PRODUCT CARBON FOOTPRINTING: IMPROVING ENVIRONMENTAL PERFORMANCE AND MANUFACTURING EFFICIENCY

A tool for competing more effectively in a carbon-constrained economy

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Product carbon footprinting is based on life cycle assessment (LCA), which is a method of analysis that seeks to quantify the environmental and human-health impacts associated with products and services. LCAs have been used successfully to characterize a number of environmental and social impacts, examples of which include global warming, ecosystem health, and resource depletion.

THE LCA APPROACH

The boundaries of LCA evaluations can encompass a "cradle-to-grave" approach and broadly include the extraction and processing of raw materials, production, consumer-use, and end-of-life scenarios, which may include recycling of materials.

The outcome of an LCA can be used to identify significant impacts on the environment and human health and can inform actions to reduce these impacts. Data and intelligence gathered through this process can also be used to inform strategy and identify design considerations that reduce product cost while also yielding environmental benefits and providing the opportunity to enhance brand value.

PRODUCT CARBON FOOTPRINTING

The term "product carbon footprinting" refers to using LCA to focus specifically on the quantification of greenhouse gas emissions throughout the product's life cycle. The results of a product carbon footprint are usually presented as a total absolute value of life-cycle carbon dioxide-equivalent (CO_2e) emissions measured in kilograms or metric tonnes.

Many organizations have recognized that carbon footprinting provides the ability to evaluate the efficiency with which they produce goods and services using a different set of metrics. The process has enabled companies to improve the environmental performance of their business activities, reduce manufacturing and supply-chain costs, identify environmental risks in the supply chain, and position themselves to compete in a carbon-constrained economy.

BUSINESS DRIVERS FOR PRODUCT CARBON FOOTPRINTING

The results of a carbon footprint can inform important business decisions and should be used as one of several indicators of product environmental performance. The key to effectively using carbon footprinting as a business tool is balancing the complexities of such an analysis with meaningful results that can be applied in a commercial context.

Even though there are no current regulatory requirements in the United States, there has recently been a dramatic increase in the number of companies that are examining the greenhouse gas (GHG) emissions associated with the supply chain of their products and services. Carbon labeling of products is being actively explored in the United Kingdom and may be pursued in the US in the future.

The majority of companies that have reported GHG emissions are only accounting for their organization's impact in an entity-wide GHG emissions inventory. As this article discusses, however, carbon footprinting that focuses on a specific product can offer significant value to business organizations.

In the authors' experience, companies are beginning to use the results of product carbon footprinting to reduce costs associated with manufacturing, energy use, waste, and packaging; to inform design using a life-cycle approach (Design for Environment); to manage their supply chain to drive greater environmental improvements; and to quantify the business value of their sustainability initiatives. These initiatives may yield immediate returns on investment.

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Additionally, companies are publishing the results of carbon footprinting externally for a number of reasons, including:

