Circular business models and sustainable development: A project aimed at learning

How can investigation into flows of material (rather than flows of money) help inform companies' and authorities business development strategies toward circular economy? These questions formed the research core of the project, part of "Sustainable Value Creation through Circular Business Models" carried out by a team at the University of Gävle. The University's project formed part of the larger effort aimed at investigating and spreading circular economy approaches in the region of Gävleborg. In the project, the University worked in coalition with the Resource Institutes of Sweden (RISE) and the steel-focused business cluster, Triple Steelix. The project description designed for the University was focused on mapping and visualizing material flows on company level. However, during the course of the project a number of different approaches were taken to understand the complexity of circular economy. The more we investigated the subject, the more we realized that it affects the whole society and its actors. Therefore, several approaches of understanding the connection between material flows and circular economy were taken. This article presents some of the most interesting results and findings.

What is circular economy?

Before going into detail, let's start from the beginning: what is a circular economy? According to literature, there are hundreds of definitions and different understanding of the subject. But there are some reoccurring descriptions everyone should know about. First off, the idea with circular economy is to turn linear material flows into circular. In the linear economy we extract materials, produce, consume and discard products. In this process, materials are lost and become unavailable for future generations, while emissions of different compounds into the ecosystems have catastrophic consequences. Conceptually, materials flow as illustrated in figure 1.

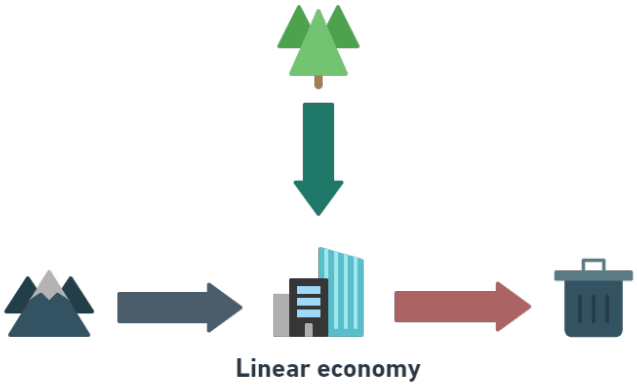

Figure 1: Conceptual visualization of material flows in a linear economy

In a circular economy, products should flow in either biological or technical cycles and energy should come from renewable sources. In technical cycles, technical materials flow, which are those found in the ground (metals and minerals for instance). They should stay as long as possible in society by circulating materials, components and products in multiple loops and by increasing product utility and lifetime. We do not want them in the biosphere, were they disturb the ecological balance. Biological materials flow in the biological cycles and are those made of organic materials such as food, cotton and wood. These can be returned to the biosphere after they have been used, but it should be done in a way that it does not harm the ecological cycles.

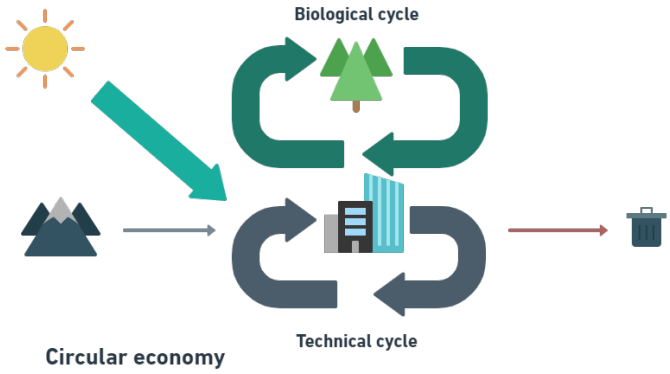

Figure 2: Conceptual visualization of material flows in a circular economy

Following these guidelines, which are visualized in figure 2, would have many advantages for sustainability: by circulating materials in the society, the demand for new material is reduced and less extraction and energy is required. That way, material availability can be ensured and CO2-emissions reduced. Material availability will be a greater challenge as economies and populations grow and more demand higher standards of living. Moreover, reduced demand for energy reduced CO2-emissions. For these reasons, the Swedish government is now adopting a circular economy strategy plan. However, the road to circular economy is long and requires collaboration between multiple actors. This creates many challenges of which we will present some of the most important. In the following paragraphs we discuss the relevance of different actors in a transition to a circular economy.

