

**Transport Mode and Network Architecture:
Carbon Footprint as a New Decision Metric**

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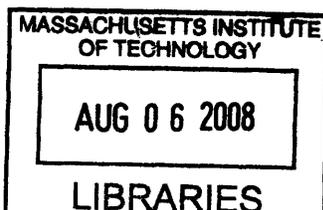
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Abstract

This thesis examines the tradeoffs between carbon footprint, cost, time and risk across three case studies of United States' perishable or consumer packaged goods firms and their transportation partners. Building upon previous research, and utilizing an Institute of Management and Administration (IOMA) and MIT Center for Transportation and Logistics (CTL) survey of supply chain professionals, the goal of this thesis is to better understand the decision process and motivations of our case study companies with regard to carbon footprint and implications for transport mode and network architecture, and the tradeoffs involved in making these decisions. We examine: (1) An expedited refrigerated rail service providing coast-to-coast shipment of produce for a major retailer, in lieu of its prior trucking arrangement; (2) A dairy producer which with the help of its trucking partner switched from less-than-truckload (LTL) to full truckload (FTL) and currently explore the possibility to re-organize its distribution network; and (3) A bottled water firm which created an additional container shipping route to reduce the volume of water it ships via truck. Comparisons and contrasts are made between case study firms. Findings from these case studies are used to make forward-looking recommendations for companies interested in altering transport mode and/or network architecture as a means of reducing the carbon footprint of their operations.

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1 Introduction

Carbon and equivalent gases including carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, HFCs and PFCs are believed to be the most damaging to the environment.¹ The total amount of these gasses used directly or indirectly by an entity sum to a firm's carbon footprint. This research effort will explore cost, time and risks involved with altering a supply chain with climate change as a main driver for redesign. These factors are examined in comparison with the carbon footprint of supply chains to better understand the decision process corporations make in shaping their environmental policies. Our research focuses primarily upon the United States' perishable consumer goods industry, and examines companies across the supply chain, including transportation, perishable and nonperishable consumer goods firms and retailers. After providing some information on the context of our research and motivation, we present the problem in-hand and introduce key terms in the latter terminology section.

1.1 Context and Motivation

According to the U.S. Environmental Protection Agency, in a typical year, ground freight (trucks and railroads combined) account for approximately 40% of nitrogen oxides, 31% of particulate matter, and 20% of carbon dioxide emissions from all transportation sources. Based on current trends, by 2012, ground freight transportation will consume over 45 billion gallons of diesel fuel and produce over 450 million metric tons of carbon dioxide.

¹ From the United Nations Framework Convention on Climate Change (UNFCCC) (1992).

However over the course of our research we observed dramatic changes in behavior. A logistics consulting company we interviewed had been asked about carbon footprint only once in six years; they have been asked six times alone in March and April of 2008. We have observed marketing campaigns and corporate websites dedicated to “green” issues, especially, reducing carbon footprint.

The foundation of carbon reduction efforts is the Kyoto Protocol, an amendment to the United Nations Framework Convention on Climate Change. It was ratified by 137 nations (excluding the United States) in 1997. Thirty-six developed nations and the European Union as a separate entity ratified the Protocol and made pledges to reduce greenhouse gases according to guidelines set forth at the meeting. The objective is to achieve “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.”²

1.2 Problem Statement

Using a survey of 100+ supply chain industry professionals and three case studies based on three different Consumer Packaged Goods (CPG) and perishable goods companies and their transportation partners, we seek to provide further insight into the following questions: Why are companies engaging in initiatives to reduce their carbon footprints? Are cost savings, positive press and marketing opportunities, preparation for future policy changes or some other factor the prime motivation in their decision-making? How much carbon reduction can be achieved by altering the distribution network and/or switch for different transport mode? What are the tradeoffs in the supply chain for these companies

² From UNFCCC, Article 2. http://unfccc.int/essential_background/convention/background/items/1353.php

in terms of costs, time-to-market, risks, and carbon footprint? How can other companies implement these changes of transport mode and network architecture?

1.3 Terminology

Greenhouse Gases—Gases present in the earth’s atmosphere, which reduce the loss of heat into space and contribute to global temperature increase via the greenhouse effect. According to the Kyoto Protocol, the following are considered greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).

Carbon Footprint—Greenhouse gas emissions that result from production, consumption, or other human activities accumulated over the lifecycle of a product or service.

Carbon Neutral—The carbon out of a firm, operation, or activity where there the net release of greenhouse gas emissions into the atmosphere is zero. This can be attained through energy reduction, carbon offsets, or some combination of the two.

Offset—Reduction of greenhouse gas emissions from a baseline over a restricted period of time. Carbon offsets can be made via an energy reduction, sequestration, new technology initiatives, carbon trading, and reforestation efforts. Considerations when accounting for carbon offsets include³:

- (1) Baseline and measurement—How will measurements be compiled for, and after completion of a project?)

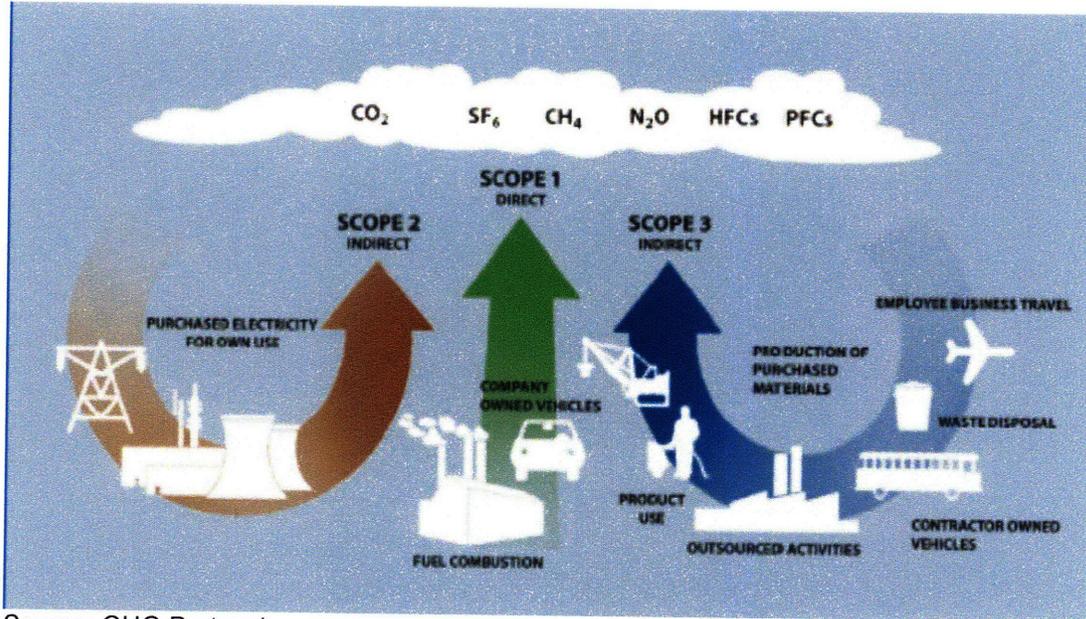
³ From http://en.wikipedia.org/wiki/Carbon_offset

- (2) **Additionality**—Does the offset have intrinsic financial value due to energy cost savings? Was it performed because of necessary adherence to environmental laws or regulations?
- (3) **Permanence**—Are any benefits of the offset reversible?
- (4) **Leakage**—Will implementation of the project lead to higher emissions outside the project boundary?

Scope 1/2/3 (GHG Protocol)—‘Scopes’ as defined in the GHG Protocol, WRI-WBCSD (2003).⁴

- **Scope 1** covers direct emissions from sources within the boundary of an organization such as fuel combustion and manufacturing processes.
- **Scope 2** covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organization. Scope 2 emissions result from the combustion of fuel to generate the electricity, steam or heat and do not include emissions associated with the production of fuel.
- **Scope 3** includes all other indirect emissions that are a consequence of an organization’s activities but are not from sources owned or controlled by the organization. Whilst being optional Scope 3 offers the greatest transparency in its inventory and creates a larger scope of potential influence.

⁴ From: http://www.carbonbalanceconsulting.com.au/?q=audits_methods/



Source: GHG Protocol

Figure 1. Definition of Scope 1, 2, and 3 emissions defined by the GHG Protocol

1.4 Research Approach

Our research is comprised of case studies of companies with increasing influence in Corporate Social Responsibility and Sustainability. We analyzed the impact of distribution center locations and transport mode selection on cost, carbon footprint, risk, and time to market by combining qualitative information with quantitative data. We surveyed companies to assess corporate involvement prior to green supply chain initiatives. This was conducted in order to prepare us to approach companies willing to participate to our case studies.

This section recaps the steps followed to carry out our work. After describing the preliminary survey, we explain the rationale for the selection of the companies we analyzed and the process followed for gathering data, evaluating and analyzing the data, and deriving conclusions.

Survey

At the initiative of the MIT Center for Transportation and Logistics (CTL) and in collaboration with Mr. Ken Cotrill from The Institute of Management and Administration (IOMA), and the Council of Supply Chain Management Professionals (CSCMP), a survey was issued to several hundred supply chain professionals with the objective of understanding organizations policies and attitudes towards environmental efforts. Invited to participate in the preparation of this survey prior to its launch at the end of December 2007, we were given the opportunity to add additional questions specific to our research. The objective was to have 100+ responses and use these to analyze company attitudes

and policies with regard to “green” supply chains: “What, if any, initiatives were enacted to change policy? What were the drivers of these changes?” The answers collected helped us define the set of questions prepared for the interviews conducted in the context of the case studies.

Selection of Cases

In choosing cases studies, we looked for companies that were already receiving publicity for altering their supply chains in order to decrease carbon footprint. Given the recent emergence of interest in carbon efficient supply chains, it is our intention that this thesis examines the tradeoff costs involved in redesigning a supply chain with carbon footprint as a decision factor, and understand how these tradeoffs and decision processes can be used to advise other companies as they attempt to alter their transport modes and network architecture, whether to enhance reputation, prepare for future legislation, or for another reason. We decided to keep our focus solely on the United States, as transport modes have different carbon footprints in different global regions. This allowed us to make better comparisons within and between case studies.

We initially learned of companies applying best practices through articles published in general and trade publications and newspapers. Firms’ promotional efforts, including advertisements and websites allowed us to hone in on innovation companies to study. In addition we systematically approached firms cited by interviewees when used as benchmarks for exploring new alternatives to reduce the carbon footprint of their supply chain.

We decided to focus primarily on consumer packaged goods (CPG) and perishable products, but extended the scope of our research based upon available information and applicability of case studies to CPG and perishable goods. We also decided to form our case studies around paired companies: a transportation provider and a CPG or general retailer. From a supply-chain analysis perspective, we felt it was more useful to understand the dynamic of two companies working together to bring a good to market, or implement initiatives, as this afforded us access to a lengthier section of the supply chain: from production to store placement. Additionally, have the perspectives of two firms per case study allow us greater insight into both sides of the paradigm and a more comprehensive view of the process involved in redesigning a product supply chain with the objective of reducing carbon footprint. The objective was to build our work around three in-depth studies and gather additional information from 3 to 4 companies to complement our analysis.

Data Gathering

The data we chose to collect was qualitative, but whenever possible we accompanied this with quantitative data. We began gathering data by accessing publicly available information, including published papers, websites of corporations, NGOs and non-profit firms, and then supplemented this by contacting firms and scheduling interviews. In preparation for interviews we formulated nine “key questions” (refer to Appendix 0). These questions had several sub-questions associated within each of them, and allowed us to have consistency between case studies. Additionally, we prepared a list of

questions specific to each of the firms we were interacting with. However, we purposefully kept interviews open-ended in order to allow discussions to evolve organically and better perceive the human factor associated with the potential paradigm change. When collecting data, we visited sights and facilities and interviewed key employees or project leaders for each of the initiatives. Much of our interviewing was followed up via phone conversation and email.

Evaluate and Analyze Data

For quantitative analysis of data we built simple models with the data at hand (i.e. location of DCs, vehicle performance with regards to CO₂ emission), with a goal of evaluating and confirming the real cost and CO₂ emission benefits of the measures implemented. Regarding our qualitative findings, our objective was to compile a list of advantages brought by the new solution as well as a list of the challenges and obstacles encountered when deciding to implement the change, with a special emphasis on the impact on risks and time to market. Our intention was to better understand the decision process companies go through when deciding which measurement standards to use, whom to partner with, and other related factors associated with attempting to reduce carbon footprint through a supply-chain redesign.

Deriving Conclusions

When analyzing this data, we compared and contrasted findings between case studies. The objective of these analyses was to derive techniques to measure the tradeoffs of cost, carbon output, time and risk that have applicability in larger contexts, ultimately helping

the decision-making process for companies considering redesigning network architecture or transport mode.

2 Literature Review

This section provides an overview of the literature of pertinence to our research. First we present the methodology used and cases analyzed by other academics and then introduce the methodology we propose to use to conduct our research. This section also introduces the emission figures that we use as reference for our analysis and explains the rationale for working with pairs of partner companies when carrying out case studies.

2.1 Context

Before explaining the methodology we have shaped from published work on closely related research, we wish to first draw attention to the context of our study, starting from the broad perspective of the economics of climate change covered by Stern (2006) and then narrowing down to the framework for the analysis of carbon supply-chain proposed by Gremouti (2007). With reference to Gremouti (2007), we also indicate the rationale for organizations to adopt a holistic perspective when analyzing the carbon efficiency of supply chain and list some of the drivers pushing companies to conduct emission inventories. This later point is reinforced by information from CarbonTrust (2006). Finally, we introduce the standard proposed by the Green House Gas Protocol Initiative and the SmartCalculator proposed by the Environmental Protection Agency (EPA).

We propose first to look at some of the aspects motivating our research. Stern (2006) discusses climate change on the world economy. Stern's report states that climate change will potentially be the greatest market failure ever seen, and that it will present dire global economic and social disruptions. In addition to these general observations, Stern

introduces concepts related to the economics of climate change. He utilizes the notion of discount factor to forecast cash flows relating to continued environmental destruction and by this technique, integrates the economical dimensions of carbon emissions and environmental destruction.

According to Gremouti (2007), “significantly reducing carbon emissions requires a comprehensive view of the supply-chain.” Gremouti suggests conducting sensitivity analyses, classifying carbon saving opportunities in NPV Negative, Neutral, and Positive projects and by the operational feasibility of these projects. She provides example of initiatives lead by Fortune 100 firms, noting “Voluntary carbon offsets counterbalancing has grown from \$6mm in 2004 to \$110mm in 2006,” which illustrates the fact that there is considerable growth in the drivers for organizational action, even without US governmental regulation.

CarbonTrust (2006) mentions, in addition to the driver above, other critical “Issues driving businesses to take action” including increased energy expenses, existing or planned legislation, and changing attitudes of consumers towards environmental policies of organizations.

Lastly, Green House Gas Protocol: A Corporate Accounting and Reporting Standard (GHG Protocol) issued jointly by the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) and revised in 2003, was important to our larger understanding of the issues at hand. The GHG Protocol initiative

is a multi-stakeholder project launched by experts from national governments, non-governmental organizations (NGOs), and 170 international companies partnering to define standards for quantifying and reporting emissions in advance of the definition of Kyoto Protocol standards. The initial version released in 2001 was rapidly adopted by companies, NGOs and governments. More than a standard, the GHG Protocol Initiative developed industry-specific calculation tools for companies to conduct GHG inventory and therefore be in better position to identify opportunities for reduction, participate in voluntary GHG programs or in GHG markets (such as the UK Emission Trading Scheme and the Chicago Climate Exchange, and the European Union Greenhouse Gas Emissions Allowance Trading Scheme). Although the “GHG Protocol Corporate Standard has been designed to be program or policy neutral,” it has been used by “many existing GHG programs” and “it is compatible with most of them.” The use of the GHG Protocol methodology is notably encouraged by the Carbon Disclosure Project for carbon emission reporting by top publicly traded companies.

The Carbon Disclosure Project (CDP) is a United States-based not-for-profit agency, which works with corporations to disclose greenhouse gas emissions and carbon footprint. In 2007 CDP published emissions information on 2400 of the world’s largest corporations, responsible for \$57 trillion under management. These 2400 firms emitted the equivalent of 26% of total anthropogenic global emissions. The firm’s goal is to provide quality information and create transparency for shareholders regarding climate-change related issues.

The use of the Environmental Protection Agency (EPA) Smartway Saving Calculators is also becoming increasingly popular, especially in the United States. As reported by Polovick et Al. (2007), 500+ companies have already joined the partnership program proposed by the EPA for companies to report and explore saving opportunities for their fleet. Although the prime focus of the program was to address emissions from freight shippers and logistics providers, the program is now been used by an increasing number of partners interested by the ready to use calculators proposed free for download on the EPA webpage.

2.2 Selecting a Research Approach

Beamon (1998) and Eisenhart (1989) describe generic methodology for, respectively, the definition of models for the analysis of supply chains, and the development of theory based on case studies. Both these works supported our analysis.

Beamon (1998) classifies other researcher models for the analysis of supply chains into four categories:

- (1) Deterministic analytical models,
- (2) Stochastic analytical models,
- (3) Economic models, and
- (4) Simulation models.

Our model fall into Beamon's categories 1 and 4. A deterministic model is used to assess the actual costs and emissions associated with the current solution. The impact of a change to an alternative solution is assessed based on what-if simulation models with transport mode and/or distribution center location for variable.

Eisenhardt (1989) describes the step-by-step process of developing theory from case study, helping to explain the rationale for choosing specific cases. Eisenhardt indicates the appropriateness of such an approach for new research topics (particularly relevant in our case). He clarifies what should be the purpose of a case study:

- (1) To provide description
- (2) To test theory, or
- (3) To generate theory.

Given the nature of our research and relative novelty of the field, our work fall under the first category.

Aside from these methodologies, and with a direct focus on carbon-efficient supply chain, Sarkis (2003) proposes a decision framework to help managers in evaluating green supply chain alternatives. Sarkis defines different approaches: technological focus, process focus, and organizational focus, examining influences and relationships of the product life cycle, operational life cycle *or value chain* (including distribution and transportation decision such as the location of outlet, the selection of transport mode), and organizational performance measurements (defined as cost, quality, time, and flexibility). Sarkis argues that these measurements “serve as a foundation for...prioritizing or selecting systems...that will aid in managing green supply chains.”

2.3 Analyzing Green Supply Chain: Examples of Models and Case Studies

This section presents works from academics and non-profit organizations. The works considered are listed in Table 1 and details are provided in the following paragraphs. The table highlights the methods adopted by researchers later mentioned, and is useful in

comparing and estimating opportunities to improve the carbon-efficiency of supply chains and the more detailed objective of their work. In addition, the type of products used to illustrate the application of their methodology is indicated in a separate column.

Article Ref.	Method	Objective	Product
CarbonTrust (2006)	Case studies based on life-cycle analysis (LCA).	Pilot projects. Estimate opportunities for reduction coming from correcting a market failure, product change, or supply chain reconfiguration.	- Snacks - Newspapers
Zhou et al. (2000)	Analytical hierarchy process (AHP) and goal programming (GP).	Maximize economic benefits, satisfy the market demand, minimize material consumption, minimize energy consumption and maximize facility utilization based on "relaxable" and "non-relaxable" constraints.	- Petrochemical
Khoo et al. (2002)	"What-if" scenarios. Model developed using ProcessModel 2000 software.	Optimize costs, time-to-market, and environmental benefits, using distance and choice of transport mode as decision-making parameters.	- Aluminum metal
Cholette et al. (2007)	"What-if" scenarios. Model developed using SEAT (in-house software).	"Analyze the energy usage and carbon dioxide emissions that result from delivery of products from the point of manufacture to the end consumers."	- Wine
Christopher et al. (2007)	"What-if" scenarios. Excel model.	- Analyze the "costs, risks, lead-times and environmental implications of global sourcing decision." - Develop "a model that can support global sourcing decisions, based on a holistic analysis of the implications."	- 15 case studies covering 7 different industries (including: retail, Aerospace, Oil/Gas, Consumer Electronics, Food, Fashion, etc.).

Table 1. Summary of Method and Case Studies Used by Researcher Analyzing the Carbon-Efficiency of Supply Chain

The stated goal of the British NGO CarbonTrust is to “help companies make better informed decisions.” More assertive than the other articles listed in Table 1, CarbonTrust (2006) has an objective of exposing and promoting a method by focusing more on the end results of the analysis than on the appropriateness of the methodology. This marketing pamphlet describes the tool created by the Carbon Trust for “carbon management across the supply chain.” Included in CarbonTrust’s research are studies of the supply chains of newspaper and snack foods product firms. CarbonTrust further advocates the win-win scenario of managing carbon emissions and increasing profits simultaneously by strategically “reducing the carbon footprint of their products.” The approach adopted by the Carbon Trust draws heavily on Life-Cycle Analysis (LCA) to propose a two-step process for measuring life-cycle emission across the supply chain. First the approach advocates identifying the largest emissions sources (from internal or external operations). Next, the method suggests prioritizing opportunities for emission reduction using factors such as cost reduction and exposure to new commercial opportunities. As an output for this analysis, companies can obtain the total carbon footprint of their product and identify the contribution per supply chain processes. CarbonTrust (2006) mentions several challenges companies need to address to get the most from their analysis. These challenges include issues with difficulty of access to data because of confidentiality and issues related to the implementation. CarbonTrust argues that often:

- (1) Results are specific, and it is not possible to make sector-wide recommendations; and
- (2) Opportunities more fundamental than simple energy efficiency changes are often harder to implement.

The works from Zhou (2000), Khoo (2002), Cholette (2007), and Christopher (2007) adopt a similar approach, first modeling the issue and later using case studies to test the method proposed. All have a main objective of identifying specific levers which most strongly affect carbon emissions within their respective supply chains, and attempt to understand the consequence of these levers in order to make optimal decisions.

Zhou et al. (2000) use an Analytical Hierarchy Process (AHP) technique to quantify qualitative variables—to order and weight economic, social, and environmental sustainability goals. They propose a Goal Programming (GP) model with the definition of a generic objective function and a set of constraints, such as transport capacity or processing capacity and use the model to achieve maximum economic benefits, while satisfying market demand, minimizing material consumption, minimizing energy consumption and maximizing facility utilization. Application is illustrated through a case study on sustainable supply chain optimization of a petrochemical complex.

Khoo et al. (2002) analyze an aluminum metal supply chain. The objective is to trade-off and optimize costs, time-to-market, and environmental benefits, using distance and choice of transport mode as decision-making parameters. Khoo et al. (2002) introduces a model developed using ProcessModel 2000 software, which helps construct models based on “what-if” scenarios to conduct analysis. Limitations are listed, such as issues with the availability of data and problems related to understanding a system’s behavior.

Another limitation of the method is that it usually leads to an unconstrained solution, assuming ideal conditions.

Cholette et al. (2007) methodically examine energy usage and carbon dioxide emissions resulting from delivery of products from manufacturer to consumer. Using in-house simulation software, they estimate “energy usage, carbon dioxide emissions and fuel costs associated with each option.” Cholette et al. (2007) conclude with the observation that their results show “very different energy profiles and that reconfiguring a supply chain can significantly affect emissions.”

Christopher et al (2007) propose conducting a more comprehensive analysis of the costs and risks of global sourcing. Their objective is:

To gain a better understanding of why and how companies make global sourcing decisions; to uncover the hidden costs and risks of global sourcing; to assess the environmental and infrastructural implications of global sourcing, with particular emphasis on the UK; to develop a model that can support global sourcing decisions, based on a holistic analysis of the implications.

The main outcome of their project is the Comparative Product Sourcing Model (CPSM).

Of the CPSM, Christopher et al (2007) write, “This model is designed to help practitioners make better sourcing decisions by allowing them to estimate the impact of different sourcing decisions and compare the differences between local and global sourcing.” The model looks at four main elements of the sourcing decision:

- (1) Cost
- (2) Time
- (3) Risks (assessing their impact and probability of occurrence), and
- (4) Environment (focus on the impact on one key indicator which is the emission of CO₂ into the environment).

Methodology used to conduct this work relies predominantly on the “presentation and analysis of the results of 15 case studies covering 7 different industries (including: retail, Aerospace, Oil/Gas, Consumer Electronics, Mechanical & Electrical Equipment, Food, drink and fast moving consumer goods, Fashion)” and on the definition of a Microsoft Excel model used to analyze “the costs, risks, lead-times and environmental implications of global sourcing decision.”

According to Christopher et al (2007), the main factors that link global sourcing decisions to emissions are:

- (1) Distance
- (2) Transport mode selection
- (3) Utilization and empty running (26.5% of the vehicle over 3.5 tonnes moving around UK)
- (4) Network Design
- (5) Exporting Emissions, define as the sourcing of “components or finished products from countries with carbon intensive manufacturing”.