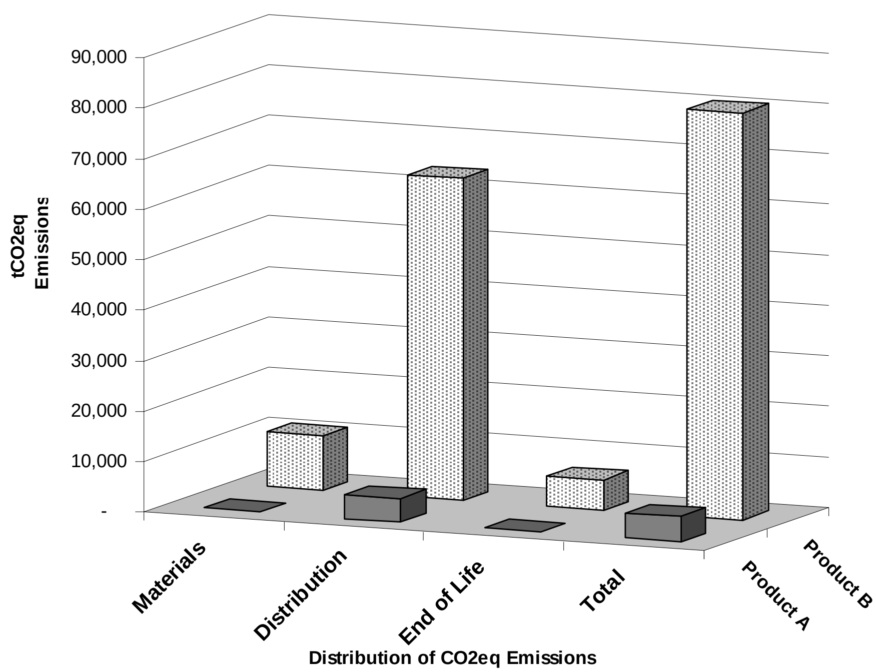
- improving transparency in their environmental reporting,
- managing risks associated with climate change,
- targeting specific market audiences and enhancing brand reputation,
- increasing market share and securing preferential product placement, and
- bolstering investor confidence by demonstrating the relationship between effective environmental management and long-term financial returns.

An example of how the results of product carbon footprinting can be graphically represented is shown below. Graphics can readily display comparisons of the carbon impacts of multiple products throughout their life cycle. Organizations can use the underlying data to identify and evaluate areas of most significant impact and find opportunities to improve efficiency in materials, manufacturing, supply chain, distribution, and end-of-life.

Proactive companies seeking better product performance have chosen product carbon footprinting to address a number of business drivers, which are described in the following sections.

Business-to-Business (B2B) Product Manufacturers

Environmental performance within the supply chain of B2B products is becoming more heavily scrutinized and measured. The Carbon Disclosure Project (CDP) Supply Chain Questionnaire was one of the first public reporting mechanisms that asked companies to look deeper into the climate impacts of products and services by reporting Scope 3 (indirect) emissions. The public disclosure of this information has led to greater transparency and traceability of climate and energy performance within supply chains.



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In July 2009, Wal-Mart announced plans to develop a worldwide sustainable product index,[i] causing a stir among its suppliers. Using a collaborative, research-driven approach, this initiative will systematically collect and convey information to the company's network of suppliers and to consumers. Wal-Mart expects the initiative to lead to higher-quality, lower-cost products. Although the manner in which the information will be delivered to consumers is still undetermined, Wal-Mart has suggested that it could take the form of a numeric score, color code, or some other type of label.

The responsibility for, and costs associated with, this initiative will be borne by Wal-Mart's partners, who must work with suppliers to quantify the environmental attributes of each product. The potential advantage for suppliers that produce environmentally preferable products is greater market share and better brand recognition.

Consumer Product (B2C) Manufacturers

Carbon labeling aims to provide consumers with simplified and comparable information that will allow them to make more informed decisions. Carbon labeling initiatives are currently being piloted in the UK by the retailers Tesco and Alliance Boots. In addition, two organizations (the UK Carbon Trust[ii] and the Carbon Fund[iii]) are facilitating the development of carbon labels in hopes of providing consumers with an easy-to-read symbol that distills the results of a complex analysis.

Carbon labels are intended to be simple and easy to recognize, providing consumers with an absolute number that measures total life-cycle GHG emissions. But the labeling process itself can involve significant complexity. An "apples-to-apples" comparison among similar products is only possible if the assumptions and context of each product's carbon footprint are equivalent -- which means that the same method of assessment and the same data assumptions must be applied equally to every product carbon footprint. Problems with data quality and availability often pose barriers to achieving this standardized approach.

Despite the challenges, a number of first movers have successfully performed product carbon footprinting and earned carbon labels. These organizations hope to send a market signal that identifies their products as "green" and enhances the value of their brand to specific market segments. A well-known example is Timberland's effort to create their own labels. This company's label identifies the origin of the product's raw materials, its social impact, and environmental performance.

