



Reducing greenhouse gas emissions through operations and supply chain management

Erica L. Plambeck

Stanford Graduate School of Business, Knight Way, Stanford, CA 94305, USA

ARTICLE INFO

Article history:

Received 22 January 2012

Received in revised form 19 July 2012

Accepted 30 August 2012

Available online 5 October 2012

Keywords:

Supply chain

Manufacturing

Operations management

Climate change

ABSTRACT

The experiences of the largest corporation in the world and those of a start-up company show how companies can profitably reduce greenhouse gas emissions in their supply chains. The operations management literature suggests additional opportunities to profitably reduce emissions in existing supply chains, and provides guidance for expanding the capacity of new “zero emission” supply chains. The potential for companies to profitably reduce emissions is substantial but (without effective climate policy) likely insufficient to avert dangerous climate change.

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1. Introduction

In December 2011, at the climate change negotiations in Durban, South Africa, representatives of 190 countries agreed upon the need to limit the increase in global average temperature to 1.5 or 2 °C above pre-industrial levels, to avert dangerous climate change. Global anthropogenic greenhouse gas emissions must fall by at least 50% below 1990 levels before 2050 to have even a 50% probability of holding the global temperature increase to 2 °C. Cutting emissions sooner rather than later will reduce temperature and associated climate change impacts (Meinshausen et al., 2009). However, emissions of the primary greenhouse gas CO₂ from fossil fuels are now over 50% higher than 1990 levels (the reference year for the Kyoto Protocol) and growing rapidly, particularly in the emerging economies of China and India (Peters et al., 2012). The production and transportation of goods causes approximately 45% of those emissions, and the energy consumed when people use those goods accounts for much of the remainder; energy use in buildings alone accounts for approximately 25% (IPCC, 2007).

Therefore, to avert dangerous climate change will require tremendous changes in the design and operation of *supply chains*, defined here as encompassing the multi-stage production, transportation, use, and eventual disposal of goods, and the energy generation and transmission that supports all of those activities. This article sheds light on how companies can profitably reduce greenhouse gas emissions in their supply chains. Section 2 below describes how the world's largest corporation and a start-up in the building industry have already profited from doing so. Those examples suggest that

the potential for profitable emissions reduction is substantial but (without effective climate policy) likely insufficient to avert dangerous climate change. Section 3 reviews academic literature on operations and supply chain management that provides further insights into ways to reduce emissions, and begins to quantify the potential impacts of climate change on supply chain performance.

2. Profitable reductions in greenhouse gas emissions: company experiences

Companies seeking to reduce their greenhouse gas emissions often find that their direct emissions are dwarfed by the emissions in their supply chains. In fact, Matthews et al. (2008) found that across all industries, companies' direct emissions average only 14% of their supply chain emissions prior to use and disposal; accounting for the emissions in use and disposal of goods would make that percentage even lower.

Therefore, companies must take a global supply chain perspective in order to identify the most profitable means to reduce overall “Scope 3” emissions.¹ They must find ways not only to reduce emissions under their direct control but also to influence emissions caused

¹ Under the Greenhouse Gas Protocol, “direct” emissions are emissions from sources that are owned or controlled by the reporting entity. “Indirect” GHG emissions are emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity. Emissions are categorized into Scope 1 (direct emissions), Scope 2 (indirect emissions from consumption of purchased electricity, heat or steam), and Scope 3 (all other indirect emissions). Guidelines for accounting for Scope 3 emissions are at <http://www.ghgprotocol.org/standards/scope-3-standard>; though extensive, these guidelines allow flexibility that may lead to widely varying estimates of Scope 3 emissions, and they may be improved over time, as discussed in Section 3.5 below.

by their suppliers and customers—by providing them information and incentives, and collaborating or even vertically integrating with them. The experience of two companies suggests how these steps can be taken. For contrast, we consider a well-established corporation (the largest in the world, as measured by revenue) and a start-up.

2.1. Walmart: increasing profits by reducing GHG emissions

Walmart is the largest corporation in the world in terms of revenues, and is widely recognized as a leader in supply chain management. In the last several years it has embraced its responsibility to protect the environment and has sought to reduce emissions in ways that improve its bottom line. In 2005, CEO Lee Scott announced that “Being a good steward of the environment and being profitable are not mutually exclusive. They are one and the same.” He set sweeping environmental goals for the company: “to be supplied 100% by renewable energy; to create zero waste; and to sell products that sustain people and the environment.” Since roughly 90% of Walmart’s greenhouse gas emissions and other environmental impacts occur in its extended supply chain, the firm must work with suppliers and customers to achieve these goals.

In a case study I wrote in 2007 and updated in 2010 (Plambeck and Denend, 2007a, 2007b), I found that Walmart is profiting from its actions to reduce greenhouse gas emissions in its own operations and its supply chain. Emission reduction is associated with cost reduction, new sources of revenue, improved employee motivation, enhanced public relations, and increased voice with policy makers. The summary below of how Walmart has tapped each of these five sources of value provides a template for other companies seeking to do the same.