Christopher et al (2007) mention that “few firms participating in the study [had] detailed information concerning the environmental implications of their sourcing decisions.”

However, they note that “it was evident that throughout the duration of the project the awareness of environmental issues increased.” Other issues include the difficulties to estimate carbon dioxide emissions from the different transport modes because of the wide range of value found in the literature. We will analyze this later point in the following section.

2.4 References for Emission Figures

Emission Figures

Emission by transport mode is the most critical constant used in building models. In order to understand the difficulties faced by companies engaging in the process of building their own estimation models, we present in this section the figures proposed by four different sources.

WRI-WBCSD (2003)⁵ and the EPA SmartWay data are commonly used as primary reference. Figures from McKinnon (2007) (who analyzed emissions from UK freight) and Hansen (2007)⁶ (who reports on figures used by Maersks from the Swedish organization NTM, Network for Transport and the Environment) are provided as supporting references. The values proposed by these four documents are indicated in Table 2.

⁵ <http://www.ghgprotocol.org/calculation-tools>

⁶ <http://www.mintel.webbler.co.uk/download.php?id=42>

	GHG Protocol * Initiative, US ¹	EPA* SmartWay, US ²	NTM, Sweden ³	McKinnon** UK Freight ⁴	McKinnon*** UK Freight ⁴
 LH	570	N/A	552	N/A	N/A
 SH	1,580	N/A	N/A	1,420 to 1,925	N/A
 20t	54	47	50	52	138
 Diesel	20	15	17	22	35
 Ocean	10	N/A	8	7	N/A

Emissions expressed in grams CO₂ per metric tonne per km.
LH = Long haul (>1,600 km); SH = Short haul (<500 km).

Source [1] : WRI-WBCSD (2003): GHG Protocol Initiative

Source [2] : EPA SmartWay (2006)

Source [3] : Network for Transport and the Environment (NTM). Sweden as quoted by Mikel Hansen, Maersk Logistics (2007)

Source [4] : A. McKinnon (2007): CO₂ Emissions from Freight Transport in the UK

* Emission based on load factor equal to 80% for truck shipment and not specified for rail shipment.

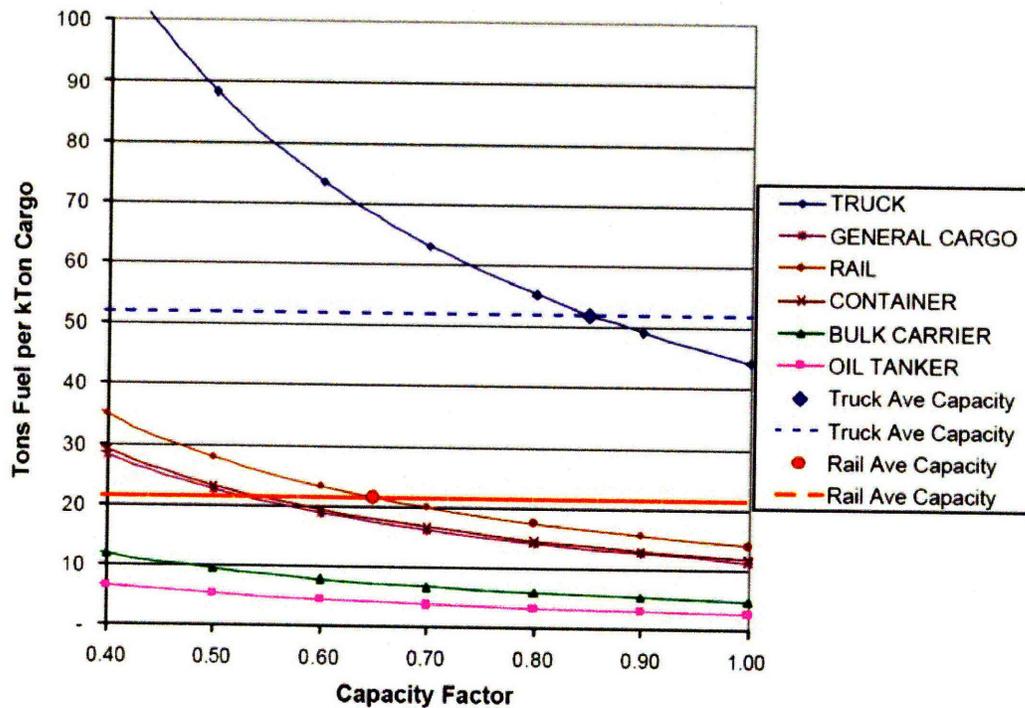
** Emission based on load factor equal to 85% for truck shipment and 65% for rail shipment.

*** Emission based on a load factor equal to 40% for heavy truck and rail shipment.

Table 2. Carbon Dioxide Emission per Transport Mode

Limitations

The following limitation is worth to be noted: with the exception of the EPA SmartWay's and McKinnon (2007)'s figures, the figures are provided without any information on the capacity usage, although differences in load induce large differences in fuel consumption (and therefore in CO₂ emission). For a truck running at 50% capacity fuel consumption approaches 90 tons per kTon shipped, whereas a truck running at 100% capacity consumes 45 tons of fuel per kTon shipped. Figure 2 illustrates this point and provides similar information for rail and tanker shipment.



Source: Marintek et al, as quoted by McKinnon (2007), CO₂ Emissions from Freight Transport in the UK

Figure 2. Effect of Capacity Utilization on Fuel Efficiency

Validity of these estimates

Beyond providing estimates by transport mode, McKinnon (2007) questions the validity of previously calculated statistics on CO₂ emissions from freight. The issues mentioned include:

- Estimation of vehicle load are imprecise and usually over-estimated,
- Use of international rate on fuel efficiency, not necessarily applicable,
- Measure of freight transport not clear since transport sector does not follow the industry sector used as reference,
- Always refer to tones/km although volume/km can be some time more relevant,
- Does not take into account the “last mile”, i.e. final consumer moving around to look for the product,
- Only focus on CO₂, although CO₂ is not the only pollutant causing global warming. It is estimated that CO₂ explains only 84% of the damage.

McKinnon's (2007) work leads to adjusted figures and a refined framework for assessing the potential of reducing CO₂ emissions. McKinnon (2007) advises companies to estimate opportunities for improvement through: the handling factor (i.e. tonnes-lifted), average length of haul (i.e. distance covered), modal split (i.e. tonne-kms carried per different transport mode), average payload, proportion of km run empty, fuel efficiency, and fuel consumption to CO₂ emissions.

2.5 Rationale for conducting case studies on pairs of organizations

Gremouti (2007) and CarbonTrust (2006) both highlight the importance of adopting a holistic approach to achieve substantial improvement. CarbonTrust (2006) suggests that companies analyze the whole supply chain and work "collaboratively up and down the supply chain."

Vachon et al. (2006) discuss the impact of supply chain "greenness" according to the way companies interact with their suppliers/customers. This work proves that we can correlate the way supply chain are organized (collaborative or competitive approach) and the way company act upon their supplier (downstream) and their customer (upstream) with regards to compliance with environmental requirement.

This observation supports our decision to get pairs of partners involved but shows the limit of the conclusion that can be inferred from this ideal relationship: when companies partner to achieve the optimum solution the combined outcome surpasses the individual organization outcomes.

3 Survey

The survey used for our thesis was overseen by Mr. Ken Contrill in collaboration with IOMA, CSCMP, and the Massachusetts Institute of Technology's Center for Transportation and Logistics (CTL). We were able to add content and revise questions from this survey before it was distributed at the beginning of December 2007. By January 2008, we received 101 responses and commenced analysis of the data.

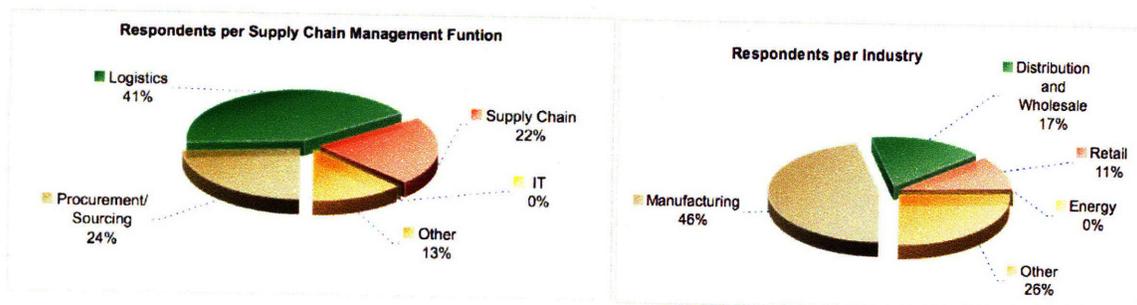
3.1 Respondent Profile

The profile of respondents breaks down as follows (divided by management function): Procurement and Sourcing 24%; Logistics 41%; Supply Chain 22%; Other 13%.

By industry, the profile of our respondents falls into the following categories:

Manufacturing 46%; Distribution and Wholesale 17%; Retail 11%; Other 26%.

By annual revenue, our respondents fall into the following categories: Less than \$100 million (21%); Between \$100 and \$500 million (27%); Between \$500 million and \$1 billion (8%); Between \$1 and \$5 billion (22%); Between \$5 and \$15 billion (13%); Over \$15 billion (9%). This information is presented in Figure 3:



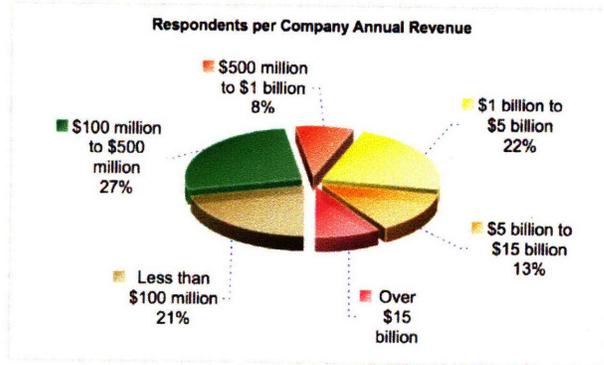


Figure 3. Survey Respondent Profile

3.2 Involvement and Motivation

Respondent breakdown when asked if their firm had initiatives to reduce the carbon footprint of their supply chain: 48% No; 44% Yes. 8% “Plan to in the future,” with the majority of these respondents anticipating program implementation in 2008 or 2009.

The rest of the results presented hereafter focuses on the 56% of respondents who indicated “Yes” or “Plan to in the future” to the former question. 56% of respondents believe this effort will be driven by corporate-led program; 25% say supply chain will be the driver of reducing the carbon footprint of supply chain and 19% say other departments (with responses ranging from “Marketing” to “Sales” to “Environmental Health and Services” (EHS)). Figure 4 presents the above result.

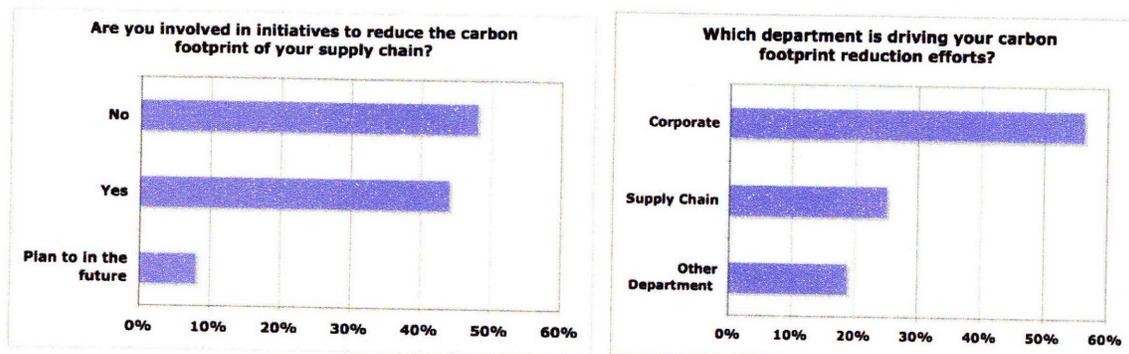


Figure 4. Respondents Involvement in Initiatives to Reduce the Carbon footprint

69% of respondents believe their company’s main reason for reducing the carbon footprint of the supply chain is, “to enhance the company's reputation for social responsibility.” 67% mentioned “cutting costs.” 40% believed initiatives would be enacted in anticipation of tighter regulations on corporate carbon emissions (although only 31% believe that carbon labels will be introduced in the next five years). The detail result is presented in Figure 5:

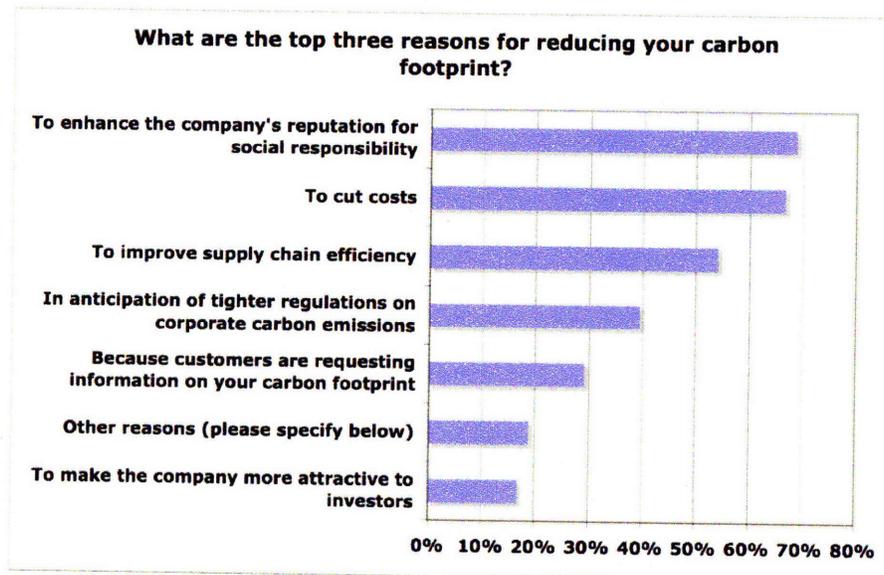


Figure 5. Reasons to Engage in Initiatives to Reduce the Carbon Footprint

3.3 Areas of Focus

The most popular initiative expected from our respondents was, “[to] establish collaborative projects with suppliers to identify reduce carbon emissions in the supply chain” (54%). Other popular responses: “Making distribution centers more energy efficient” (45%); “Reconfiguring distribution networks to reduce miles driven” (43% of respondents); “Increase loads carried on backhauls to increase energy efficiency” (43%); “Analyzing every stage in the supply chain to calculate carbon emission and to identify

where carbon emissions can be reduced” (39%); “Reviewing product life cycles to improve carbon efficiency” (28%); and, “Switching to more efficient road vehicles / modes of transportation” (28% / 30% total 58%). Additionally, we note that 13% of respondents are looking into ways to add solar power to their warehouses as the office supply retailer Staples and Stonyfield Farms have done.

“Reconfiguring distribution networks to reduce miles driven” appears to be top priority—ranked 1st by 26% of respondents; Ranked 2nd, “Making distribution centers more energy efficient” (13%). Though there was a wide range of potential initiatives offered by respondents, responses were fragmented: there is no single, overwhelming priority (refer to Figure 6).

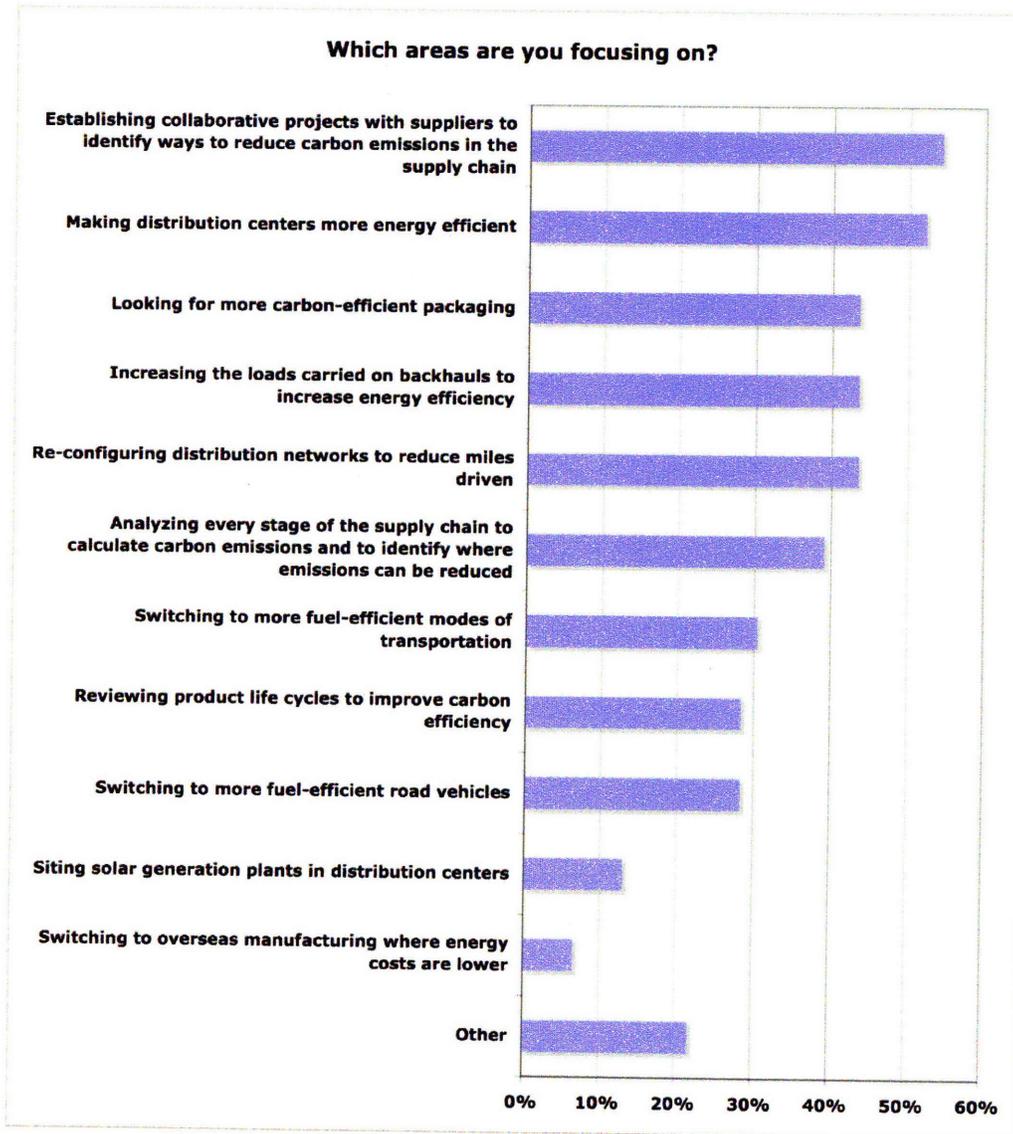


Figure 6. Area of Focus When Taking Action to Reducing the Carbon Footprint

3.4 Methods for Carbon Reduction

9% of respondents indicate that they “require suppliers to give them details on how they are reducing or plan to reduce their carbon footprints.” This would allow them better information to measure Scopes 2 and 3 of their carbon footprints. However, 21% of the respondents plan to do this in the future. Most of them expect to do this in the next two years, and from subsequent interviews we anticipate a dramatic increase in this area.

13% of respondents indicate that the carbon efficiency of suppliers influences their sourcing decisions; 23% indicate that the carbon efficiency of suppliers will affect their decisions in the near future.

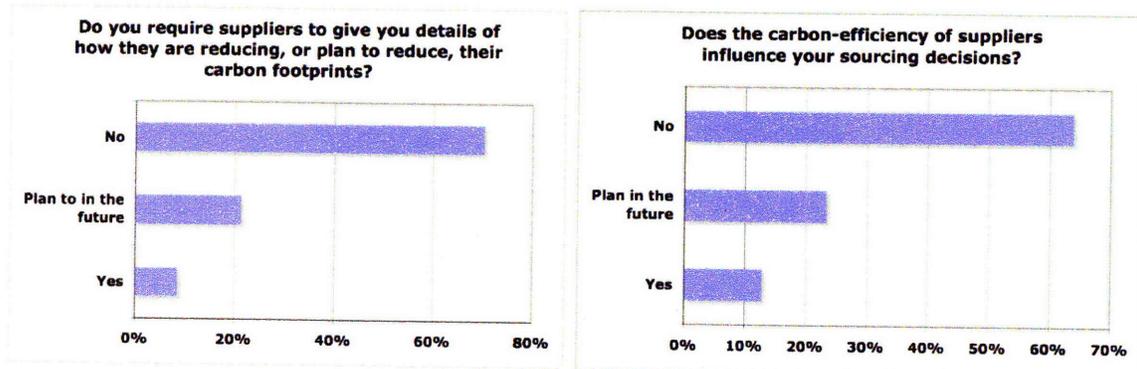


Figure 7. Suppliers Involvement in Initiatives to Reduce the Carbon Footprint

When asked what “values, measurements or estimates you refer to for decision making,” most respondents indicated (indirectly) that they use a combination of information from internal resources and widely and/or publicly available information. 73% mention the internal and suppliers estimates; 54% would use widely available national averages (GHG Protocol, etc.). Figure 8 reflects the above.

When asked of their awareness level of carbon reduction programs and initiatives, it is clear that there is no overwhelming standard of acceptance. Key findings: 53% know about EPA Smartway; only 33% know about GHG Protocol—among them, 7% use or participate in this program currently. There is limited awareness: 47% say they have never heard of the European Union emissions trading program. Table 3 presents detailed results.

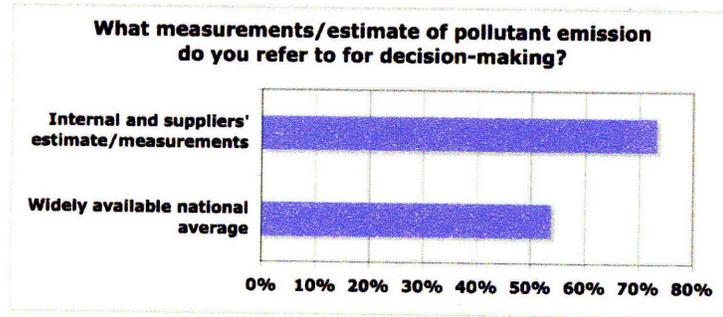


Figure 8. References Used for Emission Estimates

What is your level of awareness of the following carbon footprint programs/initiatives?

	1. Never heard of	2. heard of	3. familiar with	4. participating or using
The Carbon Trust	60.0% (54)	18.9% (17)	21.1% (19)	0.0% (0)
GHG Protocol	67.4% (60)	12.4% (11)	12.4% (11)	7.9% (7)
EPA SmartWay Program	47.3% (43)	27.5% (25)	19.8% (18)	5.5% (5)
The Chicago Climate Exchange	66.3% (59)	18.0% (16)	13.5% (12)	2.2% (2)
The Kyoto Protocol Carbon Emissions Targets	18.7% (17)	38.5% (35)	39.6% (36)	3.3% (3)
Carbon Offsets	29.7% (27)	33.0% (30)	36.3% (33)	1.1% (1)
EU Emissions Trading Program	47.8% (43)	28.9% (26)	23.3% (21)	0.0% (0)
Carbon Disclosure Project	69.7% (62)	21.3% (19)	5.6% (5)	3.4% (3)
EPA Climate Leaders Program	65.2% (58)	23.6% (21)	7.9% (7)	3.4% (3)
Other	75.0% (9)	8.3% (1)	8.3% (1)	8.3% (1)

Table 3. Awareness of the Carbon Reduction Programs

3.5 Budget, Cost Savings, and Emission Reduction

Most of the respondents indicate that there is no set budget, but rather, they believe that savings should cover costs of implementations associated with the new solutions. Only ~20% are able to evaluate actual savings from initiatives; similarly, few of them (only ~20%) are able to indicate the targeted emission-level reduction.

3.6 Conclusions

There are a wide range of planned initiatives, but there is no single, overwhelming priority. 69% of respondents named one of their top three reasons: “to enhance the

company's reputation for social responsibility.” 67% mentioned “to cut costs.” Savings and marketing differentiation efforts will drive change, especially if laws do not place restrictions on corporate action. 40% of respondents believe their companies will make changes in anticipation of tighter regulations on corporate carbon emissions.