The role of the public sector in a circular economy

In the project, most focus was given to companies, but the importance of regional circularity was also somewhat investigated. We learned a lot about the status of the linear economy by mapping the national material and regional material flows in Sweden. For more information, see the pre-print report from one of the work packages (https://www.researchgate.net/publication/354386684_Regional_policy_implications_of_the_circular_economy). For instance, regions and municipalities play a key role in the circularity of other actors, as illustrated in figure 3. Specifically, infrastructure, agriculture, forestry and mining are sectors that are affected by the work of regions and municipalities. Additionally, resource intensity of services such as energy- and water supply, food supply, waste management, transportation, health and education is highly dependent on regional work. Another insight is that regions must adopt smart city planning and improve public transportation in order for the demand for cars to reduce. This is accomplished by ensuring that crucial services can be found close to where people live.

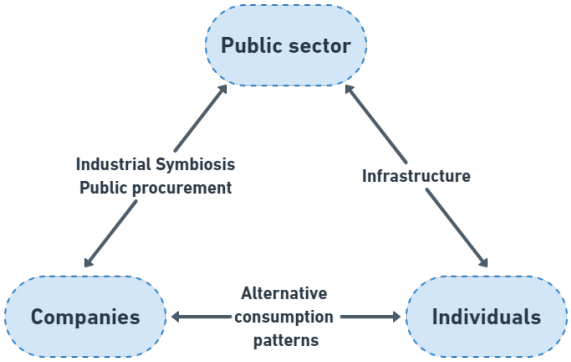

Figure 3: Key responsibilities for public infrastructure in a circular economy

The public sector also play an important role in creating Industrial Symbioses, a concept where multiple companies collaborate by sharing material flows, water- and energy infrastructure and knowledge. Doing so can improve environmental performance while increasing profits for the involved companies. In the project, existing Nordic symbioses were investigated as well as the possibility to create collaborations in the region of Gävleborg. It became clear that starting collaborations require a lot of work and consistent discussions between involved actors. According to researchers at the University of Linköping experience, who have thoroughly researched this area, the most efficient way of initiating an Industrial Symbiosis is to involve third parties and have round table-discussions. During this project, the University of Gävle joined a national Industrial Symbiosis network together with the University of Linköping. The intent is to share knowledge between regions and help fostering future Industrial Symbiosis.

Another important responsibility of the public sector is to ensure that public procurement favors businesses that adopt circular business models. In the first period of the project, this subject was examined. Currently, public procurement heavily focuses on favoring companies that can deliver cheap short term solutions. However, to foster a circular economy, procurement processes must favor long-term resource efficient solutions. Including additional requirements such as quality, and functionality will benefit businesses that adopt circular business models. This is also a comprehensive research area that did not end up in the core of this project, but we want to highlight that progress in this field is important.

Companies adopting circular business models

Today, many companies earn money from selling physical products. The more products they sell, the higher the profit. Most commonly, companies lose control over the products as soon as they are sold. Mostly, there is no takeback system that ensures that materials and components are circulated back into new products after they have been used. This drives extraction of new materials and causes pollution as new materials must be extracted to manufacture new products.

In the project, we investigated several alternative ways of making circular business models profitable while reducing environmental impact. One way to do this is to sell services instead of products. In such business models, the selling company keeps control of the products during their use phase. When the products are worn out, the companies take them back or repair them. That way they can earn more money from the same product multiple times. This gives companies incentives to provide durable, upgradable and recyclable products. One example of service companies are those that provide sharing services: car rental, tool rental and libraries. In this business model, the customer uses the products for a limited amount of time and then give them back to the company. Another example of circular business models are those that prolong the lifetime of products. This includes reuse, repair, and remanufacturing companies. This is also important as it reduces the need for production of new products. To succeed with these business models, the design phase is very important. Products must be designed in a way that their components easily can be separated and switched when necessary.

