Carbon Footprints from Enterprises to Product Instances: The Potential of the EPC Network

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Abstract: A growing number of companies quantify and report the greenhouse gas emissions associated with their activities. Collecting this data on a company-level facilitates the participation in emission trading programs and underlines the corporate social responsibility activities. However, enabling individual consumers to choose products with favorable "carbon footprints" requires data on the level of individual products, or even better, on item-level, also capturing information on transportation, cooling, etc. For providing such dynamic and fine granular measurements, the relevant enterprise information systems should be adapted accordingly. We present in this paper a spectrum of greenhouse gas reporting activities of increasing granularity and propose how companies can use EPC Information Services to reach a high level of reporting granularity.

1 Introduction

Companies measure and report their impact on the environment for legal, social, political, and monetary reasons [SL02, GOA96]. Parameters that are often measured include the amount of materials and energy used and the emissions released. In order to facilitate these environmental accounting activities, companies use Environmental Management Information Systems (EMIS) [Gu98, Ra99]. Recently, special political and public attention was devoted to greenhouse gas (GHG) emissions and their effect on global warming. The current EMIS can also account for the GHG emissions caused by a company on a process, site, or enterprise level. Furthermore, several companies plan to provide information with higher-granularity, namely by calculating the GHG emissions over all the lifecycle stages of their products [WM07, Car06]. These companies aim to make the so-called carbon footprint of their products available to the consumer, often in form of a label on the products or in marketing / consumer information campaigns [Rec07]. Since the calculation involves several stakeholders, the EMIS should be prepared to enable this inter-company calculation. In fact, different instances of the same product could have different footprints, depending on factors such as process efficiency of the logistics activities or duration of refrigeration. Calculating a dynamic footprint on the increasing granularity level of batches, pallets, cases, or even instances poses a challenge to the current enterprise information systems. We review in this paper the different levels of reporting granularity and aim at addressing the respective challenges.

In section 2 we briefly describe the enterprise tools that are available for emission calculation and reporting. In section 3 we show how companies plan to measure the carbon footprints of their products across their lifecycles and we summarize the implications on enterprise information systems. Section 4 aims at addressing the dynamic nature of emissions at a finer level of granularity, up to individual product instances. We illustrate how EPC Information Services (EPC IS) can be used to meet these requirements. We conclude in section 5 with an outlook on future work.

2 Enterprise Emissions

Enterprises quantify their impact on the environment by using several measures, one of which is the GHG emissions they directly or indirectly emit or cause. Commercial implementations of EMIS help companies to collect the required information, e.g. per company site, aggregate it and present it in different ways. The major driver behind such solutions is compliance with legislation and expected benefits from engaging in carbon trading markets [BAL95, GOA96]. Several standards exist that help companies in their carbon accounting activities, one of the most widely used is the Greenhouse Gas Protocol [RCB+04]. The available enterprise solutions are usually customizable to provide information as required by different standards, legislation, and emission trading schemes. In many cases, EMIS modules interface with other enterprise information systems to use relevant data already available, such as bills of materials, purchase orders, electricity bills, etc. [Ra99].

3 Product Carbon Footprints

The total enterprise emissions calculated as outlined in section 2 cannot be used to determine the carbon footprint of individual products since all company activities are lumped together in one performance indicator. Even if companies use their current EMIS to account for emissions associated with different products separately, they still don't know what emissions are caused by the product outside of the enterprise boundaries.. Several methodologies based on Life Cycle Assessment (LCA) [JHM+97] were proposed to guide companies in measuring product-specific carbon footprints. One of the most advanced methodologies has been recently proposed by Carbon Trust [Car08]. The organization suggests using a five-step approach to find the carbon footprints of products. First, the product lifecycle data should be analyzed, including the source of the product's ingredients or components, the production and logistics processes, and finally the usage and disposal phases. The process map is then built and the boundary conditions defined. The next step is to collect the required data and finally the GHG emissions are calculated and added up.

Recently, a few pilot projects started with the aim of measuring the product carbon footprint (PCF) of sample fast moving consumer goods (FMCG) using the Carbon Trust or other LCA-based methodologies. A prominent example is a pilot project in the UK where Carbon Trust is quantifying the PCF of sample products for Tesco [Car08b]. Another project is going on in Switzerland where climatop, a joint effort of myclimate and ökocentrum, is labeling the least carbon intensive products out of sample product groups at Migros [Cl08]. Finally, the Ökoinstitut in Germany is working with Thema1 and other partners to quantify the carbon footprints of sample products [Th08]. The goal of these projects is to get a better picture on the total GHG emissions caused by products across their lifecycle.

The pilot projects mentioned above focus on applying a suitable PCF methodology. In the future, adequate support from EMIS will be required, especially in the areas of cross-company information sharing and aggregation. For example, the Green 2.0 project [Gre08] is extending SAP's solutions to support inter-organizational PCF calculations. Such extensions will support the carbon footprint methodology and contribute to finding a single total emission number for a product. The total product emissions can be divided by the number of product instances produced to find the average emissions per instance, or per monetary unit to determine the average emissions per unit of revenue.

4 Dynamic Product Carbon Footprints

We outlined in the previous section how enterprises can quantify the average amount of emissions due to a particular product. This averaged-out number does not take the dynamic nature of the carbon footprint into consideration. Namely, when different suppliers have different footprints, or when there are temporal or spatial variances between different instances of a product, the use of average numbers results in inaccurate results [DSF08]. For example, fruits bought in different seasons of the year will require different periods of chilled storage, resulting in carbon footprints that vary over the year. Also, different instances of products may be shipped over longer distances or subject to production processes of varying efficiency, also resulting in different carbon footprints.

