

**Stimulating Carbon Efficient Supply Chains:
Carbon Labels and Voluntary Public Private Partnerships**

by

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ABSTRACT

This thesis looks at the potential of labeling products with life cycle greenhouse gas emission information as a bottom-up, complementary alternative to carbon cap and trade systems. By improving the transparency of product carbon footprint information, a market for low carbon intensity products can be created. The conduct of such product life cycle assessments often allows companies to uncover cost effective emission reduction opportunities typically in the order of 10%-20%. Society benefits both from the increased supply chain efficiency of these companies as well as the heightened awareness of climate change among consumers as companies communicate these information to them.

An examination of the history of the development of the nutritional label and various eco-labels in the U.S. highlights the importance of timely government intervention in setting guidelines and standards to prevent companies from misleading consumers with unsubstantiated product health or environmental claims. Case studies of current carbon labeling initiatives worldwide demonstrate the benefits of government affiliation in building credibility during their early stages. This affiliation helps in attracting the participation of large established companies who provide strong reinforcing effects that are crucial to the growth and success of new initiatives. There is still lack of consensus about the ideal format for a carbon label. A seal of approval type label could be ideal to attract companies in the initial stages which can later be succeeded by an information disclosure based format as more consumers start to understand the meaning of product carbon footprints in the future.

Voluntary public private partnerships have been used extensively by the U.S. Environmental Protection Agency to reduce greenhouse gas emissions. These partnerships can serve as a potential model for a future carbon labeling initiative in the U.S. The SmartWay Transport Partnership is highlighted as a successful program both in terms of membership growth and emissions saved. System Dynamics modeling is applied as a tool to aid in understanding how the structure of such programs is critical to their success and is demonstrated as a method to potentially quantify the benefits of these programs prior to their actual implementation.

Thesis Supervisor: Edgar Blanco

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1 CLIMATE CHANGE: MARKET AND POLITICAL FAILURE

Climate change is undoubtedly one of the most challenging issues facing our society today. It is a huge environmental externality where emitters of greenhouse gases are imposing the burden of increased greenhouse gas (GHG) concentrations in the atmosphere onto the rest of the world's population. These increased concentrations are believed to have contributed to the marked increase in global average temperatures since the mid-20th century and are expected to have pronounced effects in areas including ecosystems, food production and incidences of coastal flooding (Intergovernmental Panel on Climate Change, 2007). Global interest in the issue has risen tremendously over the past 20 years as reflected by the dramatic increase in the number of climate change related articles published by major news and business sources (Figure 1-1).

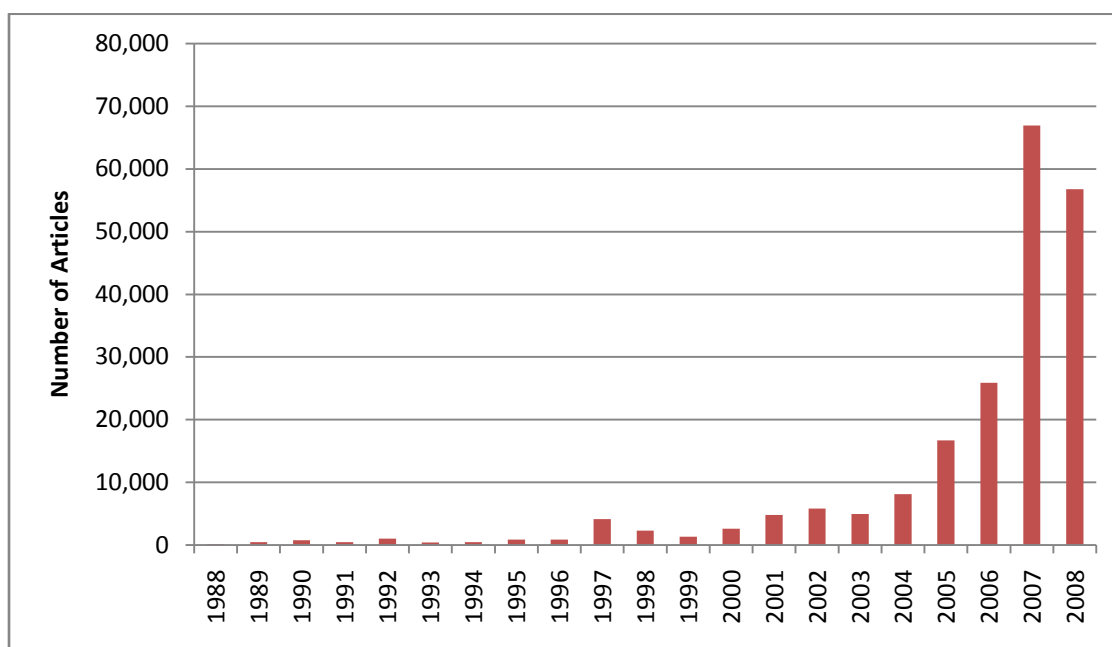


Figure 1-1: Factiva.com search on number of articles related to climate change published yearly in major news and business sources from 1988-2008

Moreover, former Vice-President Al Gore, a huge stalwart for climate change, and the Intergovernmental Panel on Climate Change (IPCC), a scientific international body tasked to evaluate the risk of climate change caused by human activity, were jointly awarded the Nobel Peace

Prize in 2007 for their efforts in raising awareness about the issue and creating foundations for change (Nobel Foundation). However, despite the urgency and seriousness of the issue highlighted by advocates through the media and the increased awareness and interest among citizens, concrete action by policymakers towards dealing with climate change has been limited.

1.1 IPCC ASSESSMENT

The IPCC in their Fourth Assessment Report states that “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.” Examples of the data gathered to support this conclusion include the increase in global surface temperatures by 0.74°C from 1906-2005, average sea levels rising at a rate of 3.1mm per year between 1993 and 2003, and the decrease in maximum areal extent of seasonally frozen ground in the Northern Hemisphere by about 7% since 1900. In conjunction with those observations, GHG emissions due to human activities have grown rapidly since pre-industrial times, increasing by 70% between 1970 and 2004 (28.7 to 49.0 GtCO₂-eq). Carbon dioxide (CO₂), which is notably the most important anthropogenic GHG, represented 77% of these emissions in 2004. As a result, the global atmospheric concentration of CO₂ has increased from a pre-industrial value of about 280 parts per million (ppm) to 379ppm in 2005. Due to the radiative forcing nature of GHG gases, the IPCC believes that the observed increases in global average temperatures is very likely due to the increases in anthropogenic GHG concentrations (Intergovernmental Panel on Climate Change, 2007).

Arguably, much of the remaining uncertainty lies in determining what the exact relation between GHG concentrations in the atmosphere and temperature rises is and what impacts the higher temperatures will have on our society. Projections by the IPCC of the temperature change in 2090-2099 relative to 1980-1999 range from 0.3 to 6.4°C depending on the scenario assumed. There is however considerable uncertainty associated with these estimates due to inherent limitations in

climate modeling. These temperature rises will most likely affect our water, food, coastal, ecological and health systems. Potential impacts within these include: 20-30% of plant and animal species at increased risk of extinction, variation in global food production with likely overall decreases with temperature rise above 3°C, increased occurrences of flooding in coastal areas and disruptions to settlements located there, increased damage from extreme weather events, increased spread of vector and infectious diseases, and increased stress on available fresh water resources (Intergovernmental Panel on Climate Change, 2007). The Stern Review in an attempt to put an economic cost to these impacts estimated that a business as usual approach to climate change would affect societal welfare by an equivalent reduction in consumption per capita of between 5% and 20% now and into the future. To prevent this by stabilizing GHG concentrations at a target of 500-550ppm instead would cost about 1% of gross domestic product (GDP) by 2050 (Stern, 2006). Despite the strong scientific consensus regarding climatic science, there are still a number of skeptics that question particular aspects regarding climate change including the causation links, modeling approaches and assumptions used (Holdren, 2008). There is also much debate regarding the quantifying of intangibles such as the environment and biodiversity and the proper rate of discounting to be used in comparing these future benefits with current mitigation costs (Nordhaus, 2007). Healthy debate about climatic issues is definitely important but unconstructive criticism and objections only serve to inhibit action towards the mitigation of climate change.

1.2 MARKET AND POLICY FAILURE

Attempts to mitigate climate change face tough challenges from both scientific and policy fronts. While scientific uncertainty is a valid reason for policymakers to be cautious when deliberating whether to make large investments in reducing GHG emissions, it is also often misused as an excuse for vested political interests as well. Climate change is systemically plagued by the fact that personal costs of taking action on reducing GHG emissions are high while the benefits of a stable climatic system are diffuse among a wide population. This is true at individual, corporate and

national levels where the costs include both the direct costs in reducing emissions and the indirect costs in mobilizing other actors to support the cause. In such situations where solutions are dependent on collective action, there are strong incentives for actors to “free ride” on the efforts of others (Olson, 1971). Consequently, there has been considerable difficulty in getting international participation and commitment towards an effective climate change agreement (Barrett & Stavins, 2003). Moreover, corporations rather than governments wield considerable influence in today’s capitalist driven society. These corporations driven by traditional profit maximization based models are often unwilling to take on concentrated burdens in reducing their emissions especially if it directly affects their bottom line. They may instead choose to participate in lobbying efforts to hinder the progression of legislation that is not in their best financial interests (McCright & Dunlap, 2003). Moreover, industries that have flourished in a non carbon constrained world such as the petroleum, automobile and coal power industries have significant clout in the present political scene. Reinforcing regulatory capture effects have resulted in them being difficult to displace even though their business models may have become antiquated (Stigler, 1971). As can be seen, the challenge of mitigating climate change does indeed face many obstacles from multiple fronts.

1.3 CLIMATE TREATIES

Presently, the most notable and significant global treaty addressing Climate Change is the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC was developed at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 with signatories agreeing upon a common objective of stabilizing greenhouse gas concentrations at a low enough level that would prevent dangerous anthropogenic interference with the climate system. Since then, the parties have been meeting annually in Conferences of the Parties (COP) to assess progress and determine actions to be taken in achieving the stated objective. One of the most significant developments from the UNFCCC was the Kyoto Protocol where industrialized countries agreed to reduce their greenhouse gas emissions collectively by 5.2% compared to the base year

1990. The protocol came into effect in 2004 after more than 55 countries accounting for more than 55% of the total carbon dioxide emissions of the parties ratified it (UNFCCC, 2008). The success of the UNFCCC and the Kyoto Protocol however has been mixed. Noteworthy achievements include the fact that it is a truly global agreement with 192 member countries participating in the UNFCCC and 183 of them having ratified the Kyoto Protocol. The treaty has also contributed to the creating of standards for the monitoring of national greenhouse gas inventories as well as the development of mechanisms and institutions to achieve the emission reduction targets. These include the introduction and implementation of cap and trade mechanisms to allow industrialized countries (defined as Annex I nations in the agreement) to meet their requirements via carbon offsetting projects in developing countries (Clean Development Mechanism) or through strategic collaborative programs with other Annex I nations (Joint Implementation). The parties will be meeting again at the end of this year in Copenhagen in a crucial attempt to develop an ambitious and effective international response to climate change as a successor to the current Kyoto Protocol (UNFCCC) (Wijen & Zoeteman, 2004).

1.3.1 EUROPEAN UNION EMISSIONS TRADING SCHEME

The European Union Emissions Trading Scheme (EU ETS) was enacted as one of the policy measures to enable the EU to meet its target under the Kyoto treaty where the EU-15 nations had agreed to a collective reduction in GHG emissions by 8%. The EU ETS started operating on January 1, 2005 and is currently the world's largest scale GHG emissions trading program covering over 10,000 installations across all 27 EU member states and three other members of the European Economic Area which are collectively responsible for 40% of its total GHG emissions (Europa , 2008). The overall success of the program is debatable with key benefits resulting from it including the setting up of institutional and operational structures during the initial testing phase from 2005-2007. However, carbon prices of the program were volatile, eventually collapsing at the end of the initial phase upon realization that the allowances allocated exceeded actual emissions. This was due

mostly to the over generous allocation of allowances by individual EU states via their national allocation plans, reflecting the inherent protectionist behaviors and strategic trade interests of sovereign states. This problem is expected to be resolved during the next implementation stage which started in 2008 with the commission having better information about baseline emission levels and hence able to assign allowances more equitably (Parker, 2006)(Ellerman & Joskow, 2008).

1.3.2 U.S. CAP AND TRADE INITIATIVES

The first U.S. regional climate change policy solution based on putting a price on carbon via a cap and trade system is the Regional Greenhouse Gas Initiative (RGGI) which involves ten Northeast and Mid-Atlantic States. The ten States have initially agreed to cap CO₂ emissions from the power sector and then require a 10% reduction in these emissions by 2018. Emissions permits for this trading scheme were auctioned off starting in September 2008 and the first three year compliance period began in 2009 (RGGI Inc.). The driving force behind the enactment of the agreement stems from the States' recognition of the importance of mitigating climate change and the realization that the Federal government was not taking the necessary steps in forming suitable policy to tackle the problem. A similar collaboration is the Western Climate Initiative (WCI) which includes seven U.S. states along the western coast of North America and four Canadian provinces. The purpose of the WCI is to identify and implement policies which can reduce greenhouse gas emissions by 15% below 2005 levels by 2020 in the region. Initial design recommendations have suggested the use of a multi sector cap and trade system and possibly becoming the most comprehensive carbon reduction strategy to date by covering nearly 90% of the region's emissions (Western Climate Initiative, 2008). At a Federal level, the Obama administration has stated its intent to reduce the country's GHG emissions 80% by 2050 using an economy wide cap and trade system (The White House). More recently, the U.S. Environmental Protection Agency proposed the first comprehensive national system for reporting GHG emissions produced by major sources (U.S. EPA, 2009). This is a

first step towards fulfilling its legislative requirement to regulate pollutants under the Clean Air Act which was determined by the Supreme Court to include carbon dioxide and the other greenhouse gases (Massachusetts et al. v. Environmental Protection Agency et al., 2007). Congress has also been involved in the drafting of climate change legislation with the most recent bill, the American Clean Energy and Security Act of 2009, being introduced by Chairmen Waxman and Markey seeking to introduce a Federal cap and trade system for carbon emissions (Waxman & Markey, 2009).

1.4 CARBON FOOTPRINT

In order to identify solutions to mitigate climate change, it is useful for policymakers and stakeholders to be able to quantify and put into perspective what their national, organizational or personal contribution towards climate change is. For example, Figure 1-2 shows the growth in global anthropogenic GHG emissions from 1970-2004 and the shares based on different gases and from different sectors (Intergovernmental Panel on Climate Change). These can be further broken down and distributed among various stakeholders in what is termed as a carbon footprint (Wiedmann & Minx, 2007). The Carbon Trust provides its definition of a carbon footprint as “the total set of greenhouse gas emissions caused directly and indirectly by an individual, organization, event or product” (Carbon Trust, 2007). The interest regarding carbon footprinting has increased dramatically in the past three years as reflected by the growth in articles about the subject and the number of internet searches on it (Figure 1-3). At the national level, Annex I countries to the UNFCCC are required to submit their GHG inventories of anthropogenic emissions by sources and removals by sinks of GHG not controlled by the Montreal Protocol (UNFCCC). Guidelines for conducting these assessments have been established by the IPCC with their most recent publication on standards being the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (Eggleston, Buendia, Miwa, Ngara, & Tanabe, 2006). Companies likewise have similar methodologies to guide them including the Greenhouse Gas Protocol Initiative’s corporate accounting standard and the International Organization for Standardization’s ISO 14064 standard (GHG Protocol Initiative,

2004). The structured approach currently recommended for organizations is to classify their GHG emissions into three main categories (Carbon Trust, 2007):

1. Direct emissions that result from activities that the organization controls
2. Emissions from the use of electricity
3. Indirect emissions from products and services

Companies in the U.S. have the opportunity to report their emissions through multiple channels including the Climate Registry¹, the Carbon Disclosure Project² and the Environmental Protection Agency's (EPA) Climate Leaders Program³. The benefits for companies in conducting such assessments and reporting them include gaining a better understanding of their carbon impacts and risk as well as providing greater accountability to their shareholders and stakeholders. This is especially pertinent given the greater importance society and policy makers are placing on climate change. Even at an individual level, there are a number of web based tools that provide users with best estimates of their carbon footprint based on questions like transportation use, household size, food consumption, location of residence etc. These have grown in popularity as more people seek to quantify and understand their personal contribution towards climate change.

¹ The Climate Registry is a nonprofit organization based in North America that works with businesses and governments to calculate and publicly report their carbon footprints in a single, unified registry (The Climate Registry).

² The Carbon Disclosure Project surveys and collates data on a chosen sample of large global corporations regarding their emissions and strategy (Carbon Disclosure Project).

³ The EPA Climate Leaders Program is an industry-government partnership that works with companies to account for their emissions and develop comprehensive climate change strategies (U.S. EPA).

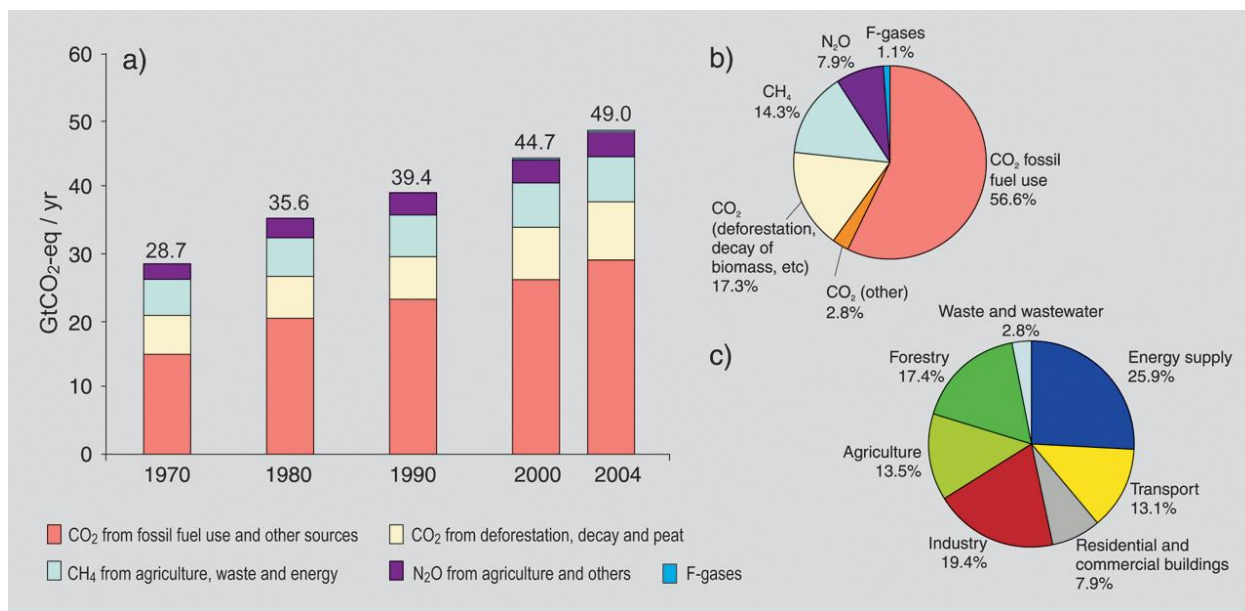


Figure 1-2: (a) Global annual emissions of anthropogenic GHGs from 1970 to 2004. (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of CO₂-eq. (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO₂-eq (forestry includes deforestation) {WGIII Figures TS.1a, TS.1b, TS.2b}

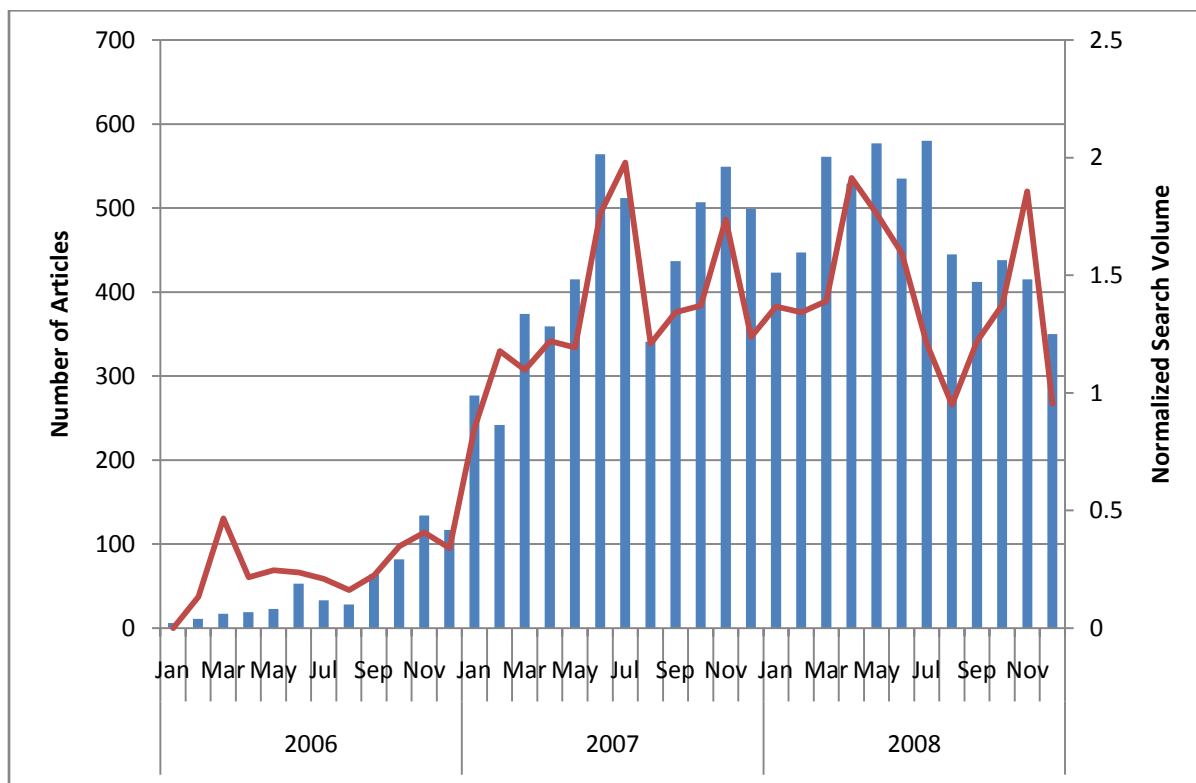


Figure 1-3: Factiva.com search on number of articles related to carbon footprint published yearly in major news and business sources (column bars, left axis) and Google Trends normalized worldwide traffic of "carbon footprint" (line graph, right axis) from 2006-2008

2 SUPPLY CHAIN PERSPECTIVE AND CARBON LABELS

A more recent and novel approach being taken to address the issue of climate change is applying a supply chain framework to dealing with the problem (Figure 2-1). The motivation behind this thinking is based on a study initiated by the Carbon Trust in the UK and completed by the Centre for Environmental Strategy at the University of Surrey and Enviros Consulting which concluded that “Consumer purchasing decisions are the ultimate driver of carbon emissions in an economy” and consequently “All carbon emissions can be attributed to the delivery of products and services to meet the needs of the consumer” (Carbon Trust, 2005). This departure from the traditional industrial sector approach towards climate change provides deep insights on how consumers’ daily purchases contribute to the generation of carbon emissions. Another key advantage of this approach is that it takes into consideration emissions that are imported through products across national borders. For instance, the study found that the carbon “trade balance”, which is the net imports over exports of carbon emissions, in the UK contributed to approximately 7% of the total emissions from consumption (Carbon Trust, 2005). Hence only accounting for emissions at a national or organizational level provides a narrow perspective and might create a misperception that emissions are declining when they are actually being outsourced.



Figure 2-1: Different stages in the supply chain of a product

2.1 BENEFITS OF SUPPLY CHAIN APPROACH

From a business perspective, applying systemic thinking towards dealing with climate change opens up many more opportunities to reduce carbon emissions that often are aligned with cost reduction as well. Using a supply chain approach provides companies with a better understanding of how their products interact with the larger environmental and social system as well as fosters stronger supplier-customer relationships both up and down stream. This is especially pertinent

looking ahead into the future where regulations regarding carbon emissions are likely to tighten and the cost of fossil based energy expected to continue rising. In addition, consumers are increasingly becoming conscious about environmental and social issues, including climate change, and are putting greater pressure on companies to improve their operational practices. The World Economic Forum found in its report *Supply Chain Decarbonization* that 2,800 mega-tonnes or 5.5% of the total GHG emissions from human activity were contributed by the logistics and transport sector and commercially viable opportunities could potentially reduce this by half in the medium term (World Economic Forum, 2009). The Carbon Trust has further identified a few categories in which these carbon saving opportunities in the supply chain can be classified under (Carbon Trust, 2006):

1. Correcting market failures – Addressing instances along the supply chain where market incentives are not well aligned
2. Product change – Altering the product mix or configuration to reduce carbon emissions
3. Supply chain reconfiguration – Changing the processes and structure of the supply chain to optimize it with respect to carbon emissions

The approach also enables companies to identify high impact areas along their supply chains and focus their attention on applying the most effective strategies where needed. Other tangential benefits raised include the improvement of a company's general business and management practices through the development of methods and tools to enhance sourcing decisions.

