals could contribute to meet sustainability challenges of increased resource use.

SveMin

Executive Summary

This report is based on a one-year project. The overarching aim of the project is to make sustainability a competitive advantage for actors in metal and mineral value chains. The combination of blockchain and innovative approaches to chain of custody models have been evaluated as a suitable application to distinguish and add value to production of metals and minerals that fulfil specific criteria. Work on the definition of such criteria has been initiated by numerous other actors and have not been part of this project. Copper was chosen as a first case metal, but the long-term objective is a system that could be applied to different metals and minerals.

The market analysis indicates that the demand for sustainably produced metals is likely to increase in the future. However, supporting activities and incentives for early adaptors would be a way to speed up this development.

Based on the state-of-the-art and the market analysis carried out as part of this study, the chain of custody model "mass balance" is recommended to use for the copper value chain. The main reason is that the production logic for copper is to mix input material, like copper scrap and copper concentrate, from different origins.

A blockchain solution would give the suggested labelling system a robust, secure and trustworthy infrastructure. However, a third-party audit would always be necessary to verify the input claims entering the blockchain.

The project has been financed by SIP-STRIM, a strategic innovation programme for the Swedish mining and metal producing industry, jointly run by the three Swedish research funders Vinnova, Formas and the Swedish Energy Agency.

The demand for sustainably produced metals is likely to increase in the future.

Introduction

Background

The world has a growing population with a righteous demand on better living conditions. In addition to that, the need for a transition to climate-friendly energy sources is urgent. A sustainable development means a resilient and robust balance of economic, environmental and social fundaments. Sustainability also includes the challenges to tackle climate change, which must be acknowledged and addressed urgently and with broad commitment. All these aspects of a sustainable future are dependent on raw materials and materials produced by the mineral and metal industry. Taken together, this will not only be dependent on a continuous supply, it will markedly increase the demand for metals and minerals.

As a basic premise, mining and metal production require energy and access to land. Depending on many factors, of which one of the most significant being the ambition of the operating company, mining and metal production will to a greater or lesser extent, affect its surrounding environment. In most cases today, prices of metals are determined on the world market and are therefore the same for producers who meet high sustainability and environmental standards as for producers who do not take the same responsibility for the environment. This means that companies with high sustainability ambitions have no advantage on the market, neither have costumers the opportunity to choose or demand sustainable produced metals or minerals.

Aim of the project and long-term objectives

This project is aiming to be a step towards developing a market and a demand for sustainably produced metals. The project has evaluated whether a solution built on blockchain combined with a novel approach to chain of custody may offer buyers of metals and minerals an option to choose a certain "sustainability level". A first example of such a solution has been developed by the project group and is now presented in this report. The proposed solution has the potential to open the possibility for downstream consumers, investors, NGOs and policymakers to agree on and demand a level of sustainability. Ahead, the suggested system could be applied for different kind of sustainability criteria. Many stakeholders are already involved in the development of such criteria. However, this project has been limited only to traceability issues and at this stage sustainability criteria has deliberately been excluded from the scope.

A suggested next step would be to conduct a pilot study of the system that is proposed in this report, using the knowledge and insights developed in the present project.

The long-term objective of this project is an international system making sustainability a competitive advantage by:

- Offering buyers and end-customers an opportunity to choose and demand more sustainable options.
- Promoting sustainable actors, which in turn promotes the development of a sustainable industry.

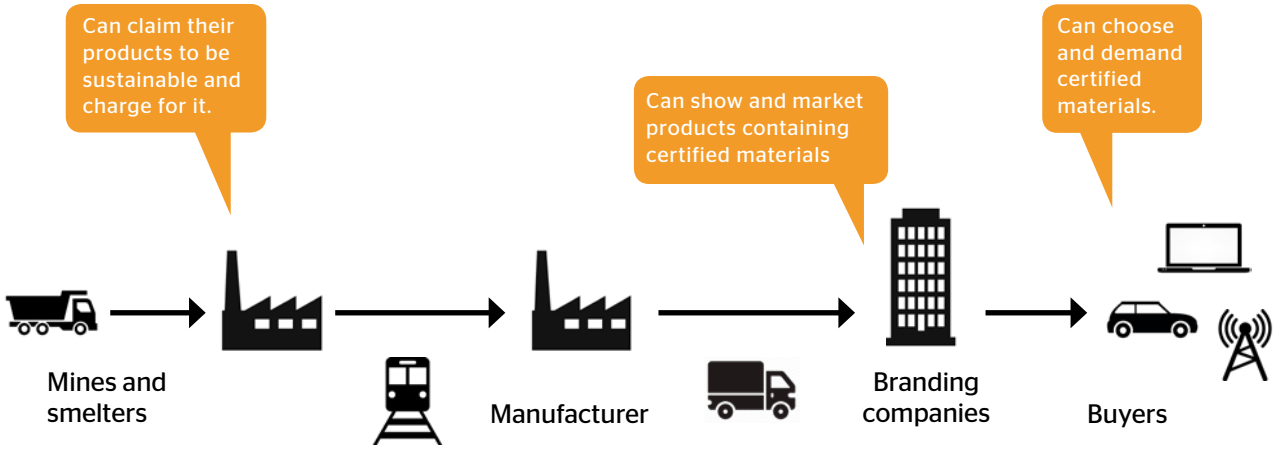

Figure 1. Certification of sustainable metals and minerals offer competitive advantages to the actors in the value chain.

Methodology and the project group

To be able to develop a system for sustainably labeled metals, questions of varying character within different research areas need to be analysed and answered. To suggest a suitable system, both an understanding of market expectations, demands and current technical possibilities are needed. Different approaches have been chosen to meet the different research needs. For example, desktop studies and development sessions have been used to develop the suggested technical solutions; while semi structured interviews have been used to understand the market and industry incentives.

The main building blocks of the study has been:

- State-of-the-art analysis
- Market analysis
- In-depth technical analysis
- Concept development

To define and focus the scope, copper was chosen as the case metal, but the long-term solution will strive to be independent on the type of metal or mineral.

The project has been financed by the strategic innovation programme STRIM (Strategic innovation programme for the Swedish mining and metal producing industry) and is part of a joint investment in strategic innovation programmes (SIP) by Vinnova, Formas and the Swedish Energy Agency. The project owner is Svemin and the project has been managed by RISE.

To ensure quality and direction of the project, a steering committee was established. The steering committee has representatives from:

- Boliden
- LKAB
- RISE Certification
- Tillväxtanalys, The Swedish Agency for Growth Policy Analysis
- SIP STRIM, the strategic innovation programme for the Swedish mining and metal producing industry
- Svemin, the Swedish Association of mines, mineral and metal producers

Key concept explained

Since the novelty of the suggested system is to combine blockchain and innovative approaches to chain of custody, the concepts are briefly explained below.

