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How to reduce CO2 emissions through better supply chain management
ROCE Partners

Midterm Report
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Niklas Tapola
Oskari Eskola
Lari Järvenpää
Antti Koulumies
Maija Mattinen
Heikki Peura

Current Status

The project is proceeding as planned. The literature review is mostly done and it has provided us a general understanding of the topic and a view how to model the problem. We have studied articles about supply chains and simulations, the measurement of environmental impacts and how these themes relate to the metal industry. Based on the articles, we have specified the objectives of this research as described later. We have also started sketching our supply chain model of Swedish steel producer SSAB's Oxelösund steelworks. We believe that we will be able to obtain all the necessary data, because CO2 emissions have been monitored at SSAB for years. Furthermore, the model does not require data on any financial aspects, which decreases the risk of not getting data, as the chance of confidentiality issues arising are small.

The project has so far been carried out according to schedule and we are confident that we will be able to conclude our work on time. We haven't seen any need for changing the division of tasks.

Findings and Results

The articles found were classified into three types: (1) Articles covering supply chains and simulation in general, (2) studies of the methodologies to measure environmental impacts and (3) metal industry specific articles. In general, we noticed that there is very little consensus on how to measure environmental impacts or how to formulate a supply chain model.

Supply Chains and Simulation in General

A supply chain includes the transition and transportation of material from raw form through several stages of manufacturing, assembly and distribution to a finished product delivered to the end customer [Jain et al. 2001].

Simulation has been identified as one of the best means to analyze supply chains [Jain et al. 2001]. We quickly realized after reading several articles on supply chain simulation that our study will differ fundamentally from "general" supply chain models. Supply chain simulations usually assess key performance indicators such as service levels, inventory turnover and order to delivery lead times with stochastic demand fluctuation. In our study, however, we seek to assess emission levels and therefore the general supply chain models are not of much use.

Several articles studied the importance of extending environmental demand beyond corporate boundaries [Ciliberti et al. 2008, Kovács 2008 and Walton et al. 1998]. These articles, along with preliminary data gathering, made us understand that the scope of our study should include the suppliers of the case company, since they play an important role in the emissions of the whole supply chain. In theory, the customers should be taken into consideration as well, but it is harder for a company to influence what the customers do with the product.

Methodologies to Measure Environmental Impacts

Although the term "carbon footprint" has become very popular during the last decade, it does not have a commonly accepted formal definition [Wiedmann et al. 2007]. The remaining questions relate mainly to the scope of the footprint; i.e. what it should include. For example:

- Should the carbon footprint include other greenhouse gases than CO2 as well, such as N_20?
- Should it include all sources of emissions, not just those that are produced in the use of fossil fuels (such as runaway CO_2 emissions from soil)?

- Should the carbon footprint figure be an absolute one indicating, for example, the amount of emissions, or a measure of impact on the environment?
- Should the figure include indirect emissions that are produced in upstream production processes or should it only include the emissions of the target organization or product?

Life Cycle Assessment (LCA) was seen as the most popular way to measure the carbon footprint. Others include the eco-intensity approach, which relates environmental or sustainable indicators to the added value of economic activities.

Life Cycle Assessment includes four steps: (1) Goal definition and determination of the scope, (2) inventory analysis, (3) impact assessment and (4) interpretation [Hagelaar et al. 2002, Geldermann et al. 1998]. A market-oriented LCA aims to measure the environmental burden caused by the design of the product and aims at achieving a competitive advantage [Hagelaar et al. 2002].

Metal Industry Specific

The metal industry is a significant CO2 emitter on a global scale. A lot can also be done to decrease emissions. Based on several articles that addressed either the steel or the aluminum industry, significant emission sources were identified. In addition to technological improvements in the processes in use at the steel plant, significant contributing factors were, for example, the electricity mix, the distances to the steel plant's suppliers the type of iron ore used. A key new technology in one article was the use of carbon-capture, which is becoming a popular way to reduce emissions in coal powered electricity plants.