One important insight that should be drawn when looking at figure 4 is that circular business models operate throughout the whole value chain. To avoid confusion and ensure that circularity improves environmental performance, a common understanding of the concept of circularity is crucial. We find that the concept of circularity should ensure a drastic global reduction of material extraction, waste creation and energy use, as these are extremely important for improving environmental performance.

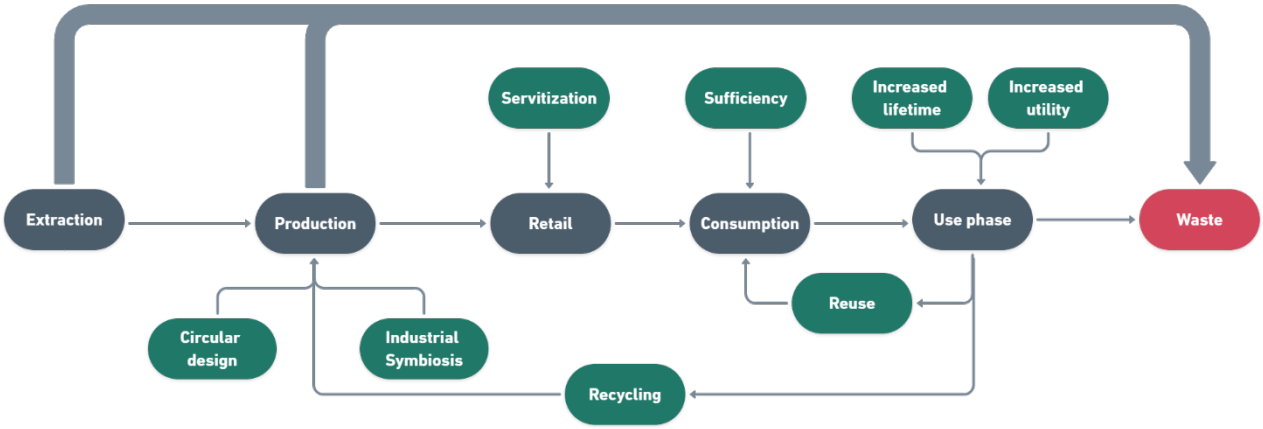

Figure 4: Resource efficiency strategies in a circular economy

In this project, much attention was hence given to evaluating circularity based on material flows. By mapping and visualizing material flows both on company level and regional level, we wanted to find out how circularity is evaluated today and how it best can be evaluated. For those purposes, we have reviewed existing circularity metrics, developed a new metric and tested some of them on a couple of circular business models. We have also mapped and visualized material flows both on company level and regional level. All outcomes have been incorporated in a course named "Introduction to circular economy". In the following section, a summary of the results are provided.

Outcomes of the project

As a result of the findings in this project, two scientific papers were published and data for a third paper was collected. Additionally, a traffic light based tool has been developed and applied on a couple of companies in the region of Gävleborg.

Paper 1: Metric development and feasibility testing

In the first paper, a new metric was developed whereupon it was tested on three SME:s in the region of Gävleborg. The metric was designed to capture how circular business models contribute to reduced material flows. The rationale behind the metric is to improve environmental performance by reducing material extraction (input) and waste creation (output). The metric was tested on Varubolaget AB, Brighteco AB and Jobmeal AB, which all have adopted business models that result in lower demand of new materials in their different sectors.

The first company, Varubolaget AB, collects old furniture, refurbishes them and sells them again. Without their service, the products would have been incinerated and the materials lost their value. Figure 5 illustrates that the total material input and output is reduced by 55 % with their business model.