Blockchain

Blockchain, and other so-called distributed ledger technologies, originate from the Bitcoin electronic currency. The creator(s) of Bitcoin wanted to create a decentralised currency, which did not have any single entity controlling the system. Instead the operators of the network all validate the transactions together by using a specified protocol. Later people recognised that there are other potential applications which can benefit from a decentralised verification of transactions. One such potential application of blockchain technology is chain of custody tracing and accounting for credits of certified materials.

A blockchain is a special kind of database which contains a ledger of transactions. A transaction may be a business transfer, but also a step of information processing. The transactions and exchange of information must follow the rules of the application. For instance, in the case of a payment application, one rule is that money cannot be spent twice. If you pay someone, then the same money cannot be used to pay someone else. Similarly, a producer of a product which contains metals that are registered in the blockchain cannot claim a larger amount of production than what the registered metals are enough for.

The blockchain ledger is distributed and decentralised. This means that it is provided to all the participants in the blockchain network and open for all participants to survey the compliance in all steps. This makes it very difficult for any individual actor to break the rules and makes blockchains interesting to use for applications where the participants want to collaborate and ensure that market rules are followed. In the case of metals, for instance a ledger can be used to account for credits and claims of certified materials in a decentralised and distributed value chain.

Although the data on the ledger is secured by the blockchain protocol, the connections to the physical world are very important to ensure that the data on the blockchain is correct to begin with. So, for a chain of custody system, it is still very important to have management systems with checks and controls, especially at the points where certified materials enter and exit the system.

Chain of custody models

The global membership association for sustainability standards, ISEAL alliance, has published a reference document about chain of custody models and their definition for sustainability standards systems where they explain;[1]

"The objective of the CoC System is to validate claims made about the product, process, business or service covered by the sustainability standard. This is achieved by defining a set of requirements and measures that provide the necessary controls on the movement of material or products, and associated sustainability data, from approved or certified businesses through each stage of the supply chain. Many standard systems set a CoC standard for this purpose, in addition to their production or management standard.

The CoC System therefore forms the basis for any claims that can be made about the approved or certified product. The supporting assurance system (including auditing, oversight, reporting, claims approval, etc) is then used to verify that the actor involved has met the requirements of the CoC Standard and supporting policies. Each industry and each scheme are different and the requirements of the CoC standard and supporting system will vary between schemes, sometimes even within models of the same name."

Blockchain originate from the Bitcoin electronic currency.

1 https://www.isealalliance.org/get-involved/resources/iseal-guidance-chain-custody-models-and-definitions

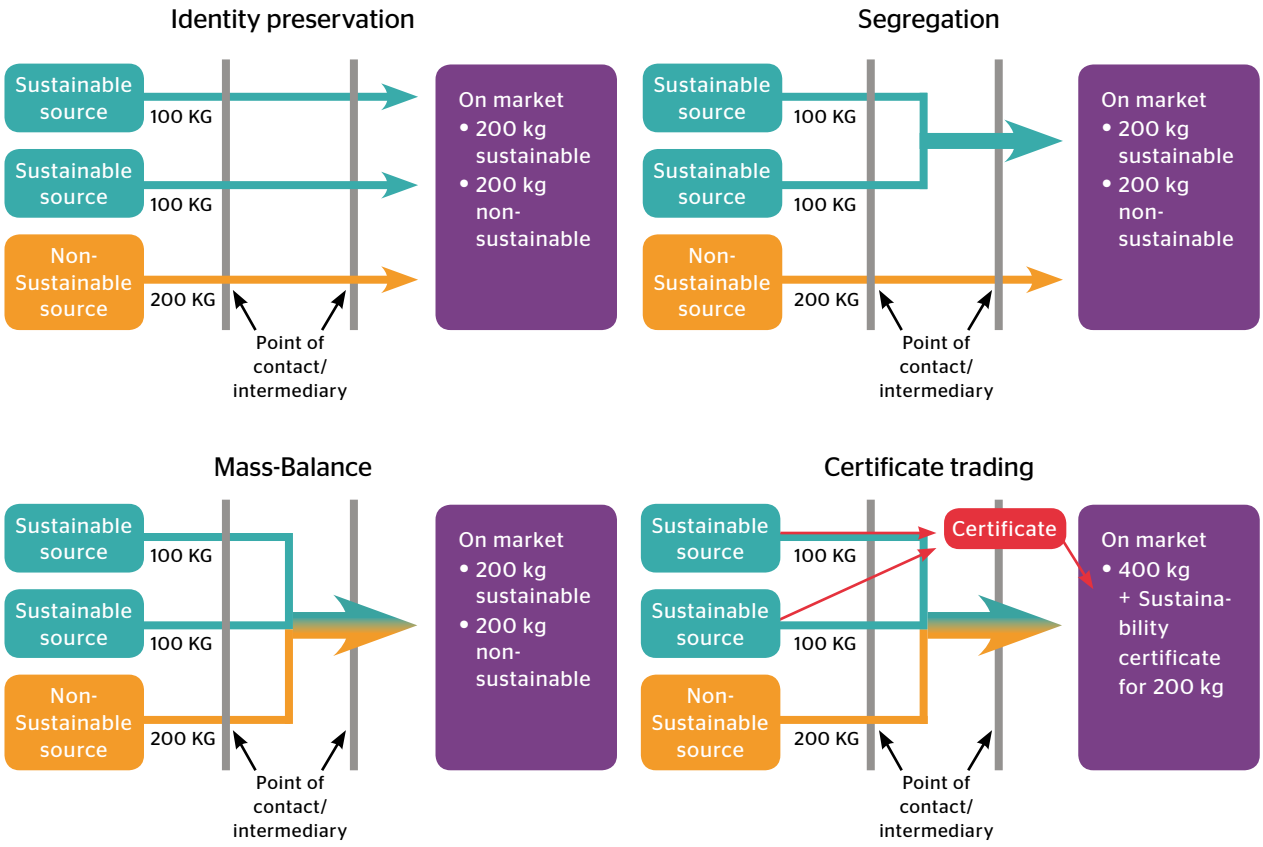

Figure 2.. Four different models for chain of custody systems.

Different models for different needs

Different chain of custody models have been developed to fit different industries and to fulfil different needs. The four models ISEAL have included in their reference document are briefly described below.

Identity preservation

Simply explained, the product can be traced back to the original source.
Example: Meat that is labeled with information regarding origin (farm).

Segregation

In this model, only products or materials from equivalent sources will be mixed in the production. What sources are equivalent must be stated. It could be, for example, that the different sources have the same certification, are from the same region, or are only from secondary material.
Example: Organic orange juice, where organic oranges will be mixed from different organic farms, but not from non-organic farms.