While no LCA-type articles were found on the steel industry, an aluminium plant LCA was studied. [Tan, Khoo, 2003] In the article, the scope used was the cradle-to-gate approach. This includes all members of the supply chain up until the gate of the aluminium plant.

The steel industry emits CO2 not only as a result of great energy intensity but also due to the process of reducing iron to steel by blowing in a gas that ties up the carbon in the ore. This is why all carbon emissions can never be prevented, no matter how the energy used is produced.

In the steel industry, it is very important to look at the whole supply chain. According to SSAB calculations, the producing of one tonne of steel emits 960 kg of CO2 as a result of their processes. According to LKAB, an iron producer, however, the total emissions caused by the supply chain in producing one tonne of steel are approximately 2000kg. The one thousand kilogram gap has to be accounted for in this study.

Conclusions

The goal of this project is to find out what an industrial company can do to reduce the emissions of its supply chain. Therefore, we have decided to approach the problem using the life cycle assessment method (LCA), with, more specifically, a market orientated approach and a cradle to gate scope. Our aim is to perform the analysis so that it enables the case company, SSAB, to measure the amount of CO2 emissions caused by a unit of its steel by the time the steel reaches its customer, and identify areas where emissions can be reduced most easily.

The rationale behind this approach is that we believe that a company can only be held responsible for the environmental impact of its products up until the point where it can decide what is done with it and how. Intra-supply chain co-operation is, of course, very important, but we believe that the pressure to optimise must come from downstream. In this sense, if SSAB wants to make low environmental impact a competitive advantage, it may put pressure on its suppliers and work together with them to optimise its supply chain and bring down emissions. We will, however, leave the steel plant's internal processes and technological choices outside the model, because our lack of expertise in the technology used hinders our chances to add value in this area.

In this study, the LCA will include only CO2 emissions. This choice has been made due to the fact that CO2 emissions are the main cause of climate change and that CO2 emissions are directly linked to the amount of energy used. It can therefore be directly affected by optimising energy usage, choosing energy efficient technologies and by using low-carbon energy production methods. Other greenhouse gases result from different combustion methods which arise from the use of different technologies. As previously mentioned the team will not assess the technologies used to produce steel due to lack of expertise in the field. Hence the impact on non CO2 emissions is also limited.

The LCA performed will be a market-based LCA, as distinguished by Hagelaar's study. The aim is therefore to be able to tell stakeholders what impact one unit of steel product has had on the environment, and not to focus on an individual process or measure compliance with certain regulations, for example.

In the articles, guidelines for what exactly an LCA should include were not found. After discussing the matter with the client, it was decided that all directly value adding activities such as the production process as a whole and transport-related emissions are to be included in the LCA. The client will discuss internally whether we should also include 'overhead emissions'. These include, for example, the emissions caused by electricity used at the company's offices, emissions caused by employee commuting and company executive and sales force travel.

In order to formulate the data request from the client and to specify what other data is needed, a preliminary model of the steel plant supply chain is presented in Appendix 1. It is important to recognise material flows, material inputs and process outputs. For this purpose, a specific steel product must be chosen on which the supply chain analysis will concentrate.

Changes in the scope of the project and definition

In the original project plan, the exact scope of the project was left undefined, as one of the major goals in this project is to find out what scope is generally used. The case company to be used, however, has been further specified to be SSAB's Oxelösund steelworks.

The decided scope can be summed up as follows:

- A cradle-to-gate life cycle assessment: From raw materials to the case company's customers
- Only CO2 emissions are included
- Case company: SSAB Oxelösund
- The inclusion of "overhead" emissions is to be decided.

Risks

The risks described on the project plan are still valid. The client has yet to provide us with the data we have requested, although they have showed promising signs that we will obtain it as asked for. One new risk is the controlling of work load, as it depends a lot on what aspects in the supply chain are included. The complexity of the model is going to dictated by the data we receive, after which the group has to carefully decide with the client, how complex the model is going to be and in this way mitigate the risk.

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Appendix 1: Preliminary Model of the Supply Chain