Anticipating Regulation

While there currently are no regulations requiring product carbon footprinting, trends in existing and proposed regulations indicate a move towards mandating greater transparency about the resources, energy use, and material waste involved in bringing products to market.

The European Union has begun to consider the energy efficiency of products under its Energy Using Products (EuP) directive. In the United States, California legislators have proposed a Carbon Labeling Act (AB 2538)[iv] that would create a standardized labeling program for the total greenhouse gases emitted in the harvesting, manufacture, distribution, and selling of consumer products sold in California.

TECHNICAL ASSESSMENT PARAMETERS

Standards

Currently existing standards provide a framework for consistent application and verification of LCA. ISO 14044 provides requirements and guidelines for life cycle assessment, while the British Standards Institute Publicly Available Specification 2050 (BSI PAS 2050) provides more specific definitions for the methods of data collection and emission factors to be used in measuring the life-cycle greenhouse gas emissions of goods and services.

In addition, the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) are currently in the process of developing standards for application in product carbon footprinting, akin to the WRI/WBCSD GHG Protocols.

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Objectives

The process of carbon footprinting can involve a significant investment of time and resources. It is important that a business define its objectives and expected use of the results prior to commissioning a study because the level of detail and the scope of the study will be defined by the intended use. Carbon footprints can differ considerably from product to product, but comparative analyses must apply the same assumptions and project boundaries.

Data

Following the scoping and boundary-setting process, the company will collect primary data applicable to the study. Primary data quantify those activities that are within a company's operational control. Generally speaking, this would cover operational data that the company has access to. In many cases, the company will also need to collect secondary data (such as national or industry average metrics) in order to characterize the upstream and downstream processes for which primary data are not practically obtainable.

A high-level carbon footprint, which relies on secondary data and educated assumptions, may be most appropriate for companies that are taking a staged approach. Often, such companies are developing enough information to decide whether a more detailed carbon footprint is justified.

A detailed carbon footprint would begin with a life cycle inventory (LCI), which looks at all the inputs, outputs, and by-products of a manufacturing process. LCIs are often conducted by academic institutions or niche consultants who specialize in product engineering and supply-chain processes. Much of the information gathered in this first stage is publicly available or can be purchased as a data-set. Software that incorporates these data-sets is available to facilitate the analysis, providing consistent analytical methods and, thus, an informative impact assessment.

The use of primary data specific to a product's manufacturing and distribution process (including a product bill of materials, energy consumption, and distribution logistics) is key to providing meaningful results that can inform business decisions. However, collecting primary data within a company's supply chain almost always presents unexpected challenges. Information is not always readily available, and it often must be compared across business units and integrated in a manner that unit managers are unfamiliar with.

CASE STUDIES

Company Focus: Food and Beverage Sector

Diageo, the world's largest alcoholic drinks company and a key business in the Scottish whisky industry, contributes to over 20 percent of Scotland's food and drink exports. The company worked with consultants from WSP Environment & Energy LLC to develop a methodology and evaluate the carbon footprint of its manufacturing operations across 50 sites in Scotland, including 27 malt distilleries. The work included calculating specific carbon footprints and creating a customized model for assessing the comparative impact of alternate scenarios based on changes in operations or in differing transportation modes to the final customer.

The scope of the carbon footprint was from "farm to factory." To begin, Diageo gathered and analyzed a large set of internal and external data in order to calculate the embedded energy and resulting GHG emissions from its products' supply chain. Energy consumption was measured at every stage of the production process, including the growing and malting of the barley and other raw materials, distilling, packaging, and end-product transportation. The loss of alcohol during the maturation phase (known in the industry as "Angels' Share") and the emissions impact of fermentation were also calculated in the analysis. Finally, Diageo calculated emissions arising from the transport of each raw material, including the transport of packaging materials such as glass, cardboard, plastic film, labels, and caps, as well as the impacts of transporting finished goods to distributors and suppliers.