Mass balance

The mass balance model is used when the identity preservation and segregation are lost or when physical mixing of sustainable claimed material is mixed with non-claimed material. The fundamental of the mass balance principle is that the volume of sustainable claimed material that enters the process is equivalent to the volume of claimed material leaving (the process). Depending on the conditions and the ambition, mass balance can be conducted in three levels; i) batch, ii) site, or iii) group level.

Example: Both the certification programs UTZ[2] and Fairtrade[3] apply mass balance when labeling cocoa products since coca beans are generally supplied in bulk and mixed during shipping and manufacturing. Mass balance is also an option in Forest Stewardship Council, FSC[4] chain of custody standard.

Certificate trading

Certificate trading, also referred as "book and claim" or "credit trading", is an approach to reward responsible production when it is difficult or impossible to trace products or material in the supply chain. The sustainability claims are completely decoupled from the material. Instead, the sustainability claims are traded as certificates or credits.

Example: Swedish-Norwegian electricity certificate market (in Swedish).[5] Another example is Roundtable on Sustainable Palm Oil, RSPO,[6] where responsibly produced palm oil certificates are sold on a separate market.

2 https://utz.org/what-we-offer/certification/products-we-certify/cocoa/massbalance/#undefined

3 http://www.fairtrade.org.uk/What-is-Fairtrade/FAQs

4 https://ic.fsc.org/en/what-is-fsc-certification/chain-of-custody-certification

5 http://www.energimyndigheten.se/globalassets/fornybart/elcertifikat/om/sa-har-fungerar-den-svensk-norska-elcertifikatsmarknaden-illustration.pdf

6 https://rspo.org/

State-of-the-art analysis

The state-of-the-art analysis undertaken in the project has tried to identify existing certification schemes and chain of custody models relevant for the mining sector. These have been collected and summarised to identify possible synergies and provide the project with context and credibility. Specific interest has been given to the trade of copper and another focus area has been how certification and blockchain may create a common basis of understanding and trust. The analysis is very briefly summarised below, follow the footnote to find the full report.[7]

Key findings

- A concept confusion is identified among stakeholders. The meaning of concepts like sustainability certification schemes, standards and initiatives is not clear and have a different meaning for different stakeholders.
- Most academic research in the area of sustainability certification schemes have had a management system focus while this project focus on how to create value based on certified products or materials in the value chain
- An industry example of sustainability labelled metals is the Norwegian company Hydro. In the end of 2017, Hydro launched two new products which are independently certified by the certification body DNV GL.[8]
  - Hydro 4.0; hydropower-based aluminium with a maximum emission of 4.0 kg CO_2 per kg aluminium.
  - Hydro 75R; aluminium with a guaranteed post-consumer recycled content of minimum 75 percent.
- There are many indications in media that the demand for sustainably mined and produced metals is growing, however there is a lack of scientific studies presenting evidence for customers willingness to pay for sustainably mined and produced metals.
- Mapping the material stream of copper is very difficult since the actors in the value chain are unwilling to reveal who they buy from and sell to.
- Blockchain applications for traceability is at an early stage. There have been pilot studies, particularly in the food industry, but no full-scale implementation.

7 https://www.svemin.se/mineralbidraget/

8 https://www.hydro.com/en-SE/products-and-services/low-carbon-aluminium/

Market analysis – "the copper case"

Stakeholders' interests, needs and possibilities

To get a better understanding of the copper value chain and stakeholders' different interests, needs and possibilities, interviews have been conducted with actors representing different stages in the value chain. Key insights from the interviews are summarised below. The statements in purple are translated from the interviews conducted in Swedish.

The market analysis has been constructed in two parts. Semi-structured questionnaires have been used in the first part and SWOT analysis have been contrasted with the interviews in the second part.

"It must be an internationally accepted standard or labelling" Among the interviewed, it is a consensus that the system must have a global ambition, since the copper market is global. However, it might be strategically wise to start in a small scale, focus on the development of the system and not to get entangled in international politics on what might be sustainable or not.

To track the transaction of the material and give material a sustainability value is a new way of thinking for many stakeholders. Today, larger branding companies have sustainability demands on their suppliers, but with a focus on their suppliers as organisations and not on the offered material. *"We think in terms of organisation and not products, and we help our suppliers to get better regarding their total emissions as organisations."* A risk of implementing a system that is focusing on materials, is that larger organisations often already have invested in a system with focus on organisational developments and therefore may not be willing to try a new approach. *"We have our system to inspect or control our suppliers. It is "special" if you are selected as a supplier."*

In today's supply chains, the supplier usually does not need to report who their sub suppliers are. The system is built on the buyers' trust in their suppliers and by different actors applying different management systems certified by a third independent party, for example ISO 9001 and ISO 14001 certification standards. It is a system that makes sense, since it would be ineffective if everyone should audit all other actors in the value chain. At the same time, it is not a "fool proof" system. There is no common opinion on whether suppliers in the future will have to know and report the origin of their products. Some professional buyers, for example in the construction industry, have started to demand information about the origin of materials but some suppliers do not think they have the right to know. Some of those that were interviewed put high hopes into new digital solutions like blockchain, while some are more sceptical and believe they already have seen too many failed attempts in developing traceability systems.

Suppliers buying raw material early in the supply chain have different challenges in keeping track of the origin compared to suppliers buying products or items, since an item can get tagged or provided with some unique identification. Buyers later in the value chain, do not always have a full understanding of those challenges. At the same time, some buyers interviewed have experienced that when starting to demand a higher level of traceability, their suppliers initially complain, but in the end the suppliers always deliver the information requested.

The copper industry has agreed on how to grade copper quality, viz levels of purity, based on the LME London Metal Exchange grading. For example, the buyer of copper cathodes can decide to only buy grade A cathodes which indicates 99,995% Cu purity or higher. The next buyer can then be confident in receiving the demanded quality, but they have no possibility to demand to know the source of the copper.

Some stakeholders expect that they will get more questions about the emissions during manufacturing of their products in the future. One example is from the renewable energy sector. When energy providers have shifted from fossil to renewable energy, the emissions have changed from the energy production to the production of renewable energy products like wind turbines and sea cables which may create a need for new information. *"We have an emerging need to show that renewable energy sources are sus-*

tainable. We have shifted the emissions from the electricity production to the production of products." At the same time, brand companies do not necessarily believe they can charge more for products containing sustainable materials. *"I find it difficult to see that we can charge more for our products because we would use sustainable copper."*

Public authorities can be identified as important early adapters of sustainability labelled metals, since they can create a pull effect by public procurement. Public authorities interviewed believe that they would be able to pay more for sustainably produced metals. However, to be able to demand sustainability in the procurement, they need to use established standards to give all suppliers a fair chance. Public authorities also find it difficult and time consuming to review their suppliers. An easier way to make sure laws and requirements are followed would be an important support for public authorities, such as an independent and certified labelling and traceability system.