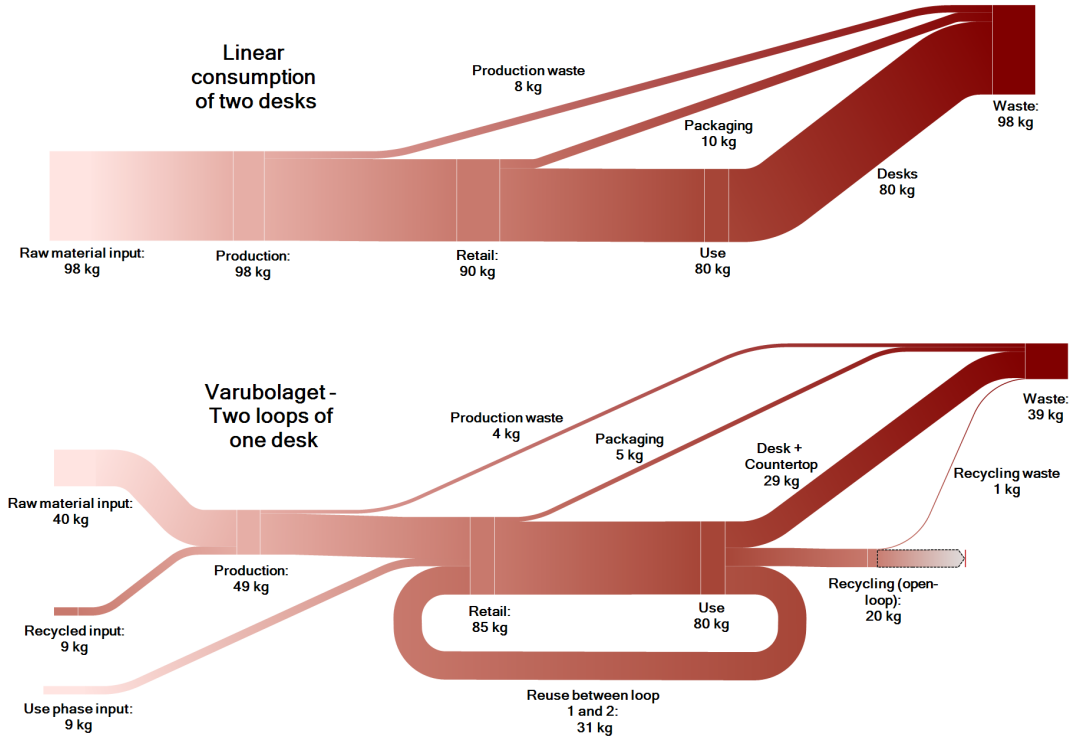

Figure 5: Material flows in the case study made on Varubolaget AB

The second company is Brighteco AB, which sells lighting as a service. They provide their customers with LED-monitors composed of recycled and reused materials instead of selling new LED-fixtures. By using a value chain perspective, they can increase lifetime of products and reuse and recycling of components and materials. Figure 6 shows that they reduce material input and output with up to 93 % compared to linearly produced LED-fixtures.