Apart from savings stemming from energy and waste efficiency measures across the supplier chain, there are added benefits for companies in communicating these efforts with consumers. The use of carbon labels on products can serve as a factor for differentiation in the marketplace. Surveys conducted in the UK have found that 67% of consumers were more likely to buy a product with a low carbon footprint, and 44% would switch to a lower carbon product even if the brand was not

their first choice. The Carbon Trust also found that 49% of consumers were more likely to buy a product if the label was displayed on pack and 65% declared a label indicating suppliers have committed to reducing a product's emissions would make them more likely to buy it. Labels likewise can serve a similar purpose for business to business products by providing similar differentiation given the increased demand for carbon related information among companies. The appropriate use of labeling also has the potential to boost a company's overall brand image. Walkers, a UK based subsidiary of PepsiCo, found that 44% of its customers surveyed stated that the Carbon Trust Carbon Reduction Label used on the company's crisps made them feel more positive about Walkers (Carbon Trust, 2008).

From a societal perspective, carbon labels serve to increase consumer awareness about the issue of climate change and through information transparency and leveling empower consumers to affect corporate behavior by purchasing climate and environmentally friendly products. There are also likely to be rollover effects as consumers change their lifestyles and behaviors after learning more about their personal impact on the climate. These changes could ideally balance out the current inefficiencies in the market system where carbon intensive products are excessively demanded because their full societal cost is not incorporated into their price on the shelf. While putting a price on Carbon through a tax or cap and trade system would help address part of the issue regarding hidden environmental costs, if it is not instituted globally there is the potential of carbon "leakage" where investment and jobs are driven to nations with looser or non-existent climate regimes and lower associated costs (Wall Street Journal, 2009). Whereas, a supply chain approach would factor in overseas emissions and even penalize outsourced products more because of the distances involved in shipping.

2.2 LIFE CYCLE ASSESSMENT

The subject of assigning environmental impacts to products is known as Life Cycle Assessment (LCA) and is described in detail in ISO 14044: Environmental management – Life cycle assessment

(International Organization for Standardization, 2005). Recently, the British Standards Institute (BSI) has also developed the Publicly Available Specification (PAS) 2050 which pertains directly to GHG emissions for products and services (British Standards Institute, 2008). The main issues commonly raised in calculating the carbon footprint of a product is that it is highly resource intensive to do a detailed and precise assessment due to the many complexities and unknowns in tracing its supply chain. In addition, it is impossible to be perfectly certain about the final accuracy of the calculated figure due to the use of industry averages and various simplifying assumptions. One less resource intensive alternative is the Economic Input-Output Life Cycle Assessment (EIO-LCA) that estimates the materials and energy sources required for, and the GHG emissions resulting from, activities in our economy (Green Design Institute). This top-down approach however understandably creates greater uncertainty due to the many generalizations and averages used in the calculations. Hybrid LCAs which incorporate both EIO-LCAs and detailed LCAs could potentially provide a bridge between this trade-off (Carbon Label California). The selection of an appropriate methodology would perhaps depend on the purpose of the assessment and what the accuracy versus trade-off curves look like for a particular product (Figure 2-2).

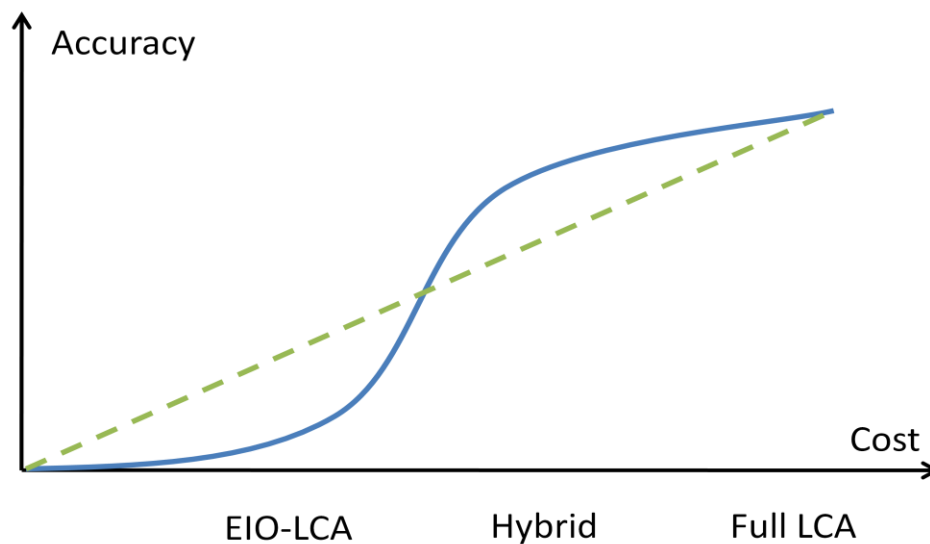


Figure 2-2: Possible tradeoff curves (linear and s-shaped) between accuracy and cost for EIO-LCA, Hybrid and Full LCA approaches

2.3 SYSTEMS DYNAMICS PROPOSITION

This thesis looks at what the potential effectiveness of product carbon assessments and labels would have in mitigating climate change and how best such a policy should be implemented in the U.S. This bottom up approach could serve as an alternative or be complementary to the top down cap and trade systems in operation or being proposed. The main premise behind the proposition is illustrated in the causal loop diagram shown in Figure 2-3. The reinforcing effect of this process can be described as follows:

1. As more companies conduct product carbon assessments and communicate this information to their consumers, the prevalence of carbon labels in the market grows
2. The increase in the number of products with carbon labels in the market leads to an increase in general consumer awareness about the impact their purchasing and consumption has on global carbon emissions
3. As a greater proportion of consumers become aware and concerned about their climate change impact, they begin to demand and value products with low carbon footprints
4. Companies looking to meet this demand choose to conduct more product carbon assessments which results in the closing of this reinforcing loop

Tangible GHG emission reductions are achieved when companies conduct product carbon assessments and commit to reducing the carbon footprint of their products as they learn about inefficiencies in the supply chain system or sub optimization in the product design as well as when there is a market shift towards low carbon intensity products. However there is reason for concern that unregulated labeling could potentially lead to market saturation and fallacious claims leading to consumer confusion regarding the beneficial attributes and validity of low carbon intensity products (Figure 2-4). This highlights the need for a structured approach towards the introduction of carbon labels into the consumer marketplace. The following chapters dive deeper into analyzing this proposition by taking a closer examination at the lessons that can be learnt from past labeling

initiatives as well as potential structures and formats that a future carbon labeling policy in the U.S. could be modeled after.

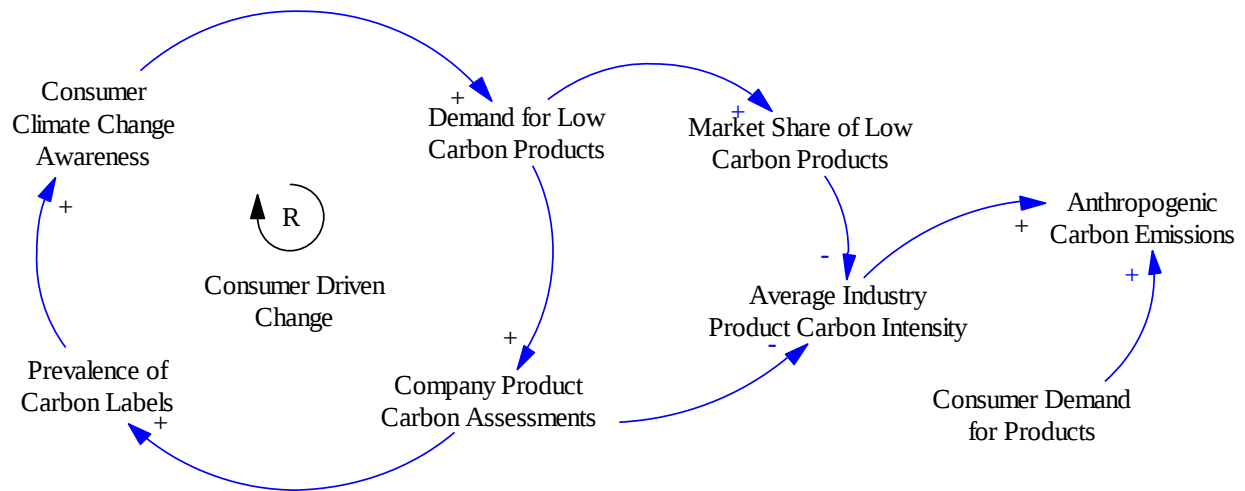


Figure 2-3: Reinforcing causal loop diagram for product carbon assessments and labels

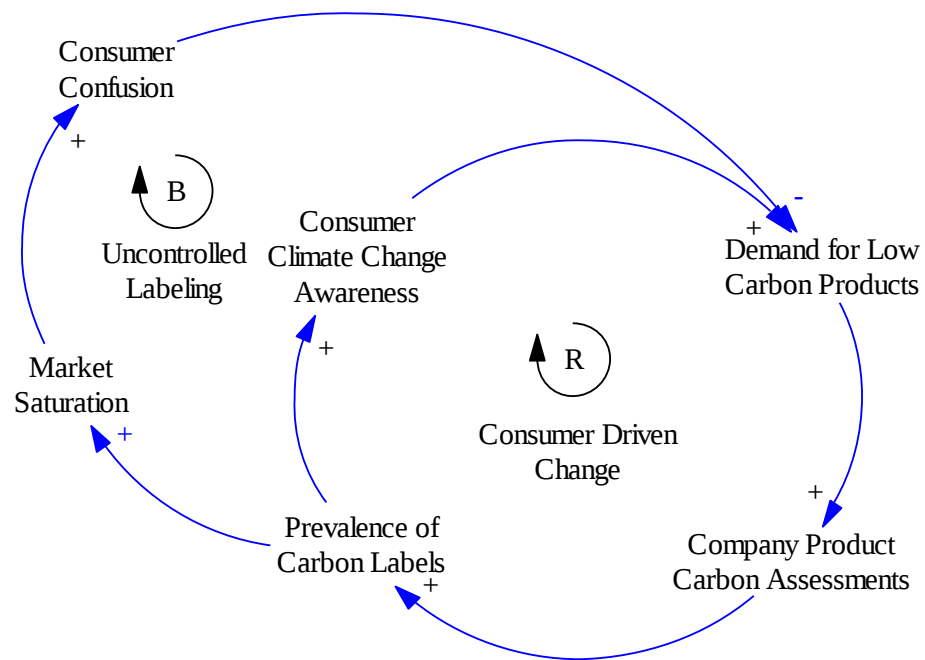


Figure 2-4: Potential balancing effects negating the benefits from carbon labeling

3 HISTORY AND DEVELOPMENT OF LABELS

This next chapter explores the purposes, history and evolution of consumer product labels. By studying and learning from the development of successful labels such as the Nutritional and Energy Star, we can better understand and evaluate the potential and factors for success in developing a carbon labeling initiative in the U.S.

3.1 BENEFITS OF LABELS

The main purpose of product labels is to convey information regarding the product that is not readily available or evident at the point of purchase and is of importance to the consumer in making his purchase decision. The history of product labeling in the U.S. dates back to the early 20th century as advocates sought to raise awareness about shady business practices, dangerous working conditions and questionable product ingredients. Several of these were introduced via Federal legislation such as the Food, Drug and Cosmetic Act⁴; the Federal Hazardous Substances Labeling Act⁵; and the Fair Packaging and Labeling Act⁶. Others have been introduced by individual States, as well as private and non-profit organizations (U.S. EPA, 1994).

Environmental labels in particular are a more recent occurrence and it was not until the mid-1970s that environmental issues relating to products started being raised in the U.S., and even so only indirectly through programs such as the Energy Guide which stated the annual electricity use of an appliance and the automobile Fuel Economy Information program which gave a vehicle's average mileage per gallon (U.S. EPA, 1994). In the 1980s, a number of environmental certification

⁴ The Food, Drug and Cosmetic Act of 1938 required the review of new drugs, and the listing of food ingredients, artificial colors and flavors. It also allowed the banning of substances that could not be adequately labeled.

⁵ The Federal Hazardous Substances Labeling Act of 1960 succeeded the Caustic Poison Act and applied to any substances defined as "toxic, corrosive, strong sensitizers, irritating, flammable, combustible, or that generate pressure", excluding pesticides, food, fuel and tobacco. It set standards for determining the dangerous property of a substance.

⁶ The Fair Packaging and Labeling Act of 1966 required that product labels display the name and address of the manufacturer or distributor, the "usual name" of the product and for the use of standard units of quantity measure.

programs including the Green Seal and Scientific Certification System's Environmental Report Card began operation and evaluated products based a range of different attributes. More recently, there has been a prevalence of 'single-issue' labels that include Dolphin-friendly, Energy Star and Organic (Business for Social Responsibility, 2008). A number of these are also starting to incorporate social issues within them like the Forest Stewardship Council (FSC) and Fair Trade labels.

Product labels serve as an alternative to direct regulation, protecting consumer rights while minimizing government interference into the market. A summary of the key benefits from product labeling for the three main stakeholders – consumers, industry and government are shown in Figure 3-1 below.

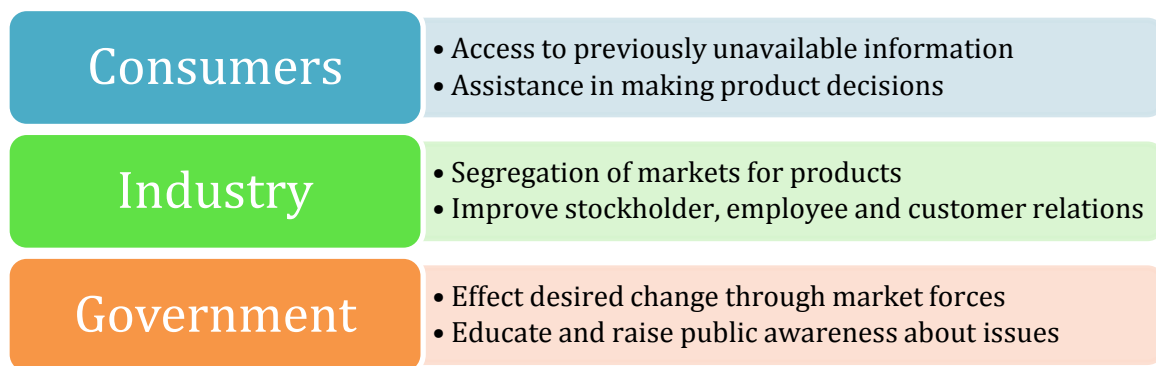


Figure 3-1: Summary of product labeling benefits for key stakeholders

3.1.1 CONSUMER BENEFITS

Ideally, for the efficient operation of economic markets, consumers must have perfect access to information to make economically rational decisions. Typically however this is not the case and consumers have limited information regarding the products they are deliberating to purchase. In economics, products and services can be classified into three categories depending on the degree of observation possible about a product's characteristics. Search goods have features and characteristics which are easily evaluated before purchase. This is in contrast with experience goods whose product characteristics such as quality are difficult to observe in advance, but can be ascertained upon use or consumption (Nelson, 1970). Finally, we have credence goods whose utility

is difficult or impossible for the consumer to determine even after use or consumption (Darby & Karni, 1973). Third party inspections are often required to reveal characteristics of credence goods and can be useful in determining those of experience goods as well. The fuel economy label is an example on how an experience good can benefit from a labeling program (Figure 3-2). While drivers can determine the mileage per gallon of a vehicle through use, it is much more convenient for buyers to have this figure certified and made available when making purchasing decisions. The nutrition label reveals information about the various nutrients and ingredients contained in a food product, which are credence attributes that consumers are not able to determine on their own inspection and consumption (Figure 3-3). Similarly, the carbon footprint of a product being a process attribute is credence in nature and hidden from the view of consumers. Through the use of product labels, credence and experience goods become akin to search goods as buyers can determine previously hidden product characteristics directly from the label. Consumers stand to benefit from the transparency and symmetry of product information by being able to make more economically rational decisions.

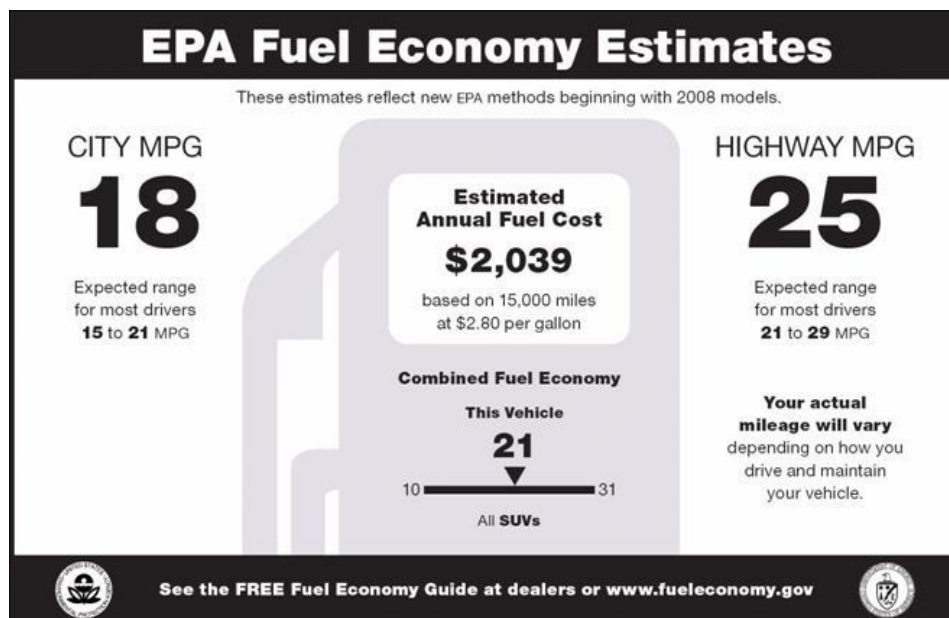


Figure 3-2: EPA fuel economy label (U.S. EPA, 2006)

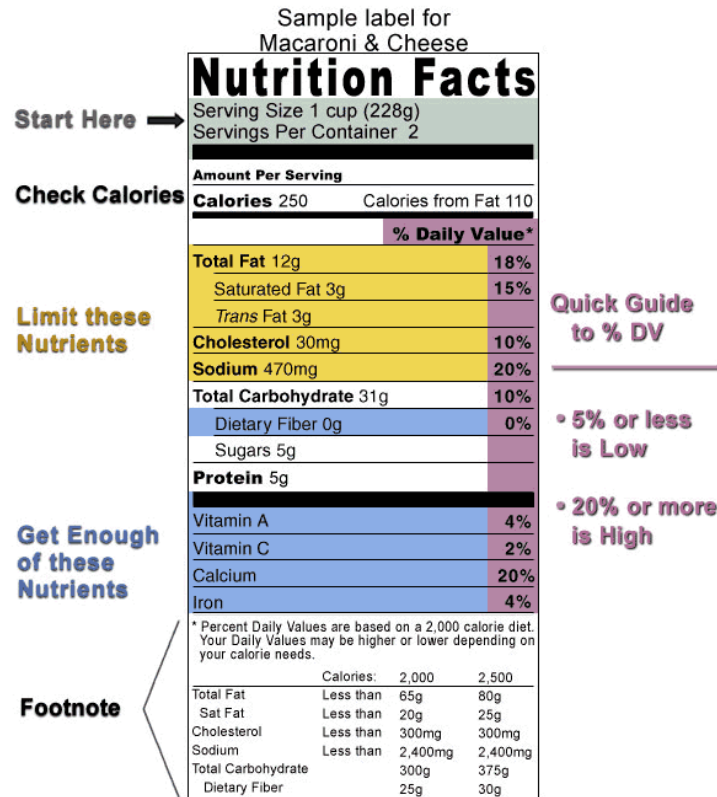


Figure 3-3: FDA nutrition label (U.S. FDA, 2004)



Figure 3-4: Effect of product labeling on information transparency

The second benefit of product labels is the assistance they provide consumers in interpreting product credence or experience attributes when making their purchasing decisions. This is the case for seal-of-approval labels including the Energy Star and Green Seal (Figure 3-5). These labels are useful when consumers are not able to understand or make their own conclusions from the information provided. For example, the Green Seal label is awarded to products which meet environmental and performance requirements as outlined by the program's standards (Green Seal).

Consumers are saved the burden of having to determine on their own what appropriate environmental standards should be and making sense of the large amounts of data available from a product's life cycle assessment. These standards are determined by third parties in consultation with experts from both industry and academia, and provide accurate, unbiased judgments which consumers can rely on. The Energy Star program was established by the U.S. Environmental Protection Agency (EPA) in 1992 when it realized that homeowners and businesses were not taking advantage of cost saving opportunities in energy efficiency due to the lack of information available (U.S. EPA, 2003). By selecting and promoting the top performers in each product category, consumers are saved the hassle of doing their own quantitative energy measurements and cost calculations among different products. Labels in this case correct the market inefficiency present by recommending to consumers products which make simple economical sense, but they were not aware of previously.



Figure 3-5: Energy Star and Green Seal labels (U.S. EPA)(Green Seal)

3.1.2 INDUSTRY BENEFITS

The use of labels enables manufacturers to highlight positive attributes of their products. It provides for the broadening of existing markets and the creation of new ones by allowing companies to design a wider range of products to cater to various consumer preferences. One example was the creation of low and fat free food product markets with the passing of the Nutrition Labeling and Education Act (NLEA) in 1990. Healthy Choice and Nabisco's SnackWell's were two of the biggest success stories then. Both companies introduced fat-free and reduced fat products and

saw their sales soar amidst the growing discussion and interest for nutritional products during that period. Healthy Choice debuted in 1988-1989, introducing products with reduced calories from fat and controlled amounts of sodium and cholesterol. The attention the labeling legislation drew to fat was a huge bonus for them. SnackWell's tasty yet fat-free products saw sales rise from \$50 million in the line's first six months to over \$440 million in 1994. The market grew so rapidly that Kraft Foods estimated they made \$3 billion in 1994 from sales of fat-free and reduced fat products (Fusaro, 1995).

The Fair Trade Movement is another program which has benefited greatly from labeling initiatives. While Fair Trade products had been around since the 1960s and were experiencing growing sales, they were contained to relatively small Worldshops scattered around Europe with a handful in North America. It was generally felt that these shops were too disconnected from contemporary markets and the inconvenience of going to them to buy a product was high for even the most dedicated of customers. In order to increase sale opportunities, there was a need to expand to larger distribution channels and start offering fair trade products where consumers normally shopped. A solution was found in 1988, when the first Fair Trade labeling initiative, Stichting Max Havelaar, was created. The independent certification allowed the goods to be sold outside the Worldshops and into mainstream outlets, reaching a larger consumer segment and boosting Fair Trade sales significantly (Redfern & Snedker, 2002). This revolution led to the creation of Fairtrade Labeling Organizations International in 1997 which launched for the first time an International Fairtrade Certification Mark in 2002. In 2007, Fairtrade certified sales had amounted to approximately 2.3 billion Euros worldwide, a 47% increase from the previous year and almost seventy times that ten years ago (Fairtrade Labelling Organizations International, 2008).

Participating in labeling initiatives also benefits companies by boosting their Corporate Social Responsibility (CSR) image. This is important for companies in maintaining the support of their

consumers, employees and shareholders. A survey conducted by Tandberg and Ipsos Mori in 2007 found that more than half of global consumers interviewed said they would prefer to purchase products and services from a company with a good environmental reputation, and almost 80% of global workers believe that working for an environmentally ethical organization is important (Tandberg, 2007). Timberland for example considers CSR as a very important part of its branding. In 2006, they introduced the “Our Footprint” label which informs consumers about aspects of their environmental and community impact. The information provided includes the average amount of kilowatt hours needed to produce a pair of footwear, the amount of energy that is generated from renewable sources, hours volunteered in the community by their employees, and the name and location of the factory where the product was made (Figure 3-6). It has won numerous accolades ranging from being on Forbes magazine’s “Best Big Companies in America” to ranking on Business Ethic’s list of “100 Best Corporate Citizens” (Timberland, 2006). These have helped bolster its appeal to its consumers, employees and shareholders. Following up in 2007, Timberland introduced their Green Index rating system which scores products from a scale of 0 to 10 for three categories – climate impact, chemicals used and resource consumption (Figure 3-7). Climate impacts are calculated using LCA methodologies with numerical data obtained mostly from publicly available datasets. Timberland has set a standard for its shoes to have a carbon emissions footprint of below 2.49kg in order to achieve the best score of 0. The remaining scores are tiered with the worst score of 10 being assigned to products with over 100kg of emissions (Timberland).