"We will only get involved if it can give us a profit advantage from our customers." It is not difficult to build a certification system and design a label. The challenge is how to create a system that gives enough added value for stakeholders to absorb the added cost of a system. *"Many are good at creating certifications, but poor at creating pull from the market."*

The respondents agreed on that the most important and urgent sustainability issue in the area of metals is the risk from conflict minerals. Conflict minerals are identified as one of the largest risks for companies because the issue has a large media coverage and because of laws like the Dodd Frank act. Some of the respondents experience that they must focus all their resources on following the laws, and do not have the possibilities to consider other sustainability factors such as carbon foot print.

Stakeholders in the later stages in the value chain appreciate circularity. Buyers like public authorities have clear goals for a more circular economy, but do not yet have clear ideas regarding how to implement circular value chains.

> The most important and urgent sustainability issue in the area of metals is the risk from conflict minerals.

SWOT analysis – What kind of Chain of Custody system should be applied?

To evaluate what kind of chain of custody model would be most suitable for copper and the stakeholders, a SWOT analysis has been conducted for the different models (see image 2) together with involved stakeholders in the value chain and experts, such as auditors and researchers. Conclusions from the SWOT-analyses is presented below.

A mass-balance approach is recommended

The analysis indicates mass-balance being the most suitable chain of custody model for copper. The main reason is that the production processes of copper products today mix materials from different sources to create the most suitable products regarding quality and economical aspects. Copper concentrates from different mines are mixed when producing copper cathodes, and copper cathodes from different smelters are mixed when producing copper wire. To not rely on only one source is often also part of strategic risk management for stakeholders in the value chain.

As a comparison, when benchmarking the forest industry and the FSC labelling chain of custody, the mass-balance approach has been an important success factor uniting stakeholders to a agree on a common certification system for the complex value chains and production processes with mixed commodities.

Important factors for mass-balance to be accepted and adapted

Although the mass-balance approach seems to be the most suitable solution, challenges have been identified. One major challenge is how to make buyers in the value chain motivated to pay for "sustainable" products that might not physically contain the equal amount of sustainable materials. Partly, this is a matter of communication, to make the stakeholders understand and acknowledge the value and product outcomes created by a mass balance system. Such communication could refer to that customers can have a positive impact and contribute to a more sustainable industry by choosing sustainable

labelled products. The label does in fact correspond to the claimed amount being produced and secured on a blockchain to only be sold once.

The logic of mass-balance is to claim the "sustainable" percentage of the material or product. This can be suitable for sustainability factors like percentage of recycled material or level of carbon foot print, where the sustainability factor or claim is not a yes or no. Mass-balance cannot handle the challenges with conflict free minerals since customers will not accept even fractions of conflict materials and require fully guaranteed *conflict free* materials. Therefore, when the crucial factor is conflict free, another chain of custody model must be used. Aside to the specific situation with conflict minerals, the chain of custody standards for other metals will probably need to clearly state that certified material will only be mixed with materials from controlled sources, so it can be guaranteed that the end-product does not contain metals from any unwanted sources. A first step in defining what a controlled source is could be to use procurement requirements already use, for example ISO standards or Responsible Minerals Initiative (RMI).

Until now, a challenge in the mass-balance approach have been to eliminate double spending. Experiences shown that in many cases, an auditor has only been able to evaluate if the input and output of an organisation have seemed to be reasonable. By introducing a blockchain based system, this project will offer a new solution to avoid double spending.

What adjustments need to be adopted for the identity preservation model; the segregation model; or the certificate trading model?

To apply an **identity preservation** model, a smelter could use copper concentrate from only one mine at a time. This is not coherent with the production and the business logics of copper smelters. It would also be impossible to add copper scrap and still preserve the identity of the material. And even if a smelter would only use copper concentrate from one mine, the identity preservation would still lead to challenges in the next step since copper product producers commonly mix copper cathodes from different smelters in their production. For these reasons, identity preservation clearly cannot be used as an applicable chain of custody model for copper production.

The **segregation model** is more flexible since the claim is in focus, not the origin. However, it could be difficult to find a suitable claim or sustainability criteria that would stand out in the industry, since all input material needs to meet the same claim. Segregation could be suitable for broad claims, for example if organisation has a certified management system. If the claim would be that only material from ISO 14001 certified sources (mines and recycling stations) are used, buyers could eliminate other sources and only use material from suppliers with a valid ISO 14001 certificate. Segregation is not suitable to claim the sustainability level of a product. To be able to claim for example a carbon footprint value in the segregation model, the highest value added must be used. Which probably will not to give as fair result as in a mass balance model where a calculated average value can be applied.

Certificate trading does not require adjustments in the production processes. However, a new marketplace where the certificates will be traded needs to be established and a new business model needs to be adapted where stakeholders will buy the material and certificates from different markets. The interviewed stakeholders have been sceptical to this approach and point out possibilities of green wash when conducting the SWOT-analysis.

This project will offer a new solution to avoid double spending.

What different values can the different chain of custody models provide?

The analysis shows that many stakeholders first think of an identity preservation model when talking about traceability. The identity preservation model has some strengths such as it would be easy to create trust for the system and to communicate the rationale behind the model. For example, it would be possible to claim a car as 100% recycled or 100% "made in Sweden", especially to end-consumers. However, based on how most metals and minerals are used in the value chain this is not a possibility. One exemption would be gold (and gemstones).

It is questionable how valuable information about origin would be to professional buyers. For high risk materials, like conflict minerals, it is important to know the origin to meet the needs and requirements for a transparent and effective risk management process. However, copper is not rated as a conflict mineral and the needs are somewhat different compared to conflict minerals. According to Tillväxtanalys[9], a more critical sustainability factor, that is relevant for copper, is carbon emissions. Since carbon emissions have a global impact, professional buyers could have a pragmatic approach that focus on being able to claim a contribution to the reduction of carbon emissions, independent of where that reduction take place. This is something that a mass balance approach would offer.

The copper market is also mature to implement a mass balance approach since they have already agreed on a highest quality grade of copper, so called grade A on LME, London Metal Exchange. The chain of custody system does not need to assure a certain physical quality performance, only the value of the sustainability impact in the production.

A more radical approach would be to use a certificate trading model. Then professional buyers could buy certificates or credits from an online marketplace to make sure that somewhere in the world, the same amount of copper have been produced as the claim of the certificates or credits they buy. In this case, buyers would support stakeholders early in the supply chain in an effective way, since no middle men are needed. It could also have a (sustainable) logistic benefit, since copper can be bought from the nearest supplier and to avoid transportation. This approach might be accepted for a carbon emission approach since it has a global impact. It could be harder to motivate certificate trading for local sustainability issues or factors.

A main difference between certificate trading and mass balance is that in mass balance, the sustainability benefit is always within the same value chain as the claimed material. In certificate trading the value and the claim is totally separated.