Using the model that has been developed, Diageo can now identify the climate impact at each stage of the supply chain and distribution process. The model can evaluate whether changes made to the manufacturing process have a positive or negative impact on the carbon footprint. The model also can be updated as production patterns change and logistics modifications are made.

Coupled with financial information, this tool has helped Diageo assess the carbon intensity of its products and compare it against the financial costs of potential GHG emission mitigation strategies. Diageo used the information provided by the product carbon footprint to:

- design a carbon-reduction strategy to mitigate the organization's overall emissions, and
- inform its suppliers of actions they can take to meet Diageo's 2015 goals for carbon reduction throughout its global supply chain.

Industry Focus: Biofuels Sector

Regulation will soon begin to serve as a strong market-driver for producers of biofuels to quantify and lower their fuel products' global warming intensity (GWI). In the United States, companies that produce biofuels (such as corn ethanol and soy biodiesel), as well as companies that import biofuels produced abroad and blend them in the US, will soon need to show that their products achieve specific targets for life-cycle reductions in GHG emissions compared with the fossil fuels they displace.

The Energy Policy Act of 2005 created the first Renewable Fuels Standard (RFS) and provided a tax credit for all biofuels produced or blended in the US, regardless of GWI. The regulation aims to put a specific volume of biofuels in the US liquid fuels market via an increased level of incentives for biofuel producers.

The Energy Independence and Security Act of 2007, which provided additional incentives within the Renewable Fuels Standard, may offer a larger tax credit for fuels with a lower GWI. Starting in 2010, biofuel producers who use alternative and cellulosic feedstocks and produce fuels with a reduced GWI can earn a greater volume of Renewable Identification Numbers (RINs)[v] for their product, thus earning a larger tax credit. The RFS specifies that "cellulosic" biofuels must reduce GWI by 60 percent, "alternative" biofuels by 50 percent and "conventional" biofuels by 20 percent, relative to petroleum-based fuels, if they are to be awarded RINs.[vi]

The US Environmental Protection Agency has issued guidelines that delineate the emission factors used in determining the GWI of various types of biofuels. These emission factors take a holistic life-cycle approach by including global indirect land use change (ILUC) emission impacts resulting from the RFS-driven increase in grain consumption. However, for some biofuels, incorporating an ILUC emission factor into a carbon footprint is a very contentious issue. Some estimates for the ILUC effect indicate that conventional corn ethanol may have a higher GWI than gasoline. Many have argued that ILUC models are not sophisticated enough to accurately determine the effect using available data inputs. In response to these concerns, EPA has given the National Science Foundation five years to develop the underlying science and create more rigorous models for estimating ILUC effects.

Another regulatory driver for the biofuels sector is the Low Carbon Fuel Standard (LCFS) adopted by the California Environmental Protection Agency. Similar programs are under consideration nationally and regionally. The California LCFS regulates fuel distributors in the state using a cap in much the same way that the federal Corporate Average Fuel Economy (CAFE) standards attempt to regulate fuel economy by auto manufacturers. For a given company operating in California, the annual energy-weighted average GWI of all fuels sold must be low enough to meet the state reduction target, which is 10 percent for the first year. California EPA will raise the reduction target in subsequent years, thus driving increased demand for low-carbon fuels.

Because the GWI of petroleum-derived fuels is largely fixed in the fuels' fossil carbon content, a substantial reduction in the GWI of petroleum-based fuels is not feasible. This means that the targets of the LCFS program will be met primarily by producers of biofuels and other alternative fuels (such as hydrogen and electricity for electric-powered vehicles). The program creates an incentive -- and an opportunity -- for biofuel producers because the lower GWI of their fuel products will translate into higher market value as fuel distributors seek sources to meet their corporate targets.

For biofuel producers, product carbon footprinting offers a quantitative tool that can help their businesses adapt to new regulations by measuring the life-cycle climate impact of their products. Industry experts, such as William Roddy, the Environmental Affairs Director at ICM, Inc.,[vii] have noted an increased interest among ethanol producers in having the GWI of their fuel analyzed.