Figure 3-6: Timberland Our Footprint label (Timberland)

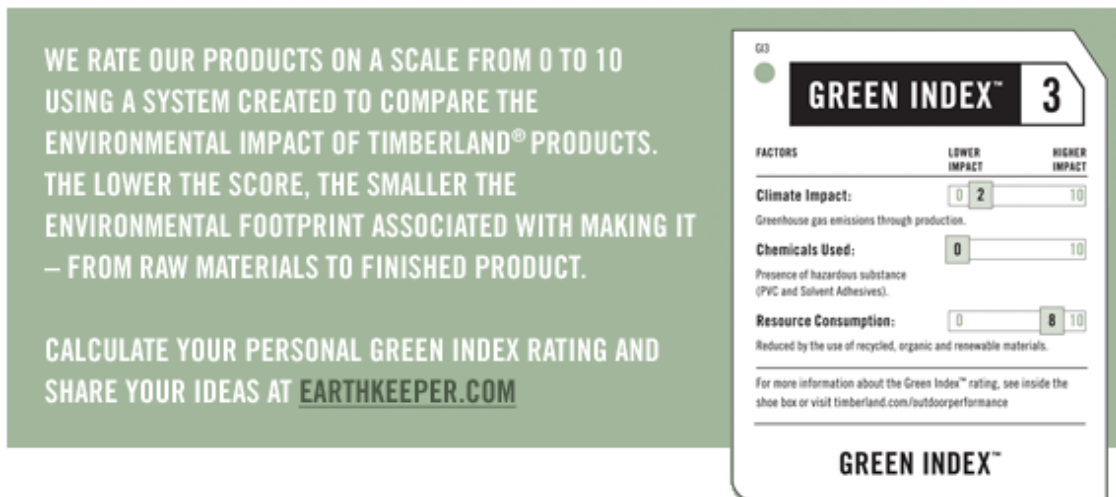


Figure 3-7: Timberland Green Index (Timberland)

3.1.3 GOVERNMENT BENEFITS

Labeling can serve as an important policy tool if used effectively by the government. Government intervention in labeling in the U.S. has traditionally served three main purposes: to ensure fair competition among producers, to increase consumers' access to information, and to reduce risks to individual consumer safety and health (Hadden, 1986). For example, the main motivation for many

government labeling laws in the food industry have historically been to ensure fair competition. In recent years, government intervention in labeling has been targeted at influencing individual consumption choices to align them with social objectives (Golan, Kuchler, & Mitchell, 2000). In a regulatory impact analysis conducted when the final rules of the NLEA were issued in 1993, the Food and Drug Administration (FDA) estimated that the label might save between \$4.4 and \$26.5 billion in healthcare costs over the next 20 years (U.S. DHHS, 1993). This well exceeded the estimated \$2 billion in costs to food manufacturers for implementation (Silverglade, 1996).

In addition, a properly designed labeling program can be a significant stimulus for the market transformation of products. The Energy Star label for example updates its performance specifications as market conditions change so as to continuously identify the most efficient, cost-effective products on the market (U.S. EPA, 2003). Manufacturers as a result have to keep developing and improving on their existing products if they want to maintain the label. It has also been commented that by disclosing nutrition composition, mandatory labeling intensifies competition on nutritional quality. Even if only a portion of the population bases its purchasing decisions on nutrition labels, this may be sufficient to induce product changes by manufacturers who wish to increase their market share by selling to these information-seeking consumers (Baltas, 2001). It can be seen that the government through labeling policies, is able to affect market forces and achieve a desired social result.

Another use of product labeling as a policy tool is to raise awareness about a social issue. This usually is the initial objective of a labeling initiative initially as it is in practice difficult to affect consumer purchasing behavior solely through labels especially if the majority of people are still unaware or uninformed of the issue in question. In this situation, price and quality often still are the primary factors these consumers consider when making their purchasing decisions. However, it is important to take a first step in getting the desired message across to the public before attempting

to change their behaviors. Therefore, labeling initiatives often work hand in hand with other policy tools including education to raise awareness. When launching the newly revised nutritional label in 1994, the FDA held educational conferences nationally, produced and distributed educational materials, made public service announcements and conducted a major media campaign in order to inform consumers on how to interpret and use the label (Kessler, Mande, Scarbrough, Schapiro, & Feiden, 2003). Once there is a high degree of consumer awareness about the issue at hand, labels are able to better serve their intended purpose of promoting informed selection.

3.2 ECO-LABELS

Environmental labels, also known as eco-labels, form a subgroup within product labels which is where carbon labels would be classified under. They typically identify overall environmental preference of a product within a product category based on life cycle considerations. Products may also be labeled based on a wide range of environmental considerations including recycled content, toxic emissions, biodegradability, waste generation and harm to wildlife etc. These labels are often verified and awarded by a third party organization to ensure impartiality and accuracy. The overall goal of eco-labels is through the provision of accurate and verifiable information about the environmental impacts of products, encourage consumer demand for environmentally friendly products and consequently stimulate the market towards continuous environmental improvement (ISO, 2000). The majority of product environmental attributes is credence in nature, hidden within a product's supply chain, and not readily apparent at the point of purchase or after use. Therefore verification and labeling is more essential for eco-labels as compared to mileage, energy use or even nutritional labeling information which can be gathered over time by the consumer through personal experience and shared through other information channels.

The International Organization of Standardization (ISO) has classified voluntary environmental performance labels under three generic categories in an attempt to design standards for them (Global Ecolabelling Network, 2004). Type I and III labels are verified by a third party with the

difference being that Type I labels involve interpretation and evaluation of the assessment results whereas Type III labels simply state the quantified environmental data. Type II labels often have no pre-defined criteria nor is verification involved.

Table 3.1: ISO voluntary environmental performance label types

Type I- ISO 14024:2000

- Voluntary, multiple-criteria based, third party program that awards a license which authorizes the use of environmental labels on products indicating overall environmental preferability of a product within a product category based on life cycle considerations

Type II- ISO 14021:1999

- Informative environmental self-declaration claims

Type III- ISO 14025:2006

- Voluntary programs that provide quantified environmental data of a product, under pre-set categories of parameters set by a qualified third party and based on life cycle assessment, and verified by that or another qualified third party

The EPA has also developed a categorization system based on whether the labels are voluntary or mandatory and if they highlight positive, neutral or negative attributes (Table 3.2) (U.S. EPA, 1998).

Table 3.2: Categories of environmental labels

	Mandatory	Voluntary
Positive	N/A	Seal of Approval, Single Attribute
Neutral	Information Disclosure	Report Card
Negative	Hazard Warning	N/A

Seal of Approval programs generally evaluate multiple attributes of a product and employ some form of life-cycle assessment (LCA) to evaluate the environmental impacts of a product. If the product meets the program’s pre-defined standards and criteria, it is awarded the rights to use the label for promotional purposes. For example, the Green Seal, an independent, nonprofit organization established in 1989, issues seal of approval labels to products which it deems to “cause less harm to the environment than other similar products”. These standards are based on

previous studies done on the product as well as independent testing and studies by its own experts (Green Seal). **Single Attribute** programs in contrast only analyze a single product attribute and award a label certifying the environmental preference of only that attribute. Examples are the Totally Chlorine Free paper certification label which indicates that no chlorine or chlorine containing compounds were used in the papermaking process and Dolphin Safe which ensures that no dolphins were intentionally chased or killed with tuna fishing nets.

Report Cards are voluntary programs which present neutral summary information on an established set of environmental attributes. These are less prevalent as there is little incentive for producers to communicate information that does not increase their product marketability. These programs are likely to merge and become closer to seal of approval programs. For instance Scientific Certification Systems performs life cycle assessments that covered all relevant impacts for each of a product's life cycle stages. The results used to be presented quantitatively on a "Certified Eco-Profile" which communicated an overall declaration of the environmental performance of the product. This has evolved more recently into its Certified Declaration of Reduce Impact program for products that have demonstrated significant environmental improvement over their historic performance as well as their Certified Environmentally Preferable Product program that indicates the product has successfully reached the threshold of across the board impact reduction in its product category (Scientific Certification Systems). Likewise, Timberland started off with their "Our Footprint" label that informed customers of quantified information including energy needed per footwear, percentage of renewable energy used in its facilities etc. Their next evolution label, the "Green Index" as discussed previously provides an overall rating based on three specific categories (Timberland, 2006):

- Climate – greenhouse gas emissions specific to the product
- Chemical – chemicals and solvents used in the manufacturing of the product

- Material – use of organic, renewable and recyclable materials

These shifts are important for producers to ensure that the information they provide to consumers is meaningful and can be understood. At the very least, being able to communicate to consumers that the company is putting a serious and sincere effort towards improving its impact on the environment is beneficial for the company.

Information Disclosure programs are similar to Report Cards just that they are made mandatory by government regulation. The fuel economy label is an example of a program made mandatory after Congress passed the Energy Policy and Conservation Act (EPCA) in 1975 which established Corporate Average Fuel Efficiency (CAFE) standards that required a label to appear in the windows of new cars listing the miles-per-gallon and estimated annual fuel costs associated with the cars operation. The energy guide label similarly provides quantitative information showing the energy consumption of an appliance and its estimated yearly operating cost (Figure 3-8). The label is mandatory for certain household appliances including refrigerators, dishwashers, furnaces, heat pumps etc. as part of the Federal Trade Commission's Appliance Labeling Rule.

Hazard Warning labels identify negative attributes of a product and are generally mandatory. This includes EPA's Ozone Depleting Substance (ODS) warning label which became necessary under the amended Clean Air Act in 1990. The label warns consumers if a product contains substances which are known to destroy ozone in the upper atmosphere (U.S. EPA, 1998).

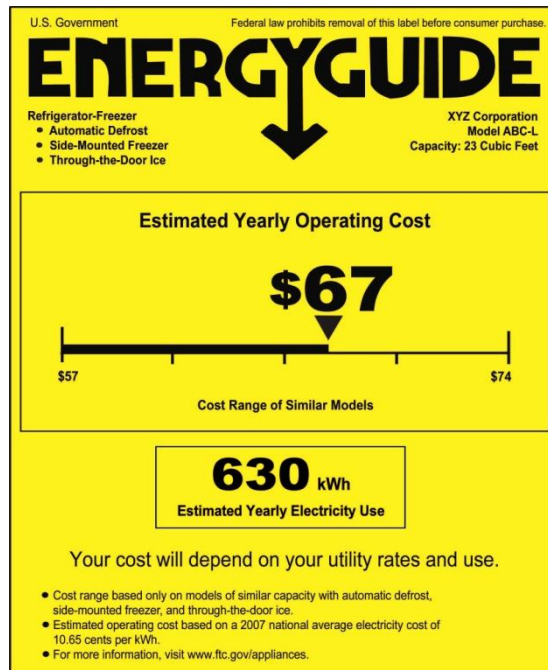


Figure 3-8: EnergyGuide label for appliances (U.S. FTC, 2007)

3.3 GOVERNMENT INTERVENTION IN DEVELOPMENT OF LABELS

In studying the development of nutritional labeling in the U.S. and the early trends in eco-labels, I have come up with a four stage linear process model that describes my observations of the system. The model highlights the involvement of four key stakeholders in the development of labels which are namely researchers, consumers, corporations and the government.

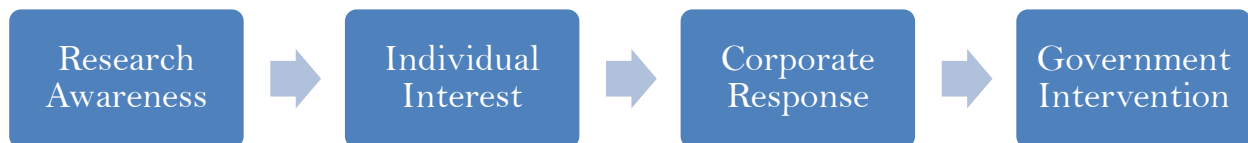


Figure 3-9: Linear process model for the development of labels

3.3.1 DEVELOPMENT OF NUTRITION LABELS

After World War II, nutrition policy in the U.S. focused initially on reducing the incidence of vitamin-deficiency diseases. These ailments declined dramatically over time largely as a result of implementing nutrient fortification programs across the country. Researchers started shifting their

attention to studying the relationship between nutrition and chronic disease. One of these well known initial studies was the Framingham Heart Study which was introduced in 1949 and had been very effective in showing how diet and sedentary lifestyles contributed to the development of heart disease. Fat and in particular saturated fat was identified as a major culprit (Kendall, 2007).

Physiologist Ancel Keys from the University of Minnesota was another key contributor in the 1950s, publishing studies that found strong associations between the cardiovascular disease of a population and average serum cholesterol and per capita intake of fatty acids (Hoffman, 1979). The most pivotal research findings were the release of the Surgeon General's *Report on Nutrition and Health in 1988* and the National Research Council of the National Academy of Sciences issue *Diet and Health: Implications for Reducing Chronic Disease Risk*, which presented evidence of the growing acceptance of diet as a factor in the development of chronic diseases, such as coronary heart disease and cancer (U.S. DHHS, 1988)(National Research Council, 1989).

As individual consumers became more aware of these issues and findings, they started to demand more comprehensive and useful information on labels. Since 1973, a label had been required on foods if the manufacturer had added certain nutrients to them or was making claims about its nutritional properties. While the food label was required to list the type and amount of nutrients in foods, it did not yet put that information in the context of a daily diet, nor did it present the information in a uniform format. Decisions about the label's design, typeface, type size, and location on the package were left to the discretion of the manufacturer. By the 1980s, corporations began to realize that nutrition was starting to be marketable due to the increased interest and concern of consumers, and began swarming the market with new products and claims. The vast number of claims entering the market and their often misleading information however led to the confusion and distrust of consumers instead. It became apparent that the current food label did not offer enough information to help consumers and coupled with often questionable market practices led to a serious effort by the government to revamp the food label (Porter & Earl, 1990).

In 1989, the FDA published an advanced notice of proposed rule-making on food labeling and over a period of several months, held hearings and other meetings in many parts of the country to solicit comments from consumers, industry, and scientists. After obtaining feedback from more than 3,500 people, it published proposed labeling changes, which included mandatory nutrition labeling for most foods, standardized serving sizes, and uniform use of health claims. The Nutrition Labeling and Education Act (NLEA) was passed by Congress in 1990 and gave the FDA more explicit authority to require nutrition labeling on most food packages and set demanding deadlines for completing the task, requiring the FDA to issue final rules within two years. In November 1991, one year after the NLEA was signed into law, the FDA proposed 26 new food label regulations to implement the statute (U.S. DHHS, 1993). The proposals generated 40,000 written comments which were each reviewed before final rules were issued in January 1993 (U.S. DHHS, 1993). The Nutrition Facts label started appearing on food packages across the U.S. over the next 18 months.

3.3.2 DEVELOPMENT OF ECO-LABELS

The early development of eco-labeling can similarly be described in the four stage model proposed. In the 1970s and 1980s there was a growing understanding of the environmental impact that humans were causing which lead to a greater motivation for individuals to reduce the harm that they were causing the environment. Commercial enterprises recognized that environmental concerns could be translated into a market advantage for certain products and as a result there was an increase in the number of environmental declarations and claims. In the late 1980s, products making claims including biodegradable, recyclable, eco-friendly and ozone-safe were being introduced at about 20-30 times greater than other goods. This influx of environmental claims led to confusion among consumers and distrust about the claims being made. The FTC intervened in 1992 by issuing guidelines for the responsible use of environmental claims (U.S. FTC). By the late 1990s, misleading declarations and claims had nearly disappeared from the market and third-party certification programs started gaining popularity and use (Banerjee & Soloman, 2003).

3.4 DETERMINANTS OF EFFECTIVENESS OF A LABELING PROGRAM

Most labeling programs are often initiated with the goal of targeting a particular issue of societal concern. For example, the overarching goal of environmental labeling programs is to reduce the environmental impacts of companies from the provision of goods and services to consumers. Programs achieve this by educating consumers in an attempt to change their purchasing behavior and to stimulate markets to provide products that are less harmful to the environment. It is however difficult to measure and quantify the true effectiveness of a labeling program. This is both due to issues with accurate data collection as well as determining the causality between product labels and consumer and manufacturer decisions. Three key concepts can be used to describe labeling effectiveness (U.S. EPA, 1994):

- Concrete effectiveness – the extent to which the issue being addressed is resolved
- Behavioral effectiveness – the degree of influence on consumers and manufacturers
- Potential effectiveness – changes in consumer awareness and attitudes

While concrete and behavioral effectiveness provide the most meaningful and accurate way of assessing the success of a labeling program, they are often the hardest to determine. Most research and evaluations of labeling programs hence often have to rely on indicators measuring potential effectiveness such as surveys on consumer recognition of a label and their receptiveness to the information provided. Building on these concepts regarding effectiveness, the EPA postulated five specific metrics to measure label effectiveness. These metrics can be viewed as potential but not necessarily progressive steps to achieve the program's desired goal or outcome.

Consumer Awareness - Measuring the consumer awareness of about an issue or label can be carried out easily through market surveys. It is important as a first step for the general public to be aware about the issue at hand for a labeling program to become successful. High levels of awareness about an issue or label however do not necessary translate directly to a change in

purchasing behavior as consumers often evaluate many other characteristics of a product when making a decision.

Consumer Acceptance - Consumer understanding and recognition about the issue being addressed by a label is a second critical metric by which to judge a labeling program's effectiveness and success. It is important that consumers understand the relation between their product choices and the larger issue at hand, be it the product's effect on their own health and personal safety, whether workers who manufacture the product earn a living wage under safe conditions, or if the forests where raw materials are sourced for manufacturing the product are managed sustainably. Increasing consumer acceptance often requires a concerted effort on the part of the program and participants to educate consumers through various channels such including media campaigns, print material, product packaging etc. Consumer awareness and acceptance rates can both be determined through market research and surveys.

Consumer Behavior Change - An important step for a labeling program to achieve its desired goal is in getting a significant portion of consumers to change their purchasing habits based on the information provided by the label. This can be difficult as consumers often consider various factors when making their decisions such as price, quality, brand, personal experience, etc. It is also hard to accurately measure and determine how changes in product sales are affected by the use of labels.

Company Behavior Change - In a consumer driven market, companies will tailor their products to meet the demands of their customers. If a company perceives consumer concern about a particular issue, and changes its manufacturing processes to address this concern in adherence to product labeling guidelines, then the labeling program has been successful in changing the company's behavior. Hence even though consumers may not place additional value on a labeled product, if a company modifies the product to meet a label's requirements with the goal of enhancing their

public, stockholder and employee relations and reputation, the label has achieved its desired effect as well.

End Benefits - The main difficulty in quantifying the exact contribution of a labeling initiative towards the resolving of an issue is determining its additionality. For example, while it is possible to track the incidence of heart disease or the amount of paper recycled in the U.S. over time, it is hard to isolate and determine what the contribution particular labeling programs have on these indicators. Moreover, there are many other intangible and indirect effects stemming from labeling programs that these indicators may not be able to capture completely. There is also the issue of deciding what the baseline or status quo would have been without the introduction of a particular labeling program. Hence most evaluations of the effectiveness of labeling programs still fall back on measurements of potential effectiveness through consumer surveys.

3.5 FACTORS FOR A SUCCESSFUL LABELING PROGRAM

Various studies have been done to analyze what are the determinants of a successful labeling program (Banerjee & Soloman, 2003)(U.S. EPA, 1994). The results of these studies can provide useful guidance regarding the establishment of a successful carbon labeling initiative in the U.S. These factors can be categorized under three main groups:

Program Label Type and Design - The structure and design of a program are critical to its growth and potential success. These include the type of label offered as well as the incentives provided for companies and consumers to participate in the program. Seal of Approval and Single Attribute labels are generally easier for consumers to understand as the labeling authority has already analyzed the product's relevant life cycle information and given its verdict on it. Consumers can simply use the seal as their primary decision factor or as a secondary factor if the two products they are choosing between are tied based on primary factors such as price and quality. While Report Cards provide an unbiased judgment, consumers often are not willing or have difficulty in

understanding or using the information provided. In addition, it has been highlighted that consumers often confuse these labels as seal-of-approval ones, thus defeating their purpose (Banerjee & Soloman, 2003). Information Disclosure labels on the other hand are useful in reducing information asymmetries between producers and consumers especially when the information in question is well understood. For instance the current nutritional label format for food products and the fuel economy label for vehicles are familiar to most consumers and often factored into purchasing decisions. However for other categories such as energy consumption of appliances, the Energy Star (Seal of Approval) Label is much more recognized and effective than its Energy Guide (Information Disclosure) counterpart.

Program design is also important in narrowing down and selecting product categories that are most relevant for labeling. Ideally these products would have large room for improvement at a low cost. For example, factors of consideration for product inclusion in the Energy Star program include potential for improvements in unit energy savings, size of stock, turnover rates, receptiveness of the industry and the visibility of the product with consumers (Brown, Webber, & Koomey, 2002).

Creating additional incentives for participation is valuable as labeling often involves an investment in time and resources by producers and consumers. The Federal Government for instance has helped in stimulating the market for energy efficient products by providing tax incentives for the purchase of select products that meet the Energy Star criteria (Energy Star, 2009).

Program Affiliation - Government run or affiliated programs are known to be more successful than privately run ones. Government support to a program not only increases its credibility and recognition, but also improves the program's financial stability, legal protection and long-term viability. Government programs also tend to have higher budgets, which gives the program more flexibility in its operations and allows the program to spend more on publicity. Privately run programs funded solely by participation fees may also have higher credibility risk because of the

inherent conflict between the independent selection of product categories and awarding of labels and the need to generate program revenue (U.S. EPA, 1998). In addition, privately run programs often encounter difficulties in establishing their credibility and long term viability making large corporations reluctant to join them (Paulos, 1998). On the other hand however, a non-governmental program run by a respected consumer organization may be more immune to political pressure which can affect government decision-making and may enjoy more credibility from the perspective of skeptical consumers (U.S. EPA, 1994). Government support can also be through legislation such as former President Clinton's Executive Order 12873 in 1994, which directed all federal agencies to adopt environmentally preferable purchasing policies, helping create an automatic market for Energy Star products (Banerjee & Soloman, 2003). Renewable Portfolio Standards which require a certain percentage of electricity provided by utilities to be generated from renewable sources likewise provide market boosts for green power certifying labels. Affiliation with external organizations including trade associations, universities and municipal governments among others are also beneficial in increasing recognition and credibility of a program.

Education and Publicity - The effectiveness of a labeling program can be increased when it is linked to a well organized education or publicity campaign. Well educated consumers are more likely to make more informed purchasing decisions, and will better understand the issues surrounding the label. A study by the DOE on The Energy Guide label showed that consumers exposed to educational materials in addition to the label tended to purchase energy efficient appliances more often than those not who were not (U.S. EPA, 1994). Publicity is also important at the initial launch stage of a label in order to raise public awareness about its existence and use. When launching the new nutrition label in 1994, the FDA made numerous presentations to consumer, health, and industry groups about the food label and even developed a campaign targeted at children (Kessler, Mande, Scarbrough, Schapiro, & Feiden, 2003). Education also helps

the public become more informed about the issues at hand and even if it does not immediately change their purchasing behavior, they are more likely to take other steps towards getting involved and improving the issue through other avenues and opportunities. A well structured labeling program together with the affiliation of established organizations and/or the government coupled with a strong education campaign can definitely have positive effects towards solving the social and environmental issues at hand.

4 CURRENT CARBON LABELING INITIATIVES

This next chapter takes a look at the major carbon labeling initiatives that are currently being implemented worldwide. By examining the different approaches taken and their varying degrees of success, we can better determine what an ideal model or framework for designing a carbon labeling program should be. Case studies of charter participants involved in the various programs are also included to aid in understanding what product categories are most meaningful for labeling and what the potential improvements and benefits for these products are with regards to climate change impact. In addition, looking at these companies' values and attitudes towards sustainability and climate change provides insights regarding the reasons for their participation and what incentives may be needed to attract future participants.