However, certificate trading could be misused as "green washing" when a stakeholder buys a lot of copper from suppliers who have a very negative sustainability impact and at the same time, buys equal amounts of certificates. As a parallel, critics of the European electricity certificate system argue that the buyers of electricity in countries which have a high level of renewable electricity feel satisfied that they already consume green energy and do not buy certificates, while buyers in regions with not as much renewable electricity buy certificates to justify their emissions.

9 http://www.tillvaxtanalys.se/publikationer/pm/pm/2019-02-07-sparbarhet-och-markning-av-hallbara-metaller-och-mineral----insatser-for-okad-transparens-trovardighet-och-efterfragan.html

Desktop study – how other sectors apply and communicate a mass balance approach

As stated in the market analyse, it may be a challenge to communicate the mass-balance approach and motivate customers to pay extra for a product that might not contain sustainable materials but that promotes sustainable production. A desktop study has been conducted to understand how other industries have implemented the approach and how they are communicating the increased value of the system.

UTZ certification

UTZ, a certification program for cocoa, coffee and tea (part of the international non-profit Rainforest Alliance), uses mass balance as one of the options in their certification, most commonly used for cocoa. To support their members in communicating the value of certified cocoa, they have an online platform they call "mass balance member pack". The mass balance member pack consists of different kind of communication materials, for example short videos and in-depth documentation. The infographic below is one example of a communication tool. UTZ are using the same label for all UTZ certified products, but when mass balanced have been applied, it must be stated on the back of the packaging.[10]

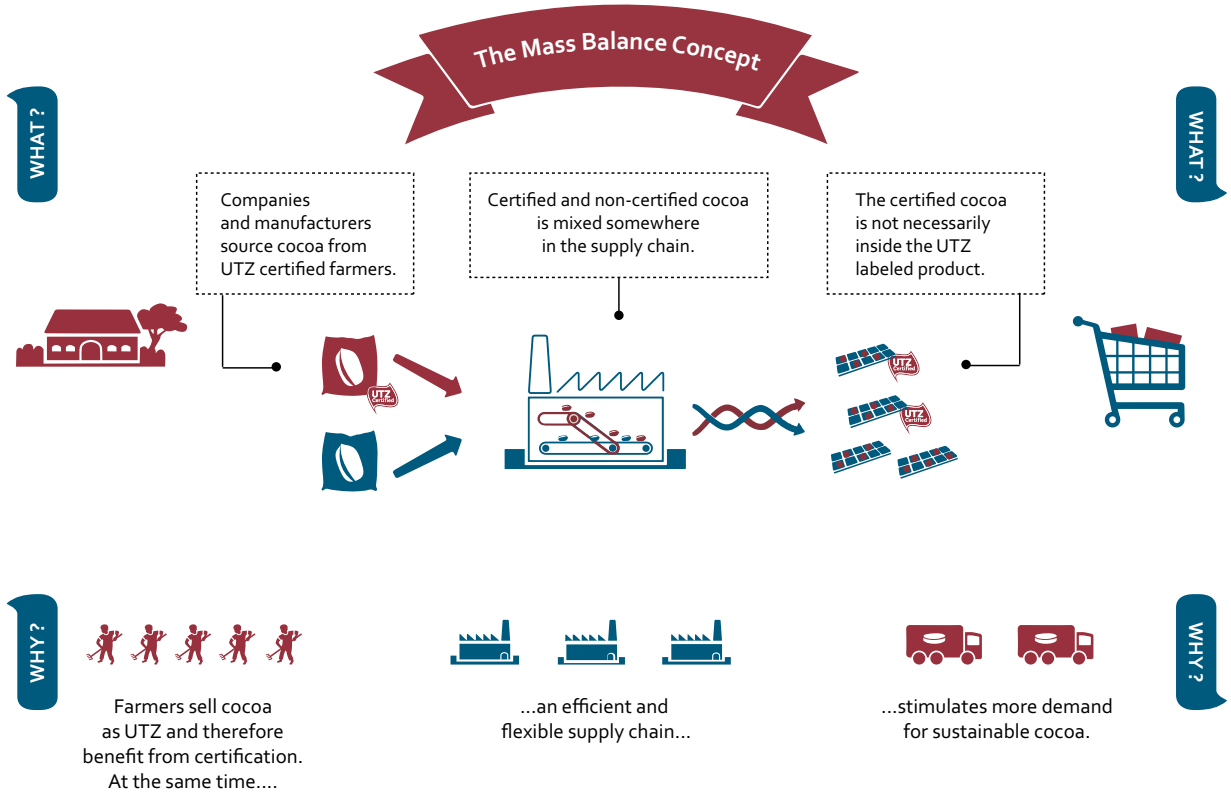

Figure 3. The UTZ certification mass balance concept applied across the cocoa value chain.

10 https://utz.org/what-we-offer/certification/products-we-certify/cocoa/massbalance/member-pack/

Forest Stewardship Council – FSC

Since the Forest Stewardship Council, FSC, has different levels of traceability in their chain of custody, they are using different kinds of labels. When a mass-balance approach has been used, a MIX label is communicated. When segregation is guaranteed they use they same FSC brand but the label state 100% of certified material instead of MIX.

BASF

The chemical company BASF uses the mass balance approach to offer customers to allocate the renewable input materials to specific products. BASF use the certification body TÜV SÜD to validate their claims. They use a TÜV SÜD label that claims that 100% of fossil resources is saved by using renewable raw materials and that an audited feedstock balance is applied. BASF have created YouTube videos to explain the value of the system.[11]

11 https: //www.basf.com/global/en/who-we-are/sustainability/value-chain/renewable-raw-materials/biomass-balance.html)

Certification System

The suggested concept is first explained in general terms, then described from a blockchain perspective. The last section of the chapter shows how the chain of custody system can be used in a copper value chain in a concrete case.

The aim of the certification system is to provide confidence in that the production processes and products in a production value chain conform to specified criteria, such as being environmentally sustainable.

We present in this project a general system which can be applied to different metals, minerals and value chains, and with different performance criteria. At the end of this section we present a more concrete example using the copper value chain.

The figure below gives an overview of the actors and components of the certification system at one step of a production value chain.