The CTL survey confirms our belief that companies want to:

- Establish collaborative projects with suppliers to identify reduce carbon emissions in the supply chain.
- Reconfigure distribution networks to reduce miles driven.
- Increase loads carried on backhauls to increase energy efficiency.
- Analyze every stage in the supply chain to calculate carbon emission and to identify where carbon emissions can be reduced.
- Switch to more efficient road vehicles / modes of transportation.

However, these companies do not have the appropriate knowledge, as awareness level of programs and initiatives is low. There is no unique, overwhelming standard of acceptance: 53% know about EPA SmartWay. Only 33% know about the GHG Protocol, and among them, 7% use or participate in this program. There is limited awareness of international efforts to reduce corporate carbon footprints, as 47% of respondents say they have never heard of the European Union emissions trading program. Alternatively, it is important to note that none of these US-based programs is mandatory.

Regarding knowledge of budget savings and carbon dioxide and equivalent gas reduction: firms do not know the results of their actions. Alternatively, most firms have not yet begun to arrive at conclusions. Thus, our thesis arrives at a crucial time, as firms are now more willing to make changes—(44% are involved in initiatives and another 8% plan to get involved within the next 2 years).

4 Calculating Emissions from Transportation

In this section we present the common methods used to estimate emissions from transportation (i.e. mainly the methods proposed by the GHG Protocol and the EPA SmartWay) and the method we propose to use for later application in our case study. As explained by McKinnon (2007), two types of measurements are used by companies, governments, and not-for-profit organizations to derive CO₂ emission estimates:

- (1) Input-based measurements: Estimates of the quantity of fuel/energy purchased times the efficiency ratio (i.e. emissions per gallon);
- (2) Output-based measurements: Estimates kilometers traveled and multiply by estimates of average emission, often derived from national emission average.

Although the GHG Protocol considers both types of measurements, only the latter method (output-based) is considered by the EPA SmartWay and in the method we propose to use.

4.1 Common Methods Used

4.1.1 GHG Protocol

The Greenhouse Gas Protocol (GHG Protocol) is recognized as the most widely used accounting tool to quantify greenhouse gas emissions. Jointly prepared by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), *The Green House Gas Protocol, A Corporate Accounting and Reporting Standard* was initially published in 2001, and later revised in 2003, in order to provide guidance for companies to report on CO₂ emissions.

Since then, the WRI-WBCSD developed several cross-sector and sector specific calculation tools to assist organizations in determining their greenhouse gas emissions. One of such tools looks more specifically into the emissions from transportation: the “WRI-WBCSD Calculation tool: CO₂ from transport or mobile sources.”⁷ According to the guidance document provided with the Excel tools, i.e. WRI-WBCSD (2005), *Calculating CO₂ Emissions from Mobile Sources – Guidance to calculation worksheets*, the purpose of the tool is to analyze both direct (owned fleet) and indirect (upstream/downstream transportation, employee commuting, etc.) emissions from transportation. Given that N₂O and CH₄ emissions varies significantly according to the emissions control equipment used and given that N₂O and CH₄ emissions constitutes only a small proportion of the emissions, only CO₂ emissions estimates are considered in the calculations.

The tool proposed two methods for calculating GHG Emissions: (1) a fuel-based method (referred earlier as “input-based” method) and (2) a distance-based method (also referred to as “output-based” method), however the use of the fuel-based method is recommended by the GHG Protocol, since fuel consumption data, in the form of fuel receipts or fuel expenditures, are usually considered as more reliable than the records of number of miles-run.

The Fuel-Based Approach: “Based on Fuel Use” Worksheet

In the case of the fuel-based method, the emissions are estimated as the sum, for each fuel type, of the products of the fuel used by the emission per fuel factor (i.e. = the carbon

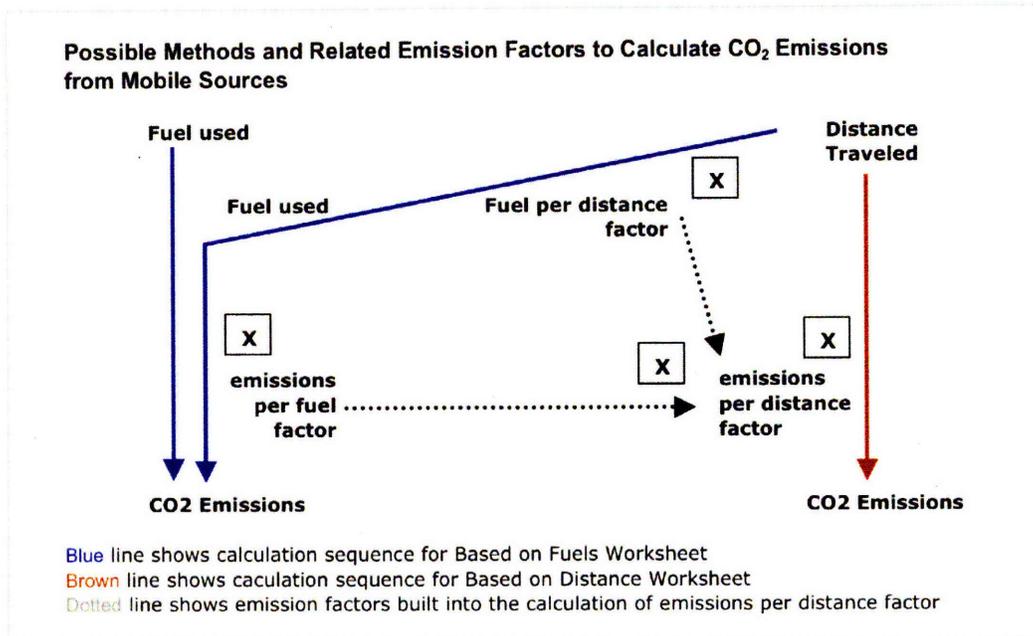
⁷ <http://www.ghgprotocol.org/calculation-tools/all-tools>

content coefficient of the fuel). The fuel-based worksheet can also be used when vehicle kilometer run (or miles run) and fuel economy factors are available. In this case, the product of the vehicle activity data by the fuel economy factor of the vehicle would replace the fuel-used value. It can be argued that in such case the “Based on Fuel Use” worksheet would be used to conduct an “output-based” estimate. Although pre-set values for all key factors are used by default throughout the Excel tool, users are encouraged to enter company-specific factors when available. Figure 9 presents the principle of the calculation described above.

The Distance-Based Approach: “Based on Distance” Worksheet

In the case of the distance-based model, kilometers or miles traveled by vehicle type are used to determine the total emissions: $CO_2 \text{ emission} = \text{Distance Traveled} \times \text{Emission per Distance Factor}$. Figure 8 provides information on the main emission factors used by default in the model (refer to the first column). Figure 9 presents the two-step calculation processed by the tool; the first step (i.e. $\text{Emission per Distance Factor} = \text{Emission per Fuel Factor} \times \text{Fuel per Distance Factor}$) is transparent to the user in the case default values are selected.⁸

⁸ The default value used by the Excel tool and reported in the table provided in Figure 8 does not match the figure presented in the tool user guide: *Calculating CO₂ Emissions from Mobile Sources – Guidance to calculation worksheets*, Table 5.4 and 5.5.



Source: WRI-WBCSD GHG Protocol Calculation tool: CO₂ from transport or mobile sources.

Figure 9. Fuel and Distance-Based Methods – GHG Emissions from Transportation

ISO 14064 & ISO 14065

Derived from the GHG Protocol, the ISO 14064 (2006) specifies principles and requirements and provides:

- Guidelines at the organization/project level for “the quantification, monitoring and reporting of GHG emission reductions or removals”,
- Guidance for the “validation, verification and certification” of greenhouse gas inventory statement.

The ISO 14065 (2007) lists the “requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition”. According to Wintergreen et al. (2007), the main difference between the ISO 14064 Standard and the GHG Protocol, is that the ISO 14064 identifies “what to do” and the GHG Protocol explains “how to do it.” Wintergreen therefore affirms that the two documents should be seen as “complementary documents.”

4.1.2 EPA SmartWay Calculators

The Environmental Protection Agency (EPA) SmartWay Transport is a voluntary partnership between the United States Government and the freight industry that aims to reduce 66 million metric tons of carbon dioxide (CO₂) emissions, 200,000 tons of nitrogen oxide emissions, and 150 million barrels of oil annually by 2012. SmartWay proposes tools to guide membership partners and help them achieve fuel savings and emissions reductions in several ways: reducing idling time, usage of speed governors, fuel-efficient tires and tire inflation systems to reduce rolling resistance, by upgrading their truck fleet. The EPA SmartWay provides two models: the shipper model and the fleet model. Both models are described hereafter.

The Fleet Model

Presented as a simple pre-configured Excel Spreadsheet, the SmartWay Calculator Fleet Model enables carriers to estimate where they stand in terms of environmental practices compared to the average carriers. Looking at some characteristics of the vehicles (such as the aerodynamics, tires and lubricants type) and the way these vehicles are used (idling time, average speed), a final score, also called SIF (Shipper Index Factor), is attributed to the carrier company. This score ranges from 0.00 to 1.25, with:

- A score of 0.00 reflecting the company's adherence to the program (rather than any particular environmental performance);
- A score of 0.75 reflecting good environmental performance (most of the Smartway partners fall into this category);
- A score of 1.00 reflecting very good environmental performance; and
- A score of 1.25 reflecting outstanding environmental performance.

The Shipper Model

The Shipper Model enables shippers, i.e. all non-logistics service provider or carrier, to evaluate their company performance. Based on the volume and kilometer-run with their contracted carriers, the shippers' scores are determined as a weighted average of their carrier and logistics service provider's scores. As for the Fleet Model, the Shipper Model attribute to companies a score ranging from 0.00 to 1.25. Score should be 0.50 or above for company to qualify for the right to use the SmartWay partner logo. Aside from this score, the same tool enables companies to evaluate the emissions footprint of their fleet for all trucking and intermodal kilometer-run ("output-based" estimates).

If specific CO₂, PM, and NO_x emission factors are not provided directly by the carrier/shippers, values of emissions for these calculations are based on the following default values:

- Rail (Diesel Loco) = 24.1g CO₂/ton-mile
- Truck = 74.5g CO₂/ton-mile
- Dray (truck for intermodal connection) = 93.1g CO₂/ton-mile

Other assumptions include:

- Truck empty miles = 20%
- Drayage empty miles = 25%

4.2 Software Available to Companies Interested in Reducing Carbon Footprint

In this section, we propose some of the main resources available on the market for conducting carbon footprint estimates. For later reference in our case study, we first

present the ILOG add-on and later introduce two more applications for the sake of completeness.

The ILOG LogicNet Plus XE Carbon Footprint Extension

Proposed by the supply chain optimization software firm Logictools, the ILOG LogicNet Plus XE Carbon Footprint Extension allows companies analytic evidence of how supply chain decisions affect carbon footprint. The software allows companies to run sensitivity analysis and perform what-if scenario analysis to better understand how adding or removing plants and warehouses impacts the manufacturing and distribution components of a firm from both a carbon output perspective. ILOG claims that its LogicNet Plus XE Carbon Footprint Extension software “provides standardized, comprehensive and up-to-date data from the United States government and the World Resources Institute”, which should be understood as relying on the EPA SmartWay and The GHG Protocol. The application permits to measure the impact of both the transportation and warehouse costs and carbon footprints for a set of scenario configured by the user.

Other Software

Other major applications include the tools proposed by the software companies INFOR and Barloworld Optimus. As a first mover, INFOR is generally recognized as providing the most comprehensive tool for carbon estimate. Barloworld Optimus has extensive experience working with companies on reducing carbon emissions. This extensive experience help the company develop CAST-CO2 software designed “to calculate the

carbon footprint of any supply chain and provide the optimal network configuration based on cost, service and/or carbon emissions.”

4.3 Limits of the Methods Presented Above

The methods proposed by the GHG Protocol, the EPA SmartWay, and the other applications listed above present some common limitations. None of them consider the impact of capacity utilization on carbon emissions by taking national load average as reference versus actual loads. Most of these methods do not explicitly indicate the pollutant considered when providing with carbon equivalent emission estimates. In addition, the emissions related to inventory warehouse are generally omitted, as are the effects on inventory holding costs and impacts on service level.

4.4 Proposed Estimation Method for our Case Analysis

In this section we present the method we used to compare alternatives in terms of transport mode selection and/or DCs location for the cases analyzed in the following section (refer to 5. Case Study).

Following the same logic than the output based methods proposed by the GHG Protocol and the EPA SmartWay, we suggest to estimate emissions from different transport alternatives as follows:

- We first gather information on the distance run and load shipped in order to obtain the weight per distance traveled for each transport mode.
- We later estimate the average capacity utilization for both the headhaul and backhaul for each transport mode, and from there make adjustments to the emissions per distance-weight factors (cf. below for details).

- We then multiply the “weight per distance traveled” by the “emissions per distance-weight adjusted factor” and obtain the emissions per transport mode.
- We finally sum all emissions from the different transport mode considered.

Method Used to Estimate CO₂ Emissions from Transportation (from plant/grower to retailer DC)

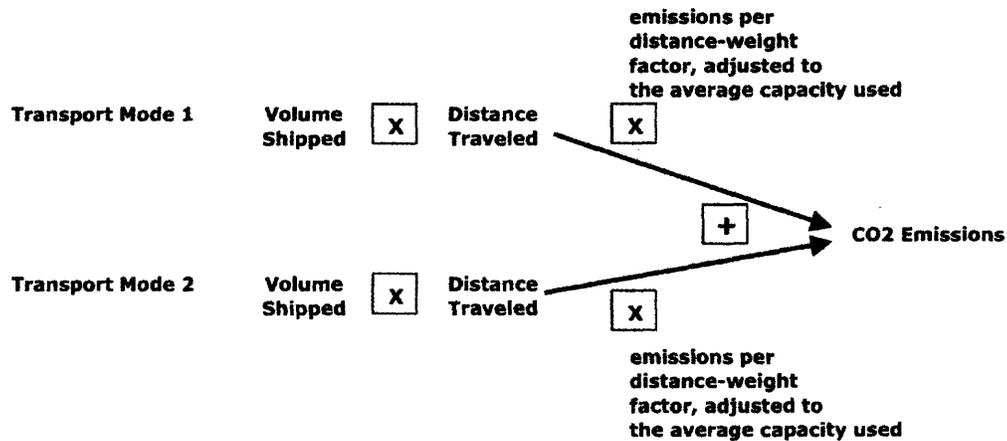


Figure 10. Customized Method for the Estimation of Emissions from Transportation

Adjustments to the Emission Per Distance-Weight Factors

Considering that the values of CO₂ emission per tonne-kilometer proposed by the GHG Protocol, EPA SmartWay, NTM, and McKinnon (reported in Table 2) differ by up to 12% for truck, 25% for rail, and 30% for ocean freight, we suggest to take the average value for reference: 50.8gm/tonne/km for truck, 18.5gm/tonne/km for rail, and 8.3gm/tonne/km for vessel shipment. Although not always explicit in the respective reference documents, we consider that the based figures, and therefore the resultant figures, correspond to a capacity utilization of 85% for truck and 65% for both rail and ocean freight. In order to account for the effect of capacity utilization on fuel efficiency, we propose to adopt the approach suggested by McKinnon (2007) and to look at the emissions based on the capacity utilization as per Figure 11. The curves presented in

Figure 11 are derived from the curves proposed by McKinnon (2007) and presented earlier in Figure 2. *Effect of Capacity Utilization on Fuel Efficiency*. These curves have been adjusted to present emissions in gm of CO₂ per metric tonne per kilometer and to get aligned with the average figures we selected. Taking these curves as the new reference, we later account for the difference of capacity utilization on the headhaul and backhaul by taking the average of the corresponding emission factors. Figure 12 illustrates the above with the example of a truck traveling at 95% capacity on the headhaul and 50% on the backhaul. In this example, the resulting emission factor is 70gm/tones/km.

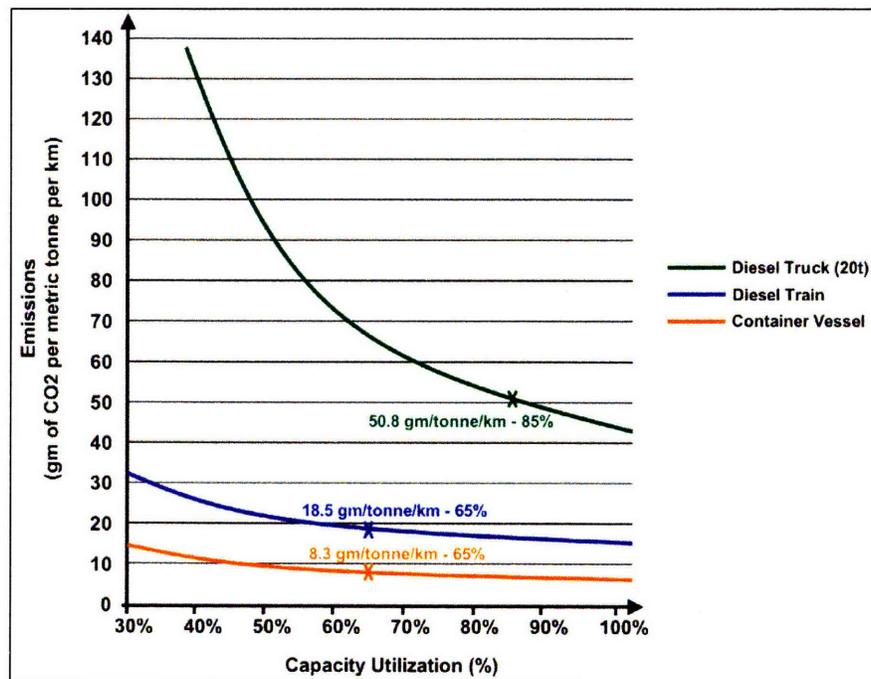


Figure 11. Emission as a Function of the Capacity Utilization

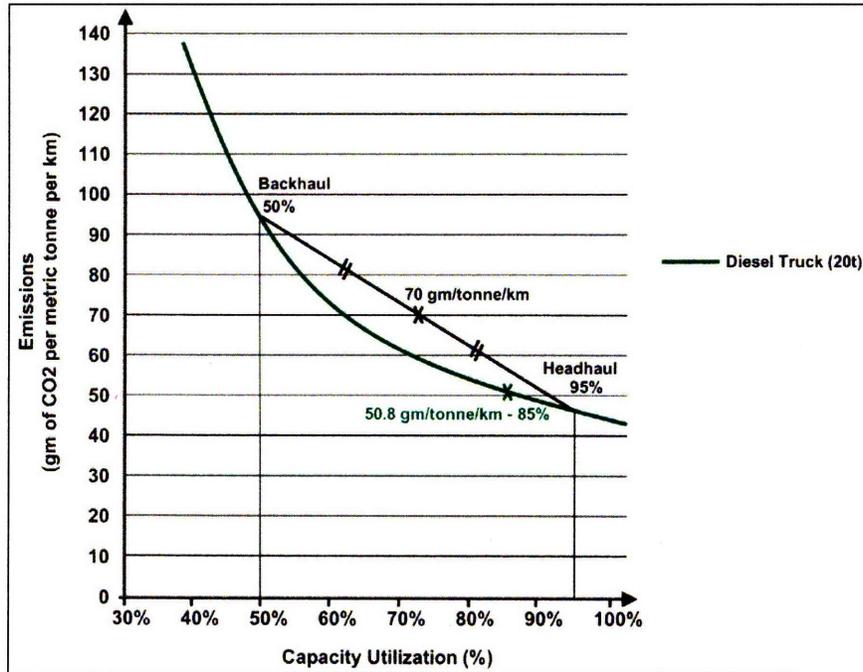


Figure 12. Emission based on the Capacity Utilization of the Headhaul and Backhaul

Benefit and Limit of our Approach

The advantage of using the emission factors derived from this approach over the factors proposed by either the EPA SmartWay or the GHG Protocol lies in the fact that this approach accounts for the dissymmetry of the capacity utilization to fairly account for the overall harm caused by the kilometers traveled. However it is important to note that the curves proposed in Figure 11 are solely based on rough estimates and would require gathering extensive sets of data to properly reflect the effect of capacity utilization on CO₂ emissions. For this reason, we later propose in the calculation section of our case studies to examine (1) the results obtained when using the reference standard selected by the company analyzed, (2) the results obtained following our approach.

5 Case Studies

This section contains three case studies we conducted between November 2007 and April 2008 with Railex, Stonyfield Farm, and Fiji Water. The case studies were shaped through a composite approach of interviews with corporate sources, site visits, and information and data collection. Our cases studies examine paired companies—a perishable or consumer packaged goods company and a transport provider; however, while we discuss collaborative efforts, we focus on each case study from the point a view of one of the paired companies.

The first case study, presented below, describes the relationship between Railex, a coast-to-coast expedited rail provider, and Wal-Mart, for whom Railex consolidates from West Coast growers, and then carries tons of apples from its facility in Wallula, Washington to its East Coast facility in Rotterdam, New York. Prior to Railex, Wal-Mart had its shipments of apples trucked across the United States. This case study examines tradeoffs of cost, time to market, risk and carbon output associated with the modal shift.

Furthermore, the Railex and Wal-Mart case study provides insight into the change management procedures that both firms faced in shaping their partnership.

The second case study examines organic yogurt producer Stonyfield Farm, and alterations the firm has made to its supply chain with the assistance of its transportation partner, the trucking firm Ryder. Stonyfield Farm, continually setting more stringent goals to reduce carbon output, utilized data collected by Ryder to redesign portions of its network architecture, allowing the firm to eliminate less than truckload routes, and move

almost exclusively to full truckload. In this case study we examine the structural modifications made to Stonyfield Farm's distribution network, and estimate the tradeoffs of cost, risk, time to market, and carbon output reduction associated with these changes.

Our final case study looks to Fiji Water, a bottled water company that transports water from the island of Fiji via 2500 TEU container ship to the United States. Prior to November 2007, Fiji shipped all US-bound water shipments to the Port of Los Angeles, and then trucked bottled water to destinations throughout the United States. In November 2007, as part of a broader company initiative to become "carbon negative," Fiji Water added an additional container-shipping route—from Fiji, through the Panama Canal to the Port of Philadelphia. In this case study we examine the effects of Fiji Water's maximization of shipping routes, and compare Fiji's practices with its competitors in the bottled water industry.

5.1 Railex and Wal-Mart

5.1.1 Introduction

This case is based on the customer-supplier relationship established between Wal-Mart, the world's largest retailing and distribution company, and Railex, a coast-to-coast expedited rail carrier, for the transport of apples, pears, and other produce perishables from their growers locations in Washington state to Wal-Mart distribution centers located in New England. Intrigued by the Railex business model, we selected this case with the objective of understanding the benefits of a rail freight solution for the transport of perishables. The information obtained from the interview of Louis Piccione, Railex's

Senior Vice-President Sales & Marketing, was our primary source of information when preparing this case study. After some preliminary phone conversations in January of 2008, the bulk of our interviewing was conducted on the 8th of February 2008 at Railex's headquarters located just outside of Albany in Rotterdam, NY. Additional quantitative data was extracted from a publication of the U.S. Department of Agriculture, the *Agricultural Refrigerated Truck Quarterly*, and from the Fruit and Vegetables Market News website, which presents information gathered by the U.S. Department of Agriculture and State agencies.⁹

In this case study, we focus on the change Railex service brought to the Wal-Mart fresh-fruit distribution network. Originally shipped exclusively by heavy truck, perishables grown in the Yakima Valley (Washington State, cf. Figure 13 for the location of main growers) are now carried across the United States in considerable volume by Railex for delivery to Wal-Mart's East Coast distribution centers. In this case study we propose to analyze the benefit of this new rail route versus the old road freight solution in terms of carbon footprint and possible impacts in terms of costs and time to market.

⁹ <http://marketnews.usda.gov/portal/fv>



Source: http://www.sqfi.com/2006Presentations/Case_Study_Washington_Apple_Growers_lauve.pdf

Figure 13. Washington State: Grower Location

5.1.2 Company A : Railex

Company History

Railex is a coast-to-coast rail shipping company founded by AMPCO Distribution Services Management owner (and current Railex CEO) Andy Pollack in 2004. Railex ran its first line from Wallula, Washington to Rotterdam, New York in September 2006. Despite poor accessibility, Washington State was emerging as one of the top producers of produce in America: number one in apple production, and number two in potatoes. As of 2005, apple production totaled 100,000,000 cartons, pear production was 8,500,000 cartons, and cherry production: 14,500,000 cartons.¹⁰ Mr. Pollack's goal was to create a

¹⁰ http://www.sqfi.com/2006Presentations/Case_Study_Washington_Apple_Growers_lauve.pdf

route for pipeline coast-to-coast shipment of refrigerated produce that took comparable time to traverse the United States as would long-haul truck. The first facility was built as a public/private partnership in Wallula, Washington at a cost of \$34 million. An additional facility was built in Rotterdam, New York at similar costs and with similar tax incentives from state government, and Railex had the skeletal frames for its service.