4.1 THE CARBON TRUST

The Carbon Trust was set up by the UK Government in 2001 as an independent company tasked with accelerating the move to a low carbon economy. The Carbon Trust aims to achieve this by working with organizations to reduce their carbon emissions and to foster the development of commercial low carbon technologies (Carbon Trust). The Carbon Label Company was set up by the Carbon Trust in 2007 to work with businesses and consumers to lower their carbon footprints. The Carbon Label Company's primary objective is to help businesses measure, certify, reduce and communicate the lifecycle GHG emissions of their products and services. Its secondary objective is to help consumers make choices that would lower their own carbon footprints, and to educate them on how the way they use the products they buy can lower their carbon footprints (Carbon Trust). The Carbon Trust is one of the pioneers in the field of carbon assessments and labels and was a key participant in assisting the BSI British Standards with developing their Publicly Available Specification for assessing the life cycle greenhouse gas emissions of goods and services which was released in 2008. To date it has worked with over 10 companies mostly in the UK on product certification based on its present "reduce or lose" criteria where companies commit to further

reduce their carbon footprint from their baseline assessment within two years in order to maintain the label.

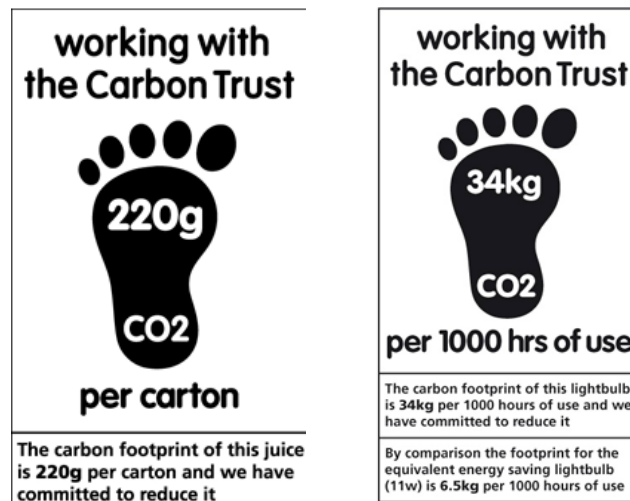


Figure 4-1: Sample carbon reduction labels issued by the Carbon Trust (Carbon Trust)

4.1.1 INNOCENT

Innocent is a highly successful producer of natural drinks and fruit smoothies based originally in the UK. The company was founded in 1998 with the fundamental guiding principle of using only “100% natural, healthy renewable ingredients” and differentiates itself based on taste, health and sustainability. The company has incorporated numerous sustainability practices including the ethical sourcing of ingredients that meet the highest available accreditation standards such as those from the Rainforest Alliance and pioneering the use of 100% recycled plastic for their smoothie bottles (Carbon Trust, 2008).

Starting in late 2006, Innocent worked together with the Edinburgh Centre for Carbon Management and the Carbon Trust to assess the carbon footprint of their smoothie products. The process involved collecting data from over 120 of the company’s suppliers and the analysis covered the product’s entire life cycle less the use phase which was deemed insignificant. The carbon footprint assessment of their 250ml bottle product revealed that the majority of its emissions were created during the agriculture, packaging and manufacturing stages (Figure 4-2).

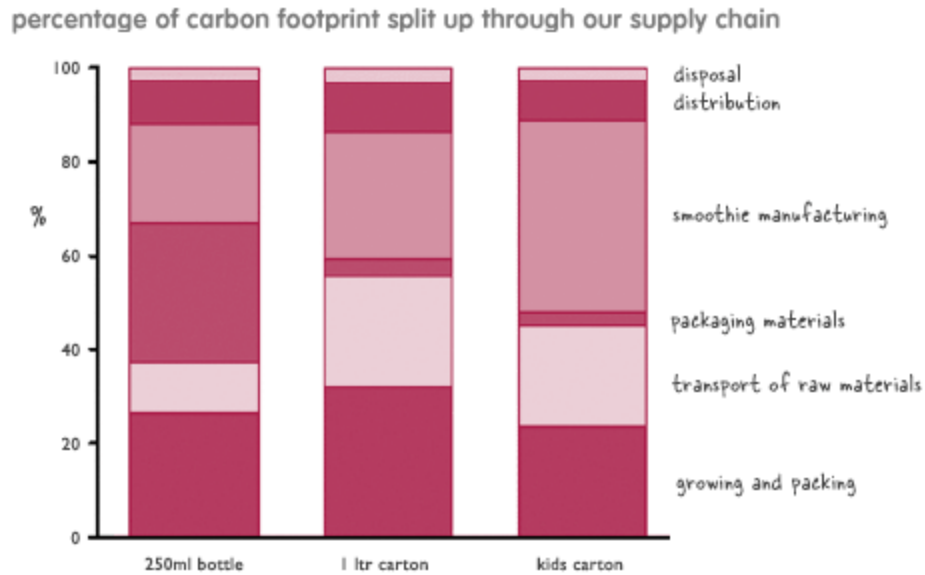


Figure 4-2: Product carbon footprints of various sized smoothies (Innocent Drinks, 2009)

With this knowledge in mind about the high impact areas of its carbon footprint, Innocent decided to focus on increasing the recycled material content of its plastic bottles and working with suppliers to reduce waste and improve energy efficiency. Both of these areas were identified as having the highest potential to maximize savings and improve carbon efficiency. By using 100% recycled plastic bottles, the company has achieved a 20% reduction in materials and a 55% carbon reduction in the product's manufacturing stage. Getting their suppliers involved in recycling and energy efficiency has also resulted in further reductions in waste and savings in energy. For example, one of their suppliers has managed to reduce its carbon footprint by as much as 60% after working with Innocent in identifying saving opportunities (Carbon Trust, 2008). Overall, Innocent has managed to reduce the carbon footprint of their 250ml bottled smoothies by 20% on average in the 22 months since they initiated their footprint analysis (Figure 4-3). The company has since also made carbon emissions impact a key determinant in its sourcing decisions.

we've made some reductions...

our 250ml smoothies	Carbon (grams) March 2007	Carbon (grams) December 2007	Carbon (grams) December 2008
 strawberries & banana	282 grams	241 grams	230 grams
 mangoes & passion fruits	273 grams	227 grams	209 grams
 cranberries & raspberries	258 grams	217 grams	206 grams
 pineapple, bananas & coconut	266 grams	225 grams	207 grams
 blackberries, raspberries & boysenberries	I'm new		207 grams

↑ We are still working to reduce these numbers even more. Bit by bit.

Figure 4-3: Carbon footprint reductions of various 250ml smoothies (Innocent Drinks, 2009)

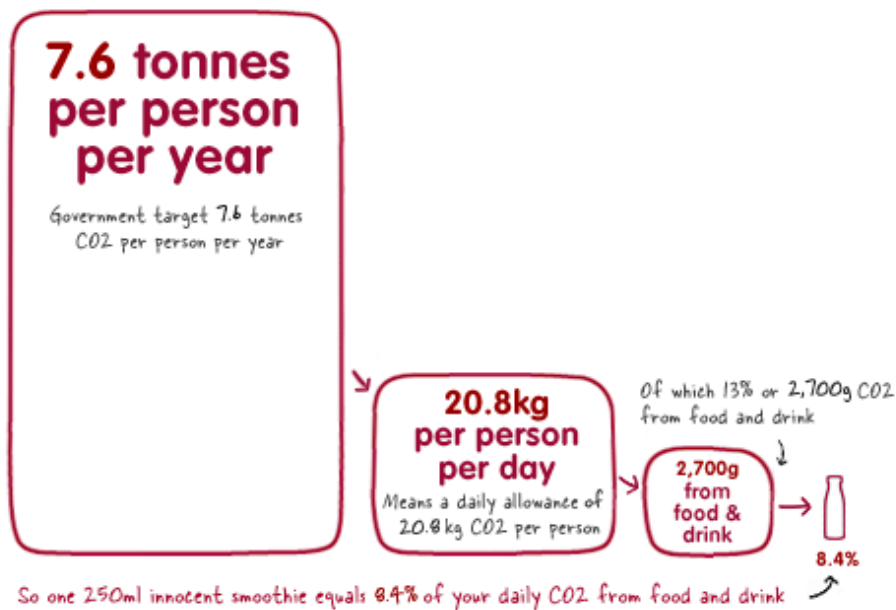


Figure 4-4: Guideline daily allowance for smoothies (Innocent Drinks, 2009)

Innocent has chosen to educate its consumers about product carbon footprint information mainly through its website. There the company acknowledges the uncertainty regarding its methodology and calculations but states its commitment to continual improvement of measurement accuracy. To assist consumers in understanding the value of carbon footprints, the company has estimated a

fictional guideline daily allowance based on the UK Government's CO₂ emissions target per capita and the average portion which goes into a person's food and drink consumption (Figure 4-4).

4.1.2 BOOTS

Boots is a member of Alliance Boots, an international pharmacy-led health and beauty group which is the UK's leading health and beauty retailer. The company's core purpose is to make its customers "look and feel better than they ever thought possible" through the provision of "exceptional customer and patient care". With regards to corporate social responsibility, Boots has chosen to focus on the four areas of community, environment, workplace and marketplace. Addressing climate change was identified as a key priority under its environmental goals (Alliance Boots, 2008).

Boots has been working closely with the Carbon Trust since 2003 on its Carbon Management Program aimed at reducing carbon emissions at the corporate level and developed a five year strategy to improve its carbon footprint with initiatives geared towards technical solutions and behavioral change. As a result of initial successes and cost savings from the program, Boots became interested in learning more about the life cycle carbon impacts of their products. The company proceeded to work together with the Carbon Trust to measure the carbon footprint of its Botanics range of shampoos. The Botanics shampoo product line was selected partly due to the diversity of raw materials and processes involved across the range which Boots felt would allow useful comparisons to be done as well as the influence and control it had over the Botanics supply chain. In addition, shampoo being a standard product used by consumers on a regular basis provided the opportunity for communication of the results and findings in a meaningful way (Carbon Trust, 2008).

The process was supported by strong internal engagement and leadership from management resulting in the effective collection and analysis of data within the organization and from suppliers.

A scenario analysis was conducted to understand the effect of different actions leading to Boots introducing the use of 30% post-consumer recycled plastic in its bottles and redesigning their logistics network to allow individual products to be shipped directly to stores. This removed the need for additional distribution centers as well as reduced road miles, packaging and inventory levels. Both these actions contributed to a 10% reduction in the product's overall carbon footprint and a final assessed figure of 148g excluding the consumer use phase (Figure 4-5). The inclusion of the consumer use phase emissions to the assessment highlighted its significance as it was found to contribute 93% of the product's carbon footprint (Figure 4-6).

Boots chose to communicate the results in July 2007 using point of sale material in over 250 stores in the UK showing the carbon reduction label. The company provided additional information including their 20% reduction achievement and suggestions for consumers to reduce their emissions. Consumers have had a positive reaction to their efforts with an internal market research poll finding that 65% of consumers were positive that such a product label would make them more likely to buy the product and 72% believing that showing the actual amount of grams of carbon was important. The company has since declared a renewed commitment to the development of new products based on sustainability principles and is actively engaged in supply and logistics initiatives to further eliminate waste (Carbon Trust, 2008).

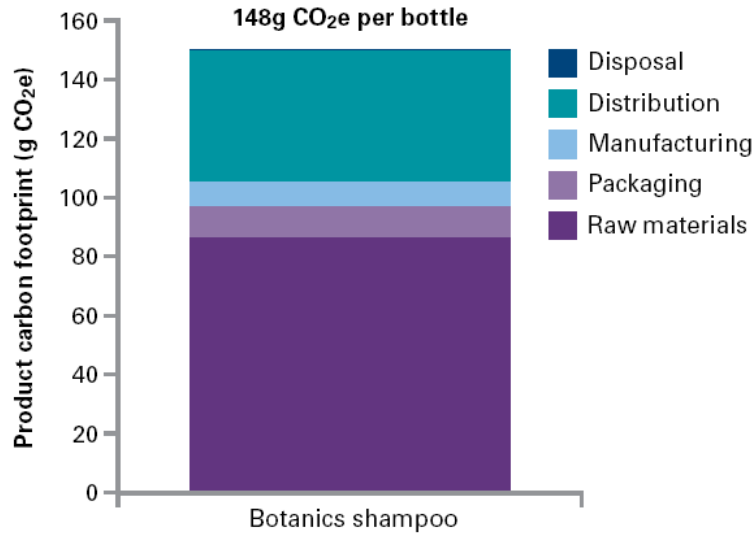


Figure 4-5: Botanics shampoo carbon footprint excluding consumer use phase (Carbon Trust, 2008)

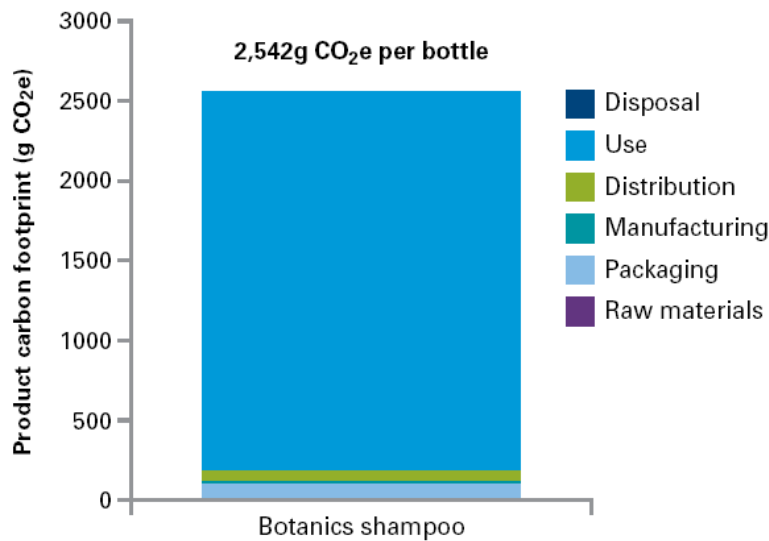


Figure 4-6: Botanics shampoo carbon footprint including consumer use phase (Carbon Trust, 2008)

4.1.3 PEPSICO WALKERS

PepsiCo UK and Ireland is the parent company of Walkers and a number of other leading UK brands including Quaker, Tropicana, Copella and Pepsi. Both the PepsiCo and Walkers businesses have strong commitments towards sustainability. In the UK, PepsiCo's action statement is described as "delivering performance with purpose" and the company has focused its sustainability efforts onto four areas of environment, health and wellness, community, and diversity and inclusion. Within the

area of the environment, PepsiCo has identified three key environmental challenges: climate change, resource depletion and water use as issues where they have the greatest ability to act and influence (Pepsico UK & Ireland, 2009).

Walkers through working with the Carbon Trust on energy efficiency and carbon management since 2002 has managed to reduce energy use in its operations by more than 30% since 2000. The successful collaboration and learning experience led Walkers to realize the potential opportunities for further emissions reductions in the supply chain and to initiate product life cycle assessment work to quantify its carbon emissions. In the late 2006, Walkers became the first pilot company to work with the Carbon Trust in analyzing the carbon footprint of its crisps. The method excluded the consumer use phase since the energy use during consumer storage and consumption was considered negligible. The study found that the majority of the product's footprint was outside of the company's direct control coming from raw materials (Figure 4-7). Their initial calculation of 75g in 2007 has since been recalculated to be 85g and after factoring in a 7% reduction that the company has achieved is presently at 80g. This adjustment results from the company being able to get more accurate data from their supply chain directly and incorporating new data on emission factors (Walkers Snacks, 2009).

Walkers has managed to achieve this reduction through various measures including increasing its manufacturing production efficiency which reduced its gas and electricity consumption by 11% and 12% respectively; reducing the weight of its packaging; and running its delivery lorries on biodiesel (Figure 4-8). Walkers has also been bringing together key suppliers of raw materials and packaging yearly at a series of self organized supply chain summits to raise awareness about product level footprints, gather data and discuss emission reduction opportunities. These summits highlight the benefit of developing a "chain of custody" approach where each participant across the supply chain

takes ownership for calculating their part of the carbon footprint and identifying opportunities to reduce it (Carbon Trust, 2008).

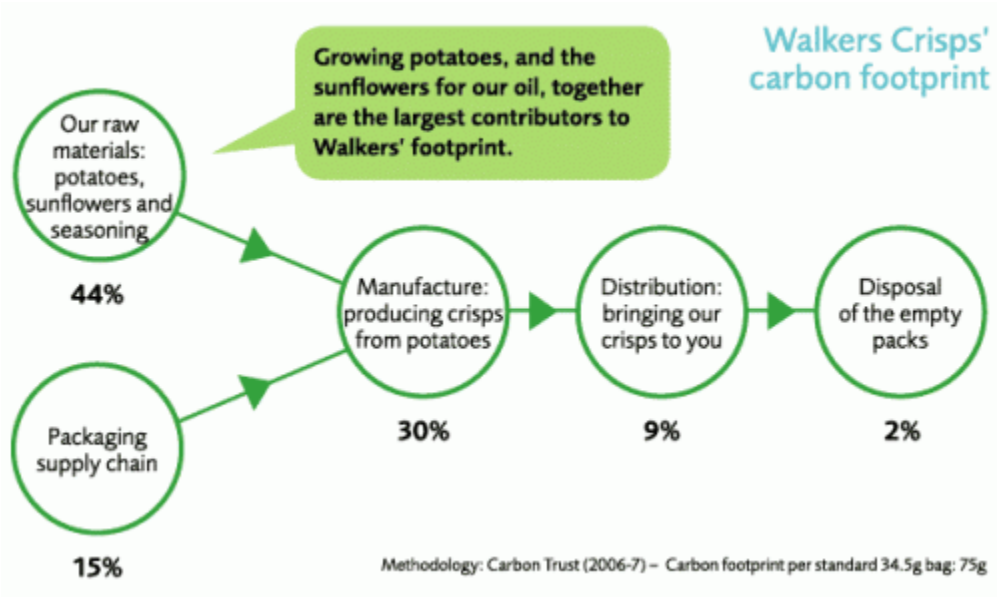


Figure 4-7: Carbon footprint of Walkers Crisps (PepsiCo)

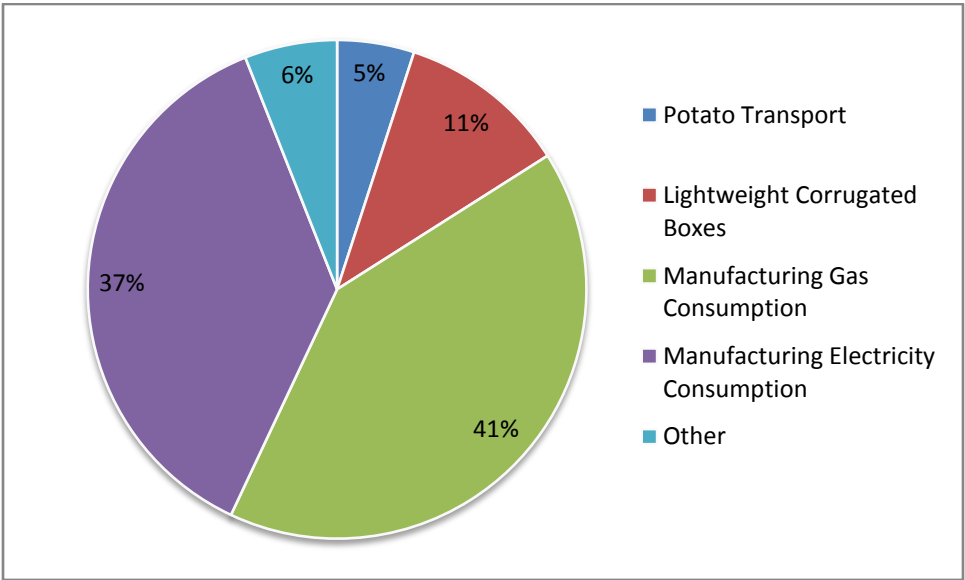


Figure 4-8: Walkers 7% reduction breakdown (Walkers Snacks, 2009)

Walkers was the first company to put the Carbon Reduction Label on their product packaging. They also have detailed information about their carbon management efforts on their dedicated carbon footprint website. Initial market surveys by Walkers shows positive reactions by consumers with

79% agreeing that the label makes them more aware of the environmental impact of the products and services they choose to buy and 71% agreeing that it helps to reduce the carbon footprint of their regular shopping items (Pepsico UK & Ireland). Looking ahead, PepsiCo is planning on extending product footprint assessments to additional product lines and countries and continuing its efforts to reduce carbon emissions in its production activities. Walkers and PepsiCo also plan to carry on with their supplier engagement activities and to invest in research to help farmers reduce their emissions through better agricultural practices and the use of technology. Walkers became the first company to retain its Carbon Reduction label by having reduced its carbon footprint for its crisps product by 7% over the past two years (Pepsico UK & Ireland, 2009).

4.1.4 CONTINENTAL CLOTHING

The Continental Clothing Company is a B2B wholesaler of blank printable apparels including t-shirts, polo shirts and sweatshirts. Their vision is to stimulate positive change in the apparel industry by demonstrating the business potential of sustainable products. This is achieved through their mission of producing high quality, low carbon fashion built upon fundamental principles of sustainable production and socially positive supply chain management (Continental, 2009).

Continental Clothing has four sustainable apparel lines including their leading brand EarthPositive which it selected to do their initial carbon footprint assessment on. The company claims the EarthPositive apparel line to be the “most progressive ethical clothing on earth” and is promoted as being climate neutral, organic and ethically made as well as manufactured solely using sustainable energy generated from wind power. The product line is involved in numerous initiatives including committing to lowering its water footprint, being certified by the Oeko-Tex 100 Standard to guarantee the safety of their textiles and dyestuffs to human health during manufacturing, implementing a “No Airfreight” policy for shipping, participating in independent audits by the Fair Wear Foundation to ensure fair labor conditions, and using biodegradable materials for packaging.

Continental Clothing carried out their assessment in three stages over a period of 18 months beginning in October 2007. The first phase focused on cradle to gate raw material, manufacturing and wholesale distribution stages with silk screen-printing being included in the second phase and the remaining retail, distribution, consumer use and disposal stages completed by the third phase in March 2009 for a full cradle to grave calculation. The initial products that were B2B certified included men and women's T-shirts, polo shirts, pullovers, zip-up hoodies and woven tote bags. These were studied in a full range of colors and sizes making up a total of 196 SKUs. A sample of the B2B carbon footprints of these products are listed in Table 4.1. Their most recent assessment update which certified their B2C products focused on T-shirts and hoodies with different prints and covered a total of 77 SKUs (Continental Clothing).

From their study, Continental Clothing found that its use of renewable instead of grid electricity resulted in nearly 90% emission reductions during the manufacturing stage. Overall though, the consumer use stage had the highest impact contributing to 48% of the final product carbon footprint (Figure 4-9). These were mainly from the operation of automatic washers, tumble dryers and irons. The footprinting analysis has helped Continental Clothing to identify opportunities to further reduce their carbon emissions. These strategies include improving the energy efficiency of their current machines and understanding and implementing low carbon alternatives in manufacturing sub-processes. In addition, the company is also looking at selecting suppliers with lower carbon footprints. By continuously expanding and improving upon their certified footprint model to include decorative options, more complex fabrics and different product configurations, Continental Clothing believes that future product footprint assessments will be much easier and faster (Carbon Trust, 2008).

Continental Clothing has chosen to communicate the Carbon Reduction Label through B2B sales materials, their website, in catalogues and most recently on B2C products as well through a

partnership with Adili.com (Continental, 2009). The company believes that the certification gives them a competitive edge in differentiating their product in the marketplace. In addition, the B2B information they provide makes it easier for their business customers to footprint and label apparel for end consumers. Continental realizing that the use phase through washing of the clothing accounts for a significant bulk of carbon emissions in a shirt's life cycle is also helping to educate consumers by sharing this information with energy saving tips like lowering the wash temperature and line drying (Figure 4-10).