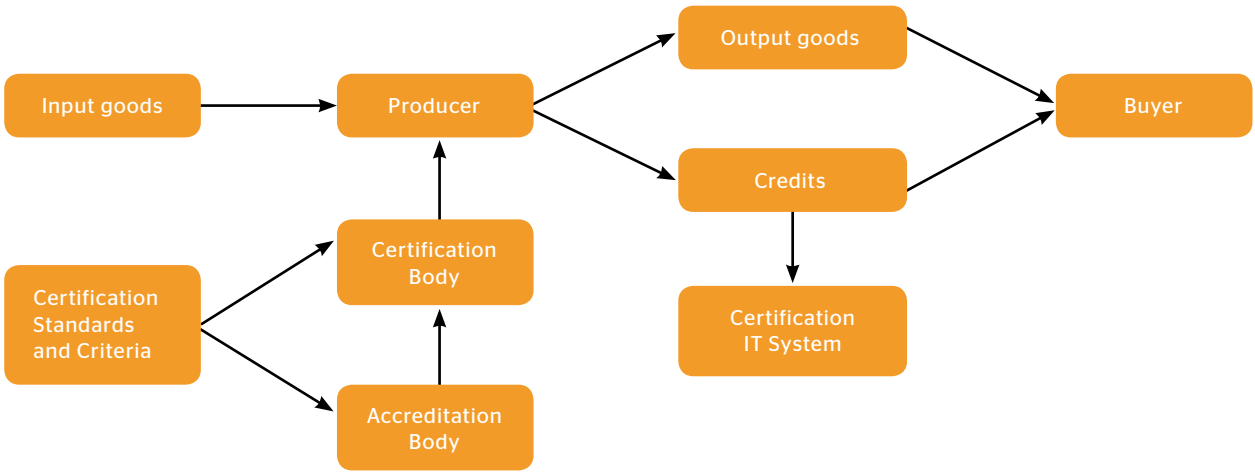

Figure 4. The relationships between value chain actors and the certification system.

A producer has been certified by an accredited certification body according to a standard. The producer uses input goods and produces certified products. Depending on the certification standard, the input goods might be certified as well. The credits and the chain of custody of the goods are tracked in the IT system on a blockchain.

A value chain normally contains several steps, connected to each other, where the outputs of one stage are the inputs to the next stage until end products are produced.

There are two kinds of certification standards, a performance standard and a chain of custody standard.

The performance standard sets criteria for which criteria should be fulfilled and for how and where these factors should be measured. For example, the total amount of CO_2 emissions from the mine to the smelter per kg copper cathodes.

The chain of custody standard defines how certified goods are tracked in the value chain. The primary role for the chain of custody standard is to set clear criteria to ensure that stakeholders dealing with certified material cannot claim more material than what they have been accounted to possess, and to ensure that non-certified material do not enter the certified value chain.

Blockchain Information System

The figure below shows the structure of the information on the blockchain. This picture has been simplified somewhat and more details are available in the technical report.

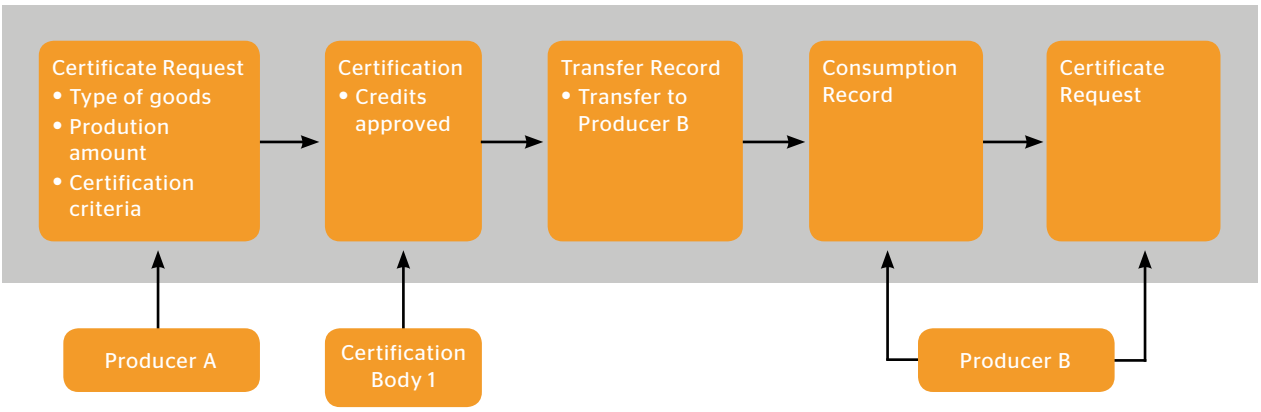

Figure 5. The information stored on the blockchain.

The figure shows a chain of transactions on the blockchain, which records the production, the certification and other chain of custody events in the value chain. The transactions are connected with each new transaction referring to a previous one, continually updating the state of the ledger.

Producer A has been certified by Certification Body 1. When Producer A produces some goods or raw materials, it is the first step in the chain of transactions that creates the record for a request of certification of these goods in the blockchain. The request for certification contains a description of the goods and the amount of production, corresponding to the information in the blockchain.

The certificate request needs to be certified by a certification body. Certification Body 1 reviews the certificate data and may perform other checks or validation as required by the certification standard. If all the certification requirements are fulfilled, the Certification Body 1 will approve the request and issue credits for certified goods on the blockchain. What kinds of checks the certification body will perform at a certain stage will depend on the certification standard, but in many cases the production certification could probably be automated under the assurance that the management systems and facilities of the producer have been audited and certified.

Once the credits have been issued by the certification body, Producer A can claim certified goods which have been accounted for on the blockchain.

Producer A can transfer the ownership of the certified goods and the associated credits to another party, say producer B, who needs certified goods in its production process. The parties arrange agreements on payment and shipping of the goods, and the ownership of the credits is transferred in the blockchain. This is accomplished by the transfer record created by producer A, containing a link to the certified credits.

Optionally, transfers may also be validated by certification bodies according to the relevant chain of custody standard, but this is not included in the case in the figure. Instead, for a simpler and less costly operation, the system could rely only on accounting the of amounts of certified goods on the blockchain to prevent claiming of more certified materials than what is available.

In our example, the certified goods are now owned by producer B. Producer B in turn wants to claim the goods in its own production process which requires certified inputs. Producer B must then create a certificate consumption record on the blockchain, to achieve the required claims for certified materials in the production. As a following step, Producer B may also create a certificate request for its produced goods. This shows how the certification cycle can be repeated continually across the production chain.

Alternatively, if only a chain of custody standard is being used in the later stages of the

There will always be a requirement for human level governance of the blockchain.

value chain, as in the earlier example, then there will be a series of transfer records, but no additional certification requests.

At the end, there will be a point in the value chain when the chain of custody tracking on the blockchain reaches its end, for instance when consumer goods are produced and sold. This is not shown in the figure, but at that point the end of the transaction chain would be indicated by a special System Exit Record.

Blockchain and chain of custody system governance

Although the technical protocol of a blockchain is decentralised, coordination is still required at other levels. The software needs to be developed and maintained and the blockchain network needs to be operated. In addition, there will always be a requirement for human level governance of the blockchain. Such governance is needed for maintenance and development of the certification system as well as managing disputes or other unforeseen events which are certain to arise at times in any kind of business.

The stakeholders of the certification system need to set up and agree on governing bodies which will maintain, develop and govern the system.

The chain of custody system exemplified with the copper value chain

This a concrete example but where all numbers, conversion factors and volumes are made up.