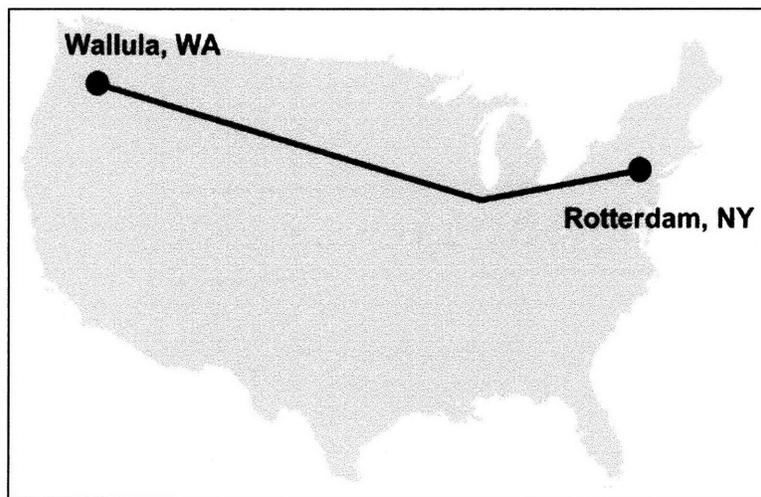


Figure 14. Railex's Route from Wallula,WA to Rotterdam,NY

This service has seen rapid adoption: in 2007, 142,300,000 pounds of apples were shipped by railcar out of Washington. In total, for all fruits and vegetables 334,700,000 pounds were shipped via rail from Washington (compared to 19,000,000 pounds for apples and 63,300,000 pounds total for intermodal). As of January 2008, Railex shipped the equivalent of 200 truckloads of produce across country each week.

In 2005, as Railex's facilities were under construction, Eric Hurlburt, an economic development specialist within Washington State Department of Agriculture said, "One of the fundamental issues here that affects all of agriculture is simply we are in the wrong place. It's cheaper to get a container from Seattle to Tokyo than it is from Seattle to

Chicago.” Attempting to circumvent this difficulty, Andy Pollack’s company, AMPCO set up at five distribution centers along the eastern seaboard between Pennsylvania and Florida; each is served by a direct rail line. Researching the difficulties faced by Washington's fresh shippers, Pollack got the idea to create a direct line from Washington to New York. He formed a subsidiary, Railex, and in 2005 it entered a partnership with Union Pacific, CSX and the Port of Walla Walla.

From terminal to terminal, the length of the Railex route is approximately 2,900 miles. The power and train car for the route are owned by Union Pacific, and contracts for some Railex services are through CSX. As the owner of one of the largest produce firms in Washington State, AMPCO remains one of Railex's largest clients. Railex has added competition and led to decreased costs throughout the marketplace. Trucking and train have slashed intermodal pricing by a few thousand dollars to compete with Railex. In addition to Wal-Mart, Railex also transports produce and other food consumption products to Price Chopper, Sysco Foods, U.S. Food Services, and Stop N’ Shop.

Industry and Sales Volume in US

According to the US Department of Agriculture, 2007 shipments of fresh produce shipped via truck totaled 29 million tons.” With only one route and two round-trips a week, Railex remains a small player: last year Railex shipped approximately 400,000 tons, about 0.01% of the market for transportation of US fresh produce. Despite this tiny market share, Railex has already made significant impact: refrigerated railcar shipments, albeit starting from a small baseline, increased by 96% in 2007, while piggyback trucking

shipments increased by only 1%. The combination of higher fuel costs and shortage of trucks to service the region led to increased shipping via railcar from Washington. This increased volume indicates that improved expediting and refrigerating rail services have swayed firms to adopt rail instead of trucking. This has benefited not only Railex, but also Union Pacific, which in 2007 began to provide similar express service.

Operation

Railex's warehouses in both Wallula, Washington and Rotterdam, New York are approximately 250,000 square feet. They are designed so that their trains can pull directly into the warehouse for loading and unloading. At capacity, each warehouse can hold the equivalent capacity of 1/2 train (35 traincars). Warehousing temperatures can be varied somewhat between holding rooms. Railex operates through partnerships with Union Pacific and CSX— the power and cars are owned by Union Pacific. Rate is negotiated by contract and fuel surcharge, and includes maintenance. The maintenance cycle includes inspections and maintenance conducted on the Washington side; Railex conducts 14 day maintenance cycles vs. 35 days for normal trains. Attempting to maximize utilization of equipment, takes considerable maintenance.

Since September of 2006, trains have run once per week between Wallula and Rotterdam. In February of 2008 Railex began running two trains per week, on Mondays and Thursdays trains depart to New York; on Wednesdays and Sundays they had westbound to Washington. Between Washington and Chicago Railex trains are staffed with Union Pacific Crews; from Chicago to New York Railex utilizes CSX Crews. At current

capacity, a maximum of 70 train cars could be filled for any given route; this is the equivalent of 400 truckloads.

At either end, for goods to be eligible for Railex shipment there is a cutoff of Wednesday midnight for a Thursday shipment. Sixty-eight train cars is the maximum utilized by Railex for any single trip thus far. The sixty-eight-train car limitation has been due to constraints on what can be loaded and unloaded in 24 hours. 70-80% of Railex clients utilize Railex door-to-door: that is, Railex is responsible for picking up and consolidating produce from the growers and then holding it in the Wallula warehouse prior to shipping. Subsequently, for this 70-80% of clients, Railex also provides trucking to their regional distribution centers, which are located from Johnston, New York to Lewiston, Maine—30 to 300 miles from the Rotterdam terminals.

Company Strategy

In January 2008, Railex began operating a second train each week between Wallula and Rotterdam. In March 2008, Railex announced the opening of a new route operated from a new facility in Delano, California. Starting in September 2008, the additional route will operate between Delano, CA and Rotterdam, NY. There are future plans to expand with a Florida to Rotterdam route, and possibly also to build facilities in Texas and Chicago, and run diagonals routes, making expedited rail shipping available to much of the continental United States. All railcars utilized by Railex are insulated, use energy efficient cooling systems and GPS monitoring to maintain temperature control for perishable produce and related food products.

Efforts towards Sustainability

According to the Railex corporate website, were its rail route eliminated and all produce and perishables it carries shipped by heavy truck instead, the carbon footprint of those trucking shipments would add an additional 85,000 metric tons of CO2 emission per year. In addition, each shipment via Railex saves approximately 100,000 gallons of fuel consumption when compared with shipping the equivalent freight via heavy truck: this amounts to a fuel savings of about 5 million gallons per year. Since March 5, 2007, Railex is recognized as a certified EPA Smartway Transport Partner. Also, because Railex is a closed loop system, nearly all damage and padding is reused by Railex, as is not the case for intermodal and trucking.

5.1.3 Company B : Wal-Mart and the Wal-Mart/Railex Relationship

Wal-Mart is the world's largest chain of discount department and retail stores, many containing grocery and produce sections. For Wal-Mart, partnership with train shipment service for fresh product is a novelty. Through Railex, Wal-Mart's deliveries of apples, pears, and onions are brought from Washington to Albany, New York twice per week. Current shipment of produce for Wal-Mart shipped via Railex equal approximately 20% of Railex's total shipment volume. Before Railex, all of these goods were trucked across country, as the ~13 day shipment time for traditional coast-to-coast rail shipment was unacceptable for produce. Railex, taking only seven days to ship door to door from Washington to New York, provides an alternative that is cheaper than truck, low risk, and fast enough to meet retailer needs. Also, 70-80% of Railex customers (including Wal-

Mart) utilize their service “door-to-door.” According to Railex senior management, Wal-Mart is looking to expand its relationship with Railex, meaning greater volume of produce shipment, as well as an expansion into canned and bottled goods, and import/export.

5.1.4 From Road to Rail

Prior to the Switch to Railex

Prior to Railex’s involvement, Wal-Mart’s trucking partners did the shed pick-up from five produce growers in Washington, and trucked via full truckload to three Wal-Mart distribution centers in the Northeast (cf.1 in Figure 15). However, even securing trucks was at times difficult. In January 2004, the United States Department of Transportation (DOT) revised regulations pertaining to hours of service. Because of this rule change, interstate commercial truck drivers could no longer drive more than 11 hours consecutively, or drive any more after 14-hours of road time since starting a duty shift until they had a full 10-hour break. The DOT implemented this rule to reduce accidents related to truck driver fatigue. However, this also increased costs to customer due to added travel time. Drivers switched to short-haul routes, which were more profitable; this triggered a shortage of long-haul operators. Conventional rail was not a viable alternative, as it takes anywhere from 11 to 28 days to deliver cross-country, and this would have been infeasible for perishable produce.

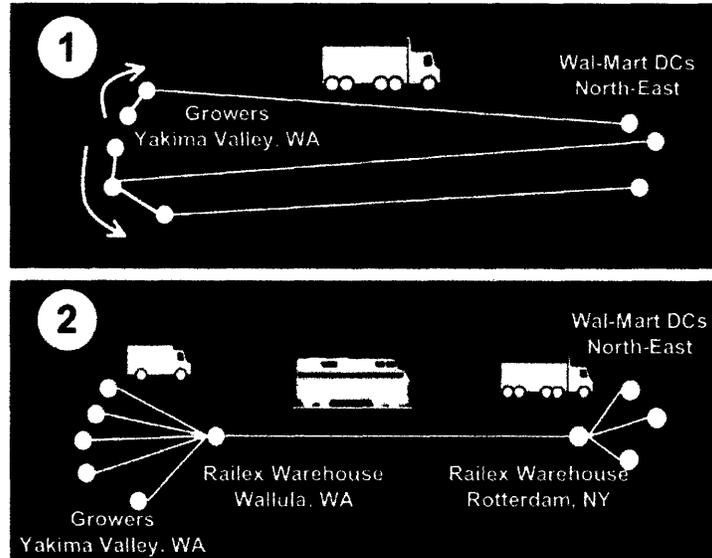


Figure 15. Distribution Network: Before (1) and After the Switch to Railex (2)

Current Situation

Currently, Railex’s trucks gather produce from growers within a 300-mile radius of Wallula, Washington via truck and consolidate sheds at the Railex refrigerated warehouse facility in Wallula. Four truckloads are the equivalent of one train boxcar. The produce is then shipped on 55 64-foot refrigerated railcars that head eastbound to Rotterdam, NY, stopping only in Chicago where the staff changes from a Union Pacific crew to a CSX crew. Upon arrival at Rotterdam, the produce is distributed by heavy truck to three Wal-Mart DCs (cf.2 in Figure 15). Via Railex, Wal-Mart ships approximately 10,000 pieces per year at 50 pounds per piece; this is approximately 5% of Railex’s total volume.

Implementation

Although Wal-Mart was among the first Railex customers in 2006, Wal-Mart represented only a 2% share of Railex’s volume. With close to 5%, Wal-Mart is currently one of the largest Railex customers. Railex has expressed enthusiasm for their partnership with

Wal-Mart and are hopeful that they can grow their business to a point where Wal-Mart is 20-25% of their total shipping. With a cost advantage and a high service reliability, Railex offers an attractive alternative to trucking for Wal-Mart to continue to increase the volume shipped by Railex. In this case, we observe no sudden change in the way the retailer does business but a staggered implementation of an advantageous solution.

5.1.5 Estimation of Savings and Impacts

We propose in this section to compare previous Wal-Mart trucking routes with Railex's version for an entire year. We complement this analysis by looking as well at the intermodal solution. After introducing our assumptions, we provide the results of our calculation when estimating CO₂ emission reduction and cost savings. We pursue the analysis by looking at the other consequence of the change on time-to-market and risk management.

Assumptions

To make this comparison we assume that the loads per year is equivalent to 5% of the total Railex's load shipped from Wallula, WA (i.e. two shipments a week with on average the equivalent of 200,000 cartons tray pack of 42 pounds shipped). This represents close to 19,800 pounds of product shipped a year for Wal-Mart (cf. Table 4). In addition, we estimate the kilometer traveled from the grower location to Wal-Mart DCs per transport mode in the case of both the prior trucking solution and the current solution with Railex. Table 5 lists the individual distances considered to lead to a

4,500km run per load on average in the case of the full trucking solution, compared with 4,670km by train and 240km by truck (first and last miles) with Railex.

Loads

Loads per transport mode	Length (feet)	Capacity (lbs)
Refrigerated Heavy Truck *	48	40,000
Intermodal Rail Car *	48	40,000
Railex's railcars *	64	190,000

* Agricultural Refrigerated Truck Quarterly : <http://www.ams.usda.gov/AMSV1.0/getfile?dDocName=STELPRDC5065534&acct=atgeninfo>

Conversion	
lbs/cartons tray pack*	42
lbs/50lb sks	50

* Figure from the US Department of Agriculture, March 2008, <http://www.marketnews.usda.gov/portal/fv>

Loads per shipment (headhaul)	Share	Cartons tray pack	lbs	Kg
Loads (Railex)*	100%	200,000	8,400,000	3,810,176
Loads (Wal-Mart)*	5%	10,000	420,000	190,509

* From interview with Railex representative

Loads per year (headhaul)	
Number of Railex Shipment/Year *	104

* From interview with Railex representative

Loads per year (headhaul)	Cartons tray pack	lbs	Kg
Loads (Railex)	20,800,000	873,600,000	396,258,294
Loads (Wal-Mart)	1,040,000	43,680,000	19,812,915

Table 4. Loads Traveled

Distances

Prior to Railex		Miles	Kilometers
Grower 1 (Naches)*	RDC1	2,792	4,493
Grower 2 (Selah)	RDC1	2,780	4,474
Grower 3	RDC2	2,800	4,506
Grower 4	RDC2	2,800	4,506
Grower 5	RDC2	2,800	4,506
* Figures from Google Maps		Average distance per truck	4,497

Current		Miles	Kilometers
Grower 1 (Naches)*	Wallula's DC	114	183
Grower 2 (Selah) : Rainier Fruit Co.	Wallula's DC	107	172
Grower 3	Wallula's DC	114	183
Grower 4	Wallula's DC	114	183
Grower 5	Wallula's DC	114	183
Wallula's DC	Albany's DC	2,900	4,667
Albany's DC	RDC1 (Sharon Spring)	35	56
Albany's DC	RDC2	35	56
Albany's DC	OC	35	56
* Figures from Google Maps		Average distance per truck	238
		Average distance travelled w/ Railex	4,667

Table 5. Kilometer Traveled per Transport Mode

As far as costs are concerned, we look first for information publicly available on transport costs for long haul trucking from Washington to New York (\$5,644 per truck-load) and complemented this data with our interpretation of Railex's representative information on intermodal and Railex service market price. Since the introduction of its service in 2006, Railex has added competition and led to decreased costs throughout the

marketplace. Trucking and train have slashed intermodal pricing by a few thousand dollars to compete with Railex. Mr. Piccione approximates that prices for intermodal shipping via the Washington to New York route have been cut from \$5,700 to \$3,700 per full truckload equivalent. Mr. Piccione informed us that even firms that do not utilize Railex are grateful that they have entered the marketplace because of the dramatic competitiveness. While the cost varies, on average the prices for utilizing Railex are above intermodal, but below truck with the average price of \$5,500 per full truckload. We therefore estimated the average price of the Railex service to be priced at \$5,000 per equivalent full truckload, i.e. \$23,750 per full carload. Table 6 presents the cost information for all three transport mode.

Transport Cost From the Pacific Northwest to NY State	
Heavy Truck (\$/Truck = 20t)*	5,644
Intermodal (\$/Container)**	3,700
Railex (\$/Car) ***	23,750 => I.e. around \$5,000 for 20t

* Figure from Origin-Destination truck rates from the Agricultural Refrigerated Truck Quaterly, for apples for the route from Pacific-NW to New York.
 ** Estimates from Railex representative
 *** Own estimates in accordance with info. from interview with Railex representative

Table 6. Transportation Costs per Transport Mode

Finally, with regards to CO2 emissions, we used the emission factor proposed by the EPA SmartWay, which has the advantage to provide not only information on heavy truck and train emission but also details on intermodal CO2 emissions (cf. Table 7). Although we later propose to look at the impact of headhaul and backhaul capacity utilization on the emissions, we took the value as provided by the EPA for the initial estimate.

CO2 Emissions	
Emissions per Transport Mode	gm/tonne/km
Heavy Truck	47
Intermodal	25
Railex	15

* EPA SmartWay Figures

Table 7. EPA SmartWay Carbon Emission Factor per Transport Mode

CO₂ Emission Reduction and \$ Savings

The product of the number of loads traveled by the trip unit cost give us the total transportation expense for the three alternatives. Similarly the product of the load by the distance run and by the emission factors give us the total transport emissions associated with the transport of these apples from their grower location to the retailer DCs. As shown in Table 8 and Figure 16, heavy-truck is the most expensive alternative and the most damaging for the environment with a total cost of \$6,200,000 and 4,200 metric tonnes of CO₂ emissions. Railex proposes the best alternative in terms of carbon emission with a slight advantage in terms of cost over trucking: \$5,500,000 and 1,600 tonnes. Intermodal is the cheapest option: \$4,000,000, although not as attractive for carbon reduction: 2,500 tonnes.

Results		
Distribution options	Transport Cost (\$)	Transport CO2 Emissions (tonne)
Heavy Truck Option	6,163,248	4,188
Intermodal Option	4,040,400	2,533
Railex Option	5,460,000	1,608

Table 8. Costs and Carbon Emission per Transport Mode

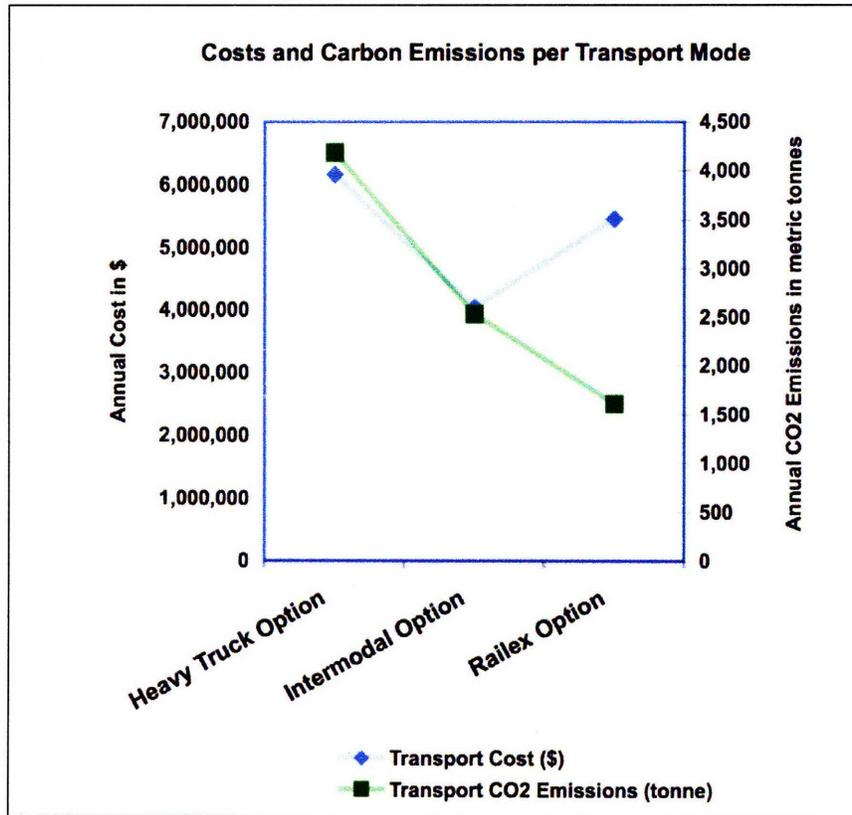


Figure 16. Costs and Carbon Emissions per Transport Mode

If we only focus on savings, the benefit of the Railex route over trucking is substantial: 11% reduction in costs (i.e. \$700,000) and 61% reduction in CO2 emission (i.e. 2,600 tonnes or the equivalent of 500 cars taken out of the road). This result is presented in Table 9. It is interesting to note that the cost benefit per tonnes of CO2 saved approach \$275.

Savings			
	Transport Cost Savings (\$)	Transport CO2 Emissions savings (tonne)	Ratio (\$ saved/tonne of CO2 saved)
Railex vs. Heavy Truck	703,248	2,580	273
Emission Savings (In US household equivalent, I.e. 50t/year) *	52		
Emission Savings (In US car equivalent, I.e. 5.1t/year) **	507		
* Household = 2.5 persons/year from http://bie.berkeley.edu/files/ConsumerFootprintCalc.swf			
**EPA SmartWay			

Table 9. Railex vs. Heavy Truck: Costs and Carbon Savings

CO₂ Emission Reduction based on Adjusted Emission Factors

We propose in this section to compare the estimation of the savings obtained earlier based on the EPA SmartWay emission factors to the estimation based on the adjusted factors we introduce in section 4.4. To make this comparison we assume headhaul load = 90% of capacity, and backhaul = 35% of capacity for the Railex case, but consider heavy truck capacity utilization for this route to be 95% and 55% for the headhaul and backhaul respectively. Capacity utilization assumptions and adjusted emission factors are presented in Table 10 and Table 11.

Capacity Utilization	Heavy Truck	Intermodal	Railex
Capacity Utilization Headhaul (North-Pacific to North-East)*	95%	90%	90%
Capacity Utilization Backhaul (North-East to North-Pacific)*	55%	35%	35%

* From interview with Railex representative

Table 10. Capacity Utilization of the Headhaul and Backhaul

Adjusted CO₂ Emissions	
Adjusted Emissions per Trans. Mode	gm/tonne/km
Heavy Truck*	60
Intermodal*	30
Railex*	22.5

* Estimates based on the method introduced in section 4.3

Table 11. Adjusted Emission Factors

The results in terms of cost savings do not differ substantially from the results obtained earlier. Cost saving again approaches \$700,000. However we note that we obtain a sensibly higher CO₂ emission reduction with close to 3,000 metric tonnes vs. 2,600 for the previous case (cf. Table 12). This is mainly due to the fact that the carbon footprints of both solutions are pushed up because of the less favorable emission factors (affected by the relatively low capacity utilization), therefore creating a larger gap between the two options.

Results			
Distribution options	Transport Cost (\$)	Transport CO2 Emissions (tonne)	
Heavy Truck Option	6,163,248	5,346	
Intermodal Option	4,040,400	3,056	
Railex Option	5,460,000	2,363	

Savings			
	Transport Cost Savings (\$)	Transport CO2 Emissions savings (tonne)	Ratio (\$ saved/tonne of CO2 saved)
Railex vs. Heavy Truck	703,248	2,983	236

Table 12. Results and Savings based on the Adjusted Emission Factors

Impact on the Time to Market

Actual shipment time via Railex is 4.5 days. However there are an additional two days associated with the shipment as consolidation and transportation from grower to Railex Washington facility, and final leg transportation from the Rotterdam facility to the destination point must be accounted for as well. In total, shipping via Railex takes approximately seven days from door-to-door. This is considerably longer than the 3 to 3.5 days it takes to truck goods from Washington to New York; using an expedited trucking service it can potentially take as little as 2.5 days. Also, while there is considerable flexibility with regard to shipping schedule via truck, when in shipping via Railex there is a more restrictive schedule.

Risks

As of January 2008, the most a Railex train has ever been late is 6 hours (three late deliveries out of 70 total train runs). Thus, the risk is minimal and the consistency is high. To be compared with 16,000 trucks per train route, look at risk profile of the truck routes with cost-benefit analysis. However, shipping via rail is not risk free. After our visit to the Railex Rotterdam facility, on February 18, 2008 there was a mudslide on the

Union Pacific mainline track south of Eugene, Oregon. While Railex's 1st train was able to continue without delay, Railex was forced to temporarily postpone service on its 2nd route, as Union Pacific estimated that 153,000 truckloads of fallen trees, mud and snow needed removal before the track could be restored to service. Although rail networks do not offer the same level of redundancy that the road network allows for, Railex affirms that contingency plans have been defined to face issues leading to track shut down, such as for fire, mudslide, or terrorist attack. However, as this mudslide affirms, while risks are few, they are still a potentiality when shipping via Railex. In addition to consistency, it is of note that the expedited train service enables correction of some of the imbalance between demand and supply for long-haul shipment. As mentioned by the U.S. Department of Agriculture in the *Agricultural Refrigerated Truck Quarterly*, truck availability from the Pacific Northwest remains an issue.