Table 4.1: Continental Clothing EarthPositive apparel B2B carbon footprint in kg of CO₂

Product/Size	XS	S	M	L	XL	XXL
EP01 Men's T-Shirt White	-	0.595	0.614	0.671	0.717	0.785
EP01 Men's T-Shirt Black	-	0.605	0.624	0.682	0.730	0.799
EP02 Women's T-Shirt White	0.421	0.454	0.506	0.530	0.566	-
EP02 Women's T-Shirt Black	0.428	0.462	0.515	0.539	0.575	-
EP21 Polo Shirt White	-	1.060	1.155	1.223	1.284	1.322
EP21 Polo Shirt Black	-	1.106	1.202	1.260	1.318	1.360
EP61P Men's Pullover Hoody	-	2.854	2.886	2.914	2.942	-
EP62P Women's Pullover Hoody	2.114	2.142	2.182	2.206	-	-

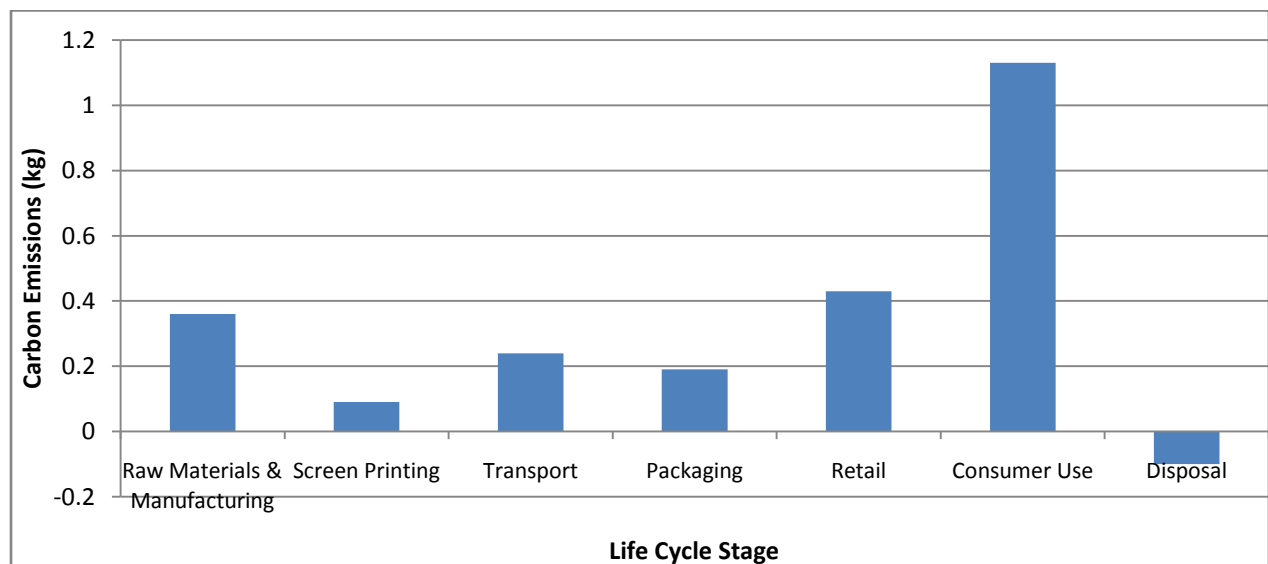


Figure 4-9: Sample B2C carbon footprint of Continental Clothing's "Women's Short Sleeve T-Shirt" (Continental, 2009)

working with the Carbon Trust  per garment We have committed to reduce this carbon footprint	The carbon footprint of the lifecycle of this T-shirt is 2.4kg. This is the total carbon dioxide (CO₂) and other greenhouse gases emitted from the raw materials, production, distribution, use (which is washing, tumble drying and ironing 25 times) and disposal. By using green renew- able electricity we have reduced the footprint by 4.0kg per garment.	You can reduce this carbon footprint by washing at 30°C or lower, avoiding tumble drying, ironing only when necessary, and recycling at the end of its life. For example, avoiding tumble drying and ironing will save approx. 0.9kg of CO₂ or one third of this garment's carbon footprint in its lifecycle.
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Figure 4-10: Continental Clothing carbon reduction label (Continental, 2009)

4.1.5 *TESCO*

Tesco is the world's third largest grocery retailer with \$93.8 billion dollars worth of sales in 2008. Their "balanced scorecard" approach commits to weighing the five identified key elements of their business: customers, operations, people, finance and the community equally in their decision making. Formal inclusion of the community into Tesco's strategic approach was recently decided upon and unveiled in 2006 in their "Community Plan" which declared their intention to put social and environmental issues at heart of their business. Climate change is one of the environmental challenges that Tesco has deemed important to its continued operations and the company has identified three strategies to address it. These are through setting an example in their own operations, working with others to support research and the implementation of carbon efficient technologies, and empowering their customers by providing them with relevant and meaning information and advice (Carbon Trust, 2008).

In 2007, Tesco worked with environmental consultant ERM to assess its global carbon footprint. The study revealed that heating and lighting in stores, chilling or refrigerating products, and the transporting of goods had the largest contributions to the company's carbon footprint. These areas have since become the focus of the company's energy efficiency improvements. Additional, as part of its attempt to educate and empower consumers to make more environmental choices, Tesco launched an initiative in 2007 with the goal of providing carbon information for all the goods that

they sell. Their first step towards meeting this target began with a partnership with the Carbon Trust to assess the product carbon footprint of 20 products in four categories: potatoes, light bulbs, laundry detergents and orange juice.

This process required the active engagement of Tesco's suppliers and was particularly challenging for products with multiple ingredients and processing stages. The results of the assessment are consolidated in Table 4.2 and some higher level findings for the particular product categories are described below (Carbon Trust, 2008):

Lighting products - Tesco found that while energy saving light bulbs produces more carbon emissions during manufacturing than conventional light bulbs, the use phase accounts for about 99% of the life cycle carbon emissions of the light bulb making it the key area to focus on. Hence proposed reduction efforts would involve further increasing the energy efficiency of compact fluorescent light bulbs and promoting their sales.

Laundry detergents - Tesco found that concentrated versions had smaller carbon footprints due to the use of less ingredients and packaging. The particular ingredients chosen contributed significantly to the final calculation as well. The majority of carbon emissions were however once again from the use phase and the resulting opportunity was to educate consumers about the energy and carbon savings from cold washing and line drying as well as ensuring the efficacy of their detergent products at lower temperatures.

Potatoes - One of the takeaways was that the method of cooking them had significant impacts on the life cycle footprint. To highlight this point, oven baking results in a footprint that is more than 3.5 times greater compared to boiling or microwaving. Attempting to change the cooking practices of its consumers is however a difficult task.

Table 4.2: Summary of Tesco product carbon footprints (Carbon Trust)

Lighting	Variant	Carbon Footprint per 1,000 hours use
	60W Pearl Lightbulb	34kg
	100W Pearl Lightbulb	55kg
	11W CFL	6.5kg
	20W CFL	12kg
	60W Spotlight	34kg
Laundry	Variant	Carbon Footprint per wash
	Tesco Non-Biological Liquid Capsules	700g
	Tesco Super Concentrated Non-Biological Liquid Wash	600g
	Tesco Non-Biological Liquid Wash	700g
	Tesco Non-Biological Tablets	850g
	Tesco Non-Biological Powder	750g
Juices	Variant	Carbon Footprint per 250ml
	Tesco 100% Pure Squeeze Orange Juice	360g
	Tesco Pure Orange Juice From Concentrate	260g
	Tesco Pure Orange Juice (1L)	240g
	Tesco Pure Orange Juice (3x200ml)	220g
Potatoes	Variant	Carbon Footprint per 250g Serving
	King Edwards (2.5kg)	160g
	Organic New Potatoes (1.5kg)	160g
	Organic Baby New Potatoes	140g

The process of engaging suppliers and analyzing their supply chains has resulted in Tesco identifying and implementing a host of different emissions reductions measures. These include better network planning to improve vehicle utilization, the use of more efficient refrigeration equipment, and reducing the application of agricultural inputs such as fertilizers and pesticides. The measures are often both energy and cost saving. Tesco is intending to extend its trial of carbon footprint assessments to cover the full range of products in the current categories as well as to experiment with new product categories that have more complex supply chains.

To communicate the information with its consumers, Tesco began a trial of the Carbon Reduction Label in April 2008. They were presented on-pack at the point of sale and in a supporting leaflet to educate consumers about their efforts. Apart from displaying the numerical carbon footprint, the

label expresses the commitment Tesco has in working with the Carbon Trust to reduce their footprint, a brief explanation of the meaning of a carbon footprint, comparisons with alternative products within the same category and suggestions for consumers to reduce their footprint further. Tesco has also incorporated carbon labeling information as part of its Greener Living website that serves to educate consumers about actions and products they can purchase to reduce their environmental impact.



Figure 4-11: Tesco carbon reduction label on orange juice and laundry detergent products (Tesco)

4.1.6 AGGREGATE INDUSTRIES - BRADSTONE

Aggregate Industries is an international construction and building company and a major producer and supplier of primary, secondary and recycled construction aggregates, asphalt, ready-mixed concrete, and precast concrete products. Bradstone, which is a business of Aggregate Industries, is a leader in the manufacture and supply of domestic paving, walling, edging, decorative aggregates and driveway products. These are distributed mostly through DIY stores, builders' merchants and garden centers.

Aggregate Industries is committed towards sustainability and their environmental management strategy is focused on carbon management, biodiversity and the community. Their goal is to support continuous development through efficient production processes that prevent the overuse of scarce natural resources. One of their key performance indicators is CO₂ per ton of production and this has decreased steadily from 10.12 kg CO₂ per ton in 2002 to 7.16 kg CO₂ per ton in 2007 which is below the industry average of 7.71 kg CO₂ per ton in 2006 published by the Quarry

Products Association. Aggregate Industries achieved this by lowering the process energy consumption per ton of production and contracting electricity with lower carbon emissions (Aggregate Industries, 2008).

Bradstone similarly adheres strongly to the principles of Aggregate Industries' Environmental and Community Policy. These include promoting the use of sustainable construction methods, ensuring the protection of biodiversity, and encouraging recycling and reduction of waste. The company worked together with BRE Certification Limited and the Carbon Trust to conduct and verify an initial assessment for three of their core paving and block paving products. Part of the Bradstone's strategy to further reduce its carbon emissions include the sourcing of lower-carbon materials; reducing the amount of transport movements; and sourcing raw materials locally. The company has currently chosen to communicate this product carbon footprint information to customers via its website (Bradstone, 2009).

Table 4.3: Bradstone carbon footprint of paving and block paving products (Bradstone, 2008)

Product	Variant	Carbon Footprint kg CO₂/m²
Driveway 50mm Concrete Block Paving	Autumn	20
	Brindle	20
	Buff	20
	Burnt Oker	19
	Charcoal	19
	Grey	18
	Red	20
Milldale 35mm Paving	Antique Chestnut	24
	Golden Sand	24
	Antique Grey	22
	Weathered Cotswold	20
Peak Smooth 400 Paving	Grey	12
	Buff	14
	Red	13



Figure 4-12: Carbon footprint images of Bradstone paving products (Bradstone)

4.1.7 MARSHALLS

Marshalls, which has been in business since the late 1880s, is a leading manufacturer of superior natural stone and concrete hard landscaping products. They operate in the construction, home improvement and landscape markets, providing both products and technical design expertise. In addition, the company owns its own quarries, manufacturing facilities, service centers and offices. Marshalls' sustainability framework focuses on a balanced approach towards environmental, social and economic aspects of sustainability. The company has established an environmental management system in place to ensure operations meet or exceed legislation requirements. Of particular concern are the impact of its quarries on natural habitats and the environment as well as life cycle impacts of its products.

Climate change is one issue that Marshalls is concerned about and is committed to reducing its operational carbon footprint. The company worked with the Carbon Trust over a period of 18 months to get its full range of 503 domestic landscaping products certified and labeled. Their choice for doing so was made based on the importance they felt in providing consumers with environmental data across product lines to assist in their decision making process (Marshalls, 2008).

In order to communicate the carbon footprint calculations to consumers, Marshalls has introduced a carbon calculator application on its website to allow users to estimate their carbon impact based on a selected product and given quantity in terms of area. In addition this information is reinforced and explained in detail in their report *Marshalls Guide to Carbon Labelling*. The carbon footprint

value calculated using their online calculator can also be converted in terms of number of trees to give consumers a more tangible understanding of the magnitude of a kg of CO₂. Comparisons have also been made across products and with competitors like Bradstone emphasizing the fact that the carbon impact for their equivalent products is lower (Marshalls).

Table 4.4: Marshalls selected list of products with carbon footprints (Marshalls)

Product	Variant	Carbon Footprint kg CO₂/m²
Gardens Natural Imported Paving	Eclipse Granite	55
	Haworth Moor Riven Sandstone Paving	30
	Natural Slate	30
Gardens Manufactured Paving	Chancery	20
	Heritage Paving	17
	Saxon	15
Driveways	Drivesett Duo	26
	Drivesett Tegula	19
	Driveline 50	16

4.1.8 CADBURY

Cadbury is a leading global confectionary company whose portfolio includes chocolate, gum and candy brands. The company's overall strategic priorities as highlighted in their *Vision into Action* business plan are on growth, efficiency and capability. Corporate social responsibility is viewed as being vital to future success and Cadbury has targeted six key areas to ensure responsible and sustainable growth: corporate governance, employment practices, ethical trading, food and consumer trends, environment, health and safety, and the community (Cadbury plc, 2009).

The Cadbury Purple Goes Green initiative was launched in July 2007 as one of the visions set by the company is to tackle climate change. The company plans to minimize their global environmental footprint by cutting down on energy use, reducing excess packaging and improving water management. The company has set targets including a 50% reduction in absolute carbon emissions, a 10% reduction in standard product packaging, and putting water reduction programs in place for

all of its “water scarce” sites (Cadbury plc). As part of the Purple Goes Green initiative, the company worked together with the Carbon Trust to assess the carbon footprint of a bar of Cadbury Dairy Milk chocolate. The study encompassed the product’s entire supply chain and Cadbury worked closely with its suppliers to gather data regarding energy, fuel use and emissions. The finding was that a 49g bar of Cadbury Dairy Milk had a carbon footprint of 169g with the majority of emissions coming from milk production. Milk production contributed to just over 60% of emissions, compared to 20% from in-house production, 10% from sugar and only 2% from packaging (Addy, 2008).

As a direct result of the finding, Cadbury has announced the initiation of a pilot program to work with dairy farmers in UK to provide practical advice in helping them reduce their emissions. The company has published a guide to low carbon dairy farming which it has distributed to the farmers and includes farm management best practices such as: improving herd health and welfare so that more milk is produced per cow, optimizing milk yields by giving cows a diet with the optimized balance of fiber and starch levels, prudent use of fertilizers, and reducing energy consumption (Cadbury plc, 2009). The company has seemingly limited the communication of the product carbon footprint information to consumers choosing to mainly highlight the lessons learned from the assessment and its consequent efforts rather than the quantitative findings.

4.1.9 BRITISH SUGAR

British Sugar is the UK’s leading supplier of sugar products to the food manufacturing and consumer markets. The company’s stated objective is to “exceed the demanding and diverse needs of all their customers”. British Sugar’s corporate social responsibility focuses on developing stakeholder relationships as well as minimizing their impact on the environment through the consideration of issues surrounding sustainability, energy, water consumption, biodiversity and agricultural sourcing and innovation (British Sugar).

British Sugar prides itself as being one of the most efficient sugar manufacturers in Europe, having invested around a billion Euros in the past two decades to improve energy and process efficiency. In February 2008, the company initiated a study with the Carbon Trust to assess the carbon footprint of their homegrown granulated white sugar. The analysis covered their B2B supply chain starting from the growing and transporting of sugar beet, to manufacturing their granulated sugar and delivering it to their customers. The assessment results unveiled that 0.6g of CO₂ was emitted per gram of product (British Sugar).

Silver Spoon, who is part of British Sugar and supplies to the retail and foodservice markets, extended the analysis to incorporate their product's distribution and disposal stages and arrived at an assessment of 0.5kg of CO₂ per kg of their commercial product (Figure 4-13). Both British Sugar and Silver Spoon emphasize that the low carbon footprint is a result of their efforts over the past two decades to improve their production and supply chain efficiency. In addition, the companies intend to use results from their assessment to identify further opportunities for energy and carbon reduction.



Figure 4-13: Silver Spoon's sugar carbon footprint (Silver Spoon)

Recently, two other divisions of British Sugar plc – Topsoil and LimeX have built on the initial carbon footprint findings to certify their own products as well. Topsoil is the UK's largest supplier

of quality topsoil products to the landscape and amenity industries their product carbon footprint was calculated to be 9kg CO₂ per ton of product (Topsoil). LimeX products are used for the correction of soil acidity and were found to have a carbon footprint of 2kg CO₂ per ton of product (LimeX). The product carbon footprint results of all the companies under British Sugar plc are currently being communicated to customers on their websites.

4.1.10 PEPSICO TROPICANA

PepsiCo is one of the world's largest food and beverage companies whose portfolio includes 18 brands that generate \$1 billion or more each in annual retail sales. Walkers, as highlighted earlier, was one of the pioneers that worked with the Carbon Trust in the UK to measure the carbon footprint of their crisps. PepsiCo's corporate mission is to be the world's premier consumer product company focused on convenient foods and beverages and their vision is to do so while continually improving all aspects of the world in which they operate. Tropicana, a subsidiary brand of PepsiCo, is likewise committed to environmental sustainability and has placed strong emphasis on the 3 Rs – to Recycle, Reuse and Reduce. These are engrained in the numerous initiatives it has taken in the areas of energy, water and packaging to implement these. Tropicana is also committed to protecting the rainforests and is working through Cool Earth with partners throughout the Amazon to do so. The company believes that the rainforests are important both as carbon sinks for the planet as well as for the livelihood of local communities (Tropicana Products).

In 2009, Tropicana's 64-ounce container of Pure Premium Orange Juice became the first consumer product in North American to receive Carbon Trust certification. The estimated carbon footprint of 1.7kg was calculated with the assistance of Columbia University's Earth Institute by mapping the product's lifecycle from growing and squeezing the oranges to retail and distribution and finally disposing or recycling the packaging. The company found that agricultural and manufacturing-related emissions accounted for about 60% of the product's carbon footprint with transportation and distribution accounting for 22%, packaging for 15% and consumer use and disposal the final

3%. Tropicana is planning to use the findings to prioritize their emissions reductions efforts.

Looking to the future, PepsiCo is intending to continue partnering with the Carbon Trust to measure and certify the carbon footprint their other North American brands (Carbon Trust, 2009).

Tropicana intends to communicate the information to their consumers through their website but is still undecided about putting it on their packaging. Meanwhile, they are intending to work with researchers and their orange growers to explore opportunities in reducing carbon emissions during the growing and harvesting process (Martin, 2009).

4.1.11 COCA-COLA

The Coca-Cola Company is a global leader in the beverage industry, offering hundreds of brands encompassing a wide range of product categories including soft drinks, fruit juices, energy and sports drinks, tea and coffee etc. Their stated mission is to refresh the world in body, mind and spirit; inspire moments of optimism through their brands and actions; and to create value and make a difference everywhere they engage. Sustainability is a core part of their operating strategy and their vision is focused on four key areas including the workplace, environment, community and marketplace. With regards to protecting the environment: water stewardship, sustainable management and energy management and climate protection are key focuses (The Coca-Cola Company).

The Coca-Cola Company believes that climate is one of the biggest long term challenges for our planet and is committed to reducing emissions as part of its commitment to be a responsible and sustainable business. It has in partnership with the Carbon Trust, calculated the carbon footprint of a range of their most popular drinks. Even though the company has reduced the energy use in its factories per liter of drink produced by 17% since 2001, it believes there is potential to reduce energy and emissions even further through examining its supply chain. The footprint was calculated by identifying the key stages in the life cycle of their drinks including the growing of ingredients, production, distribution and retailing to final disposal and measuring the energy used

and calculating the associated emissions. The results of the assessment are currently being communicated through the company's online corporate responsibility report (The Coca-Cola Company).

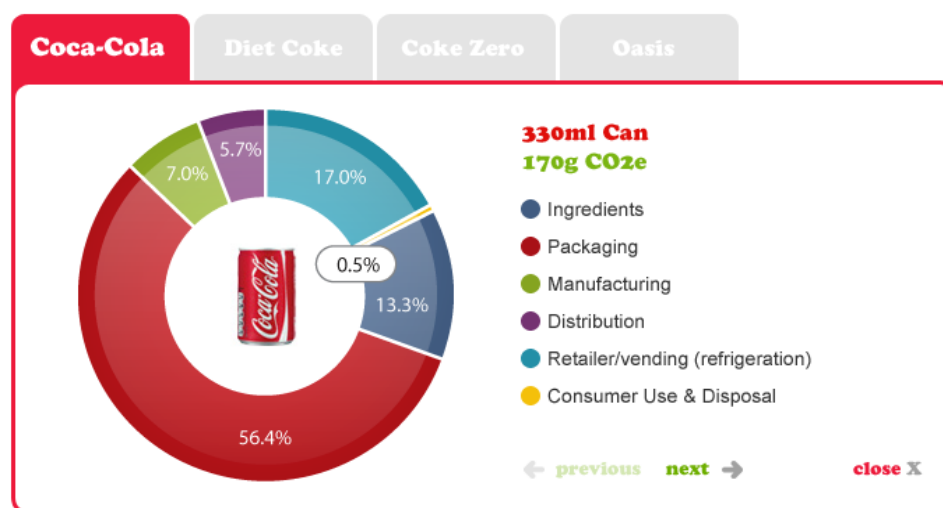


Figure 4-14: Breakdown of carbon footprint for 330ml Coca-Cola can

Table 4.5: Carbon footprints of various Coca-Cola products (The Coca-Cola Company)

Product	Size	Carbon Footprint in g CO ₂
Coca-Cola	330ml can	170
	330ml glass bottle	360
	500ml plastic bottle	240
	2L plastic bottle	500
Diet Coke	330ml can	150
	330ml glass bottle	340
	500ml plastic bottle	220
	2L plastic bottle	400
Coke Zero	330ml can	150
	330ml glass bottle	340
	500ml plastic bottle	220
	2L plastic bottle	400
Oasis	375ml glass bottle	340
	500ml plastic bottle	240

From the results of the assessment, The Coca-Cola Company has realized that packaging can make up to 70% of a beverage product's carbon footprint and that the use of recycled material and encouraging consumers to recycle containers can reduce this by up to 60%. The company has

identified certain key areas to focus on to reduce its carbon emissions. It is looking to work closer with raw material suppliers to ensure crop production is carried out sustainably through good agricultural practices. The company is also looking at cutting the weight of their bottles and cans, as well as reducing the amount of secondary packaging and to increase the amount of recycled material used. Currently in the UK, their cans contained about 50% recycled aluminum and their glass bottles contain 40% recycled glass. They intend to increase the recycled material used in their plastic bottles to 25% by 2010. In addition, the company already recycles over 95% of the waste material generated at their manufacturing sites and their next step is to encourage their consumers to recycle as well. Apart from reducing energy and water usage in manufacturing, Coca-Cola is looking at improving the efficiency of their distribution and storage systems (The Coca-Cola Company).

4.2 CLIMATOP

Climatop is a non- profit organization founded by Okozentrum Langenbruck and myclimate in November 2008 with the main purpose of creating a label for climate friendly products. To obtain the label, a product manufacturer has to prove that its product emits at least 20% less CO₂ emissions than other available substitutes. In addition, it has to meet certain minimum environmental and social standards. The methodology used for calculation of CO₂ emissions is a full life cycle approach including the product's ingredients, production, transportation, manufacturing, retail, use and disposal. The assessments are peer reviewed and a labeled product can keep its certification for two years until the certification label expires. The organization's motivation behind the label is to provide consumers with information to factor in their concern for climate change in their decision making process and to spur competition in the marketplace for climate friendly products (Climatop).