The Challenges of Product Carbon Footprinting

Companies that utilize product carbon footprinting to assess product performance can face a number of challenges. In order for carbon footprinting to be fully leveraged as a tool for continual improvement, the organization must make an investment of both time and financial resources to establish the appropriate methods of assessment, clearly define the scope and boundaries of a system, identify and gather the required data, and institutionalize the process for evaluating existing and new products.

The process of data gathering often reveals the need for more consistent and integrated information management across the company's business units and geographical locations. Depending on the organization's needs and the anticipated goals of the assessment, some companies may choose to purchase their own software tools and train employees to perform LCAs, while others might work with consultants who specialize in these analyses. Another set of challenges can arise when organizations use the results of carbon footprinting to make comparative assertions about the environmental attributes of products. Comparing the results of different carbon footprint studies should only be done if the purposes, assumptions, and functional units involved in the studies are equivalent -- i.e., only if the comparison is "apples-to-apples." Aligning data sources, particularly if product or manufacturing processes are proprietary, can prove difficult.

Finally, the results of similar studies may involve a margin of error greater than the difference between competing products. This type of variation can seriously limit the use of product carbon footprinting for marketing purposes. It can also create the potential for misunderstandings when interpreting results, potentially leading to claims of "greenwashing." It should be kept in mind, however, that order-of-magnitude differences do often exist between consumer options and these differences may not necessarily be intuitive. In such cases, product carbon footprinting can provide very useful results.

Despite the challenges involved, once the initial databases and models are established and the appropriate employees are trained, carbon footprinting can provide a quick, quantifiable, and effective framework for understanding the overall climate impacts and embedded energy associated with a variety of products and services. Alternative scenarios can be assessed to help inform more effective methods of manufacturing and distribution, often resulting in cost savings.

Software tools that facilitate Design for Environment and assessment of product carbon footprints, and which can be integrated with company product lifecycle management (PLM) systems offer the opportunity to integrate product carbon footprinting with the product design process and day-to-day business operations.

CONCLUSION

Product carbon footprinting is a useful tool for understanding the climate impacts of bringing products and services to market. The insight it can offer into a product's supply chain and its efficiency of production can be used to improve product environmental performance and identify cost savings, often yielding a significant return on investment. Provided with this level of insight, companies can align their business practices to minimize risk and maximize competitive advantage, especially in sectors where life-cycle climate impacts are used for product differentiation.

Companies can also use the results of product carbon footprinting to provide consumers with information that helps them make informed decisions. In particular, the use of product carbon labels is expected to increase as a means of communicating life-cycle GHG emission impacts to consumers and others who purchase and use goods and services.

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ABOUT WSP ENVIRONMENT & ENERGY LLC

WSP Environment & Energy LLC is a multidisciplinary environmental, sustainability, and energy consultancy headquartered in London with over 1,100 employees located in North America, Europe, Asia, South Africa, and Australia.

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NOTES

[i] See http://walmartstores.com/Sustainability/9292.aspx

[ii] See http://www.carbon-label.com/business/forbusinesses.htm

[iii] See http://www.carbonfund.org/site/pages/businesses/category/Carbon_footprint

[iv] See http://info.sen.ca.gov/pub/07-08/bill/asm/ab_2501-2550/ab_2538_bill_20080222_introduced.html

[v] A Renewable Identification Number is a 12-digit number assigned to a producer for each gallon of renewable fuel produced. These numbers are transferred to fuel distributors, who can redeem them with the Internal Revenue Service for tax credits.

[vi] Generally, "cellulosic biofuel" refers to fuels derived from agricultural wastes and non-food energy crops; "alternative biofuel" refers to fuels derived from non-corn grains such as sorghum, and includes sugarcane ethanol; "conventional" refers only to corn ethanol and soy biodiesel.

[vii] ICM, Inc. is one of the largest suppliers of process technology to the corn ethanol industry in the US.