5.1.6 Change Management

The green initiatives of Railex's client companies factor in to their choice of shipping via Railex rail service. For example, the regional grocer, Wegmans, and REI, a sporting goods concern, both utilize Railex even though it would be cheaper for them to use intermodal. Cost is not their only bottom line, and as Mr. Piccione reported to us, a sizable minority of the firms who use Railex chose to do so even though it is more expensive for them. He estimates that many firms with green initiatives have an approximately 10% ceiling over cost for choosing carbon-reducing alternatives.

5.1.7 The Future

In February 2008, Railex added a second weekly train to ship fruits and vegetables from Washington to New York. The new trains leave Washington every Thursday morning and Saturday evening, arriving in Rotterdam every Tuesday morning and Friday evening. This expanded service will make Railex more attractive to companies who previously avoided the rail shipper because of scheduling constraints.

Railex is looking to extend their shipment volumes of core produce, including apples, pears, onions, and potatoes. They have done some temperature-controlled beverage shipping, including bottled wine and beer, and are looking to expand canned goods and especially import/export (exports are taken cross country and then on to Europe, or via mini land bridge to Central and South America, through Rotterdam and then on to the Port of New York or Newark Airport). As mentioned earlier, Railex has short-term plans to add a route from Central California that will connect both with Wallula, WA and Rotterdam, NY; this is expected to begin in September or October of 2008. Railex also has plans to add additional facilities in Illinois, Texas, and Florida, and have all routes be interconnected. Mr. Piccone informed us that this is an aspiration of the company: “That’s part of our aggressive expansion plans—to get the four corners of the US connected with high-speed unit trains.”

5.1.8 Limitations and Future Research

Regarding Railex subcontractors, we were not able to obtain precise figures on the capacity utilization of the LTL trucking used for consolidation. Because of this we could

not estimate the first and last miles of the Railex transportation footprint as accurately as we would have liked. Also, while we asked Railex representatives how they select carrier partners, Railex was unable to confirm whether carbon footprint was a factor in their decision-making.

We did not take inventory holding costs, or warehousing costs into account when conducting our analysis, because of limited information available to us at this time. We acknowledge that this biases our final cost estimation results. That is why we have highlighted above that cost reduction is only for the transportation component of Railex. In this specific case, we believe that the impact in this specific case should be small, because warehousing is part of the Railex service proposal. We assume that consolidation and warehousing is considered in the transportation costs. However, this needs to be confirmed from further conversation with Railex representatives.

5.2 Stonyfield Farm/Ryder

5.2.1 Introduction

This case focuses on the partnership established between Stonyfield Farm, the world's largest organic-yogurt company, and Ryder, a major third party logistics provider.

Started in 2006 at the initiative of Stonyfield Farm, this partnership enabled the yogurt company to reduce significantly the carbon footprint of its distribution network.

Created in 1983, Stonyfield Farm has grown steadily at a 27% growth rate (to be compared with the 5 to 7% growth rate for the industry) over the past 18 years. With sales revenue exceeding \$300 million in 2007, Stonyfield Farm has a well-established position as “the world's largest organic-yogurt maker.”

Through Gary Hirshberg's strong commitment to sustainability causes, Stonyfield Farm has, over several years, managed to reduce CO₂ emissions in proportion equivalent “to taking 4,500 cars off the road,” and by doing so, “saved more than \$1.6 million” according to Hirshberg (2008). The company-led initiatives are articulated around four efforts, set as a guideline for all of the company's stakeholders:

1. Measure carbon footprint
2. Reduce emissions – energy efficiency, incorporating renewable energy, farming and packaging reduction.
3. Offset emissions
4. Educate and advocate

When selecting this case, we considered the positive remarks formulated by peer companies with regards to Stonyfield Farm initiatives; according to companies we

interviewed, Stonyfield Farms was consistently considered a leader in this new field. In addition to peer recognition, the other reason for choosing Stonyfield was to learn from a company with considerable cumulative experience dealing with environmental issues. Stonyfield Farm has been a pioneer company in carbon inventory. In 1994, Stonyfield Farm was “the first manufacturer in the US to mitigate the CO₂ emissions from [their] facility by investing in carbon offsets.” In addition to the positive comments from the industry, the fact that Stonyfield was awarded the “Logistics Innovator Award,” for its successful partnership with trucking transportation partner Ryder in their combined effort to reduce the carbon footprint of their distribution, added to our curiosity.

Most of the information provided in this section was collected through interviews with Ryan Boccelli, Stonyfield Farm Director of Logistics. The primary interview was conducted on the 24th of March 2008 at Stonyfield Farm’s main manufacturing facility in Londonderry, NH. In addition to the detailed information gathered during the interview, additional information about the context of the Stonyfield Farm / Ryder case were compiled from our lecture notes, when we attended Stonyfield Farms’ CEO Gary Hirshberg’s presentation at Harvard Business School on the 17th of March 2008. This information was complemented with key facts taken from Gary Hirshberg’s book *Stirring it Up* (2008).

The objective of the case is to focus more specifically on two efforts led by the company’s logistics group, i.e.:

- 1- To eliminate all LTL movement to drastically reduce miles-run,
- 2- To redesign the distribution network to further reduce miles-run.

5.2.2 Company A : Stonyfield Farm

Industry and Sales Volume in US

Based in Londonderry, NH, Stonyfield owns a 200,000 square foot facility, from where the firm produces and dispatches the entirety of its yogurt production. Stonyfield Farm is currently the largest organic yogurt company and the fastest growing yogurt company. With \$325 million in annual revenue expected for 2008, \$290 million annual revenue recorded for 2007, Stonyfield Farm is the 3rd largest yogurt brand in the US. Over the past 19 years, compound annual growth rate (CAGR) = 26.3%. Currently (for 2007) the company earnings before interest and taxes (EBIT) was approaching 12%.

Company History

Stonyfield Farm was founded in 1983 by Gary Hirshberg, an entrepreneur eager to demonstrate that there are means to do good and still make money. When he graduated from Hampshire College in 1972 where he studied climatology, Gary Hirshberg was already an experienced ecologist-scientist-farmer. After several years working for a non-profit sustainable farm in Massachusetts, he decided to start Stonyfield Farm. Stonyfield Farm's original mission statement was defined 25 years ago and formulated as follows:

- 1 - "To provide the very highest-quality, best-tasting, all-natural, and certified organic products."
- 2 - "To educate consumers and producers about the value of protecting the environment and supporting family farmers and sustainable farming methods."
- 3 - "To serve as a model that environmentally and socially responsible business can also be profitable."

4 - "To provide a healthful, productive, and enjoyable workplace for all employees, with opportunities to gain new skills and advance personal career goals".

5 - "To recognize our obligations to stockholders and lenders by providing an excellent return on their investment."

Although the company struggled first, Gary Hirshberg remains committed to his sustainability values. The company finally turned profitable after five years of operation. Recently acquired by Dannon in 2001, the company results continue to flourish under the lead of Gary Hirshberg, "CE-Yo." From a 6% EBIT in 2001, the company has close to doubled this result by 2007.

Company Strategy

The company's strategy has not changed over time. The idea remains to maintain cost control while continuing to source premium quality organic products. With a gross margin 1000 basis points below Dannon's, Stonyfield Farm make it up by using inexpensive marketing techniques to expand its customer base: attract free press at a time they could not afford advertising. These initiatives range from joint communication with non-profit organization, partnerships with like-minded brand, internet and community marketing, and unconventional ad campaign ("adopt a cow" and "we support inflation" campaign targeted respectively to young consumers and automobile drivers). Consumer loyalty is supported by the emotional relationship established with the consumers sensitive to sustainability issues. Lid advertising helps build and consolidate this relationship.

Efforts towards Sustainability

Beyond the strong message conveyed by the mission statement, the company has a solid track record of actions taken to address sustainability issues. Early in 1986, Stonyfield Farm has already taken action to fight the following paradox: the "per-unit energy cost of delivering one package of yogurt to retailers in New York City" was actually lower than the per-unit energy cost of delivering the same package to Burlington in Vermont, due to the possibility to carry full truck load to New York City versus less than truck load for Burlington. In view of this issue, the firm initiated case by case partnership to contract their "return route" to limit empty backhaul. However, according to Gary Hirshberg, this "was still an unsophisticated view of the real environmental issue. To measure Stonyfeild's true impact on the planet, we had to measure our carbon footprint". Nancy Hirshberg, VP of Natural Ressources, was invited to take on this challenge.

By 1994, Nancy has "identified four main areas of concern: GHG emissions, toxins, resource use, and waste generated by [the plant] operations - then she began to report on them monthly." From there Stonyfield Farm created a "Mission Report" and "began an ambitious waste minimization program and packaging reduction initiatives."

By 1997, Stonyfield Farm became "the first manufacturer in the US to mitigate the CO₂ emissions from [their] facility by investing in carbon offsets" through investment in reforestation and wind projects. Offsetting was done with the guidance of Dr. Mark Trexler from the WRI (World Resources Institute). Seizing the complexity of the task, Stonyfield Farm executives decided "to publish and make available for free" "The

Carbon Cookbook” to other business for them to benefit from their experience.

However this first attempt was limited to the Scope 1 and 2 of the emissions involved in making and distributing the product. Both the eco audits (GHG inventory) conducted in 1994 and 1997 only covered Scope 1 and 2, although Scope 3, i.e. External, = 94% of the emissions. The next step was therefore to complete the detailed assessment of “the entire carbon footprint (from the methane released by the cows to the trucks delivering the products to the retailer DCs)”. This was conducted in 1999 with the support of Pure Strategies consultancy services.

This exercise was repeated in 2000 and as the result of this carbon emission inventory, Stonyfield Farm ranked the emissions issued from the different contributors as follows:

- First largest contributors are the cows themselves due to both methane emissions and emissions due to growing and transporting feed (grain feed is carbon inefficient; Methane is 20 times worse than carbon in terms of greenhouse gaz effects),
- Second is packaging,
- Third is shipping of finished product, and
- Fourth is the energy used to run the plant.

The inventory proved to be of great help to identify priorities, and pushed Stonyfield to take on the challenge of aggressively reducing the carbon footprint of the distribution network: all truck movements from the plant in NH to all retailer DCs spread across the country. In addition to these proactive efforts, the company established a new group called the Climate Counts, to leverage on the company expertise in carbon count and the will to produce a bigger impact on the community. A set of 22 questions has been defined to serve as a guideline when analyzing companies with the objective to rank companies

per sector according to their efforts to measure, reduce, and report on their carbon footprint. Interesting enough, Stonyfield Farm results were below Unilever in 2007.

Similarly to Stonyfield Farm effort to condition the market to accept organic as the norm (although organics remain marginal = 2.5% of the products consumed), Stonyfield's objective is to get the big players to buy into sustainability values and later improve and shift the market. According to Gary Hirshberg, no one is too small to impulse a change.

Sustainability In Practice

In order for all employees to take ownership of the change, the carbon reduction program is currently driven by ten Mission Action Program teams (or MAP). Created in 2006, the Mission Action Plan (MAP) team are to tackle the top-ten priority issues, with the objective "to get all employees, not just managers, emotionally connected to [the] long-term environmental goals".

Examples of achievements from the MAP include the construction of an anaerobic hybrid biological treatment facility at the Stonyfield premises. This wastewater treatment system runs partially on the biogas it generates and enables to decrease energy use by 40% and operating costs by 50%. With no sludge hauled away for 1.5 years, the project is a true success with an expected \$3.6 million return after the first ten years. Other examples of combine benefits for the environment and the bottom line include the replacement to foil lid for new packaging, resulting in 16% less energy used, 13% less water used, and \$1 million saved annually.

5.2.3 Company B : Ryder

Industry and Key Figures

With \$5 billion in revenue, Ryder is a Fortune 500 third party logistics provider and commercial truck rental and leasing company.

The Ryder and Stonyfield Farm Partnership

In 2006, Stonyfield Farm selected Ryder as supply chain partner to develop a baseline. Ryder was to play the role of Stonyfield Farm's Freight Bill Audit & Payment (FBAP) Service provider (equivalent to a "contract carriage management program"). Ryder has already been Stonyfield Farm partner for 15 years through leasing contracts. In its FBAP Service function, Ryder is to consolidate all shipment data on behalf of Stonyfield Farm for both their assets and other carrier assets. Stonyfield Farm sends daily to Ryder information on carrier, source, destination. Ryder complements this information with costs and kilometer run information obtained directly from the carriers.

5.2.4 Eliminate LTL and move to only FTL

The first objective of the logistics MAP team was to eliminate all less than truckload shipment. Led by Stonyfield Farm Director of Logistics, Ryan Boccelli, this project took less than a year to complete.

Organization

Stonyfield Farm logistics team comprises of 102 persons (including 15 to 20 clerks) working under the Logistics Director and the VP of Supply Chain, which covers both

Logistics and Procurement/Planning. The team is responsible for all outbound shipment; inbound is usually taken care of by suppliers with whom Stonyfield negotiates delivered price. Stonyfield Farm uses a dedicated fleet of 7 trailers, 5 tractors, and 9 drivers to serve all its customers within 250 miles (Note: 55% of of Stonyfield Farm volume is distributed within 500 miles). The average shipping cost is \$1,100 per FTL, i.e. around \$44 per pallet. For their own fleet, backhaul is as much as possible used for carrying finish products from partner companies (responsible for final assemblies), pallets, or raw materials/ingredients from suppliers.

Beyond 250 miles, carriers are awarded 100% of a lane under annual contract. Selection of carriers is based on a scorecard for which environmental aspects count towards 25% of the final mark, the remaining 75% for on-time delivery, management, driver cautiousness, etc. Carriers are encouraged to bid only on the lanes that work for them, i.e. for which they can fill the backhaul. New Hampshire being a high consumption state helps address the backhaul issue by using the reverse route. In total, Stonyfield Farm rely on 15 major carriers, which covers one or several lane, + 40 other carriers under contract. On average Stonyfield Farm ships the equivalent of 150 full truckloads per week (with each FTL equal to 24 pallets, i.e. 39,000 pds, excluding the pallet weight). All shipment departs from Stonyfield Farm's warehouse, which is adjacent to the production lines of Stonyfield unique plant located in Londonderry, NH. The surface occupied by the warehouse is 60,000 sqft. Around 5 to 6 days of production are stored at the warehouse. The total time to market is close to 13 days: 1 day (15h) from delivery of ingredients to production, 1 day minimum to obtain the status "ready for shipment" (but in reality up to

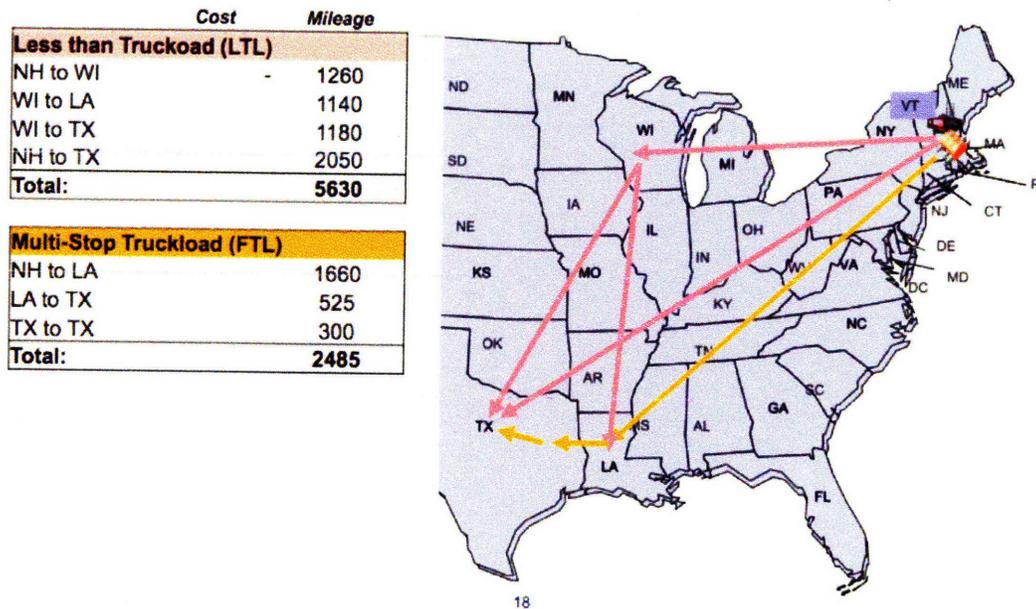
5/6 days at the warehouse), 6 days max. of delivery time to get the product shipped anywhere in the US.

Prior to the change

All LTL were routed through a unique "pull-point" in Wisconsin, independently of the final destination of the product. This resulted in additional kilometer-run. Although this seems not to make business sense, it was worth to note that Organic Logistics was at that time Stonyfield Farm carrier for all LTL and were proposing its services at a flat and attractive rate of \$200 a pallet for all shipment anywhere in US. In 2006, LTL shipment were equivalent to five full truckload shipment a week for Stonyfield Farm.

Current

After analyzing Q4 2006 and Q1 2007 LTL and truckload details, the logistics team observed that LTL could be almost entirely carried using existing fleet by re-adjusting the route of the fleet and adding extra stop (average = 2.5 stops in total for all FTL). This measure resulted in the dramatic reduction in the number of miles driven (up to 56% for certain load). Figure 17 provides an example of such a reduction with a load originally transiting through WI prior to be rerouted to TX and currently been shipped directly from the NH plant to TX via LA.



Source: Improving Transportation and Improving Transportation and Supply Chain Efficiency while Reducing your Carbon Footprint, Stonyfield Farm & Ryder Presentation Materials by Ryan Boccelli and Mark Swensson.

Figure 17. LTL vs. FTL - Reducing Miles and Cost

Implementation

In order to implement the change, the first step was to create a baseline. Prior to 2005-2006, all carrier data were only collection of paper invoices with no information on total kilometer run. In 2006, Stonyfield Farm selected Ryder as its Freight Bill Audit & Payment (FBAP) Service provider in order to establish an initial baseline, getting accurate data from Ryder and other carriers on all truck movements.

Based on the information gathered, the logistics group looked first for the easy gain and decided to address the LTL issue. The group proposed to decrease delivery frequency and pushed for a 10 days delivery, within the limit of the DOT (retailer requires 13 days DOT min.). In addition to this effort promoted by the sales group, the logistics team worked hand-in-hand with the manufacturing team to ensure on-time delivery from the production to the logistic team and thereby help synchronize production and shipment.

The last step was the redefinition of the shipping route to accommodate the new loads coming from previously LTL loads. This re-routing was done manually. Although this may appear to be a complex task, the very static nature of the network made the whole effort worthwhile. The only transfer from LTL to the exclusive use of FTL resulted in a 40% reduction in CO₂ emissions of all outbound logistics.

5.2.5 From LTL to FTL - Estimation of Savings and Impacts

Assumptions

The results presented hereafter are based on Stonyfield Farm own estimates. The EPA Smartway Shipper model has been used as a basis for all decisions. According to Ryan Boccelli, the use of the EPA Smartway model as reference permits to compare carriers (carriers graded from 0 to 1.25 according to the EPA model) and ensure consistency when conducting simulation as the EPA model covers both warehousing and transport emissions.

CO₂ Emission Reduction

With close to 40% reduction by the only implementation of the LTL to FTL measure, the MAP logistics team largely surpassed the objectives set by the group.

\$ Savings

Although the dollar savings do not match the mileage reduction, the benefits remain substantial with close to 8% savings. Important difference between mileage reduction and

cost savings are essentially due to the fact Stonyfield walk away from the attractive rate offered by Organic Logistics for LTL (achieved by serving a single route at a regular predefined time).

Impact on the Time to Market

The impact of this change on time-to-market is negative: decreased shipment frequency pushed Stonyfield Farm's customer to accept 10-day delivery.

Risks

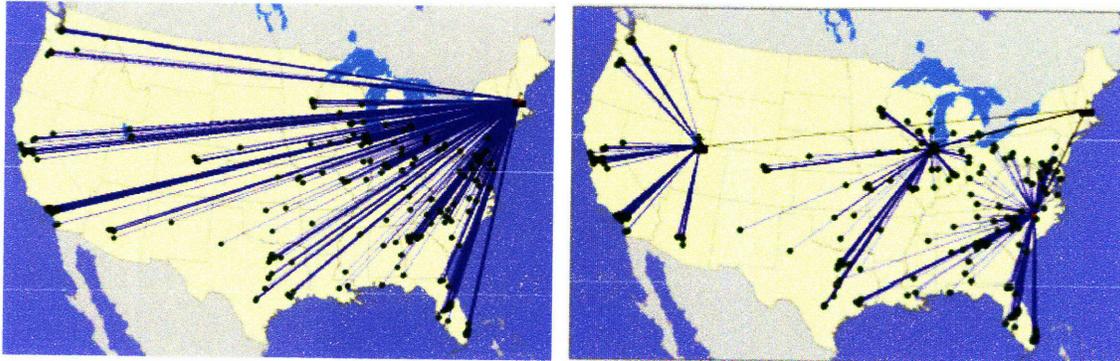
The transport changes made Stonyfield Farm less dependant on Organic Logistics, which adds reliability to their organizational design.

5.2.6 *Modify the Structure of the Distribution Network*

The next project the logistics group plans to undertake is be the optimization of the distribution network. In partnership with Ryder, and furthering the analysis conducted in 2007, Stonyfield Farm considered adding distribution centers to pursue the effort of reducing the carbon footprint of the outbound logistics. Initially planned through 2010-2015, the modification of the distribution network might take place in the next couple of years. Discussions have started with Dannon to launch this initiative sooner than previously foreseen given the advantage of the solution in terms of both cost and carbon footprint reduction.

Current

Currently all shipments are dispatched from the production and warehouse facility located in Londonderry, NH. Total miles run approach 7,600,000 miles per year and total dispatch costs \$13 millions.



Source: Improving Transportation and Improving Transportation and Supply Chain Efficiency while Reducing your Carbon Footprint, Stonyfield Farm & Ryder Presentation Materials by Ryan Boccelli and Mark Swensson.

Figure 18. Current and Optimized Network (4 DCs Model)

Expected

Based on different simulation run with 2, 3, or 4 DCs, the optimum solution appears to be the 4DCs option with DCs located in Londonderry (current warehouse), Indianapolis, Salt Lake City, and Charlotte. According to the simulation results, miles run of the outbound logistics could be reduced by more than 45%, resulting in a similar reduction in the total outbound logistics costs. Figure 18 presents both the current and proposed network with the 4 DCs.

Implementation

According to the head of the logistics department, should this solution be implemented each DC would be a third party DC (refrigerated warehouses) of approximately 12,000 sqft.

5.2.7 A New Distribution Network - Estimation of Savings and Impacts

Assumptions

The analysis was conducted based on a simulation model developed and run by Ryder and based on Stonyfield sales information and projections for the next 5 years (2013 horizon). The simulation was run on Logictools.

CO₂ Emission Reduction and \$ Savings

The measure is expected to reduce both miles traveled and the operating costs. Table 13 and Figure 19 show the magnitude of the opportunity for cost and emission reduction based on the current reference (i.e. 2007 figures) and based on the 2010 sales projection. The analysis was conducted with reference to the current distribution network, i.e. a unique DC in Londonberry, NH, and based on a 3 DCs and 4 DCs proposal.