Figure 4-15: Climatop label (Climatop)

4.2.1 MIGROS

Migros is Switzerland's largest cooperative supermarket chain with over 1.9 million cooperative members. The company's goal is to provide high quality products and services at affordable prices to its consumers while maintaining the highest environmental and social standards. Migros is committed to providing its customers with products that are environmentally or socially produced and has been historically involved in a range of labeling schemes including Bio (organic), Max Havelaar (fair trade), Marine Stewardship Council (sustainable fisheries), Terra Suisse (Swiss sustainable agriculture), Organic Cotton and the Forest Stewardship Council (sustainable forestry). It is also involved in a number of processing standards that range from socially responsible working conditions, food security, and ensuring minimum living condition standards for hens. Migros is very concerned about climate change and has embarked on a number of efficiency efforts which have helped in reducing its CO₂ emissions by more than 20% since 2000. Migros has worked together with Climatop to identify the best performing product for a number of different product categories (Migros). These are listed in Table 4.6 and discussed briefly below:

Table 4.6: Carbon footprints of selected Migros products (Climatop)

Product	Variant	Carbon Footprint
Sugar (1kg)	Sugar made of sugar beet (cubes, granulated and organic) from Switzerland and Germany	0.6kg
	Sugar made of sugar cane (cubes, granulated) from Columbia	0.42kg
	Organic Havelaar sugar made of sugar cane from Paraguay	0.34kg
Reusable Shopping Bags	Shopping bag made of synthetic material	If used five times more often than the paper bag, CO ₂ emissions are equalized. If used eight times as often, reduction of CO ₂ emissions is about 35%
	Shopping bag made of paper	
Cream (1L)	Valflora and Heidi whole cream 35% fat, in cup	3.6kg
	Valflora whole cream 35% fat, in combibloc	3.4kg
	Valflora and Heidi half cream 25% fat, in cup	2.9kg
	Valflora half cream 25% fat, in combibloc	2.5kg
	Leger cream 15% fat, in combibloc	2.0kg
Powder Laundry Detergent (40°C with 4.5kg load)	Total Classic and Savo Sensitive	315g
	Total Concentre, Elan, Total Cool Active and Total Tabs	250-280g
	Total Cool Active at 20°C	195g
Powder Color Laundry Detergent (40°C with 4.5kg load)	Total Color and Form	315g
	Total Color and Form Concentre, Total Cool Active Color and Form, Total Color and Form Tabs	220-245g
	Total Cool Active Color and Form at 20°C	175g
Toilet Paper (1kg)	Soft Comfort and Soft Deluxe Sensitive	2.0kg
	Soft Deluxe Supreme and Soft Deluxe Noblesse	1.75kg
	Soft Comfort Color	1.55kg
	Soft Deluxe Velvet	0.85kg
	Soft Recycling	0.6kg
Kitchen Towels (1kg)	Twist Deluxe Style	1.85kg
	Twist Deluxe Magic	1.70kg
	Twist Hobby	1.55kg
	Twist Classic and Twist Deluxe	1.25kg
	Twist Recycling	0.80kg

Sugar Products - The Organic Max Havelaar sugar from Paraguay had a carbon footprint of at least 40% lower than the average sugar product sold in Migros. The main reason for this was that cultivating sugar cane is less carbon intensive than sugar beet and in organic agriculture the amount of synthetic fertilizers, pesticides and machinery is minimized. Moreover, the waste from the sugar cane plant is often used for energy generation as well. It is also worth highlighting that the organic sugar product is preferable in other environmental aspects as well. Since no pesticides are used in organic farming, the toxic emissions associated with cultivation are reduced too. The bulk of the carbon emissions for the Organic Max Havelaar sugar from Paraguay come from the transportation over the Atlantic and Rhine (Figure 4-16).

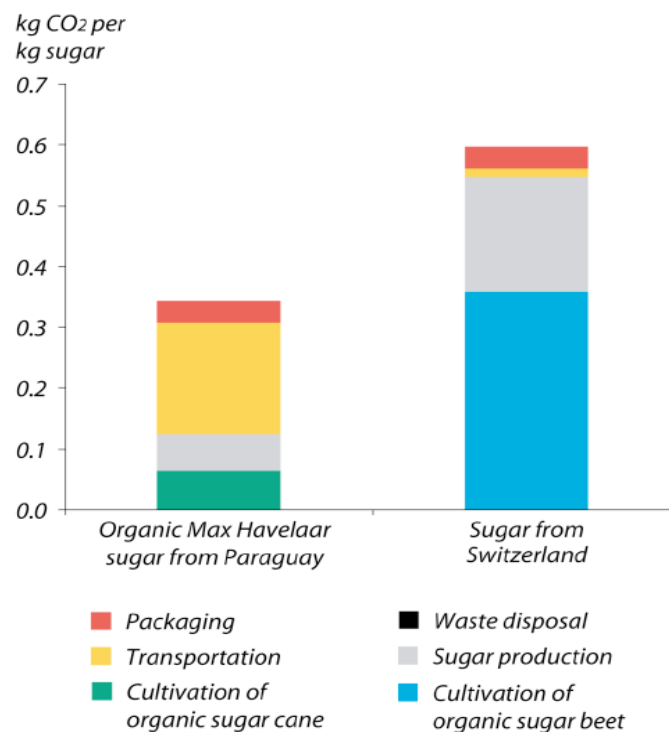


Figure 4-16: Comparison of carbon footprint for Organic Max Havelaar sugar from Paraguay and sugar from Switzerland (Climatop, 2008)

Shopping bags - Those made from synthetic material have a higher carbon footprint than those from paper. This is primarily due to the mineral oil used in the production process. However because the higher quality synthetic material shopping bag is more durable, if it is used five times

more often than the paper bag, the carbon emissions for both bags are equivalent. If the synthetic bags are used eight times as often, the emissions saved are 35%.

Cream products - The Leger cream has a carbon footprint which is about 35% lower than average. The main reason is that it contains the lowest fat content of 15% which means that less milk is needed. The production of milk at farms constitutes a significant proportion of a cream product's carbon footprint.

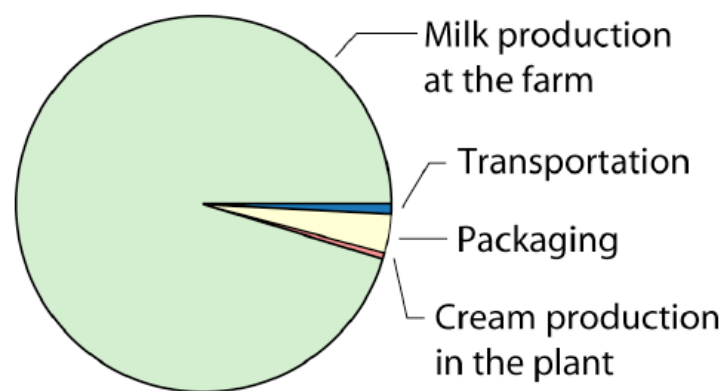


Figure 4-17: Carbon footprint broken down by process for Leger cream (Climatop, 2008)

Laundry products - The key determinant was amount of detergent required per wash and the washing temperature. Total Cool Active had the lowest standard dosage at 60g and was effective at washing temperatures of 20°C. The production of the laundry detergent contributed the greatest to its carbon footprint per 4.5kg load followed by the electricity used to heat the water and operate the washing machine (Figure 4-18).

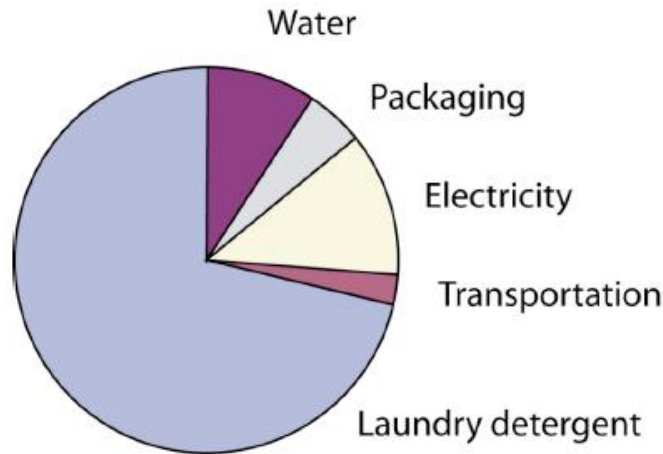


Figure 4-18: Carbon footprint broken down by process for Total Cool Active detergent powder (Climatop, 2008)

Toilet paper and kitchen towels - The Soft Recycling and Twist Recycling brands had the lowest carbon footprint in their respective categories. Both products were made from 100% recycled material and had carbon footprints that were 50% lower than the average in their product categories. The reasons for the lower carbon footprint for recycled products included the fact that recycled production of paper is less energy intensive and the low consumption of fossil fuels in the manufacturing process.

4.2.2 DYSON

Dyson is an appliances manufacturer based in the UK and founded by James Dyson in 1993. Its main products are vacuum cleaners that use cyclonic separation. They worked together with Climatop to do a comparative life cycle assessment of their Airblade model hand dryer with other conventional hand drying modes.

The Dyson Airblade hand dryers were found to have a carbon footprint per hand drying of around 50% lower than the next best alternative of conventional warm air hand dryers. This was attributed to their lower consumption of energy. The results were calculated assuming a typical Swiss electricity power mix but were found to still hold for an European electricity power mix too despite the latter having five times as much carbon emissions for an equivalent amount of electricity

produced. Paper towels had the majority of their carbon footprint from the paper production process and the textile roller towels from washing and drying of the towels and cotton production (Climatop).

Table 4.7: Hand drying comparative life cycle assessment summary (Climatop)

Product	Assumption	Carbon Footprint per Hand Drying in g CO₂
Dyson Airblade hand dryer with ABS-PC casing “AB03”	Cold air drying, 10 sec	1.2
Dyson Airblade hand dryer with aluminum casing “AB01”	Cold air drying, 10 sec	1.4
Warm air hand dryer	Warm air drying, 27 sec	2.6
Paper towel scenario “best case”	2 recycled paper towels per hand drying	2.9
Paper towel scenario “worst case”	3 virgin pulp paper towels	13.4
Textile roller towels	One pull on the textile roller	9.2

4.3 CARBONFUND.ORG

Carbonfund.org is a non-profit organization in the U.S. that is dedicated towards the fight against climate change. It achieves this goal through education and outreach programs as well as carbon offset and reduction services. The organization has also introduced a CarbonFree Certified Label where they work together with companies to determine the carbon footprint of a product, reduce it where possible and offset the remaining carbon emissions associated with the product.

Carbonfund.org has developed a carbon footprint protocol together with the Edinburgh Centre for Carbon Management which describes the standards and guidelines required to obtain their label (Carbonfund.org, 2007). A diverse range of companies and products have been certified by Carbonfund.org and these are described briefly below:



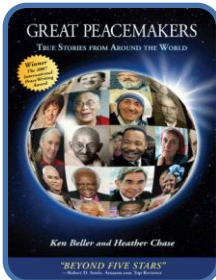
Grounds for Change

- Family owned and operated coffee roasting business located in the Pacific Northwest
- All coffee is fair trade and organic certified with a vast majority being shade grown as well
- First coffee roaster in the country to acquire CarbonFree Certified Product Label



Motorola

- Global communications leader with a portfolio of technologies, solutions and services including enterprise mobility solutions, home and networks mobility and mobile devices
- MOTO W233 Renew's plastic housing is made from recycled water bottles and 100% recyclable
- Packaging size reduced by 22% and printed materials on post-consumer recycled paper



LTS Press

- Independent publishing house dedicated to helping create a more peaceful, sustainable and humane world
- Award-winning book, Great Peacemakers tells the true-life stories of twenty great peacemakers from around the world
- Book has been Certified CarbonFree in keeping with their message and concern about the environment



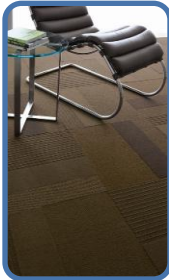
Florida Crystals

- Leading domestic sugar producer and North America's first fully integrated cane sugar company
- Uses crops and urban wood waste as fuel to generate renewable electricity
- Organic and Natural cane sugar product lines are certified CarbonFree



Monarch Beverages

- International beverage company that markets a range of Carbonated, New Age and Ready-To-Drink products
- Their newly launched Acute Fruit, CoMotion, NTrinsic and Ntrinsic Sugar Free energy drinks are CarbonFree certified



Tandus

- Provider of floorcovering solutions that enhance spaces for learning, working, healing and living with a strong focus on sustainability
- Creator of carpet industry's first closed-loop recycling program and numerous other sustainability driven carpet technology innovations
- Tandus offers its modular or Powerbond carpet certified CarbonFree at a nominal additional cost



Tropical Traders Speciality Foods

- Wholesale speciality food company focusing on hand-crafted, artisanal goods including Royal Hawaiian Honey is 100% raw, certified organic and made in the U.S.
- Tropical Traders recognizing its impact on climate change has got its Royal Hawaiian Honey brand certified CarbonFree as an extension to their commitment to organic agriculture



Figure 4-19: Carbonfund.org product certification label (Carbonfund.org)

4.4 THE CLIMATE CONSERVANCY

The Climate Conservancy is a non-profit organization founded by scientists at Stanford University with the mission of informing decision makers about the GHG emissions embodied in the products and services they buy and to stimulate market mechanisms that will lead to reduced emissions. The

organization has devised their own methodology, the Climate Conscious Assessment, which is based on process specific life cycle assessment methods to document the carbon footprint of consumer products (The Climate Conservancy, 2007). The Climate Conservancy believes that merely communicating a quantitative value of carbon is not meaningful enough to consumers. It has devised an initial metric based on the concept of GHG intensity which is the ratio of a product's carbon footprint to its retail value. This would be compared to the industry average of the economic sector in which the product is from and a rating given based on the percentage difference. Current potential tiers are reductions of 10-40% for Silver, 41-70% for Gold and >71% for Platinum. The benefit of this approach is that since the baseline of each sector's GHG intensity is dynamic over time, as society transitions to a low-carbon economy, the metric will remain progressive (The Climate Conservancy). Presently, the organization has completed its first assessment with the New Belgium Brewing Company and is working on a second assessment with Earthbound Farm.

4.4.1 NEW BELGIUM BREWING COMPANY

Founded in 1991 in Fort Collins, Colorado, the New Belgium Brewing Company aspires to operate a profitable brewery which makes their love and talent manifest. The company believes strongly in the importance of environmental sustainability and has instilled a number of practices including using wind-powered electricity since 1999, utilizing green design throughout their building and increasing efficiencies in their brewing process. In 2007, the company established a Sustainability Management System to keep track of their environmental impact and to set targets in reducing them. Their initial efforts are focused on four target areas: carbon footprint reduction, water stewardship, closing loops and advocacy (New Belgium Brewing Company, 2007).

As part of their initial goal to reduce the carbon footprint per barrel of beer brewed by 50%, the New Belgium Brewing Company worked in partnership with the Climate Conservancy in 2007 to complete a greenhouse gas life cycle assessment for a six-pack of Fat Tire Amber Ale. The estimated

emissions were 3,188.8g with 48.0% coming from upstream emissions, 46.6% from downstream and only 5.4% from within the company's own operations (The Climate Conservancy, 2008).

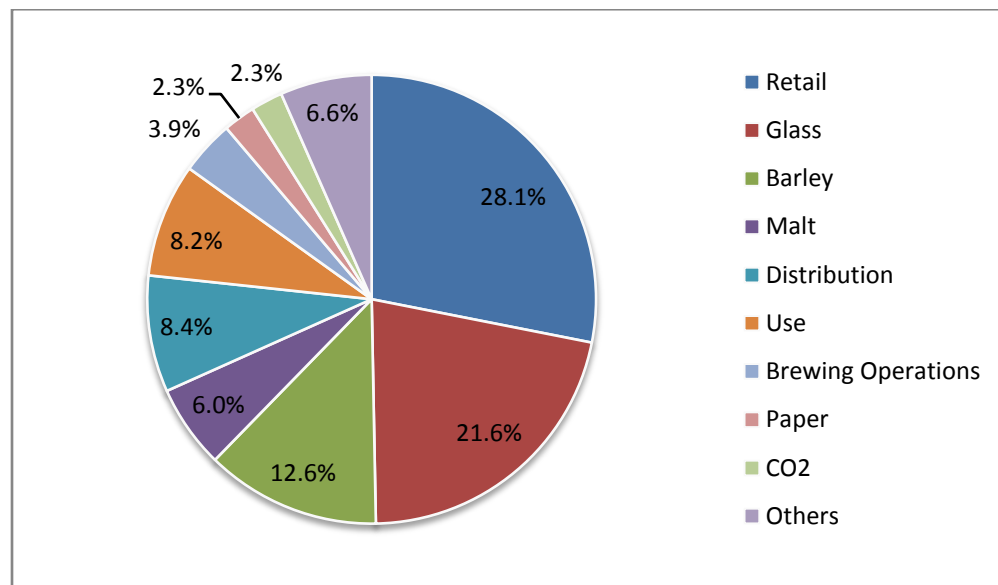


Figure 4-20: Carbon footprint of Fat Tire Amber Ale showing major sources of GHG emissions (The Climate Conservancy, 2008)

As a result of the findings, the New Belgium Brewing Company has decided to take a few steps to reduce the product's carbon footprint. The company has decided to look into using organic malt, work with industry to increase the supply of recycled container glass for bottle manufacturing and to get retailers to reduce the energy wasted by in-store refrigeration. They are also planning on also developing their own database to understand the detailed impact of each of their raw material and process inputs on their carbon footprint. After analyzing the findings, they have decided that setting a 25% reduction in emissions per barrel by 2015 would be a more realistic goal and are working towards that (New Belgium Brewing Company, 2007).

4.5 CARBONCOUNTED

CarbonCounted is a non-profit organization based in Toronto, Canada whose goal is to develop an accounting system that allows businesses to assess the carbon footprint of their products and services. CarbonCounted's proprietary CarbonConnect web application allows businesses and

suppliers to calculate and record their direct emissions as well as to purchase carbon offsets. The system aims to provide businesses with greater information transparency regarding the selection of low carbon suppliers and to improve overall carbon efficiency of their supply chains. The information recorded on the system will be audited annually to ensure accuracy. At the end of 2008, CarbonCounted was working together with 11 consulting partners globally and had over 4,500 sites with carbon footprints registered on their system (CarbonCounted).

4.6 CARBON REDUCTION INSTITUTE

The Carbon Reduction Institute is based in Sydney, Australia and is committed to enabling individuals and organizations to take real and effective action to reduce their impact on the climate. The organization offers a suite of services to corporations, small businesses and individuals ranging from its carbon neutral business certification programs to life cycle assessments of GHG emissions from products or services. Their NoCO₂ certification is for businesses that have achieved climate neutrality and their LowCO₂ certification for businesses that wish to communicate that they have achieved a percentage reduction from their initial carbon emissions baseline. In addition NoCO₂ certified organizations are qualified to sell their products as Carbon Neutral and LowCO₂ certified organizations can provide their customers with the Make It Carbon Neutral option (Carbon Reduction Institute).



Figure 4-21: Carbon Reduction Institute's various logo and labels for companies and products (Carbon Reduction Institute)

The Carbon Reduction Institute has also created a corporate network of carbon neutral and low carbon certified businesses which is named the Low Carbon Economy. The website provides

consumers and business customers with a list of organizations and their products that have been certified, encouraging them to purchase goods from and to support these companies in order to reduce their own impact. The 100 over organizations listed on the website that are certified span a host of industries ranging from travel to food and hospitality to finance solutions and include a dental surgery, poker tournament organizer, pub, home loans provider, florist, event management firm, consultancy, fireworks company, wine producer, espresso and food bar etc. (The Low Carbon Economy).

4.7 PRODUCT CARBON FOOTPRINT PILOT PROJECT GERMANY

The Product Carbon Footprint (PCF) Pilot Project Germany was initiated by a consortium consisting of the WWF, the Oeko-Institut – Institute for Applied Ecology, Potsdam Institute for Climate Impact Research and THEMA1 in February 2008. The mission of the project is to provide a forum for stakeholders to discuss how to best measure and inform consumers about the carbon life cycle emissions of products. The aim of the project is through initial assessments and case studies to develop specifications for product carbon footprint assessments and to communicate the information in a credible and meaningful way that can encourage environmentally friendly purchase and consumption decisions (PCF Pilotprojekt Deutschland).

4.7.1 BASF

BASF is the world's leading chemical company with over 96,000 employees serving customers and partners in almost all countries of the world. The company has identified five key global challenges for it to address moving into the future: energy and energy efficiency, housing and construction, health and nutrition, mobility, work and life. BASF has identified the need for integrating social and ecological responsibility into its business activities in order to achieve sustainability. The company views climate change as a long term strategic risk and even has its own appointed Climate Protection Officer. To date, BASF has conducted extensive carbon footprint assessments of its sites as well as the lifecycle of its products (BASF).

As part of its participation in the PCF Pilot Project, BASF did a case study on Neopor, an innovative material for building insulation that can be applied to save energy required for heating. They did a comparison between an insulated and non insulated house with a wall surface area of 1600m² assuming a use phase of 40 years and calculated that the insulated wall had total carbon emissions of 490 tons versus 750 tons for the non insulated wall which was a reduction of 35%. Production of the insulation material constituted less than 5% of the total footprint which was more than accounted for by the savings in energy use (BASF, 2008).

4.7.2 DM-DROGERIE MARKT

Dm-drogerie markt is a large German retailer operating over 2,000 branches across Europe. The company prides its success on integrated entrepreneurial and social thinking and putting the interests of people first. Dm believes strongly about the importance of environment sustainability and the conservation of natural resources. Understanding climate change and the impact it has is therefore of great concern to the company. Dm also believes in encouraging consumers to make more environmentally purchases by providing them with greater information.

Dm selected its triple-ply toilet paper Sanft and Sicher for assessing as it was the company's second highest sales item in terms of quantity. A package of 10 rolls of Sanft and Sicher was selected as the functional unit and the total carbon footprint was calculated to be 2.5kg. Dm found that the production stage had the highest contribution of 83% due mainly to energy consumption in processing. Opportunities the company identified to reduce emissions include increasing the efficiency of its manufacturing processes and substituting non fossil based energy where possible. From the experience, Dm believes that it is important for a single international methodology to be developed given the nature of global trade. In addition, the company felt that specific data should be used in order to provide meaningful differentiation within a product category for consumers (Dm Drogeriemarkt, 2008).

4.7.3 DSM

Royal DSM N.V. creates innovative products and services in life and material sciences that contribute to the improved quality of life. DSM's products and services are used globally in a wide range of markets and applications to support a healthier, more sustainable and enjoyable way of life. These are grouped into five main clusters: nutrition, pharma, performance materials, polymer intermediates, and base chemicals and materials. The company has identified four global trends that it believes will have an increasing impact on the world and has positioned its strategy around them. These trends are: climate and energy, health and well-being, functionality and performance and emerging economies (DSM).

DSM selected one of its innovative products – Claristar for the case study. Claristar is an additive that prevents the formation of chill haze in beer for over fifteen months. Head retention is maintained in beer stored at room temperature for over a year, while the natural antioxidant potential of the beer is preserved. The estimated carbon footprint per use in 100 liters of beer was 295g. The company determined that the use of Claristar reduced the carbon footprint associated with the stabilizing process by up to 70% as traditionally the most commonly applied beer stabilizing technology used is “cold stabilization” which requires cooling of the beer to -4°C for up to several weeks. From the study, DSM also identified opportunities for further reduction of emissions through increasing the process yield of Claristar; reducing electricity consumption in production; and using more energy from renewable sources. The company is now interested in having carbon footprint assessments done for 80% of its products by 2010 (DSM, 2009)(DSM, 2007).

4.7.4 HENKEL

Henkel is a leader with brands and technologies that promise to make people's lives easier, better and more beautiful. The company operates in three main business sectors: laundry and homecare, cosmetics and toiletries, and adhesive technologies. Sustainability is a key focus of the company's strategy and it has grouped challenges it has identified into five focal areas: energy and climate,

water and wastewater, materials and waste, health and safety, and social progress. Within energy and climate, Henkel has realized that for most of its products, the majority of carbon emissions come from the use phase rather than manufacturing. The company is focused hence on improving the efficiency of its products while still optimizing its production processing where possible.

Henkel selected its well known detergent brand Persil Megaperls for its case study and calculated its carbon footprint to be 700g per 3.9kg wash load at a temperature of 46°C. The use phase contributed to over 70% of the product's footprint followed by raw materials with under 20%. The company also conducted a range of different scenarios varying temperature, detergent dosage and size of wash load. It was determined that getting consumers to reduce their washing temperature had potentially the highest impact in reducing the product's carbon footprint. Henkel concurred that having an internationally acceptable standard was important to avoid consumer confusion and market distortion and product level communication useful only if it provides meaningful and reliable guidance for consumers to make sensible purchasing decisions. Nonetheless, the company is still determined to reduce its impact on the climate and has set a target to reduce energy consumption and GHG emissions by 15% in 2012 compared to a 2007 baseline (Henkel AG, CO. KGAA).

4.7.5 TCHIBO

Based in Hamburg, Tchibo is one of Germany's largest internationally active retail and consumer goods companies as well as the world's fourth largest coffee producer. The Tchibo brand is synonymous with its first-rate roasted coffee as well as the diverse range of consumer products it sells. These are distributed in a multi-channel sales system including its own shops, mail order and internet channels as well as through retail outlets. The company believes in treating the environment in which it operates business with respect and climate protection is one of the areas that it is concerned about. Tchibo initiated a joint pilot project in November 2006 with the Hamburg University of Technology titled "Logistics towards Sustainability". The objective of the

project is to develop solutions spanning the supply chain that reduce the company's environmental impact and GHG emissions (Tchibo).

Tchibo worked together with Oeko-Institut e.V. (Institute for Applied Ecology) to measure the carbon footprint of one cup of brewed Tchibo Privat Kaffee Rarität Machare which is equivalent to 7g of coffee powder and 0.125L of water consumed. The carbon footprint per cup of coffee brewed was calculated to be 59.12g with the majority, 55.8% coming from the extraction of raw materials followed by product use accounting for 30.3%. With regards to product use, there was significant uncertainty and variability regarding the coffee preparation methods. The use of automatic coffee machines significantly increased the carbon footprint compared to using a filter drip or French press. Hence, opportunities for reduction would be focused on the cultivation and use phases. This would require further investigations into coffee cultivation methods and communicating use phase emissions to consumers in a meaningful and impactful way (Tchibo GMBH, 2008).