2.1.1. Reducing costs

Cost reduction through energy efficiency is the most obvious source of business value associated with emissions reduction. Anderson and Newell (2004) have documented that small and medium-sized firms in the U.S. commonly overlook energy-efficiency projects that have a high net present value. Walmart, though famous for the efficiency of its operations, found “quick wins” in profitable energy efficiency as soon as it looked. In just the first year of its sustainability program, for example, Walmart improved the average fuel efficiency in its logistics network by 25%, which translates into annual savings of \$75 million and 400,000 tons of CO₂, with relatively little investment.

Nonprofit environmental organizations, including the Rocky Mountain Institute, contributed substantially to Walmart’s success in reducing emissions and costs in its logistics network, by identifying energy-efficient technologies and ambitious-but-achievable goals for emission reduction. Walmart is also relying on various other nonprofit organizations to help its suppliers identify and implement energy efficiency projects (see Sectio2.1.8.8), which will ultimately reduce Walmart’s cost of goods.

Not surprisingly, cost reduction is a primary reason for seeking to measure and reduce supply chain emissions, for many of 57 multinational corporations (as various as Dell, Ford, EADS, and Vivendi) participating in the Carbon Disclosure Project (CDP) Supply Chain Program (Carbon Disclosure Project, 2011).

2.1.2. Increasing revenues

Walmart’s efforts to reduce emissions have opened up many sources of new revenue. For example, improved public relations stemming from its environmental stewardship initiatives may help the company to add stores in communities where they would otherwise face greater resistance, and may also help the company to attract more customers to its existing stores (see 2.1.3).

Consumers are more inclined to pay a premium for “green” products when “green” is associated with some private benefit. Walmart charges a higher price per unit for organic cotton clothing, for

example. The company was surprised to see, in point-of-sale data, that customers who historically would shop only for toiletries began to “cross the aisle” to buy organic cotton clothing and other organic products. Many consumers perceive a health benefit with organic apparel and food. Walmart also informs customers of electricity-cost savings with some energy-efficient products.

Greenhouse gas emissions may decrease substantially as Walmart sells organic instead of conventional products. The first reason is that organic farmers do not use synthetic nitrogen fertilizer, which tends to reduce emissions of nitrous oxide, a potent greenhouse gas, as well as CO₂; fertilizer manufacturing consumes a huge amount of natural gas. The second reason is that nonprofit organizations monitor and certify each stage in the supply chain for an organic product. That gives Walmart (and other buyers) unprecedented visibility of the entire supply chain, which enables rationalization of the supply chain to reduce emissions and production costs (see Section 2.1.6). Walmart is pursuing local sourcing of organic produce, and transports local produce in the same trucks used for other goods, to avoid adding trips (Ata et al., 2012). However, out-of-season produce must be transported over long distances or grown in energy-intensive hot-houses (Rosenthal, 2011), which tends to increase emissions.

Walmart can earn higher revenue by selling products that are more energy-efficient, even without charging a higher price for energy-efficient products. Many of its customers have little disposable income and shop almost exclusively at Walmart. When they save money on their electricity bills, they spend that money at Walmart. The potential for emissions reduction with energy-efficient products is huge. For example, in its first year of promoting compact fluorescent (CFL) lights, Walmart achieved sales of over 100 million bulbs, which would reduce customers’ electricity use and hence CO₂ emissions by 20 million metric tons, approximately equal to Walmart’s total corporate emissions (Scope 1 and Scope 2) in 2010. (That figure presumably does not account for any increase in emissions when customers used money saved on electricity bills for additional consumption.) A second example arises in apparel, the product category wherein Walmart has the highest associated supply chain greenhouse gas emissions. Approximately half of those emissions occur in the customer use phase—i.e., washing and drying. The company is working with suppliers to change labeling on clothes to “cold water wash” instead of “hot water wash,” which will substantially reduce electricity use. The company also gives prominent shelf space to detergents that are designed for cold-water washing and are triple-concentrated, which reduces cost and emissions in transport.

Even in product categories where Walmart cannot charge a premium for “green,” it may gain market share by labeling products with environmental impact information. Laboratory experiments suggest that when a firm voluntarily reveals the environmental impacts associated with its product—even when those emissions are very high—it gains market share and the trust of consumers (Kalkanci et al., 2012). Indeed, of 57 prominent firms participating in the CDP’s supply chain program, 73% cite brand improvement and 60% cite product differentiation as objectives for their climate strategy (Carbon Disclosure Project, 2011). Walmart took a leadership role in launching the Sustainability Consortium to develop industry standards for labeling consumer products with environmental impact information (including greenhouse gas emissions). Especially for Walmart’s privately branded products, an eco-label indicating that a product performs as well or better than alternatives with prominent brands could boost sales. However, developing appropriate metrics and labels for the environmental impacts of consumer products and gathering the requisite data is difficult and contentious and will take time. Labels may eventually be used in only a limited number of product categories.

Conceivably, in future, Walmart or its suppliers or customers might be allowed to sell offset credits for emissions reductions that are measurable and additional (not profitable without the offset

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