Providing increased granularity in the GHG calculation process, such as finding the footprints of individual batches, cases, or even items, could have two important effects:

1. Providing more visibility for enterprises into their processes, thus enabling them to understand and mitigate the cause of potential variations in their products' footprints.

2. Differentiating an enterprise from its competitors by providing the consumer with more information, and thus decision empowerment. The consumer could then purchase the less carbon-intensive variants of a product and by this exert his or her market power.

Both effects could act as incentives for companies to decrease their GHG emissions.

Calculating the carbon footprint information with an increased level of granularity poses some additional challenges on enterprise information systems. Namely, companies need to identify each unit whose emissions should be quantified and track those emissions across the lifecycle of the unit.

4.1 The EPC Network for identification and tracking

Several technologies are available that can identify products, logistic units, individual items, etc., and each technology uses one or more coding schemes. The Electronic Product Code (EPC) [EPC07] has been developed for the purpose of identifying heterogeneous types of units, e.g. products, cases, and pallets, in addition to uniquely identifying individual product instances. EPC Information Services (EPC IS) provide the services required for querying and capturing EPC event data about the tagged products and the repositories needed to store this data. EPC Discovery Services (EPC DS) locate the EPC IS instances that have information about a particular EPC. Together, the EPC IS and EPC DS, in addition to the readers and middleware underneath, constitute the EPC network infrastructure [EPC05]. We propose in the following using the EPC network for tracking environmental information, e.g. GHG emissions, on the identified units. The goal is to enable the dynamic calculation of GHG emissions on different levels of granularity, such as batch, pallet, case, and item.

4.2 The EPC Network for dynamic, fine granular emission tracking

In this section, we will give an example of how the EPC network can be used to track GHG emissions dynamically and in varying levels of granularity across the supply chain. Consider the exemplary supply chain shown in figure 1. .

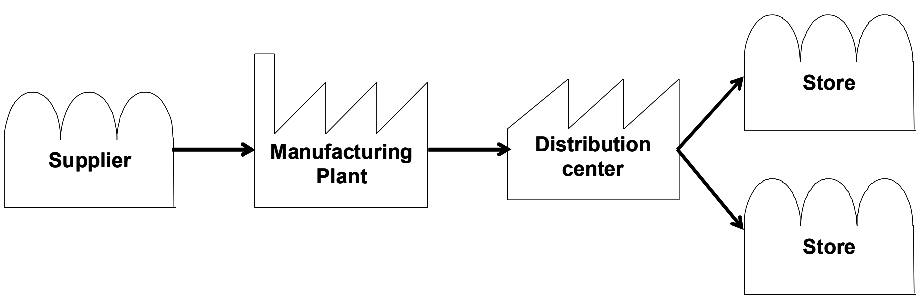

Figure 1: Sample Supply Chain

The manufacturer receives EPC-tagged components from its supplier; with the carbon footprints of the components already calculated using the supplier's EMIS and stored in the respective EPC IS. The manufacturer accounts for the GHG emissions of its internal production processes using its EMIS. In addition, the manufacturer publishes an EPC aggregation event, specifying the parent-child relationship between the produced item and its components. A user can query for the PCF of a particular item right after production using its EPC number, and the unique item is identified along with its components and the cumulative GHG emissions. Items with components from different suppliers will already have different PCF at this stage.

After producing the items, the manufacturer aggregates them into cases and aggregates the cases into pallets. These aggregations are stored as EPC events with the parent-child relationships accounted for. The manufacturer then ships the pallets to the distribution center and publishes an EPC event that includes the pallet EPC and the time of shipment.

An EPC event is generated when the items reach the distribution center. We assume that the relevant environmental information, such as the type of transportation used and its corresponding emissions, is integrated in the shipping notices. Using the time difference between the two EPC events (leaving the manufacturer and arriving at the distribution center), and given the emission factor of the transportation fuel used, we can calculate the emissions caused by the shipment of goods to the distribution center.

When the goods leave the distribution center we can similarly calculate the storage time. If the storage included chilling the goods, we can calculate the emissions caused over that period of time and attribute the corresponding amount of emissions to those goods.

Before leaving the distribution center, the goods get disaggregated into cases and those cases and shipped to different retailers. The cases may have differing footprints from this point because, for example, of the different transportation distances and the different cooling time. These different footprints can be accounted for separately because the cases are uniquely identified with EPC numbers.

With all the supply chain processes accounted for, and all aggregation and disaggregation events recorded, we can deduce the footprint on different levels of granularity, e.g. the whole shipment, a pallet, case, or an individual item.

5 Conclusion

We presented in this paper a spectrum of approaches for companies who wish to monitor and communicate their GHG emissions. We first reviewed the commonly practiced enterprise-wide reporting activities and supporting tools. We then described the current goal of several companies to quantify the emissions with respect to particular products across their lifecycle. Finally, we proposed how enterprises can go a step further to account for their GHG emissions on an increased level of granularity, such as that of cases or single instances. We gave a conceptual example involving the EPC network that could support such dynamic, fine granular information. We plan, as our next research step, to implement a prototype that demonstrates the dynamic calculation of carbon footprints across several supply chain partners. The implementation should be flexible enough to find the carbon footprints of different aggregation levels irrespective of the type of supply chain partners involved.

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