A second product that Tchibo analyzed was that of a sports bag manufactured from coated polyester fiber. The best estimate calculation for the carbon footprint of Tchibo's sports bag was 35.3kg. The emissions were fairly evenly distributed across the supply chain stages: feedstock materials (21%), preparation and finishing (22%), dyeing and coating (16%), finishing (12%), make-up (15%) and waste disposal (10%). This would possibly vary between 75%-200% depending on certain assumptions and scenarios but was considered realistic and robust. Opportunities Tchibo identified to reduce the product's carbon footprint included optimizing energy efficiency in production, focusing on green design through better selection of less impactful materials, and selecting suppliers with the best environmental practices. Potential future steps that the company identified would be to expand product carbon footprint analyses to a wider portfolio of applicable products and incorporating industrial ecology and green design into internal thinking (Tchibo, 2008).

4.7.6 *TETRA PAK*

Tetra Pak is a world leading food processing and packaging solutions company. Tetra Pak works closely with its suppliers and customers to provide safe, innovative and environmentally friendly products that meet the needs of people worldwide. Tetra Pak believes in responsible industry leadership and a sustainable approach to business. The company is committed towards reducing its emissions, stated through its energy and climate goals established in 2000 and 2005 respectively. It aims to reduce absolute carbon emissions in 2010 by 10% compared to its 2005 baseline. Tetra Pak intends to achieve this goal through improved production efficiency and increasing the use of renewable electricity. The company also works closely with environmental groups including the World Wildlife Fund and the High Conservation Value Resource Network to protect forests.

The Tetra Brik Aseptic Slim is a carton packaging system used for the packaging of UHT food and beverages. The functional unit used was Tetra Brik Aseptic Slim packaging for 1L of milk with LightCap and the carbon footprint was calculated to be 82g. The main contributors to the product's carbon footprint were the raw materials production, filling, use and end of life phases. Sensitivity analyses were conducted to understand the impact of different proportions of renewable electricity used in the production phase and whether consumers stored the carton in a fridge before use. Tetra Pak has had many years of experience with conducting life cycle assessments and was familiar with the methodology. Issues specific to carbon emissions the study raised were with factoring in renewable electricity purchases and recycling rates. The company has learnt through this and previous work about the importance material selection, recovery and recycling of products and energy efficiency plays into a carbon footprint. Tetra Pak intends to continue focusing on improving the environmental impact of its packaging in the future and assist with the development of standards in assessing carbon footprints (Tetra Pak GMBH, CO. KG, 2009).

4.7.7 DEUTSCHE TELEKOM

Deutsche Telekom is one of the world's leading telecommunications companies. The group offers customers a range of state of the art IT and telecommunications services from a single source. They also support personal and social networking using innovative products and services. The T-Home brand falls under the company's "T" umbrella and represents all home services and products. Similar brands include T-Mobile which signifies products and services for customers on the move and T-System for medium and large companies. T-Home offers home consumers services including high speed internet, and innovative multimedia services combining TV, telephony and the internet. Climate change is an issue that company regards seriously and categorizes its climate protection activities into three categories: increasing efficiency and reducing emissions through optimization and switching to renewable, developing products and services for consumers that promote the efficient use of resources, and a public commitment towards climate change and increasing societal awareness about the issue.

The Environmental Protection and Sustainable Development Team at T-Home led the project with the assistance of the Oko-Institut to calculate the carbon footprint of the operation and usage of T-Home's Call and Surf package over a period of 12 months. The assessment encountered significant difficulties in obtaining data regarding the manufacture of the router, distribution of the network services, disposal and accounting for capital infrastructure. The summary results were that the carbon footprint for the company providing the network services was 46.56kg and that of customers operating their IAD router was 41.40kg. Improving energy efficiency and changing user behavior were possible steps identified to reduce the product's overall carbon footprint. As part of Deutsche Telekom's overall sustainability strategy, creating a "Low Carbon Society" is one of its key focuses and it expects to do similar assessments for other products (Deutsche Telekom AG, 2009).

4.7.8 TENGELMANN GROUP

The Tengelmann Group is a privately-run conglomerate that comprises of the Kaiser's and Tengelmann supermarkets, building supplies and do-it-yourself stores OBI, the textile and non food discount chain KiK, the Plus Online Shop and Plus Eastern Europe. The group's decision to participate in the PCF Pilot Project is part of its continuation of the Tengelmann Climate Initiative where the company has committed to several projects to protect the climate and reduce GHG emissions.

The product selected for assessment was a box of six organic free-range eggs from the group's private brand Naturkind. The majority of the product's 1.176kg carbon footprint came from the egg laying farm process step (Figure 4-22). Various scenarios were calculated based on consumer usage assumptions and a sensitivity analysis on the results was conducted using a range of different emissions factors available. These were found to contribute significantly and result in the product's carbon footprint varying between 0.660kg and 1.463kg.

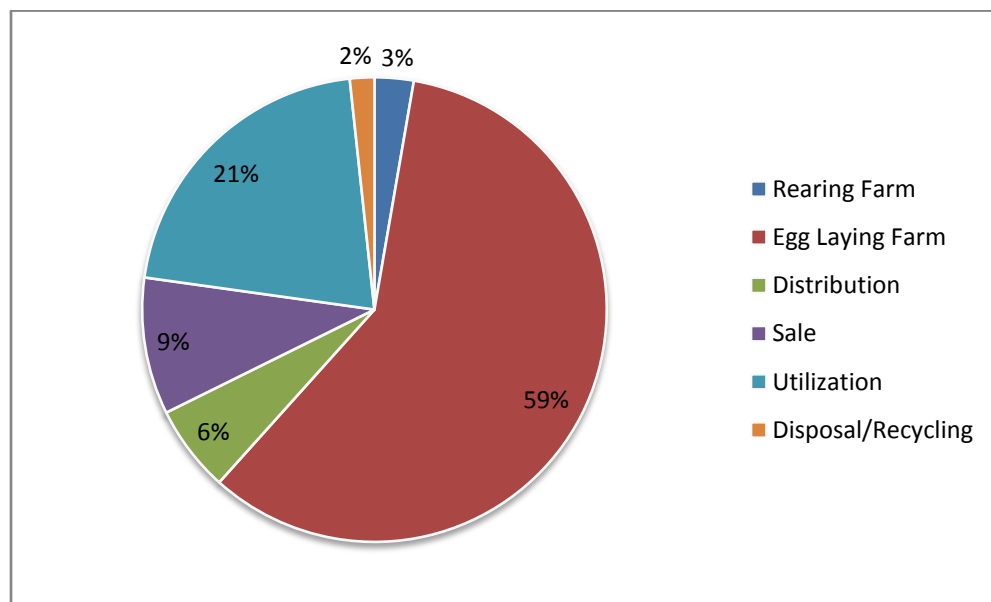


Figure 4-22: Naturkind eggs carbon footprint breakdown

Possible reduction opportunities identified included installing a biogas plant (160g) and changing consumer behavior such as their mode of transport used when shopping (48g) and method of preparing eggs (130g). Using renewable electricity for regional warehouses and stores (110g) was also a viable option. Challenges highlighted from the study included the difficulty in drawing life cycle boundaries for biological products and uncertainties regarding consumer utilization. The Tengelmann Group intends to initially furnish customers with general information to introduce them to the subject and proceed with providing more quantitative results once a broader knowledge base about carbon footprinting has been built up. The company is also committed to supporting and contributing to the development of the PCF Pilot Project and may decide to assess more products in the future (Tengelmann Group, 2009).

4.8 KRAV

KRAV determines certification standards as well as certifies organic production in Sweden. It is an association made up of 28 members comprising of farmers, food processors as well as trade, environmental and animal welfare interest groups. In 2007, KRAV and Svenskt Sigill (Swedish Seal) initiated a joint labeling project with the goal of providing climate related information for food products to consumers. Other stakeholders that have since joined the project include Milko, Lantmannen, LRF, Skanemejerier and the Swedish Board of Agriculture. Initially, the standards aim to cover fruit, vegetables, cereals, fish and shellfish which have simpler supply chains due to the reduced amount of processing required. The standards will expand to cover milk and meat production in the later stages. The intent of the initiative is not to inform the consumer about the quantitative value of a product's carbon footprint but to compare products within the same category and to highlight companies with the most climate friendly practices. An initial proposition is to label food products that have a 25% lower carbon footprint than the industry average for the product category. The organization has found through its internal surveys in Sweden that

consumers are willing to pay more for climate labeled food products but believes it would be harder to influence dietary choices (Tidaker & Ekmark)(KRAV, 2008).

4.9 PRIVATE INITIATIVES

4.9.1 CASINO

Casino is one of the largest food retailers in France, managing over 10,000 stores. The majority of its sales are in France but it also operates stores worldwide in countries including Brazil, Argentina, Thailand and the Netherlands. Sustainable development is a priority for the group and it categorizes the challenges into the four areas of production, logistics and transport, retailing and restaurants, and consumption. While Casino has already taken personal action to reduce its carbon footprint through various initiatives including optimizing packaging and improving efficiency of transportation and refrigeration equipment, it is also interested in promoting sustainable consumption among its consumers. The company hopes to achieve this by increasing the environmental quality of its products and to inform consumers of the environmental impact of the products they consume daily.

The Casino carbon footprint is calculated based on GHG emissions on the five key stages of a product's life cycle: production, manufacture, transport, packaging and distribution. The methodology has been independently developed by the Bio Intelligence Service agency. This footprint is expressed in grams of CO₂ generated per 100g of a product. Data used for the calculation is based on energy consumption of production plants and from life cycle analysis literature. The first wave of products to be labeled by Casino includes yogurt, soda, pizza base, pancake mix and sponge cake mix. The retailer plans on eventually labeling all its brand products. Casino plans to educate its consumers through a specially designed website providing more detailed information and content about the calculation and label as well as through on shelf visibility aids and print media. It also intends to educate suppliers and provide them with an IT tool

to calculate and update their carbon measurements independently (Picard, 2008).

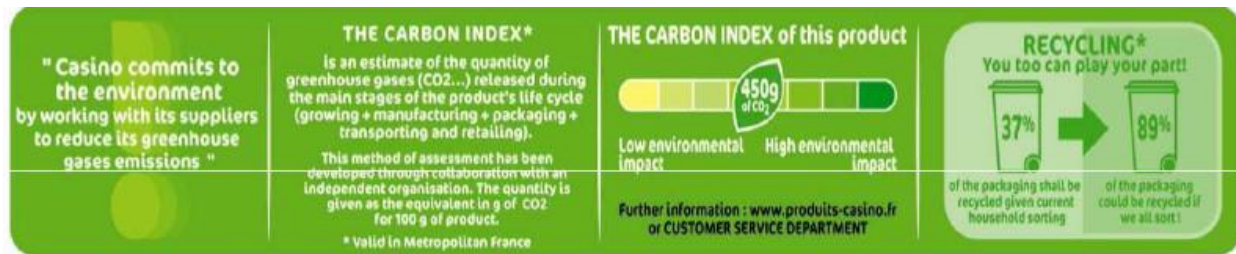


Figure 4-23: Casino carbon label (Picard, 2008)

4.9.2 E.LECLERC

E.Leclerc is a French hypermarket chain, operating over 560 stores in France making it one of the largest food retailers there. The company has started an initiative where customers will be provided with CO₂ emissions figures on their receipts based on their purchases. Consumers can then compare their household footprint against the average of similarly sized households who have also purchased products at the store. Product carbon footprint information is currently available for all food products but based on generic data on broad product categories.



Figure 4-24: E.Leclerc carbon footprint on receipt and average household weekly footprint (ConsoGlobe, 2008)(E.Leclerc, 2008)

4.9.3 PATAGONIA

Patagonia grew out of a small company that made tools for climbers but now focuses on making clothes for climbing, skiing, snowboarding, surfing, fly fishing, paddling and trail running. Their approach towards product design is that of simplicity and utility while minimizing their impact on the environment. Patagonia's mission statement is to "Build the best product, cause no unnecessary harm, and use business to inspire and implement solutions to the environmental crisis". Patagonia promotes the use of environmentally sensitive materials and sponsors and participates in a host of environmental initiatives from promoting wildlife corridors to combating genetic engineering. The company is also active in improving the social conditions of the factories where production is outsourced to and conducts regular social audits on these factories as well as training sessions on social responsibility for staff that are in contact with them (Patagonia).

Table 4.8: Patagonia product carbon footprints (Patagonia)

Product	Carbon Footprint in kg CO₂
Wavefarer Board Shorts	8
R2 Jacket	9
Short-Sleeved Kamala Top	5.4
Cashmere Hoody	3
Down Sweater	3
Freewheeler	35
T-Shirts	1.6
Talus Jacket	30
Puckerware Shirt	7
Nine Trails Shorts	1.4
Capilene 3 Bottoms	3.6
Vitaliti Strappy Dress	14
Sugar & Spice (Footwear)	23
Wool 2 Crew	21
Synchilla Vest	13
Honeydew (Footwear)	22
Polo Shirt	12

The footprint chronicles is an initiative which examines and documents the environmental and social impact of products that Patagonia makes. Their interactive website provides detailed supply

chain information of each product listed as well as data regarding energy consumption, distance travelled, CO₂ emissions, waste generation and water consumption. These calculations are based on vendor provided data wherever possible, otherwise industry life cycle data and LCA studies are used. While the company's assessment focuses on the impact of primary materials of production, secondary materials are included if they make up a significant portion of the product. Patagonia's current goal is for total materials accounted in each analysis to make up at least 95% of the product's weight (Patagonia, 2009). Apart from providing detailed product environmental and social impact information on their website, consumers are also actively engaged to provide feedback and comments.

4.10 JAPAN CARBON FOOTPRINT PROGRAM

The Japanese Ministry of Economy, Trade and Industry is leading a voluntary initiative to work with industry partners to put carbon footprint labels on consumer products. The Ministry is currently working with around 30 firms to put labels on dozens of items including food and drink, detergents and electrical appliances. This was done through the initiation of "The Study Group for Developing and Promoting a Carbon Footprint Program" in June 2008. The Ministry plans to design a uniform method for measuring and labeling carbon emissions which will be more detailed than the other present global initiatives. The Carbon Footprint Program is part of the government's plan to reduce the country's total carbon emissions by 14% by 2020 and up to 80% by 2050 (McCurry, 2008). Prior to the launch of the program, products were exhibited at the Eco-Products Exhibition in December 2008 in Japan. Sapporo, a leading Japanese Brewery company presently has labels on its beer cans which state that 295g of CO₂ were released in production of the beer (Figure 4-25).



Figure 4-25: Japanese Sapporo beer carbon label (Gustafson, 2009)

4.11 CARBON LABEL CALIFORNIA

Carbon Label California is a group seeking to implement a GHG content label for consumer products in California. To date, they have managed to get assembly member Ruskin to introduce a bill, The Carbon Labeling Act of 2009 (AB 19) for action by the California State Legislature. The group's intent is to provide information to allow consumers to choose between comparable products based on their carbon content. In addition, their belief is that this would spur producers to reduce the carbon intensity of the goods they manufacture. Carbon Label California seeks to bring together academics, environmentalists, business leaders and policy makers together in a collaborative effort to achieve this goal (Carbon Label California).

4.12 SUMMARY OF CARBON LABEL INITIATIVES

The presence and growth of carbon labeling initiatives globally reflects the growing interest companies have in communicating their environmental and specifically climate related efforts to consumers. Many of the chartering companies participating in these initiatives have begun to recognize the importance environmental sustainability and climate change have on their continuing operations. This changing mentality among corporations can be attributed to one or more of the following reasons:

- Improved knowledge and understanding regarding the finite physical limits of our earth and the constraints that puts on resource availability
- Increased likelihood of governmental intervention and regulation on the environment
- Greater consumer awareness and concern in protecting the environment

Table 4.9: Summary list of major carbon labeling initiatives worldwide

Initiative	Country	Year Started⁺	Organization Type	Label Type	Participating Companies
Carbon Trust	UK	2007	Government Funded Independent Company	Seal of Approval/ Report Card	10
Climatop	Switzerland	2008	Non-Profit	Seal of Approval	2
Carbonfund.org	U.S.	2007	Non-Profit	Seal of Approval	11
Climate Conservancy	U.S.	2006	Non-Profit	LCA Report	2
CarbonCounted	Canada	2007	Non-Profit	Report Card	-
Carbon Reduction Institute	Australia	2007	For Profit	Seal of Approval	-
PCF Pilot Project	Germany	2008	Collaboration	LCA Report	10
KRAV	Sweden	2007	Non-Profit	Seal of Approval	-
Japan Carbon Footprint	Japan	2008	Government	Report Card	30

⁺Refers to the year in which carbon labeling initiatives within the organization started

Leading companies engaged in sustainability are often also involved in a range of product initiatives including fair trade, organic production, reducing water usage, and recycling materials etc. Climate change is understandably one of the more recent corporate focuses given the growing scientific knowledge and consensus surrounding the subject. Many of these leading companies and initiatives are based in the EU where individuals and governments there have very forward thinking with regards to environment protection. Product carbon footprinting has been recognized by these companies as a method to both better understand their supply chain operations and identify opportunities to improve their efficiency as well as to empower consumers with more information to supplement their decision making. Carbon labeling standards and certification bodies are

important in ensuring accuracy and reliability of the information that these companies provide to their consumers. While some companies have chosen to develop their own methodologies and scorecards, many have decided to join external initiatives. The differences in approaches taken by the various global initiatives are further discussed in this section.

Details and Transparency - As discussed previously, a great amount of effort is involved in obtaining life cycle data of a product. This is not always feasible depending on the depth and complexity of the supply chain and industrial average data may have to be used. The issue with using secondary data is that it makes comparisons within product categories less meaningful and reduces the accuracy of the calculation. One approach which CarbonCounted is working on is the development of a database where various suppliers can report the emissions of product stages under their control. These kinds of initiatives would facilitate the computation of a product's carbon footprint once sufficient companies participate in them and start contributing data. Currently, the BSI PAS 2050 standard requires the collection of primary activity data for all upstream processes owned, operated or controlled by the organization implementing the assessment. If the implementing organization does not contribute 10% or more to the upstream GHG emissions of the product, the requirement will apply to the first upstream supplier that does (British Standards Institute, 2008).

While most carbon labeling initiatives claim to be using some form of life cycle assessment, details provided regarding the amount of primary data used is varied. Initiatives like the Climate Conservancy and PCF Pilot Project Germany provide well documented publicly available reports of their assessments while others like the Carbon Reduction Institute and Carbonfund.org do not even reveal their certified products' quantitative carbon footprint values. The first issue involves the willingness of companies to publicly reveal confidential information regarding their operations. Although doing so provides greater transparency and credibility, it also potentially undermines

their comparative advantages. The second issue is whether revealing unflattering product carbon footprint information might be detrimental to the sales of the product. For example companies like Cadbury seemed hesitant in promoting the fact that milk, a key ingredient in the dairy products they manufacture, has high carbon emissions from the rearing of cows. These companies may instead prefer to highlight the fact that they are dedicating resources and effort towards reducing their emissions. Conversely, companies that believe their products are superior to other substitutes are keen on leveraging labeling initiatives to highlight this fact. These include Continental Clothing which uses renewable electricity for its manufacturing that results in a significantly lower product carbon footprint than its competitors and Dyson who believes its hand dryers are the most carbon efficient hand drying solution available in the market.

Label Criteria and Program Structure - There is much variability and lack of consensus regarding what an ideal label criteria and program structure would be. The Carbon Trust has chosen to issue its Carbon Reduction Label to companies that carry out assessments with the provision that they reduce their product carbon footprint within two years to maintain use of the label. Climatop has decided to label products only if they achieve 20% less emissions than the next best alternative and KRAV if the product's carbon footprint is 25% less than the product category average.

Carbonfund.org and the Carbon Reduction Institute on the other hand certify products for companies that have purchased the necessary offsets for their emissions. The Climate Conservancy has proposed a GHG intensity metric which is the ratio of the product's carbon footprint to its retail value while Casino has decided to normalize it per 100g of product mass. These differences underlie the uncertainty regarding whether a carbon label should be best used in highlighting leading companies, best products within a category or best products across the board.

While Climatop and KRAV's approaches in following Energy Star's "best in category" model have advantages in stimulating continued improvements in product performance, issues associated with

the accuracy of data used and uncertainty regarding life cycle assessment results poses significant challenges to making such comparisons meaningful. In addition, at the onset of the initiative it may be difficult to get sufficient participation within a product category for useful comparisons to be made. One approach around this is by targeting retailers such as Migros, Tesco and Casino that sell a range of products within a single category to participate and get their products assessed. Schemes that certify companies based on their commitment towards reducing their impact such as the Carbon Trust, Carbonfund.org and Carbon Reduction Institute are easier to verify but a lack of transparency in the latter two initiatives raise the question of whether the labels are merely being “bought”. The Carbon Trust addresses this issue by requiring companies to reduce their product carbon footprint from their baseline within two years to keep the label.

Participating Companies and Products - For most of the initiatives, household consumables are the popular choice for assessment. These include groceries, food and beverages as well as laundry and bathroom products. Among the reasons for this include:

- Household consumables can be considered commodities and would benefit from any additional market differentiation possible
- Shorter and simpler product life cycles make implementing carbon assessments easier
- The products are familiar to and used by a majority of consumers
- High turnover and sales of the products result in immediate and large impacts upon redesign or reformulation of the product
- Potential for improvement in production are significant

While any type of product can be compared across brands based on its carbon footprint, consumers are more likely to consider factors like quality and price for products that are purchased less frequently and are more expensive. Hence, the effect of a carbon label on such products might not be as significant. Also, products like electronics and automobiles which have many parts and

components are more difficult to analyze using LCA and might actually be better compared based on other environmental related factors like energy efficiency. It is also important to note that multiple environmental and social issues including organic production, fair trade, sustainable production, recyclability and water resource consumption could be relevant to the product in question. Leading companies like Innocent, Patagonia and Continental Clothing look to carbon efficiency as one of the many criteria that they design their product to meet. A holistic approach to incorporate these other issues might be more meaningful than merely addressing and comparing climate change impacts.



Figure 4-26: Matrix categorizing companies based on environmental commitment versus size

Product carbon labeling seems to appeal most to the following categories of companies: large multi-national corporations in the consumer products and goods industry, large retailers, and smaller private companies that are focused on sustainability. These pioneering companies with strong commitments towards the environment fall in the upper half of the matrix shown in Figure 4-26 and are the ideal targets for a new carbon labeling initiative. High Impact Leaders can provide huge

boosts for a labeling initiative considering the large amount of publicity they generate and the extent of their consumer reach. These include companies like PepsiCo, Tesco and Boots. Green Revolutionaries do not have as extensive an influence but their consumer profiles typically encompass people that are highly concerned about the environment and would most likely support product labeling initiatives as well as spread word about it within their communities. Such companies that have participated in carbon product footprint initiatives are the New Belgium Brewing Company, Innocent and Continental Clothing. Followers and Laggards tend to join initiatives in the later stages and usually only when there are identifiable tangible benefits from marketing or branding. They are likely to be put off by initiatives that require detailed life cycle assessments and hence a large commitment of resources and may not be as willing to invest capital into improving their product design and processes.

Affiliation and Government Support - Program affiliation is important in demonstrating a program's long term viability. Affiliation with the Government for example provides financial stability and a certain level of credibility. This is needed to attract High Impact Leaders into programs as these companies do not want to be associated with failed initiatives. For example, The Carbon Trust was able to attract many large multi-national companies given their affiliation with the UK Government and the reputation they had built up from their work on carbon management systems. Also, a strong consortium backed by reputable non-governmental organizations and academic institutions like in the case of the Product Carbon Footprint Project Germany can be successful in recruiting well established companies. It is understandably more difficult for organizations like the Climate Conservancy, Carbonfund.org and CarbonCounted with limited affiliations or government support to attract the High Impact Leaders needed to help the program gain traction and take off.

5 VOLUNTARY PUBLIC PRIVATE PARTNERSHIPS

The EPA has been involved in voluntary partnership programs for more than 20 years. These programs are designed to address a variety of issues ranging from recycling and human health to climate change. The EPA's Office of Inspector General (OIG) reported the total number of voluntary programs in operation to be 75 in 2004 and 133 in 2005. This large rise between the two years was attributed largely to the changing definition of voluntary partnership programs used by EPA. Of these, 54 programs are headquarters-based and have a national scope (EPA Office of Inspector General, 2007).