Scenario		Warehouse Locations	Distance Traveled (Miles)*	Load Traveled (Tons-Miles)**	CO2 Emissions (metric tonnes)**
2010	Baseline	Londonderry	20,355,375	407,107,500	36,269
	3 DC	Londonderry, Indianapolis, Salt Lake City	12,423,899	248,477,980	22,137
	4 DC	Londonderry, Raleigh, Salt Lake City, Chicago	10,862,651	217,253,020	19,355
Current	Baseline	Londonderry	7,627,537	152,550,740	13,591
	3 DC	Londonderry, Indianapolis, Salt Lake City	4,671,076	93,421,520	8,323
	4 DC	Londonderry, Raleigh, Salt Lake City, Chicago	4,000,836	80,016,720	7,129

Scenario		Warehouse Locations	Transportation Cost (\$)*
2010	Baseline	Londonderry	35,108,413
	3 DC	Londonderry, Indianapolis, Salt Lake City	21,060,790
	4 DC	Londonderry, Raleigh, Salt Lake City, Chicago	19,074,802
Current	Baseline	Londonderry	13,417,790
	3 DC	Londonderry, Indianapolis, Salt Lake City	8,042,146
	4 DC	Londonderry, Raleigh, Salt Lake City, Chicago	7,050,721

* Estimates from Stonyfield Farm
** CO₂ Emissions based on the falling assumptions:
- Only covers emissions related to transportation (exclude warehousing)
- Capacity Utilization : 85%
- Load per truck (in lbs) : 40,000
- Road Mileage Conversion Factors (in gm of CO₂ per tonne per km) - EPA : 62

Table 13. Cost and Carbon Emissions for Different Network Configuration

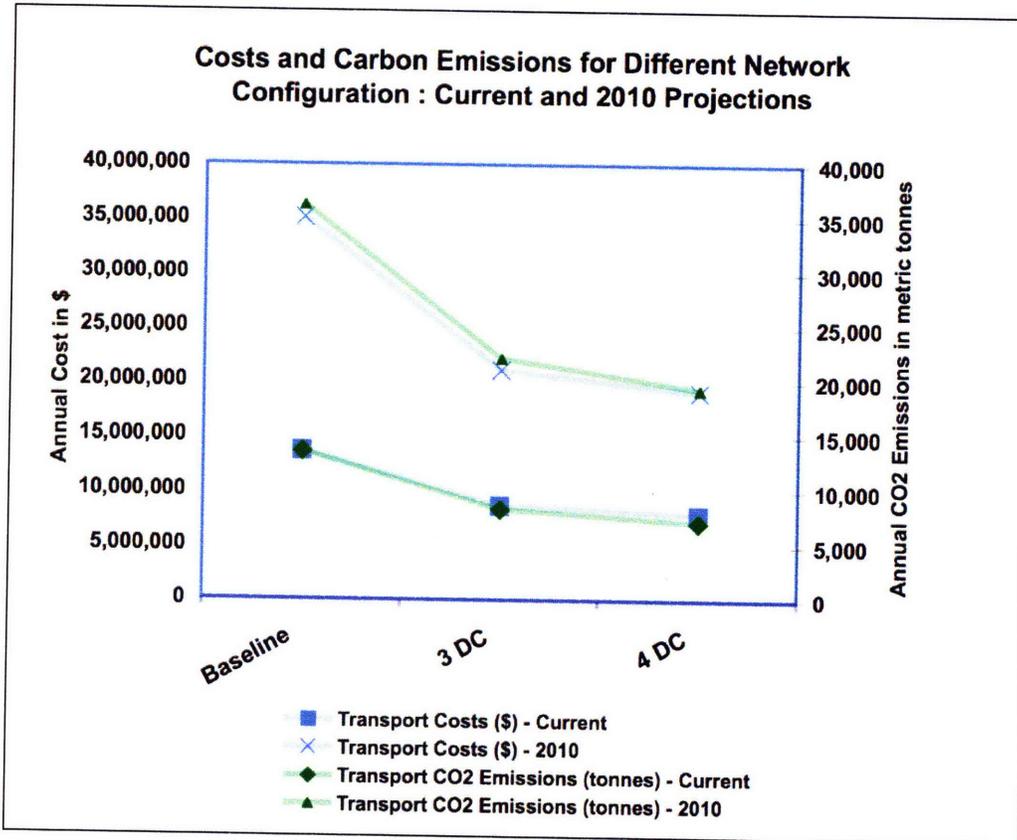


Figure 19. Cost and Carbon Emissions for Different Network Configuration

If we focus on savings and analyze the benefit of the 4 DCs solution over the 1 DC network based on the current sales volume, we would note that the costs savings approach \$5.8 millions and the carbon reduction approaches 6,500 metric tonnes of CO₂.

Results			
Distribution Network Option	Transport Cost (\$)	Transport CO2 Emissions (tonne)	
Current Sales Volume with 1 DC	13,657,790	13,591	
Current Sales Volume with 4 DCs	7,830,721	7,129	
Savings			
	Transport Cost Savings (\$)	Transport CO2 Emissions savings (tonne)	Ratio (\$ saved/tonne of CO2 saved)
4 DCs vs. 1 DC	5,827,069	6,462	902
Household emission (tonnes per year)*	50		
Car emission (tons/vehicle/year)**	5.7		
Car emission (tonnes/vehicle/year)	5.1		
Emission Savings (in US household equivalent)	129		
Emission Savings (in US car equivalent)	1270		

* Household = 2.5 persons/year from <http://bie.berkeley.edu/files/ConsumerFootprintCalc.swf>
**EPA: Smartcalculator

Table 14. 4DCs vs. 1DC: Costs and Carbon Savings

Impact on the time to market: Improve on-time performance

With DCs located closer to Stonyfield Farm’s customers, service level is expected to be significantly improved with a time to market that could be reduced by up to 4 days for the farther customers.

Risks

A decentralized network will be more complex for Stonyfield Farm to put in place and maintain. The new network will drive inventory up through the distribution center system.

5.2.8 Change Management

Pushed by its CE-Yo, Gary Hirshberg, Stonyfield Farm remains committed to its sustainability effort. With the recent creation of the MAP (Mission Action Program) teams (10 teams in total), Stonyfield Farm is now armed to attack more aggressively these challenges. Ryan Boccelli, Director of Logistics, estimates that close to 30% of his time is dedicated to the analysis of green issues (which have proved to ultimately drive to

cost reduction). Although his MAP team (= strategical team, comprising 7 members across function) only meet quarterly to decide on new initiatives and report on current activities, weekly meeting with the logistics team are organized to address all tactical issues.

MAP teams are asked to set stretch goals, bold objectives for their team. For the logistic group, the objectives set in 2006 were to reduce the outbound transportation carbon footprint by 50% by 2010 and 75% by 2015. By 2007, 40% reduction was achieved by eliminating the LTL network.

Incentives

At the management level, up to 25% of the bonuses are tied to the achievement of environmental objectives. Other logistics team members, clerks and workers, are asked during their annual review to report on what they did to improve the company environment practices. In general, it is observed that employees have a greater awareness of the issue (reduction of pallet misplacement resulting, etc).

Source of Idea / Innovation

For Stonyfield Farm, the first source of idea is learning from others. Very active on the sustainability scene, representatives of the company frequently attend conferences and discussions on the topic and seek assistance of partners, such as the EPA for the Smartway program. Although none of the measures implemented by Stonyfield might be considered as a real novelty, the combination of all these measures place Stonyfield at the

forefront of this effort. Stonyfield Farm remains cited by other companies as an example to learn from.

5.2.9 The Future

For the future, new initiatives under consideration include reducing further truck idle times at Stonyfield premises (1) by generalizing the use of an appointment software for dock scheduling (started in 2007), since more accurate information could avoid to keep truck idle all day, and (2) by looking at the possibility to get electrification at the dock to plug in refrigerated trailer. It is estimated that 1h of refrigeration is equivalent to 1 gallon of fuel burnt.

In the immediate future, Stonyfield is looking for all its carriers to be SmartWay partners by the end of Q4 2008. SmartWay scores will be subsequently considered as part of the carrier selection process. This initiative is expected to induce a further 10% reduction in the company emission. In parallel, Stonyfield Farm analyzes solution for vehicle efficiency: for example, the analysis of the pertinence of bio-diesel solution. Stonyfield Farm has been the first company to order Ryder Green EPA certified truck. Stonyfield Farm's hands-on involvement in three parties discussion with Ryder and Thermoking in the evaluation of climate control system design for refrigerated truck.

At the time being, selection of alternative transport modes such as intermodal and train has been considered but discarded due to the high perishability of the product. Although possible, this would require a very high level of service consistency to stay within the

DOC-13 days limit (13 days before the date of conservation that appear on the product). This would require retailer to order more than 10 days in advance, which seems difficult to envisage at that time.

5.2.10 Limitations and Future Research

All the figures for the move from LTL to FTL were provided directly from Stonyfield Farm; due to a limited information set, we were not able to make our own calculation to confirm what was provided by Stonyfield Farm. Regarding the switch from 1 DC to 4 DCs, our calculations did not take inventory holding costs, or warehousing costs into account when conducting our analysis, because of limited information available to us. We acknowledge that this could be misleading when looking at our final cost estimation results. That is why we wish to again highlight that cost reduction is only for the transportation component of Stonyfield Farm. In this specific case, the impact will be significant in terms of inventory holding costs due to a move from centralized to decentralized system. With regard to warehousing costs, we made a quick estimate and found that the impact was minor.

5.3 Fiji Water

5.3.1 Introduction

This case focuses on Fiji Water, a Fiji-based company that in 2007 became “the first bottled water company to release [the] carbon footprint of its products”¹¹ In November 2007, Fiji Water announced a sustainable growth program including a commitment to becoming carbon negative beginning in 2008. Fiji Water pledged to reduce actual greenhouse gas emissions 25% by 2010 by reducing packaging 20%, supplying at least 50% of the energy used at its bottling facility with renewable energy and optimizing logistics to take advantage of more carbon efficient modes of transportation. Across all products sold in 2008, the company expects to deliver a net reduction of more than 20 thousand tons of carbon dioxide and carbon equivalent gasses from the atmosphere as a result of this commitment. Fiji Water reports that, “This is equivalent to taking over 3,500 cars off the road or planting over 500,000 trees.”

The media buzz around Fiji Water’s sustainable growth program caught our attention early in our research. In 2006, the water brand created a controversy with the slogan “The Label Says Fiji Because It’s Not Bottled in Cleveland.” Since then the company took many steps to act proactively, analyze the footprint of its brand, and inform its customer on the detailed carbon content of its product.

We first met with Barbara Chung, Senior Manager within Fiji Water’s Sustainable Growth division, the 19th of March 2008 at Harvard Business School (HBS), where

¹¹ <http://www.csrwire.com/News/11649.html>

Barbara was invited to present Fiji Water's new FijiGreen initiatives. Following this initial introduction to Fiji Water's initiatives, we had the opportunity to further discuss the logistics piece of this program during a phone interview arranged with Barbara on April 3rd, 2008. The information gathered during this interview was key to the preparation of this case study; other sources of information included newspaper and magazine articles, and online media interviews as referenced later in this section. The objective of this case is to focus more specifically into the measure taken by Fiji Water to minimize the truck miles traveled to distribute bottles throughout the United States to reach its North-East customers by taking advantage of longer shipping route and accessing this market through the Port of Philadelphia via the Panama Canal.

5.3.2 The Company: Fiji Water

Company History

Fiji Water was founded by David Gilmour, who owned a vacation resort in Fiji. He noticed many of his patrons were bringing Evian water over to the island, and thought, "Fiji must have better water." He searched the island nation for an optimal water source, and finding a desirable aquifer he built a bottling facility and created the brand, believing he had the purest, best-tasting water in the world, and that consumers would pay a premium for this. He built brand equity by establishing Fiji Water in luxury settings—not just in Fiji, but in resorts and restaurants globally. In 2004, he sold the business to Roll International, majority owned by Lynda and Stewart Resnick, successful serial entrepreneurs who also own POM Wonderful and are one of the largest producers and distributors of nuts in the United States. They have continued to grow brand equity, making Fiji the preferred choice beverage in the luxury Peninsula Hotels chain, and a

staple of bottled water lists in the United States' most highly acclaimed restaurants. Historically, the Resnicks favored the "Buy-Build-Sell" model; according to our source at Fiji Water, they now have changed approach and plan to grow and retain the brand.

Industry Overview

In 2006, per capita, Americans drank 28.3 gallons of bottled water—the equivalent of 18 half-liter bottles a month. The only beverage category with greater consumption is carbonated soft drinks, with 52.9 gallons ingested annually. Globally, total sales of bottled water equaled \$50 billion, with the United States being the largest consumer. The US bottled water business does \$15 billion dollars in revenue, and water is one of the faster growing segments of the bottled beverage industry, growing at a much faster rate than carbonated beverages (soda sales are declining). Sector research has shown the bottled water market growing at about 5% annually. According to market research group Beverage Marketing, the best selling bottled water in the US is PepsiCo's Aquafina, with a 13% market share. Coca Cola's Dasani is second, with 11% market share. Both Aquafina and Dasani are purified municipal water that is processed, packaged and branded by Pepsico and Coca Cola, respectively. Evian is owned by French food and beverage conglomerate Danone, and is distributed in the United States by Coca Cola. The largest bottled water company in the United States is Nestlé SA, which has acquired a portfolio of water brands (organized under the Nestlé Waters umbrella), and has expanded them aggressively. In total, Nestlé's bottled water brands make up 26% of the U.S. bottled water market.

Fiji Water Sales Volume in the U.S.

Fiji Water anticipates year-on-year total revenue growth of approximately 20% over the next 3 years. Currently, Fiji Water's revenue is 1% of the \$15 billion US bottled water market, and 90% of Fiji's sales are in the United States. Despite Fiji Water's small size in terms of revenue, they have received outside publicity for their commitment to be the first "carbon negative" beverage brand in the world by the end of 2008. Already, they are the first major American beverage brand to account for entire supply chain emissions (UK-based Innocent Drinks was the first beverage brand worldwide). In total, one billion bottles of water move around the United States each week via ships, trains, and trucks. Fiji Water makes up a very small percentage of this—0.2% of total beverage industry revenue.

Operation

The Fiji Water bottling plant is located on the remote northeast coast of Fiji's main island, Viti Levu. The plant is replete with computer-controlled bottle-making and bottle-filling equipment, and has the ability to run 24-hours a day. Each of the facility's three lines has the capability to fill 1 million bottles of Fiji Water each day, producing enough finished product to fill forty 20-foot shipping containers. The plant employs 200 Fijian islanders, with an expectation of increasing the workforce by 25% this year. Fiji Water produces its bottles and caps on site at its Fiji plant. Fiji Water's bottle cross-sections are square rather than cylindrical as are most other beverage containers. The square design allows more water bottles to fit into cases, pallets, and shipping containers, and Fiji Water estimates that this allows them to ship approximately 10% fewer cases

than they would have had they adopted the cylindrical bottle. For this year, Fiji Water has calculated that this has allowed them to ship 1,000 fewer containers than they otherwise might have.

Fiji Water does not fly product. They ship via container vessel, which produces the fewest emissions per ton carried and mile traveled of the four major modes of transportation. Once filled in their Fiji bottling facility, cases of Fiji Water are loaded into containers, and then transported via truck to Lautoka or Suva, the two major shipping ports in Fiji. From those ports, Fiji Water travels by ship to markets around the world in 2,500 TEU ships (Twenty-foot Equivalent Unit). Fiji Water utilizes ships that follow two routes: (1) - Fiji to Hawaii to Los Angeles, and then circumnavigating; and (2) - Fiji to New Zealand and then on to the rest of world. Fiji Water reported to us that in essence, there is no “backhaul” either way, as the ships continually circumnavigate, stopping at different ports to pick up and drop off cargo. In Fiji, ships come to port to drop off staples for locals; Fiji Water never had to add a ship to any route. Where ballast was previously carried, now Fiji Water is carried. According to Fiji Water, these ships use nearly the same amount of fuel with or without FIJI Water, since (1) about 75% of a ship's fuel usage is required to power the ship even without cargo, and (2) Fiji Water represents less than 10% of a given ship's cargo. Once the product arrives at its destination ports, it is transported by rail or more often via truck to third-party warehouses (seven warehouses in total: Northern and Southern California, Los Angeles, Texas, Miami, Savannah, and New Jersey), and from those third-party warehouses to its customers. As part of its commitment to become a carbon negative product, Fiji Water is

looking into using bio-fuels where possible throughout the transportation process and will look to “optimize” logistics to make greater use of low carbon shipping modalities (primarily ocean freight and rail). Fiji Water reports that its container shipment carriers operating shipping routes between Fiji and the U.S. are working to reduce environmental impact by:

- Minimizing CO2 emissions by applying policies for “steady running,”
- Experimenting with low sulfur content fuel
- Using NOx efficient technology in their engines
- Reducing particulate matter emission via slide type fuel injection valve and new cylinder lubrication technology.

Company Strategy

The following quote from Thomas Moody, Senior Vice-President for Sustainable Growth at Fiji Water, summarize the key principles of Fiji Water’s current strategy: “the decision to go carbon negative has more to do with the overall philosophy of [the] company. [Fiji Water] sees itself as being in the business of making the world better, not just leaving things the way they were. That applies to the nation of Fiji, where [Fiji Water] has become the country's most important driver of economic development. It also applies to [its] consumers in many markets because the bottle of water they drink today replaces the processed beverage they were drinking a few years ago. The idea that [Fiji Water] as a business should be making things better is the main driver behind [its] decision that [it] should take out more greenhouse gas emissions than [it] puts in and not just balances the amount. In doing so, [it] gives [its] consumers the opportunity to be a part of the solution

as well.”¹²

Efforts Towards Sustainability

Fiji Water defines sustainability using a definition first offered by the Brundtland Commission, convened in 1983 by the United Nations. In the Brundtland Commission’s report, *Our Common Future*, sustainability was defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

FIJI Water's Sustainable Growth Initiative includes the following strategies:

- Reduction of CO2 emissions associated with our products' entire life cycle,
- Purchase of permanent and verifiable carbon offsets to cover 120% of the emissions that cannot be reduced directly, and
- Protection in perpetuity of the largest remaining area of pristine rainforest in Fiji.

Fiji Water is also the first privately held U.S. company to be part of the Supply Chain Leadership Collaboration. As part of this relationship, Fiji Water uses information from the Carbon Disclosure Project (CDP). This allows Fiji Water to select and encourage suppliers to measure and disclose carbon emissions associated with their actions. Fiji Water believes measurement is the first key step to managing emissions.

Though the distance Fiji Water travels—nearly circumnavigating the globe from Fiji to the United States—is the area which receives the most negative publicity, Fiji Water has found that the biggest contribution to its carbon emissions comes from packaging and the energy required to manufacture it. Fiji Water plans to reduce the amount of materials

¹² From http://www.sustainablelifemedia.com/people/innovators/climate/fiji_waters_thomas_mooney_talks_carbon_negative

used in product packaging and to increase the amount of recycled content packaging contains. Currently, Fiji Water uses recycled content in cases, but not in bottles. Fiji Water plans to make packaging a focal point in their continued efforts to reduce carbon footprint. Fiji Water has stated that by 2010, more than 50% of their Fiji-based bottling plant energy will come from renewable sources. The firm is examining installation of a wind farm designed for the facility. Building off of a July 2006 to June 2007 baseline, by 2010, Fiji Water plans to deliver the following sustainability benefits:

- 25% reduction in CO2 emissions,
- 50% of energy used in the production process to come from renewable sources,
- 20% reduction in product packaging, and
- 33% reduction in waste from the production facility in Fiji.

Fiji Water also believes there is room for improvement in the way they ship product. They are committed to transport via container ship for the bulk of the journey, and using rail or trucks only for short haul. Recycling is another area of priority for Fiji Water in looking to reduce carbon footprint. Senior Vice President of Sustainable Growth, Thomas Mooney stated: "Recycling a Fiji Water bottle so that material can be reused wipes out a third of the overall emissions associated with the product's manufacture and transport." The current nation recycling rate for PET (Polyethylene Terephthalate) is only 23%; because of this, 38 billion water bottles a year—more than \$1 billion worth of plastic, end up in landfills. On this front, the firm is working on a number of public initiatives to increase recycling rates in the United States, including lobbying for increased rebate for consumers who recycle plastic bottles.¹³ According to Fiji Water's

¹³ In the United States, Michigan leads all states with a nearly 100% recycling rate for aluminum cans and plastic bottles; this is largely attributed to the \$.10 rebate per container.

analysis, recycling is the firm's best opportunity to reduce the carbon footprint of its product, or any packaged beverage.

Fiji Water's Carbon Footprint

Accounting for its base year—from June 30, 2006 to June 30, 2007—Fiji Water's total annual carbon footprint from production through distribution was 85,396 metric tons of CO₂ equivalent.¹⁴ Fiji Water claims to have used all 3 scopes of the GHG Protocol in calculating its carbon emissions, including producing packaging material, transporting raw materials and equipment, manufacturing and filling water bottles, shipping finished product from Fiji worldwide, distribution, refrigerating and disposal and recycling of consumed product. Fiji Water also accounted for emissions from sales and administrative activities including commuting, business travel, and office energy usage. Taking this GHG 3 Scope supply chain point of view led Fiji Water to understand that 75% of the firm's emissions result not from the firm's internal operations, but rather, from the operations of supply chain partners.¹⁵

Fiji Water and its Freight Partners

All Fiji Water logistics is done through third party sources (3PL). Highly fragmented, different companies handle different aspects of the supply chain. Primarily Maersk (though also other firms) do the shipping on 2500 TEU ocean vessels; big and local trucking firms, individual warehouses do the land based transportation and holding of inventory. Fiji Water claims that they ship mostly full truckload; Southern California to

¹⁴ <http://www.environmentalleader.com/2008/04/09/fiji-water-releases-carbon-footprint-of-products-challenges-industry/>

¹⁵ <http://www.csrwire.com/News/11649.html>

Texas is an exception, where much of the shipping is done via rail. Fiji Water would like to ship more via rail, but thus far the firm does not believe that at this time the higher rates are worth it, as carbon offsets do not justify costs.

5.3.3 Maximizing the Length of the Shipping Routes

Context

Further to Fiji announcement in November 2007, one of the first steps Fiji took to reduce its carbon footprint was to attempt to ship to ports closest to destination customers and thus minimize land transport. The company is committed to increase the volume of water it ships intended for sale on the East Coast to the Port of Philadelphia, rather than truck much of it east from Los Angeles (refer to Figure 20 and Figure 21).

Prior to the Change

Fiji Water used to warehouse in only one location on the West Coast of the United States, close to their produce port of entry in Los Angeles.

Current

Fiji Water now has initial point of entry warehouses in both Los Angeles and Philadelphia, which they reach via passageway through the Panama Canal.

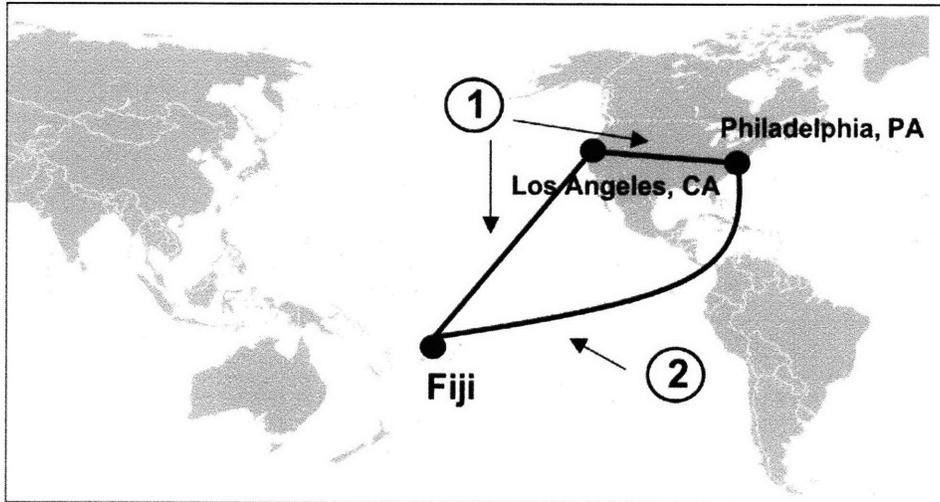


Figure 20. Shipping Route for Bottles Shipped to the East Coast

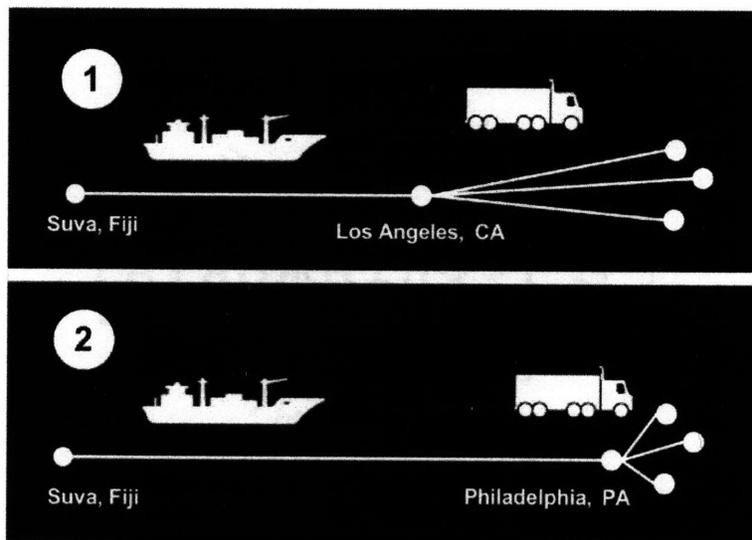


Figure 21. Network Before (1) and After (2) the Switch to the Shipping Longer Route

Implementation

Strategically, Fiji Water adopted two initiatives simultaneously: (1) “Greening the supply chain”—beginning to consider measuring their carbon footprint and looking for ways to create and promote environmental sustainability; and (2) Adapting supply chain processes to “The Toyota Way”—to try to become a leaner company. Together, both initiatives propelled sustainability. At this stage, Fiji Water is looking to, “take actions

that are also tenable from a cost perspective.” The firm is looking at sustainability and carbon footprint from “gut instinct,” and not just acting on “analysts crunching numbers.” As part of their dual initiative to create a “leaner and greener supply chain,” Fiji Water decided to level product and let inventory and warehousing fluctuate. This increased their working capital costs, but also increased flexibility.