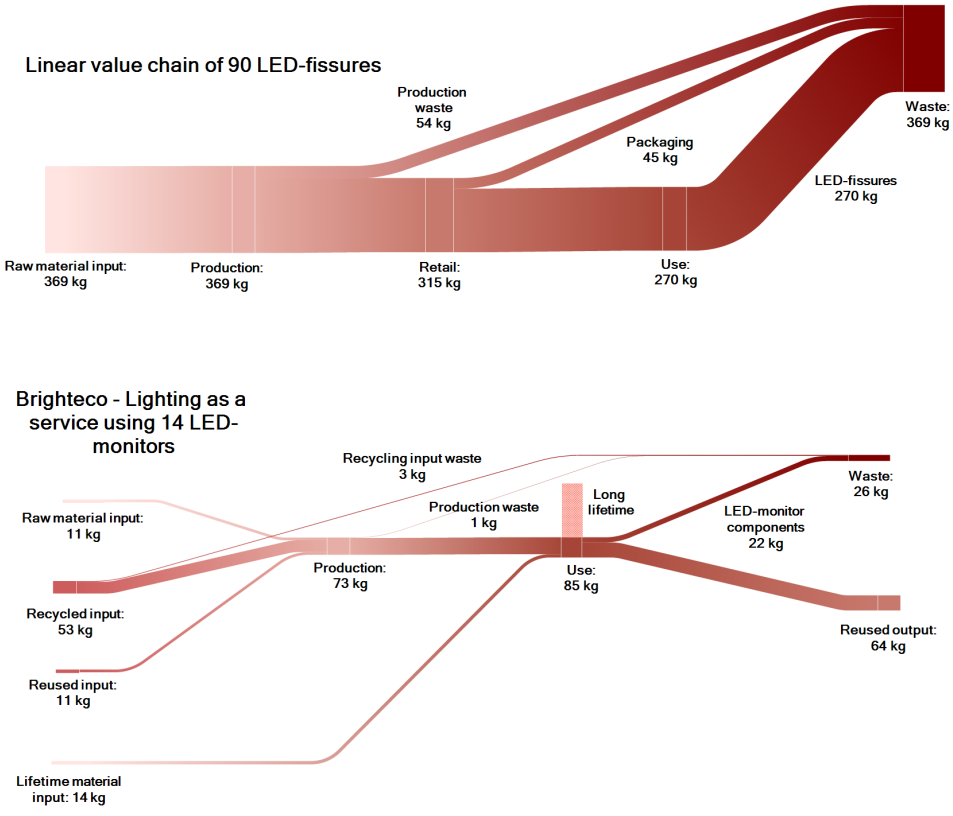

Figure 6: Material flows in the case study made on Brighteco AB

The third company is Jobmeal AB that rents coffee machines to larger organizations. Compared to the use of coffee makers, they have higher utility and lifetime. Additionally, they recycle the materials after the coffee makers are worn out. That way, they reduce the total material input and output by 77 %, as can be seen in figure 7.