Step 1

A smelter receives:

- 200 t imported copper concentrate, containing 45 t copper. (Which they have sourced in a responsibly way, to avoid for example conflict minerals, but they do not have the exact carbon foot print value of the raw material.)
- 200 t of copper concentrate, containing 45 t copper, from their own mine. (Where they mine with the latest techniques and where they have a certified process to calculate CO_2 t per 1 t copper concentrate.)
- 50 t of copper scrap, containing 10 t copper.

This input will together correspond to a production of 100 t of copper cathodes. After the smelter have applied a mass balance approach and conversion factors using a certified and audited procedure, the 100 t is divided in three different product categories:

1. 45 t of ordinary, uncertified copper
2. 45 t of Cu 8.0 MIX, meaning certified copper from mixed sources, with a mass balance of 8.0 kg CO_2 emissions per 1 kg of copper metal
3. 10 t of Cu RE MIX, meaning certified copper from mixed sources, with a mass balance of recycled copper

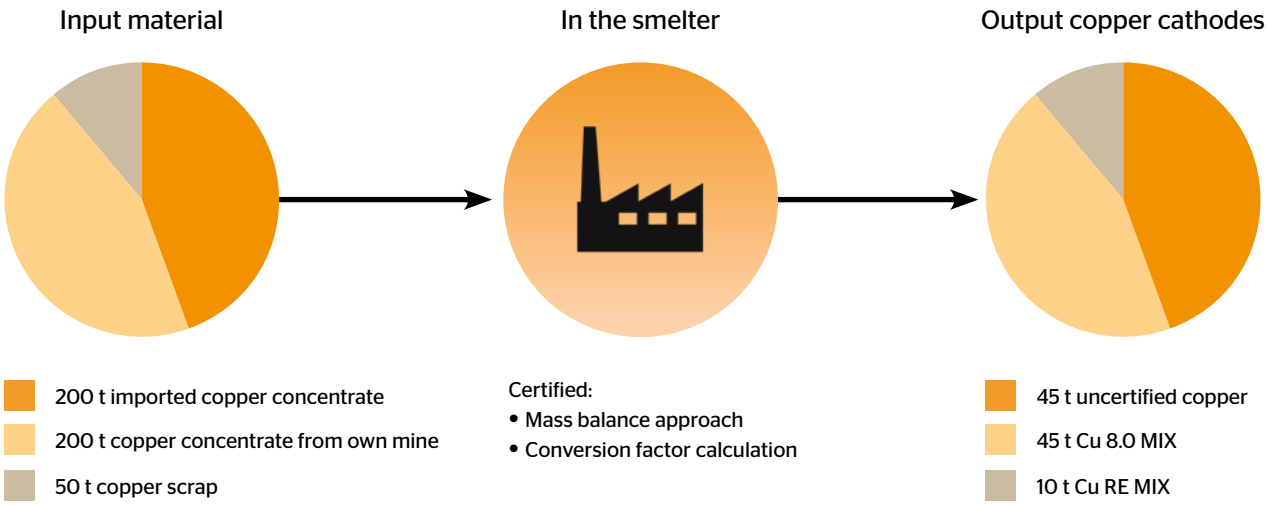

Figure 6. A mass balance based certification applied to an example at a copper smelter.

Where:
Product 1 consists of just the 45 t of copper cathodes.
Product 2 consist of 45 t of physical copper cathodes and corresponding digital credits for 45 t Cu 8.0 MIX on a blockchain.
Product 3 consist of 10 t of physical copper cathodes and corresponding digital credits for 10 t Cu RE MIX on a blockchain.

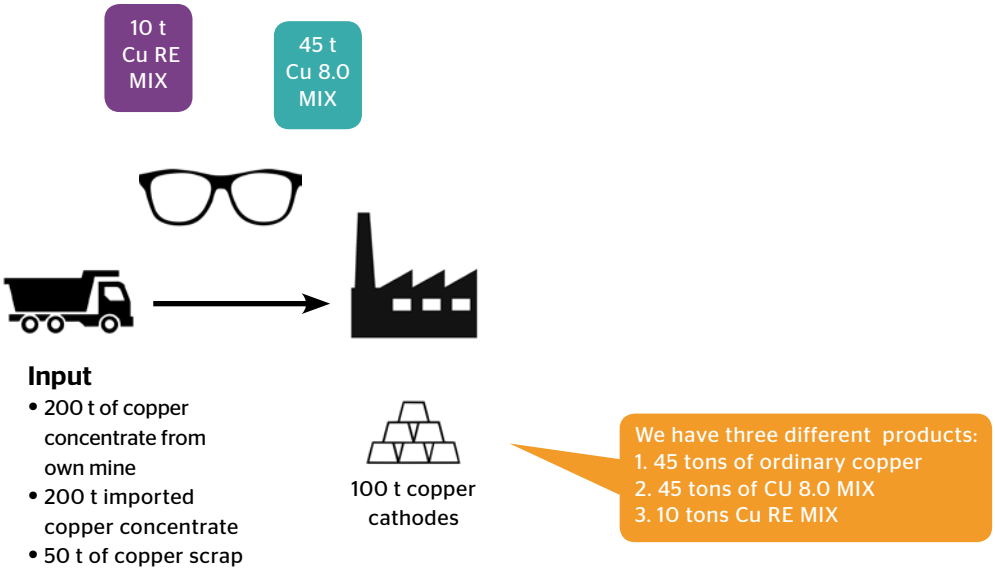

Figure 7. A mass balance based certification applied to an example at a copper refining plant.

Step 2.
A manufacturer orders 45 t of Cu 8.0 MIX. The manufacturer receives 45 tons of physical copper cathodes and digital credits for 45 t Cu 8.0 MIX on a blockchain.

The manufacturer mixes copper cathodes from different sources but has a certified and audited sourcing procedure to avoid for example conflict minerals.

The product is copper wire. Since there is no material loss in the production, the manufacturer still has 45 t Cu 8.0 MIX digital credits. This means that the manufacturer can sell 45 t of copper wire as Cu 8.0 MIX.

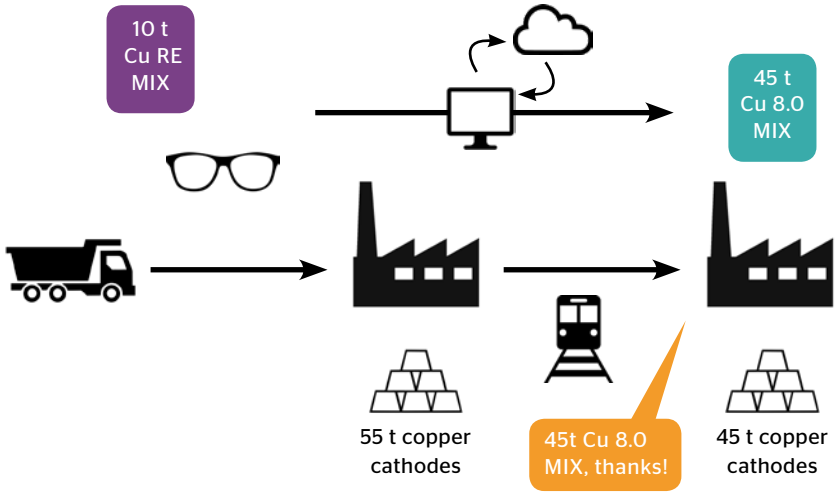

Figure 8. A mass balance based certification applied to an example at a copper wire producer.