5.3.4 Maximizing the Length of the Shipping Routes – Savings and Impacts

Fiji Water General Practice

By adopting the WRI/WBCSD Greenhouse gas Protocol, Fiji Water now accounts for all 3 scopes of the GHG Protocol, allowing for calculations of both their direct emissions from packaging and manufacturing operations, but also for shipping and transport, as well as consumer disposal/recycling.¹⁶ Maersk, a shipping partner of Fiji Water, has carbon calculator for clients, but Fiji Water decided not to use this, and instead built their own calculator, which it believe allows for more accurate accounting.

Fiji Water measures GHG Scopes 1 and 2 in-house. Fiji uses actual route, not linear distance for measuring its transportation. For Scope 3, Fiji Water uses emission factors from suppliers and publicly available information. Fiji Water is also in the process of joining the Carbon Disclosure Supply Chain group. Fiji Water began taking carbon inventory June 30, 2007.

¹⁶http://www.sustainablelifemedia.com/people/innovators/climate/fiji_waters_thomas_mooney_talks_carb_on_negative

Assumptions for our own calculation

As for the Railex and Wal-Mart cases, our first objective for Fiji water was to estimate the benefit in terms of transport costs and carbon emissions of the change; in this case the switch to the Fiji-Philadelphia route for shipment to the East Coast. We later examined the impact on time-to-market and risks related to this new practice.

For our own calculation, we decided to use the following assumptions:

We considered that the number of units sold through the U.S. North-East, and therefore shipped to the East-Coast, is 50 million 500ml bottles per year based on the assumption that the revenue per bottle is close to \$1 (and \$2 for the retail price), the total company revenue is 150 million (2007), and sales to the US North-East represent approximately 1/3 of the total sales of Fiji Water. From there we assumed that the load carried to the East Coast (and therefore impacted by the change) was equivalent to 1,157 truck load or 4.6 times 250 TEU-container load.

In addition, we estimated the kilometer traveled (1) by ocean freight from the port of embarkation in Fiji to the U.S. port of entry for both cases: Los Angeles and Philadelphia, and (2) by truck from Los Angeles to the North-East for the first case or in the vicinity of Philadelphia for the second case. Table 17 lists the individual distances considered to lead to a distance of 9,200km by ocean freight and 4,340km by truck for the first option (going through Los Angeles) and to a distance of 20,000km by ocean freight and 300km by truck for the second option (going through Philadelphia).

Assumptions on Volume Sold		
Revenue (\$)	\$	150,000,000
Retail Price (\$ per Unit (500ml) = \$1.70 to \$2.50)	\$	2
Revenue per Bottle (\$ per Unit)	\$	1
Bottles Sold (Units - 500ml bottle equivalent)		150,000,000
with West Coast (Units - 500ml)*		100,000,000
with East Coast (Units - 500ml)*		50,000,000
Bottles Produced (Units per Day)		410,959
Vessel Shipment (TEU)		2,500
Share of Fiji Shipment (%)		10%
Volume of Fiji Shipment per vessels (TEU)		250
TEU Volume (cubic meter)		39
TEU Volume (cubic feet)		1,360
TEU Volume (pallets)		10
* assumed to be two third California / one third East Coast		

Table 15. Assumptions on Volume Sold

Loads					
Conversion - specific to Fiji Water					
500ml bottles/TEU *					49,500
500ml bottles/TEU **					43,200
* 3 million 330ml bottles = 40 TEU, from Fiji representative					
** http://en.wikipedia.org/wiki/Twenty-foot_equivalent_unit ; max weight = 21,600kg; including container weight = 24,000kg					
Loads per transport mode					
	Capacity				
Heavy Truck (metric tonnes)					22
Container Vessel (TEU)*					2,500
* From interview with Fiji representative					
Loads per shipment (From Fiji-US)					
	Share	lbs	Kg	Units (500ml bottles)	
Loads (2,500 TEU Vessel)*			120,000,000	54,431,084	108,000,000
Loads (Fiji Water)*	10%	12,000,000	5,443,108	10,800,000	
* From interview with Fiji representative					
Loads per shipment (Within US)					
	Share	lbs	Kg	Units (500ml bottles)	
Heavy Truck *	100%	52,911	24,000	43,200	
* Dedicated Truck to Retailer DC					
Loads per year					
	Number of trips per year	Nbr trip for West Coast	Nbr trip for East Coast		
Frequency of Fiji Water Container Shipment	13.9	9.3	4.6		
Frequency of Fiji Water Truck Shipment	3,472	2,315	1,157		

Table 16. Load Traveled

Distances			
Prior to Philadelphia Route			
	Transport Mode	Miles	Kilometers
Fiji - Honolulu *	Container Vessel	3,160	5,086
Honolulu - Los Angeles *	Container Vessel	2,558	4,117
Los Angeles - East Coast Retailer's DCs **	Heavy-Truck	2,700	4,345
* Figures from Google Earth		Total distance per Container Vessel	9,202
** Figure from Google Map (LA-Philadelphia)		Total distance per Truck	4,345
Current			
		Miles	Kilometers
Fiji - Honolulu *	Container Vessel	3,160	5,086
Honolulu - Panama Canal *	Container Vessel	5,756	9,263
Panama Canal - Philadelphia *	Container Vessel	3,540	5,697
Philadelphia - East Coast Retailer's DCs **	Heavy-Truck	200	322
* Figures from Google Earth		Total distance per Container Vessel	20,046
** Own estimates : around 200 miles run on average to serve North-East customers		Total distance per Truck	322

Table 17. Kilometer Traveled per Transport Mode

As far as costs are concerned, we looked first for information publicly available on transport costs for ocean freight and completed this information with our own estimates from discussing with several persons experiences in both ocean and ground transportation. Table 18 presents this information.

Cost	
Container Vessel - Fiji to LA via Honolulu (\$/TEU)**	\$ 2,000
Container Vessel - Fiji to Philadelphia via Honolulu (\$/TEU)*	\$ 3,000
Heavy Truck (\$/Truck = 20t) - LA to North East**	\$ 4,000
Heavy Truck (\$/Truck = 20t) - Within North East, 300 miles**	\$ 500

* <http://www.freight-calculator.com/> for Auckland to Philadelphia
 ** Own estimates

Table 18. Transportation Costs per Transport Mode

Finally with regards to carbon emissions, we decided to use the emission factors proposed by the GHG Protocol in order to follow the Fiji Water management approach (cf. Table 19). Although we later propose to look at the impact of headhaul and backhaul capacity utilization on the emission, we initially took the factors as provided by the GHG Protocol for the initial estimate.

CO2 Emissions	
Emissions per Transport Mode	gm/tonne/km
Heavy Truck	54
Container Vessel	10

Table 19. GHG Protocol Emission Factors per Transport Mode

CO₂ Emission Reduction and \$ Savings

The product of the number of load traveled by the trip unit cost give us the total transportation expense for the two alternatives. Similarly the product of the load by the distance traveled and the emission factor give us the total transport emissions associated with the transport of Fiji Water bottles from their plant to their customer’s DCs in the U.S. North-East. As shown in Table 20 and Figure 22, shipping direct to Philadelphia means a 33% emissions reduction and 42% cost reduction for that leg of the supply chain (with 6,000 tonnes of CO₂ emitted versus 9,000 tonnes and close to \$4 millions in transport costs versus \$7 millions). It is of note that the cost benefit per tonnes of carbon saved approaches \$960.

Results

Route options to ship to Noth-East for 50,000,000 bottles	Transport Cost (\$)	Transport CO2 Emissions (tonne)
Shipping to ...		
Los Angeles + Long Distance Trucking	6,944,444	9,074
Philadelphia + Short Distance Trucking	4,050,926	6,051

Table 20. Costs and Carbon Emission per Transport Mode

Savings

	Transport Cost Savings (\$)	Transport CO2 Emissions savings (tonne)	Ratio (\$ saved/tonne of CO2 saved)
Philadelphia vs. LA	2,893,519	3,023	957
Household emission (tonnes per year)*	50		
Car emission (tons/vehicle/year)**	5.7		
Car emission (tonnes/vehicle/year)	5.1		
Emission Savings (In US household equivalent)	60		
Emission Savings (In US car equivalent)	594		
* Household = 2.5 persons/year from http://bie.berkeley.edu/files/ConsumerFootprintCalc.swf			
**EPA: Smartcalculator			
Total Carbon Footprint of Fiji Water (metric tons)	85,396		
Reduction vs. total Footprint (%)	3.5%		

Table 21. Philadelphia vs. Los Angeles: Costs and Carbon Savings

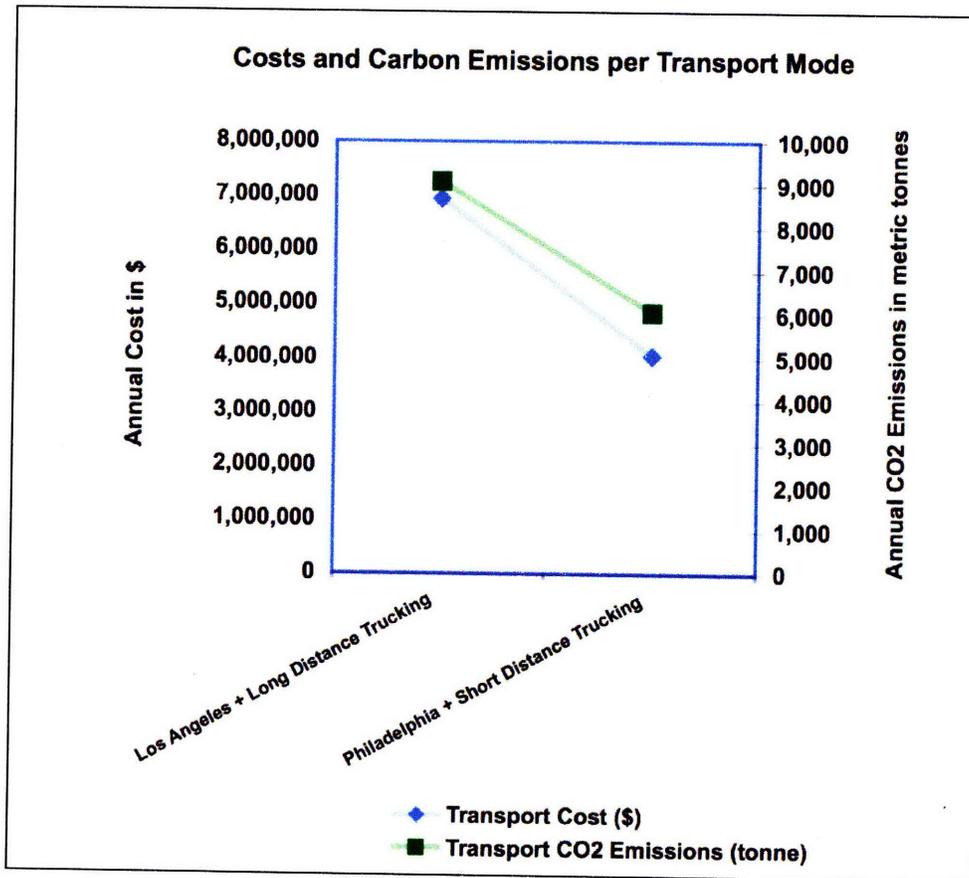


Figure 22. Costs and Carbon Emissions per Transport Mode

CO₂ Emission Reduction based on Adjusted Emission Factors

We propose in this section to compare the estimation of the savings obtained earlier based on the GHG Protocol emission factors to the estimation based on the adjusted factors we introduce in section 4.3.

It is understood that Fiji Water travels from Fiji to the U.S. via shipping lanes in place before the inception of the company, with no additional ships having joined the lanes for Fiji Water's volume. In the case of Fiji Water, headhaul capacity utilization is very low and estimated to be only 25% versus 85% for the backhaul (from Fiji Water perspective as shown in Table 22). However due to the low sensitivity of the container vessel's carbon emission factor to the change in capacity utilization (9 gm of CO₂ versus 10 gm, we note that the impact on the end result is minimal (cf. Table 23 and Table 24). In addition, no adjustment have been made to the emission factors for any of the trucking legs due to the limited data on trucking capacity utilization for both the short route out of Philadelphia and long route from Los Angeles. In this case, it seems difficult to draw any conclusion from the adjusted calculations.

Capacity Utilization		Container Vessel
Capacity Utilization Headhaul (From Fiji)*		25%
Capacity Utilization Backhaul (To Fiji)*		85%
* Estimated From Interview Notes with Fiji Representatives (vessel circumnavigate)		

Table 22. Capacity Utilization of the Headhaul and Backhaul

Adjusted CO₂ Emissions		gm/tonne/km
Adjusted Emissions per Transport Mode		
Heavy Truck		54
Container Vessel		9

Table 23. Adjusted Emission Factors

Results			
Route options to ship to Noth-East for 50,000,000 bottles		Transport Cost (\$)	Transport CO2 Emissions (tonne)
Shipping to ...			
Los Angeles + Long Distance Trucking		6,944,444	8,818
Philadelphia + Short Distance Trucking		4,050,926	5,494
Savings			
	Transport Cost Savings (\$)	Transport CO2 Emissions savings (tonne)	Ratio (\$ saved/tonne of CO2 saved)
Philadelphia vs. LA	2,893,519	3,324	870

Table 24. Results and Savings based on the Adjusted Emission Factors

Impact on the Time to Market

In total, Fiji Water estimates that from production to consumer in the United States takes about two months, on average. On average, a shipment of water from Fiji to the West Coast takes one week. Trucking cross-country takes ~1 week. Via the Panama Canal, it takes 4 to 6 weeks total from Fiji to Philadelphia, a 2 to 4 week time differential.

Even with the redesign, the majority of shipments still go to Los Angeles, though there are plans to increase volume to Philadelphia in the near future. Though it is more expensive to truck, and not as cost efficient—it is the fastest way to get product to market. This is a concern for a firm like Fiji Water, which still has portions of the year where demand exceeds supply. There is considerable seasonality to Fiji Water sales: in most regions of the country, sell much more in warm months. As a result, scale might be increased or decreased one month in advance based on sales forecast. Fiji Water holds more in their warehouses in winter, less in summer; this impacts across the entire supply chain. Leveling production, inventory flow increases and decreases. Overall the new solution imposed Fiji to hold more inventory everywhere.

Risks

Fiji holds more inventory on hand in slower seasons and thus has padded inventory costs:

via Philadelphia, shipping instead of trucking frees up budgetary funds for 3rd party warehouse space, however it is hard to estimate the exact impact in the inventory carrying cost compare to the transportation cost savings.

In addition to the increase in carrying cost, we believe that the increase of the inventory level without deep analyses might have resulted in the degradation of service level and to the augmentation of the occurrence of stock-out.

5.3.5 Change Management

The company commitment to the new program facilitated the implementation of the recent changes. The nomination of Thomas Mooney as Fiji Water's first Senior Vice President of Sustainable Growth in July of 2007 is a strong sign of the company dedication to the program. Another key to the program success was certainly the reliance on the Carbon Disclosure Projects (CDP) methodology and the support of ICF International, a global consulting firm specialized in the analysis of solutions in energy, climate change, and environment. Thomas Mooney said, "Having an accurate account of our carbon footprint and ensuring transparency by reporting it annually to CDP are important steps to enable us to understand where to focus resources to reduce our carbon emissions," "We are very proud to be the first bottled water brand to pioneer carbon disclosure of our products."

ICF International analyzes Fiji Water's emissions inventories and provides the firm with advice on climate strategy; ICF independently reviews and verifies Fiji Water's carbon

footprint. Fiji Water's objective is to continue to partner with ICF International to publicly report on their progress against their ambitious targets on an annual basis.

5.3.6 The Future

Energy use at the Fiji production facility is currently, by Fiji Water's measurements, 1/5th its total footprint. Energy reduction, and renewable alternatives for generators are goals Fiji is working towards. They are looking specifically at hydro-power for incremental generators. Wind-generated power is promising in Fiji but at least 1.5 years away from adaptation (Fiji Water plans install a windmill in 2009 to provide energy to its bottling plant). Electricity in Fiji does not reach Fiji Water facilities: the Fijian grid is unreliable, so Fiji Water has its own generators. This is Fiji Water's only plant, and the bottles, though advantageously shaped for shipping, were originally constructed by carbonated beverage experts: thus, the bottle is heavier than it needs to be for bottled water, and they are looking for ways to reduce bottle weight, as Nestlé's Poland Springs brand has recently done. In addition, Fiji Water continues to experiment with bottle changes (lightening plastic weight) to reduce carbon footprint. Also, reduction of packing, and improving recycling content rate are priorities for the firm.

Fiji Water has decided to focus on reducing greenhouse gas emissions throughout their supply chain, from production in Fiji to the consumer. To become carbon-negative they will purchase forest carbon offsets and renewable energy offsets, which they developed with the guidance of Conservation International. Fiji Water claims that these offsets are "verifiable and permanent," and that they will exceed the company's carbon footprint by

20%. Fiji Water believes that by investing in offsets they can, “take immediate responsibility for our emissions, and our intention is to replace the purchase of offsets with carbon-reducing projects we develop directly, with support from Conservation International.”

5.3.7 Limitations and Future Research

Inventory holding costs and warehousing costs were omitted when conducting our analysis, because of limited information available to us. That is why we wish to reiterate that cost reduction is only for the transportation component of Fiji Water. In this specific case, we believe the impact is major.

It would be interesting for more research to be done on shipping practices in Fiji.

According to our calculation, only fourteen 2,500 TEU container ships come to the island each year. This imposes a big constraint on the Fiji Water supply chain. Inefficiencies would come not only from the fact that there is only one boat every month, but also because the trip from Fiji to the United States takes from 3 to 6 weeks depending on final port destination. If we consider Fiji Water’s estimations of high growth and seasonality in demand, we believe the impact in terms of inventory holding costs will be considerable. A detailed analysis would be required in order to quantify this impact.

5.3.8 Other Thoughts

Ethical and Environmental Effects of Buying Water

Fiji Water acknowledges that credibility is key with any new green initiative, “especially given the increasing public skepticism about companies’ green claims.” Despite these impressive-sounding initiatives, Fiji Water has its detractors. Michael J. Brune,

executive director of the Rainforest Action Network told the New York Times: “Bottled water is a business that is fundamentally, inherently, and inalterably unconscionable. No side deals to protect forests or combat global warming can offset that reality.”¹⁷

At Whole Foods, the world’s largest retailer of natural and organic foods, bottled water is the number-one item by units sold. Regarding the ethical and environmental effects of buying water, CEO and cofounder John Mackey argues, “You can compare bottled water to tap water and reach one set of conclusions, but if you compare it with other packaged beverages, you reach another set of conclusions. It’s unfair to say bottled water is causing extra plastic in landfills, and it’s using energy transporting it, [because] there’s a substitution effect—it’s substituting for juices and Coke and Pepsi.”¹⁸ Fiji Water’s

Thomas Mooney contends:

If you look at beverage industry figures you'll find that the growth of bottle water essentially matches the decline in carbonated soft drink sales. That means that people are trading their Cokes or Pepsis for bottled water - a product that is not only healthier but also has a much smaller environmental footprint, in terms of both greenhouse gas emissions and packaging materials. It takes a lot more energy and packaging to keep a carbonated beverage in place. When you think about it that way, as the bottled water industry grows the overall environmental impact of the beverage industry in fact goes down. It's just a matter of putting it in context. We certainly don't argue that the environmental impact of bottled water is lower than that of tap water. But that's not what we're replacing.

Fiji Water also defends their business model in terms of the economic positives that they have provided for the Fijian people. On these grounds, Mr. Mooney states:

If Fiji Water just went away, Fiji would lose 3% of its GDP, 20% of its exports, and several hundred of its best-paid manufacturing jobs. Who's going to replace that? The country would have to find other ways to generate the income it needs, most likely involving activities that have a higher environmental impact than Fiji Water does....The bottom line is, if there is no Fiji Water to export, the island of Fiji will export something else.¹⁹

¹⁷ <http://www.nytimes.com/2007/11/07/business/07fiji.html>

¹⁸ <http://www.fastcompany.com/magazine/117/features-message-in-a-bottle.html?page=0%2C7>

¹⁹ http://www.sustainablelifemedia.com/people/innovators/climate/fiji_waters_thomas_mooney_talks_carbon_negative

Comparison of Fiji Water's Transportation Practices with those of Competitors

The information for this comparative overview of Fiji Water and other bottled water firms' warehousing and transportation practices draws heavily from Charles Fishman's "Message in a Bottle," from *Fast Company*.²⁰

Poland Springs, part of Nestlé's bottled water portfolio, is bottled in Hollis, Maine. The plant uses a staging area for finished product can at any time hold as many as 24 million bottles of Poland Spring water. The double-stacked pallets are held in a space 6 acres across and 8 feet high. After they are filled in one of the firms two Maine bottling plants and then stacked, these bottles are then trucked hundreds of miles from Maine to points of sale throughout the Northeast United States. If demand exceeds the plants capabilities, Poland Springs uses its in-house fleet of 80 trucks to deliver water from other springs to meet its bottling needs. To decrease waste and overall carbon footprint, Kim E. Jeffery, chief executive of Nestlé Water, reports that in recent years, Poland Springs has reduced package weight and instituted energy efficiencies and land conservation projects, well in advance of those recently proposed by Fiji Water.

San Pellegrino, another brand in the Nestlé Water portfolio, ships in 1-liter glass bottles weighing five times as much as plastic bottles. This adds considerably to logistics costs and to energy consumption. Before they are filled, the bottles are washed and rinsed with up to 2 liters of mineral water. The carbonation in San Pellegrino is derived from a natural source—though not the same natural source as the water: it is taken from highly carbonated volcanic springs in Tuscany and then trucked north and bubbled into the

²⁰ <http://www.fastcompany.com/magazine/117/features-message-in-a-bottle.html?page=0%2C7>

Pellegrino springs.

Both PepsiCo's Aquafina and Coca-Cola's Dasani begin their water sourcing with tap water rather than spring water. Both companies use dozens of bottling plants across the United States to source water close to the point-of-sale, thus reducing shipment distances. Both Aquafina and Dasani are then treated, via a reverse-osmosis filtration process. The water they are purifying is then ready for bottling. Though the water was potable before the process, the energy-intensive filtration process is performed so that the taste of each is consistent; no matter where the source water is derived, after the processing, it tastes the same.

In recent years, Dasani and parent company Coca-Cola have improved recycling and lessened the weight of their plastic bottles. Coca Cola has implemented energy-efficiency projects and is working with the World Wildlife Fund (WWF) to conserve seven freshwater river basins. According to Lisa Manley, director of environmental communications for Coca-Cola, the company has decreased its water use by 6 percent since 2002, and has pledged to replenish the water it draws in communities in which it operates: "We have committed to grow our business without growing our carbon footprint, and to become truly water neutral," said Ms. Manley.

6 Synthesis and Analysis

6.1 Synthesis

Based on information gathered in the literature review, survey, and through case studies, we understand that there is no single objective for firms trying to cut carbon emissions. There is also no single solution to limit CO₂ and equivalent emissions. The primary driver for companies to engage in greener supply chain practices are (in order): (1) reputation, (2) cut costs, and (3) anticipation of government regulation. In terms of implementation, although we focused only on the dispatch of products from the grower/manufacturing facility to the customer's distribution center, we can already see a wide range of initiatives.

In terms of impact, the difference between companies is again significant. Regarding the Railex & Wal-Mart partnership, CO₂ emissions reduction goes along with a major advantage in terms of cost and risk reduction, although time-to-market is increased by two days. In the case of Stonyfield Farm, emission reduction is a major change; these reductions have had little impact on cost and time. Changes in risk for Stonyfield Farms have yet to be assessed. For Fiji Water, CO₂ emission reduction was traded-off with considerable increases in time-to-market via the Panama Canal route. However, it is important to note that unlike Wal-Mart's apple and Stonyfield Farm's yogurt deliveries, Fiji Water is a shelf-stable good, and although rerouting affected the supply chain, perishability was not an issue.