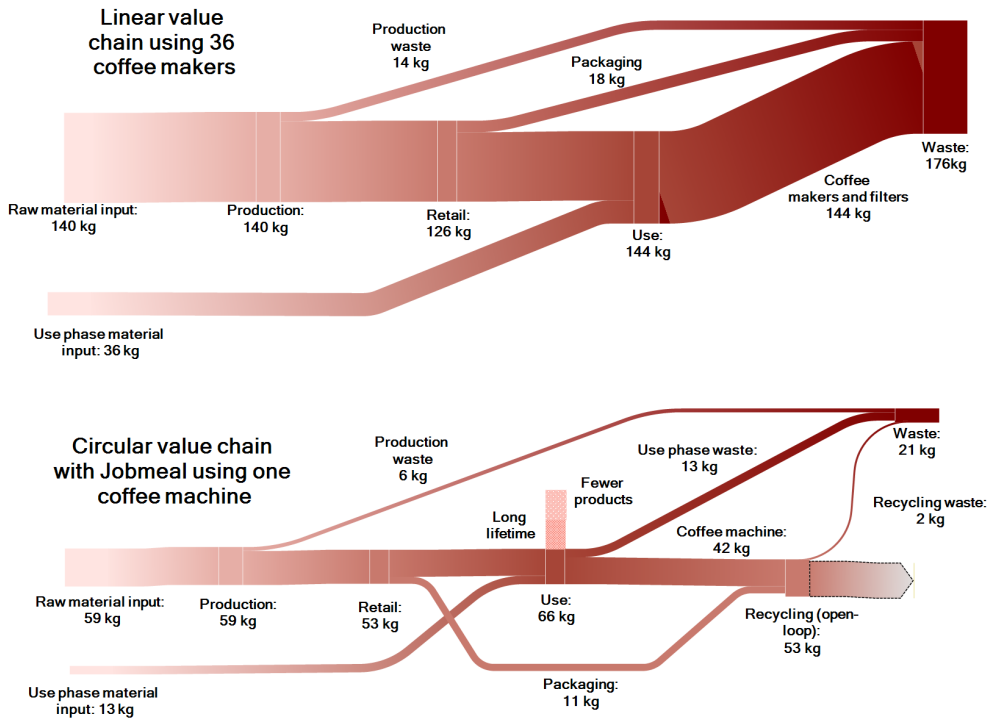

Figure 7: Material flows in the case study made on Jobmeal AB

In short, this paper showed that the metric could be applied on a variety of different business models in a way that existing material flow based metrics cannot. We consider it possible for the metric to be used to increase the understanding for how product circularity can improve circularity in complete value chains and potentially regional level. Additionally, it highlights inefficiencies in the value chain which can help companies to understand where collaborations are required to improve environmental performance.

Paper 2: Evaluation of circularity metrics

In this paper, four circularity metrics (including the one developed in paper 1) were evaluated based on if they measure what they intend to measure. For this purpose, the metrics were applied on four lawn mower scenarios where different business models were applied. The scenarios represented a recycling scenario, a quality scenario, a sharing scenario and a scenario where all solutions were combined. The metric results were compared to resource scarcity, global warming potential and toxicity calculated using Life Cycle Assessment (LCA), a scientifically robust method of evaluating environmental performance. The results showed that the metrics gave similar results as the LCA when evaluating material resource scarcity. In figure 8, a comparison of the metric results and resource scarcity for the different scenarios is illustrated.

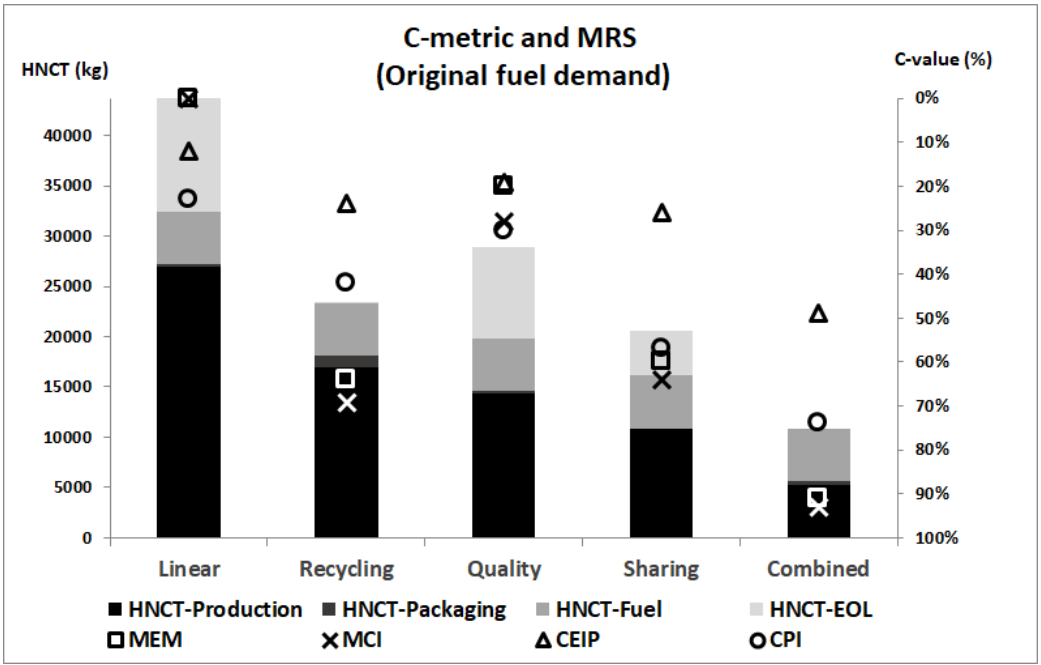

Figure 8: Comparison of circularity metric results and material resource scarcity using four lawn mower scenarios

We concluded that the metric can give good indications of material resource use, especially on products where the energy use is low relative to material use. This indicates that circularity metrics can be used as initial guidelines for finding the best business models in specific situations.