Step 3.
A brand company with a stated goal to lower their products carbon footprint buys 45 t of copper wire Cu 8.0 MIX, which means they receive 10 t of copper wire and digital credits for 45 t of Cu 8.0 MIX.

The brand company uses the 45 t of copper wire to make computers. Since they want to market and communicate that their computers contain Cu 8.0 MIX labelled copper, they have to consume the digital credits in connection to the specific computers. When the digital credits leave the blockchain, a certification body audits a process to guarantee that the input Cu 8.0 MIX amount matches what is marketed or labeled.

The brand company cannot communicate that their products contain copper with a carbon footprint of 8.0 ton CO_2 per ton, but can communicate that their products contains Cu 8.0 MIX. The use of Cu 8.0 MIX verifies that the same amount of copper that is used have been produced with this carbon footprint in the value chain.

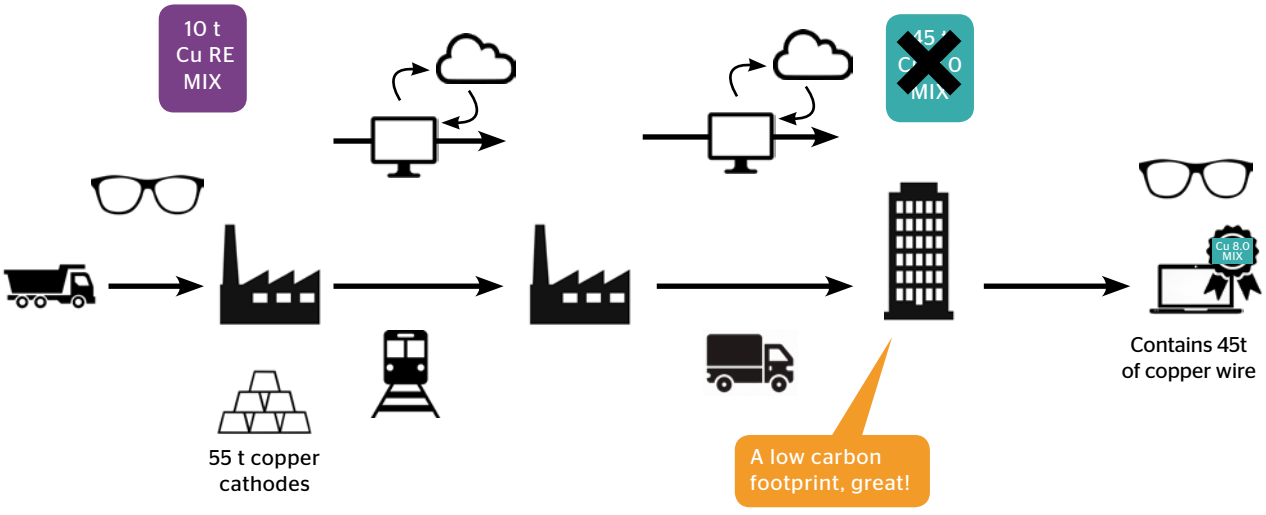

Figure 9. A mass balance based certification applied to an example at a manufacturer requiring copper wire in their products.

Related projects, reports and initiatives

Sustainable labelled metals and minerals is currently a topic that interests many stakeholders. Blockchain technique has been identified as a possible solution to solve the need of sustainable labelled metals by the industry. Below, some of the most relevant projects, reports and initiatives are presented. While our project focus on the chain of custody development, many of the other initiatives have the ambition to also cover the development of criteria. The full list of identified related projects, reports and initiatives can be found in the state-of-the-art analysis.[12]

CERA

CERA, "Certification of Raw Materials", is a standardised certification scheme currently under development within the EU. The CERA standard takes a comprehensive approach for sustainability, putting requirements on multiple aspects of sustainability, such as conflict concerns, labour issues, anti-corruption and environmental impact. RISE is involved in both CERA and the current project, providing for potential synergies between the projects.[13]

Responsible Minerals Initiative Blockchain Guidelines

RMI, the Responsible Minerals Initiative, has provided guidelines for use of blockchain in metals and minerals chain of custody projects. The guidelines provide fundamental principles for blockchain adoption and unified terminology and concepts about metals and minerals value chains. We will take these guidelines into consideration and apply them where they are beneficial.[14]

Traceability and labelling of sustainable metals and minerals – efforts for increased transparency, credibility and demands

In 2018, the Swedish government commissioned the authority Growth Analysis (*Tillväxtanalys*) to review the possibilities for traceability and sustainability labelling of metals and minerals. *Tillväxtanalys*' review cover many of the same topics as in this report and the project leader of *Tillväxtanalys* has been a member of the steering committee of the project. *Tillväxtanalys* published the report "Traceability and labelling of sustainable metals and minerals – Efforts to increase transparency, credibility and demand" in February 2019.[15]

Responsible Sourcing: LME position paper

In 2018, the London Metal Exchange (LME) published a position paper describing new proposed requirements for their listed brands regarding the responsible sourcing of metals. According to the position paper, compliance with the requirements are planned to be mandatory for listed brand in the next few years.[16]

ISO/CD 22095 Chain of Custody – General terminology and models

ISO is developing an international standard for Chain of Custody. The standard aims to contribute to a common understanding for applications and communication of chain of custody systems.[17]

12 https://www.svemin.se/mineralbidraget/

13 http://cera-standard.eu/home/

14 http://www.responsibleminerals initiative.org/about/media-news/news/responsible-minerals-initiative-releases-blockchain-guidelines-to-drive-alignment-in-mineral-supply-chain-due-diligence/

15 http://www.tillvaxtanalys.se/in-english/publications/pm/pm/2019-02-13-traceability-and-labelling-of-sustainable-metals-and-minerals----efforts-to-increase-transparency-credibility-and-demand.html

16 https://www.lme.com/en-GB/About/Responsibility/Responsible-sourcing

17 https://www.iso.org/standard/72532.html

NOTES

Find out more about the Svemin sustainability initiative #Mineralbidraget
svemin.se/mineralbidraget

Svemin is a national branch organization for mining, mineral and metal producers in Sweden with more than 40 member companies active throughout Sweden. Members include mining companies, prospecting an explorative companies, limestone and cement companies and various equipment and service providers.

SveMin