Context and Tactics

In our first case study, we examined Railex, the expedited rail shipper of perishable and other consumer packaged goods, and their relationship with the world's largest retailer, Wal-Mart, for whom Railex ships apples and other produce goods from Wallula, Washington, for distribution to Wal-Mart stores throughout the Northeast via Rotterdam, New York. The lead company for our analysis of this relationship is Railex. Before allowing Railex to consolidate and ship produce via expedited rail, Wal-Mart used trucking to carry produce cross-country. Switching to Railex, in 2006, Wal-Mart's produce shipments were 2% of Railex's total. This has grown to 5% of total Railex shipments as of 2008. Railex has not yet taken a complete inventory of their carbon footprint, nor do they have a process or methodology in place to do so; however, the expedited rail service is an EPA Smartway Partner. At this time, Railex assumes, but does not estimate the carbon-emissions benefits of using their service rather than trucking or intermodal.

In the second case study we looked at the strategic partnership between the largest organic yogurt producer in the United States, Stonyfield Farm, and its trucking transportation partner, Ryder. The lead company for our analysis of this relationship is Stonyfield Farm. With the assistance of data and strategic planning from Ryder, Stonyfield Farm was able to shift from less-than-truckload (LTL) to full truckload (FTL). With Ryder's assistance, Stonyfield Farm was able to use EPA Smartway as a reference standard to define a baseline in 2006, and begin implementation in 2007. During the same time period, Stonyfield Farm was able to modify its distribution network, moving

from a single distribution center (DC) in Londonderry, NH to a DC system, adding 3 additional DCs strategically placed to minimize transportation distances. Internally, Stonyfield Farm has created a Mission Action Program (MAP) to set goals and incentive workers based upon their ability to meet or exceed emissions-savings goals.

Fiji Water, our third case study, does not have a single transportation partner; the bottled firm which ships all of its water from the source in Fiji to the United States or other points globally, uses an assortment of container vessel carriers and third-party logistics firms for its trucking and warehousing needs. Since announcing a broad initiative to become carbon negative, one of Fiji Water's approaches to minimize carbon output has been to add additional shipping routes from Fiji to the United States. Where previously, all shipping containers went from Fiji to the Port of Los Angeles, since the 4th Quarter of 2007, some of Fiji Water's shipments begin in Fiji and continue on through the Panama Canal to the Port of Philadelphia. By maximizing shipping time, more carbon-intensive trucking time is reduced, thus reducing the firm's carbon footprint. To conduct a baseline measurement, Fiji Water used the 3-scope GHG Protocol, calculating a carbon footprint for the firm from raw material sourcing to bottled water consumption of 85,396 metric tons; for 2008 Fiji Water plans to offset the entirety of this carbon footprint, and in addition, remove an additional ~17,000 tons of carbon from the environment. To attain these goals Fiji Water hired a Senior Vice President of Sustainability, Thomas Moody, in July 2007. Currently the firm has no long-term partnerships with transportation carriers, and overall favors a "common sense approach" to offset projects rather than "just analysts crunching numbers." To certify carbon inventory, Fiji Water works with non-

profit ICF International to review and verify carbon inventory, advise them on climate strategy, and increase volume shipped closer to customers.

Key information on the context and changes analyzed in our case studies are presented in Table 25:

		Raillex and Wal-Mart	Stonyfield Farm and Ryder	Fiji Water
Context	Product Partner	Wal-Mart	Stonyfield Farm	Fiji Water
	Product	Apples and other Produce	Organic Yogurt	Bottled Water
	Transportation Partner	Raillex	Ryder	Multiple Partners
	Transport Mode	Expedited Rail	Trucking	Container Vessel and Trucking
	Leading Company for Case Study	Raillex	Stonyfield Farm	Fiji Water
	Change Introduced	Switch to Raillex instead of Truck	(1) Less-Than-Truckload (LTL) to Full Truckload (FTL) (2) Modify Distribution Network to Move from 1 DC to 4 DCs Strategically Placed Across the US	Maximize Length of Shipping Route to Minimize Trucking Distance
Tactics	Date of Change Implementation	2006- 2% of Raillex Transportation; by 2008, 5% of Raillex Shipments	2006- Definition of a Baseline; 2007- Beginning of Implementation	Q4 of 2007; 1st Container Vessel Shipment to Port of Philadelphia instead of to Port of Los Angeles
	Reference Standard	N/A, although Raillex is an EPA Smartway Partner	EPA Smartway	GHG Protocol
	Process/Methodology	N/A	Mission Action Program (MAP) - Interdepartmental Team to Assess and Make Changes	Summer 2007 - Hired SVP of Sustainable Growth to Oversee New Initiatives; November 2007 - Announcement of Sustainable Growth Program
	Quantification of Benefits	Assumed, Not Estimated	Carefully Estimated and then Measured Against a Baseline at Time of Implementation; Using LogicTools Detailed Estimates of Miles Travelled	Common Sense Approach, "Not Just Analysts Crunching Numbers"
	Partnerships with Carriers	Customer-Supplier Relationship	Strategic Partnership	No Long-Term Partnerships; Selection of Carrier based on Costs
	Partnerships with Consultancies	No Specific Partnership	Close Partnership with the EPA SmartWay.	ICF International reviews and verifies carbon inventory; advises on climate strategy.
	Next Steps	Increase Volume Shift from Truck Load and Intermodal to Raillex	Modify Distribution Network to Move from 1 DC to 4 DCs Strategically Placed Across the US	Increase Volume Shipped Closer to Customers

Table 25. Context of the 3 Case Studies and Changes Analysed

Strategies and Objectives

In attempting to synthesize findings from our three case studies, it is important to first highlight the differences: we studied 3 companies with 3 different strategies and approaches to transport mode, at 3 different junctures of their environmental strategy implementation. Raillex still assumes its quantitative advantage over trucking services, but does not make estimations; Fiji Water began a quantitative inventory in 2007;

Stonyfield Farm has been updating and refining its carbon inventory since 1994. Railex is looking to grow its position as a niche expedited rail carrier; Fiji Water is looking to protect brand image and turn sustainability into a competitive advantage; Stonyfield Yogurt looks to continue to be a model for paradigmatic change for larger CPG companies, as well as leverage its environmental initiatives for positive publicity.

Brand positioning with relation to sustainability plays a different role for each of our leading case study firms. For Railex, brand positioning plays only a small part of a larger strategy to convince perishable and CPG firms of the advantages of expedited rail over trucking. For Stonyfield Farm, brand positioning is part of a larger long-term commitment to sustainability, which can be traced back at least as far as 1994, when Stonyfield Farm performed their first carbon inventory. For Fiji Water, the commitment to sustainability is recent: only in 2007 did Fiji Water perform its first 3-Scope GHG Protocol carbon inventory.

In the future, Railex plans to create more routes—first from California to Washington and California to New York by 2009, with additional expedited rail routes planned from Texas and Florida. Railex hopes that as carbon footprint becomes a larger factor in corporate decision-making, it can aggressively market the carbon-saving advantages of expedited rail over trucking. Stonyfield Farm hopes to continue to be a model for the consumer packaged goods industry, and further utilize positive publicity from environmental initiatives to drive product popularity rather than spending more money on traditional marketing and advertising. Stonyfield Farm also hopes to reduce trucking idle

time at their Londonderry, NH premises, use only EPA Smartway certified transportation partners, and explore biofuel solutions. Fiji Water has announced a company-wide initiative to become carbon negative by December of 2008, and also to reduce the carbon footprint of the firm’s supply chain by 25% by 2010. From Fiji Water’s aggressive initiatives begun in 2007, it is apparent that the firm wishes to protect the brand from negative publicity, and turn their sustainability efforts into a strategic advantage over bottle water and bottled beverage competitors.

Table 26 provides a snapshot view of the company’s strategy:

		Railex	Stonyfield Farm	Fiji Water
Strategies	Brand Positioning with Relation to Sustainability	One Component of a Larger Strategy	Long-Term Commitment to Sustainability	Recent Commitment to Sustainability
	Starting Date for Environmental Efforts	2007- Became EPA Smartway Partner	1994,1997-First Carbon Inventory Covering GHG Scopes 1 and 2; 1994-First Manufacturer in the US to Mitigate CO2 Emissions via Carbon Offsets; 1999- First Carbon Inventory Covering GHG Scope 1, 2, 3;	2007-First Inventory Covering GHG Scopes 1,2, and 3;
	Objectives of the Environmental Effort	To Create a Market Niche for their Expedited Rail Service	Be a Model and Enduce Paradigmatic Change in the CPG Industry; Gain Positive Publicity from Environmental Initiatives Rather than from Marketing Efforts, to make up for High Cost Structure of Producing Organic Yogurt	Protect the Brand from Negative Publicity; Turn Sustainability Efforts into Strategic Advantage; Improve Supply Chain Efficiencies and Look to Cut Costs
	Plans for the Future/ Initiatives	Create More Routes; Turn Carbon Benefits of Railex vs. Trucking into a Key Marketing Asset with a Formal Approach to Carbon Estimation	Continue to be a Model for the CPG Industry, Reduce Idle Time at their Premises; Using only EPA Smartway Certified Transportation Partners; Explore Biofuel Solutions	Announced Initiative to Become Carbon Negative by 2008, and Reduce Carbon Footprint of Supply Chain by 25% by 2010

Table 26. Company's Strategies – Summary Table

6.2 Analysis

As our case studies examined only 3 companies in depth, it is difficult to draw specific conclusions. However, there are some general similarities and difference we can make from data and information we have gathered on Railex, Stonyfield Farm, and Fiji Water. From our findings, companies usually engage in the similar processes when looking to formulate a greener supply chain. In parallel, companies normally begin by “exploring transport mode alternatives” and “defining a baseline.” In defining a baseline, companies

move on to selecting a reference standard for estimating carbon and carbon equivalent emissions. Later, the combination of reference standard and exploration of transport mode alternatives allows companies to select a transport mode. Finally, selection of transport mode imposes a change in network architecture as transport mode affects the placement of distribution centers. Often, this alteration of distribution centers loops back and leads to a further alteration of transport mode selection.

6.2.1 Similarities

Railex, Fiji Water, and Stonyfield Farm are relatively similar in scale; they are not the largest players in their respective spaces, but all are large enough that supply chain redesigns are costly and have the potential to affect considerable operational change. In each instance, the three firms have to decide if a carbon reduction is worth implementing, and each firm needs to decide what they are capable of implementing with regard to cost, risk, and time to market.

It is impossible to redesign an entire supply chain in one go. In the cases of Wal-Mart with Railex, and Fiji Water with its shipping partners, only part of all the goods they ship were transferred to an alternative route—for Wal-Mart, from truck to expedited train, and for Fiji Water—from a single shipping route from Fiji to the Port of Los Angeles to dual shipping routes including the Port of Philadelphia. In the case of Stonyfield Farm, changes have been consistent and incremental as well, including their latest shifts from 1 DC to 4 DCs, and from LTL to FTL.

Every transportation redesign issue must be addressed case-by-case; solutions to one initiative are not panaceas to an entire network redesign. Each company involved in our case study looks at both individual network design changes, and how they impact the transport mode, and vice versa. It makes sense to look at network design and transport mode at the same time, because each affects the other.

In all three case studies, CO2 reduction and cost-saving created a win-win situation; that is, by decreasing CO2 output, costs decreased as well; the tradeoff for Fiji and Stonyfield Farm Railex deliveries, is a sacrifice of increased time-to-market. Because of this inventory allocation, and service levels are key areas to consider.

In terms of risk, rail and vessel make the supply chain more vulnerable. From our findings, perhaps because the U.S. road network is so dense, and there is so much redundancy, trucking is the most reliable way to transport goods from point-to-point. In switching to rail or vessel, risk management should go hand-in-hand with network redesign.

The three firms we studied have seen considerably more interest from partner companies in whether they have measured carbon inventory or whether they are using a standard such as the EPA Smartway or GHG Protocol to calculate carbon footprint.

All 3 case studies make it clear: firms can begin by modifying either network or shifting to new transport mode, but a firm can't change either factor without affecting the other.

Ideal objective: to be able to get the whole industry to shift to a more sustainable model.

Heard from Stonyfield Farm and echoed by Fiji Water, and office supply retailer Staples as well.

Table 27 summarizes the key results discussed above:

		Raillex and Wal-Mart	Stonyfield Farm and Ryder	Fiji Water
Context	Product Partner	Wal-Mart	Stonyfield Farm	Fiji Water
	Product	Apples and other Produce	Organic Yogurt	Bottled Water
	Transportation Partner	Raillex	Ryder	Multiple Partners
	Transport Mode	Expedited Rail	Trucking	Container Vessel and Trucking
	Leading Company for Case Study	Raillex	Stonyfield Farm	Fiji Water
	Change Introduced	Switch to Raillex instead of Truck	Modify Distribution Network to Move from 1 DC to 4 DCs	Maximize Length of Shipping Route to Minimize Trucking
Scope of Change	Dollar Value of the Good Shipped Impacted by the Change (in \$)	\$19 Millions **	\$290 Millions ***	\$50 Millions ****
	Transportation Cost prior to the Change (in \$)	\$6.1 Millions	\$13.4 Millions	\$6.9 Millions
	Transportation Carbon Footprint prior to the Change (in metric tonne of CO₂) *	5,300	13,600	9,000
Impact	Transportation Cost Savings (in \$)	\$0.7 Millions (I.e. -11%)	\$5.8 Millions (I.e. -47%)	\$2.9 Millions (I.e. -42%)
	Transportation Emission Reduction (in metric tonne of CO₂) *	2,600 (I.e. -61%)	6,500 (I.e. -47%)	3,000 (I.e. -33%)
	Transportation Cost Savings per Emission Reduction (in \$/metric tonnes)	\$270	\$900	\$950
	Time-to-Market	Cross-country transportation: 5 days with Raillex vs. 3 days by truck	Push inventory closer to customer. Might reduce delivery time by 4 days for delivery to farther customers.	The Fiji-Philadelphia route takes 4 to 6 weeks vs. 2 to 4 weeks for the Fiji-Los Angeles route.
	Risk	Risk is minimal and high consistency. As of January 2008, the most a Raillex train has ever been late is 6 hours (three late deliveries out of 70 total train runs).	A decentralized network will be more complex for Stonyfield Farm to put in place and maintain. A move towards a A decentralized network will necessarily drive inventory up.	Switch to the new route pushes Fiji Water to increase inventory. The increase of the inventory level without deep analyses might result in the degradation of service level and to the augmentation of the occurrence of stock-out.
	Capacity Utilization of Headhaul/Backhaul	Headhaul: 95%, Backhaul: 30%	Headhaul: 93%, Backhaul: 80% (New England is a consumer state)	From Fiji Water Perspective, Headhaul: 25%, Backhaul: 90% (There are always fewer goods leaving Fiji than arriving in Fiji).

* Results based on either the EPA SmartWay or GHG Protocol Factors (refer to the case study in section 5)

** Based on \$18 per tray pack and 1,040,000 tray pack per year

*** Based on the fact that all Stonyfield products would be affected by the change; Stonyfield Farm annual revenue in 2007: \$290 millions

**** Based on the assumption that 1/3 of Fiji Water bottles are shipped to the US North-East; Fiji Water revenue in 2007: \$150 millions

Table 27. Summary of Results – Impacts on Cost, Time, Risk, and Carbon Emission

6.2.2 Differences

Length of commitment

Raillex and Fiji Water are recent adapters of EPA Smartway and GHG Protocol standards, while Stonyfield Farm has been calculating carbon inventory since 1994.

Is Sustainability Part of the Culture?

For Stonyfield Farm, founded by climatologist and CEO Gary Hirshberg, an ethos of sustainability has been central to the firm's beliefs for over 15 years, as evidenced by carbon inventories begun in 1994, MAP teams partially incentivized on the basis of their energy savings, and commitment to convince larger CPG firms to adopt similar practices via Carbon Counts, and other initiatives:

- For Railex, marketing expedited rail as a greener alternative to trucking is but one aspect of a multi-pronged approach.
- For Fiji Water, sustainability was not an original component of their business model. As recently as 2006, Fiji Water marketed their bottled water with campaign slogans such as, "The Label Says Fiji Because It's Not Bottled in Cleveland." The firm's recent switch to carbon negative and energy reducing initiatives has thus been met with some skepticism: is such a paradigmatic shift being made solely for marketing reasons? Can it be sustained by a culture unfamiliar with such efforts?

Fiji Water claims to be measuring all 3 GHG Protocol Scopes all the way from raw material sourcing to the consumer; Stonyfield Farm claims to measure all 3 GHG scopes as well, but their calculation extend only from sourcing to DC, but not to consumer; as of April 2008, Railex does not measure carbon output at all.

- There is considerable difference in transportation issues facing each case study firm. Each explores a different mode: trucking to expedited rail (Railex and Wal-Mart), less than truckload to full truckload and network redesign (Stonyfield Farm and Ryder), vessel shipping with additional route (Fiji Water and partners). Very different needs and approaches are followed by each firm. Thus, within a company you need to go case-by-case based on requirement; and also, in terms of the whole industry you need to go case-by-case as well.

7 Conclusion

Larger Scale Recommendations

Across our case studies we see the benefit of using widely known standards such as EPA Smartway and the GHG Protocol. These include:

- Legitimacy
- Comparable results
- Ease of ensuring compliance amongst supply-chain partners.

Two of our three case studies examine a CPG firm and a transportation partner: we see the advantages in this approach. Supply chain redesign with carbon output as a key factor in decision-making presents new and complex issues. There is not one given methodology, and there are many decisions to make in creating and refining an inventory. Partnership gives more confidence to those involved in the process.

Unlike traditional business areas where costs and strategic planning are protected areas, when exploring sustainability-related issues, companies are open to sharing information and receiving feedback. Also, firms share information to gain more confidence: it is perhaps the last realm in business where firms can begin with a naive approach and look to others for insight without fear of chastisement.

Limitations

In our analysis, inventory costs are never taken into account; neither is capacity utilization. Both are beyond the scope of our proposed research, but we recommend them as areas for continued study. In our case studies we did not comment on the totality of the supply chains with regard to local optimums compared with a global optimum: for example, in the case of Fiji Water, though adding an additional shipping route to the Port

of Philadelphia reduces the firm's carbon footprint (a local option), perhaps some paradigm shift that would allow bottling to occur in Philadelphia would result in a more substantial global optimum.

The companies involved in our case study measure carbon footprint using output based rather than the input-based techniques recommended by the EPA. Further research could explore the limitations of an output-based approach. We must also mention the influence of uncertainty on the numbers we chose; we acknowledge that in future research, it would be worth a closer look at sensitivity analysis affect these results.

Future Research

In our case studies we did not look at carbon footprint of the warehouse, only at the transportation component. It would be useful to expand the scope of our research to account for warehousing. The same holds true for sourcing of raw materials. In all three of our cases we examined distribution from main plant to retailer DC. We did not consider inbound sourcing, nor the portion of the supply chain from retailer to customer. Additionally, it would be worthwhile to compare and contrast transport mode and network architecture practices in regulated European markets with our US findings. We recommend these as areas to expand upon our findings.

8 Appendices

8.2 Survey Form

Survey to Reinforce the Carbon Efficient Supply-Chain Report, Ken Cottrill, from The Institute of Management and Administration (IOMA) for MIT CTL.

Include in red the questions we suggested to add to complement our research.

THE CARBON-EFFICIENT SURVEY

We are conducting a survey on what companies are doing to measure and improve the carbon efficiency of their supply chains and would like your input. In return, we will provide you with a FREE copy of the survey results. The survey will be part of a report on the market and regulatory forces that are driving carbon efficiency and the methods companies are using to reduce supply chain carbon emissions cost-effectively.

Note: for the purposes of this report “carbon efficiency” is defined as the ability to minimize the emission of harmful greenhouse gases such as carbon dioxide generated by supply chains over the full life cycle of a product.

1. Information about you and your company

1a. What is your supply chain management function?

- Procurement/Sourcing
- Logistics (e.g., warehouse, inventory management and transportation)
- Supply Chain
- IT
- Other, please specify _____

1.b. What industry is your company in?

- Manufacturing
- Distribution and Wholesale
- Retail
- Energy
- Other, please specify _____

1.c. How big is your company (annual revenue)?

- Less than \$ 100 million
- \$100 million to 500 million
- \$500 million to \$ 1 billion
- \$1 billion to \$ 5 billion
- \$5 billion to \$15 billion
- Great than \$ 15 billion

2. Are you involved in initiatives to reduce the carbon footprint of your supply chain (i.e. the amount of carbon dioxide and other greenhouse gases emitted by your supply chain)?

- No
- Yes
- Plan to in the future
- If plan to please indicate when: _____

2a. If “yes” or “plan to” please indicate which areas you are focusing on:

- Re-configuring distribution networks to reduce miles driven
- Switching to overseas manufacturing where energy costs are lower
- Increasing backhauls to increase energy efficiency
- Switching to more fuel-efficient road vehicles
- Switching to more fuel-efficient modes of transportation
- Looking for more carbon-efficient packaging
- Making distribution centers more energy efficient
- Siting solar generation plants in distribution centers
- Analyzing every stage of the supply chain to calculate carbon emissions and to identify where emissions can be reduced
- Establishing collaborative projects with suppliers to identify ways to reduce carbon emissions in the supply chain
- Reviewing product life cycles to improve carbon efficiency
- Switching to overseas manufacturing where energy costs are lower

Other (Please specify) _____

Please rank in order of priority from the list above:

- 1
- 2
- 3

2b. If “yes” or “plan to” please indicate which department is driving your carbon footprint reduction efforts:

- Supply Chain
- Corporate
- Other Department (please specify which)

2c. If “yes” or “plan to” please indicate:

- What is your approximate budget for reducing the carbon footprint
- What cost savings are you targeting
- What emission reduction levels are you targeting
- What is the duration of the carbon footprint program

2d. If “yes” or “plan to” please rank in order of importance from the list below the top three reasons for reducing your carbon footprint

- 1
- 2
- 3

- To cut costs
- To improve supply chain efficiency
- To enhance the company’s reputation for social responsibility
- To make the company more attractive to investors
- In anticipation of tighter regulations on corporate carbon emissions
- Because customers are requesting information on your carbon footprint
- Other reasons (please specify in ranking)

2e. If “yes”, please indicate what values/measurements/estimate of pollutant emission you refer to for decision-making:

Internal and suppliers estimate/measurements

Widely available national average (from draft of regulation policy, academic studies, etc).

If not internal or from suppliers estimate, please specify the source of the information used as reference: _____

3. Do you expect product carbon labels (labels that show how much carbon was emitted to bring your products to the end user) to be introduced:

No

Yes

If “yes” please estimate when carbon labels will be introduced

4. Are you involved in initiatives to prepare for the introduction of carbon labels on your products?

No

Yes

Plan to in the future

If you plan to please indicate when

5. Do you require suppliers to give you details of their current carbon emissions?

No

Yes

Plan to in the future

If you plan to please indicate when

6. Do you require suppliers to give you details of how they are reducing, or plan to reduce, their carbon footprints?

Yes

No

Plan to in the future

If you plan to please indicate when

7. Does the carbon-efficiency of suppliers influence your sourcing decisions?

No

Yes

Will do in the future

If in the future please estimate when

8. Please indicate your level of awareness of the following carbon footprint programs/initiatives, where 1= never heard of, 2= heard of, 3=Familiar with, 4=Participating or using

The Carbon Trust

GHG Protocol

The Smartway Program

The Chicago Climate Exchange

The Kyoto Protocol Carbon Emissions Targets

Carbon offsets

EU Emissions Trading Programs

Carbon Disclosure Project

EPA Climate Leaders Program.

8.2 List of Key Interview Questions for Case Studies

Company revenue and growth rate:

Industry revenue and growth rate:

Company carbon footprint (if available):

1. When did you start to conduct carbon inventory? What do you take into account? How do you measure carbon? GHG protocol? EPA? Do you include Scope(s) 1, 2, and 3?

2. What is the Vision/Mission Statement for your carbon reduction initiatives? What initiatives are you taking to reduce carbon footprint?

3. Are you taking any initiatives to reduce the carbon footprint of your distribution network?

4. If yes, what are your objectives set by your transportation/logistics team? Do you have single year goals for reducing carbon footprint? Medium term? Long term?

5. What is the volume of your produce affected by the change?

6. What transport modes do you utilize? Do you ship mostly via full truckload? Are you considering intermodal? Could you estimate the capacity utilization of the transport mode you use for the headhaul and backhaul?

7. Does the same logistics company handle your entire supply chain distribution (Shipping + Trucking + Warehousing)? If not how do you partner? Do you have your own DCs? Do you ship to retailer DCs or do you do replenishment yourself? Do you have wholesaler partners for distribution? Where are DCs located? (Both yours and partners).

8. If you measure benefit of the initiatives, what is your baseline for measuring? What is the carbon footprint of your transportation in terms of grams of CO₂ /kilometer/ton?

9. What was the impetus behind the change?

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