Paper 3: Understanding the challenges with circular business models

Although many circular business models may seem promising from an environmental impact aspects, there are many barriers for companies aiming at adopting them. To understand how a company can successfully adopt a circular business model, it is important to understand the barriers that companies need to overcome. Although there are some papers investigating this area, little has been done to understand how barriers and drivers for adopting circular business models differ depending on where in the value chain and in which sector they operate.

For this purpose, we interviewed representatives from a variety of companies in different sectors with different size, which had varying progress towards circularity. Using questionnaires, the interviewees rated what drivers and barriers matter most for adopting circular business models in their respective companies. We included some drivers that are commonly found in literature: altruistic, economic, and competitive and pressure from outside actors. Typical barriers are regulations or those related to supply chain or organization. To further understand the context of these drivers and barriers, the questionnaire contained a set of questions concerning what kind of business model they have adopted, their level of understanding and how they evaluate progress towards CE.

At this point, representatives from six companies operating in the region of Gävleborg have been interviewed:

- Jobmeal AB
- Varubolaget AB
- Brighteco AB
- Edsbyverken AB

- Crosscontrol AB
- Lovisa of Sweden AB

The continuation of this paper will include companies outside of Sweden and companies with less restricted size. By doing so, we hope to get a deeper understanding for how company characteristics affect what the barriers are for adopting circular business models. Ultimately, understanding these patterns potentially will help suggesting regulations that foster progress towards circular economy.

Circular readiness and material flow visualization

Throughout the course of the project, additional projects with companies within the region of Gävleborg were run. Four companies were interviewed: Formaplast AB, Svenska fönster AB, Plyfa AB and PP såg och borr AB. The main purpose with these collaborations was to understand how their business could become more circular and sustainable. To succeed, we mapped and visualized their material flows and developed a circularity readiness tool that we applied on their businesses. The tool was used for capturing aspects of material flows that indirectly affect material flows. For instance, we asked for rate of renewable/reused/toxic materials, waste generation in the production, business model related questions and about what happens with the materials at the products end of life. The material flows were then visualized using Sankey diagrams and the outcomes of the reports were shared with the companies in workshops.

Close analysis of material flows and circular challenges in these companies reinforced the findings from the metrics investigations. Companies operate as steps in the supply chain. To reduce total material burden of any one provision of service, using recycle material, changing business models to increase product life dramatically reduce the need for mining and manufacture which are the main producers of waste in the supply chain.

In all cases, to change materials or business models required deeper collaboration with suppliers, customers and other companies as stakeholders along the supply chain. Helping companies understand the potential of circular economy by visualizing and quantifying circularity in the supply chains they were involved was seen as a positive first step in this development.

Conclusions

A circular economy is by far more complex than a linear for many reasons. Consequently, there are many opinions about how a circular economy can be implemented and what the goal should be. However, to ensure progress to a circular economy, a unified view of the concept is crucial. In this project, we highlight the importance of basing decisions on potential environmental impact. We explore the possibility to indicate environmental impact based on material flows, which is a concrete way to measure and visualize progress. Using literature reviews, case studies and collaborations with companies, we conclude that a collaboration between multiple actors is crucial to foster a transition towards circular economy. It is also important to ensure that circularity leads to improved environmental performance and that the concept can be evaluated in a simple manner using circularity metrics. Such metrics can be used to demonstrate how public authorities and private investors should direct money to the most sustainable solutions. With proper regulations, such solutions should also become the most profitable.