The number of staff, budget and participants varies widely across the different programs. In 2004, EPA's Innovation Action Council was given oversight of voluntary partnership programs and has since developed general program guidelines and improved the support for partnership program managers (EPA Office of Inspector General, 2006). Recently, the EPA released *A Business Guide to U.S. EPA Climate Partnership Programs* listing 36 voluntary and stewardship programs managed or supported by EPA for businesses to browse through and pick programs to participate in which are relevant to them (U.S. EPA, 2008). The EPA attributes these programs to having significantly reduced GHG emissions by tackling the market barriers that have been limiting investments in energy efficiency, clean energy supply, and other climate friendly technologies and practices. More than 14,000 organizations are involved in these programs, contributing to a prevention of 78 million metric tons of CO₂ equivalent emissions (MMTCO₂E) and net savings to consumers and businesses of \$17 billion in 2007. A majority of these emissions savings have resulted from the Energy Star program (Figure 5-1).

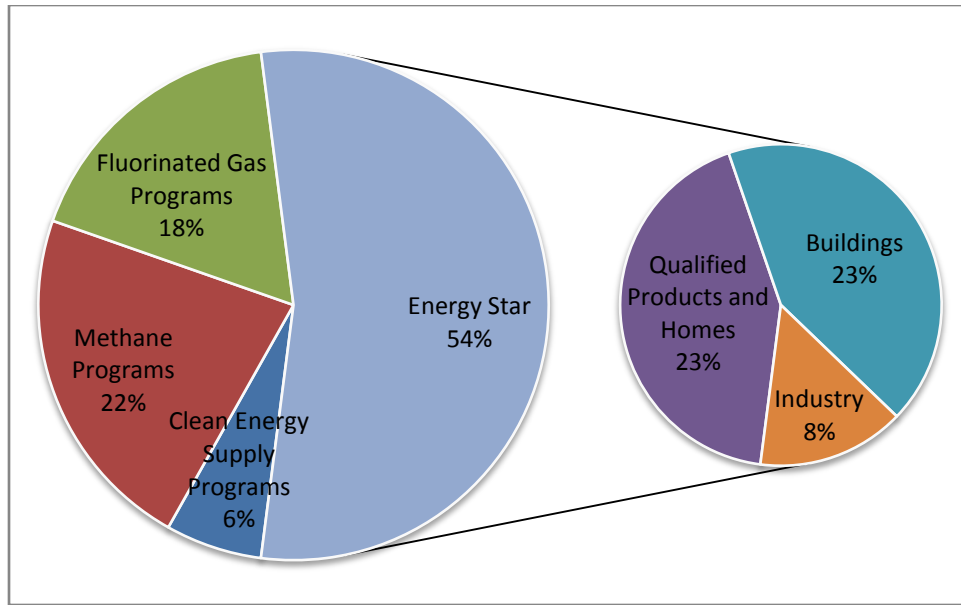


Figure 5-1: Proportion of emissions avoided due to EPA Climate Partnership Programs in 2007 (U.S. EPA, 2008)

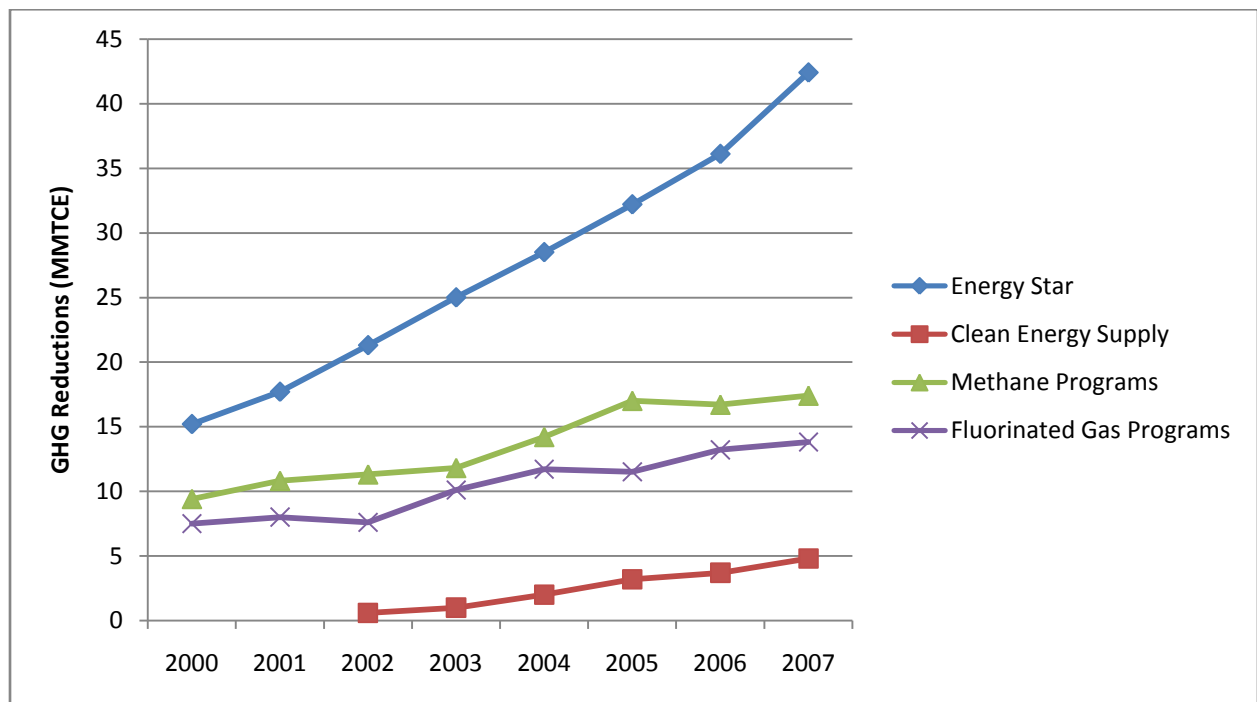


Figure 5-2: GHG reductions of selected EPA Climate Partnership Programs 2000-2007 (U.S. EPA, 2008)

These programs are successful at addressing a number of market barriers for energy consumers including (U.S. EPA, 2008):

- Lack of information about energy efficiency and renewable energy options
- Competing claims in the marketplace
- Lack of objective measurement tools
- High transaction costs
- Lack of reliable technical assistance
- Split incentives
- Perceptions of organizational risk
- Lack of objective basis for recognition of environmental stewardship

A separate report done by the OIG however suggested that voluntary GHG programs had limited potential with barriers to participation such as perceived emission reduction costs and reporting requirements. The Energy Star program however was not covered by this particular report. The report also commented it was unlikely that the programs could reduce more than 19% of the projected 2010 GHG emissions in their sector based on Marginal Abatement Curve analysis. One main weakness of voluntary programs raised was that data collection and reporting systems were often limited, non-transparent and unverifiable (EPA Office of Inspector General, 2008). A separate evaluation report done by the OIG on the reported benefits of the Energy Star program also identified inaccuracies and unreliability in the savings reported and recommended the EPA to establish and implement improved quality controls as well as to improve their methodology in computing market transformation effects (EPA Office of Inspector General, 2008).

5.1 ENERGY STAR

The Energy Star program was introduced by the EPA in 1992 as a voluntary labeling program designed to identify and promote energy-efficient products for consumers to save money and protect the environment. The program started off with computers and monitors followed by printers in 1993. This was expanded to include fax machines in 1994 and copiers, transformers, residential heating and cooling equipment, thermostats, new homes and commercial buildings were

introduced in 1995. In 1996, the U.S. Department of Energy (DOE) started partnering the EPA to promote particular energy-efficient product categories (Brown, Webber, & Koomey, 2002). Since its inception, the number of products, practices, and policies that the EPA offers through Energy Star has been growing every year. Currently, the Energy Star program covers more than 60 product categories for the home and office as well as new homes, commercial and industrial buildings (U.S. EPA, 2008).

Energy Star was designed with the goal of overcoming the market barriers to the adoption of cost-effective energy efficient products and services. The program achieves this by providing businesses and consumers with the information and tools to make the product purchasing decisions which provide them the greatest energy savings for the future. Ideally, this approach would help in directing private capital towards energy efficiency investments and provide a large environmental and economic payback for the initial government investment. Energy Star serves to enhance the market for energy efficiency by reducing the transaction costs and lowering the investment risks to the point that many more projects become attractive. It also plays a distinct role in the market place by providing credible, objective information for businesses and homeowners to make better informed decisions (U.S. EPA, 2003).

5.1.1 SUCCESS OF THE ENERGY STAR PROGRAM

In 2008, the program helped in preventing 43 MMTCO₂E of GHG emissions, saving \$19 billion in utility bills. There are currently more than 15,000 partners including:

- Over 2,400 manufacturers producing more than 40,000 individual product models
- More than 1,000 retail partners marketing Energy Star products
- Over 6,500 builder partners in charge of constructing Energy Star certified new homes
- Nearly 4,500 private businesses, public sector organizations and industrial facilities investing in energy efficiency strategies for their buildings and facilities

- More than 40 states, 550 utilities and other energy efficiency program sponsors
- Thousands of energy service providers, home energy raters, financial institutions, architects, and building engineers

More than 75% of the American public identify with the Energy Star label and in 2008, one in three households knowingly purchased an Energy Star qualified product with 75% of those households crediting the label as an important factor in their decision. A staggering 2.5 billion Energy Star qualified products have been purchased by consumers since 2000 and 940,000 homes nationwide now bear the Energy Star label. In addition, more than 11.5 billion square feet of commercial floor space has been rated using EPA's energy performance rating system with over 1 billion square feet having earned the Energy Star label for top performance (U.S. EPA, 2009).

5.2 CLIMATE LEADERS

The Climate Leaders program was launched in 2002 to assist leading companies in developing comprehensive climate change strategies. These partners represent a broad range of industry sectors, including cement, forest products, pharmaceuticals, utilities, information technology, and retail. Partner companies make a commitment to reduce their environmental impact by completing a corporate-wide inventory of their GHG emissions, setting aggressive reduction goals and reporting their annual progress to the EPA. The EPA in turn provides guidance through a range of tools, expertise and resources to assist partners in making informed decisions about the cost-effectiveness of strategies and investments with regards to energy efficiency, renewable technologies and various emission reduction projects. Partners also gain recognition and publicity from their involvement in the program. The number of partners has been growing steadily from 34 charter partners in 2002 to 251 as of 2008. Nearly 50% of these organizations are members of the Fortune 1000 with total annual revenues representing 12% of U.S. gross domestic product. The EPA estimates that the GHG reductions by Climate Leaders partners will prevent more than 13 MMTCO₂E of GHG emissions per year (U.S. EPA, 2008).

5.3 CLEAN ENERGY SUPPLY PROGRAMS

5.3.1 *GREEN POWER PARTNERSHIP*

The Green Power Partnership supports organizations in their procurement of green power by offering expert advice, technical support, tools and resources. This serves to lower the transaction costs for organizations when purchasing green power as well as to reduce their carbon footprint and provides an avenue for communicating their environmental stewardship to their stakeholders. To qualify for the partnership, organizations must meet a minimum percentage of green power that corresponds to the organization's purchased electricity use. This ranges from a minimum of 2% for organizations with annual electricity use of over 100 million kWh to 10% for organizations using less than 1 million kWh. A second tiered membership, the Green Power Leadership Club recognizes organizations with superior environmental performance, defined as purchasing 20% to 60% of their electricity from green power sources. Presently the partnership includes over 1,000 partners including state and local governments as well as commercial and industrial companies that are collectively buying nearly 1.6 billion kWh of green power annually (U.S. EPA).

5.3.2 *COMBINED HEAT AND POWER PARTNERSHIP*

The Combined Heat and Power (CHP) Partnership seeks to reduce the environmental impact of power generation by promoting the use of CHP. The partnership works closely with energy users, industry, state and local governments as well as other stakeholders to facilitate the development of new projects and to highlight their environmental and economic benefits. The partnership provides a variety of tools and services including information about funding resources, an emissions calculator as well as public recognition for partner efforts. To date, the partnership has more than 285 partners and has assisted in over 410 CHP projects representing 4,764 MW of new CHP capacity (U.S. EPA).

5.4 STATE AND LOCAL PROGRAMS AND INITIATIVES

5.4.1 STATE AND LOCAL CLIMATE AND ENERGY PROGRAM

The Climate and Energy State and Local Programs provide technical assistance, analytical tools and outreach support to state and local governments to help them in their clean energy efforts. These tools and services include helping partners in identifying cost-effective policies and initiatives to promote renewable energy and energy efficiency, measuring and evaluating the impacts of their initiatives, and fostering the exchange of best practices among state and local officials. The State Partnership program was launched in 2005 with 11 partner states and which has since increased to 16. These 16 states represent about half the population, energy use and GHG emissions in the U.S. The Local program acts more as an information-sharing resource accessible to all local governments and interested parties without any formal membership enrollment (U.S. EPA).

5.4.2 NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

The National Action Plan for Energy Efficiency co-facilitated with the DOE brings together a leadership group of over 60 top utilities, utility regulators, state agencies, large energy users, consumer advocates, energy service providers and environmental and energy efficiency organizations. The group reviews and identifies the barriers limiting investment in cost-effective energy efficiency and develops policy recommendations to tackle these barriers. The program also provides resources to help organizations to implement the recommendations. From its initiation in 2005 through 2007, 120 organizations have made commitments to advance energy efficiency through the Action Plan (U.S. EPA).

5.5 METHANE PROGRAMS

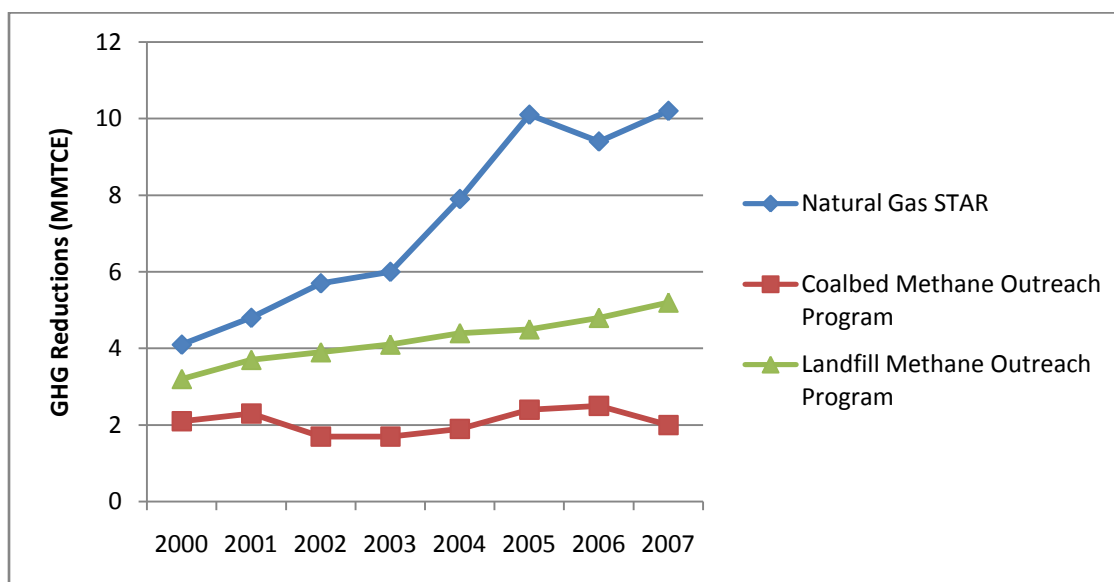


Figure 5-3: GHG reductions of selected methane programs 2000-2007 (U.S. EPA, 2008)

5.5.1 NATURAL GAS STAR PROGRAM

The Natural Gas STAR Program was initiated in 1993 and partners with companies from all sectors of the natural gas supply chain including production, processing, transmission, and distribution with the aim to reduce methane losses and improve system efficiency. The program has worked together with the oil and natural gas industry to identify technologies and practices that can be implemented to reduce methane emissions from oil and gas operations. Through the program, partners have eliminated nearly 677 billion cubic feet (Bcf) of domestic methane emissions. In 2007, the emission reductions were approximately 92.5 Bcf or 37.4 MMTCO₂E providing an additional revenue of nearly \$648 million in natural gas sales. The Natural Gas STAR International program was launched in 2006 to include companies worldwide. The total partners as of 2007 was more than 120 representing 60% of the natural gas industry in the U.S., including 19 of the top 25 natural gas production companies (U.S. EPA).

5.5.2 AGSTAR PROGRAM

The AgSTAR Program was established in 1994 as a collaborative effort with the U.S. Department of Agriculture and DOE to work with the agriculture industry in reducing methane emissions by

promoting the use of anaerobic digesters and biogas recovery systems to manage animal wastes. The EPA assists the industry through the provision of technical information and tools to help implement systems and assess potential projects. These are expected to reduce air and land pollution as well as generate renewable energy on top of reducing emissions. There are currently over 125 systems in place since the establishment of the program which produced approximately 290,000 MWh equivalent of energy generation and avoiding 0.85 MMTCO₂E of GHG emissions (U.S. EPA).

5.5.3 COALBED METHANE OUTREACH PROGRAM

The Coalbed Methane Outreach Program is a partnership with companies involved in the coal industry to reduce methane emissions from coal mines through the development of coal mine methane recovery and utilization projects. The program aims to provide high-quality, project-specific information and technical assistance to the coal mining industry and project developers. As a result of this successful partnership, the percentage of drained coal mine methane that is recovered has grown from 25% in the early 1990s to more than 80% in 2007. Between 1994 and 2006, coal mine methane emission reductions have avoided 535 billion cubic feet of methane or 216 MMTCO₂E (U.S. EPA).

5.5.4 LANDFILL METHANE OUTREACH PROGRAM

The Landfill Methane Outreach Program was launched in 1994 to facilitate the development of landfill gas energy projects. The program targets both smaller landfills that are not required by regulations to collect and combust their landfill gas as well as larger regulated landfills that are not combusting the gas cleanly. Resources provided include a project development handbook, feasibility analysis and decision making software, and a database of candidate landfills. The program currently has over 700 partners enrolled and has assisted in approximately 360 projects that have reduced methane from landfills and avoided emissions from electricity generation amounting collectively to 36 million MMTCO₂E from 1994-2007 (U.S. EPA).

5.6 FLUORINATED GAS PROGRAMS

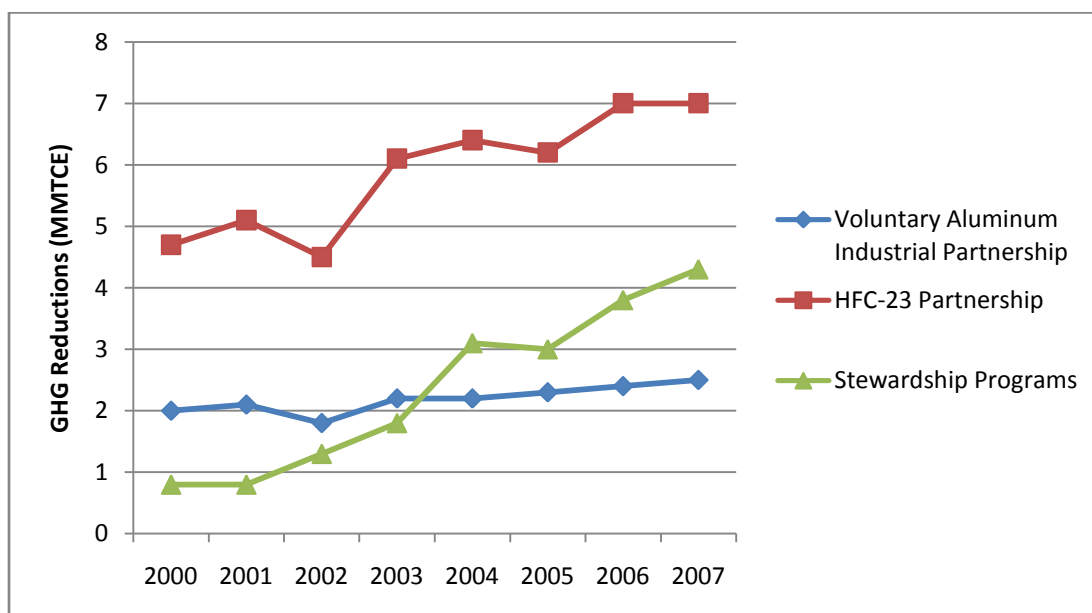


Figure 5-4: GHG reductions of selected fluorinated gas programs 2000-2007 (U.S. EPA, 2008)

5.6.1 THE VOLUNTARY ALUMINUM INDUSTRIAL PARTNERSHIP

The Voluntary Aluminum Industrial Partnership was launched in 1995 as a joint effort between the EPA and the U.S. primary aluminum industry to reduce perfluorocarbon (PFC) emissions from aluminum production. The program promotes the development and adoption of cost effective PFC emissions reduction opportunities by providing partners with technical information on strategies. The partnership represents 18 of the 19 smelters and 98% of U.S. production capacity and has resulted in the reduction of over 2.0 MMTCO₂E annually since 2003 compared to business as usual scenarios (U.S. EPA).

5.6.2 HFC-23 EMISSION REDUCTION PROGRAM

HFC-23 is a byproduct in the production of HCFC-22 which is a common air conditioning refrigerant. The program involves the partnership of 100% of the U.S. HCFC-22 industry and since 1993 has been looking into the development and implementation of cost effective strategies and technologies to reduce HFC-23 emissions. In 2007, emissions reduced as a result from the program were 7.0 MMTCO₂E less than if production had continued at 1990 emission intensity levels (U.S. EPA, 2008).

5.6.3 THE PFC REDUCTION/CLIMATE PARTNERSHIP FOR THE SEMICONDUCTOR INDUSTRY

The PFC Reduction/Climate Partnership for the Semiconductor Industry was established in 1996 to work with semiconductor manufacturers in identifying and implementing PFC reducing strategies in the production of integrated circuits that include process and manufacturing tool improvements as well as the use of alternative chemicals. In 2007, the partnership had reduced PFC emissions by 2.4 MMTCO₂E below business as usual levels and is on target to helping meet the World Semiconductor Council's goal of reducing PFC emissions by 10% below the 1995 baseline level by the end of 2010 (U.S. EPA).

5.6.4 SF₆ EMISSIONS REDUCTION PARTNERSHIP FOR ELECTRIC POWER SYSTEMS

The Sulfur Hexafluoride (SF₆) Emissions Reduction Partnership for Electric Power Systems began in 1999 as a collaborative effort between EPA and electric utilities with the goal to reduce SF₆ emissions. SF₆ is a highly potent GHG used in the industry for insulation and current interruption in electric transmission and distribution equipment. The EPA works to share information on best management practices, technical issues and cost effective options with their industry partners. These include leak detection and repair, use of recycling equipment and employee education. The program started with 49 charter partners and now has a membership of 77 partners that represent over 45% of the industry. The partnership's SF₆ emission rate, defined as the normalized value of SF₆ emissions to the amount used in electrical equipment has declined steadily from 17% in 1999 to 6.5% in 2006. The program has contributed to reducing 1.7 MMTCO₂E of GHG emissions reductions in 2007 (U.S. EPA).

5.6.5 SF₆ EMISSIONS REDUCTION PARTNERSHIP FOR THE MAGNESIUM INDUSTRY

The Sulfur Hexafluoride (SF₆) Emission Reduction Partnership for the Magnesium Industry launched in 1999 is a cooperative effort between the EPA and the U.S. magnesium industry to better understand and reduce emissions of SF₆ from magnesium production and casting processes. The EPA serves to assist partners in reviewing emission reduction strategies and technologies and as a

clearinghouse for technical information on successful strategies. The partnership has made tremendous progress, reducing emissions intensity by more than 40% from 1999 to 2002 and is striving to completely eliminate SF₆ emissions by the end of 2010. The partnership currently includes more than 80% of the US magnesium industry and reduced an equivalent of 0.18 MMTCO₂E of GHG emissions in 2007 (U.S. EPA).

5.6.6 MOBILE AIR CONDITIONING CLIMATE PROTECTION PARTNERSHIP

The Mobile Air Conditioning Climate Protection Partnership was formed in 1998 among the Society of Automotive Engineers, the Mobile Air Conditioning Society Worldwide, and the EPA to reduce the climate impacts of mobile air conditioning systems. Partners of the program include vehicle manufacturers and their suppliers, environmental and industry NGOs, and representatives from industrialized and developing country governments. In the U.S., vehicle air conditioners consume 7 billion gallons of gasoline every year, contributing to 16 MMTCO₂E of GHG emissions and refrigerant emissions contribute to an additional 8 MMTCO₂E of GHG emissions annually. The partnership is working towards promoting cost effective designs to minimize refrigerant emissions and to promote next generation systems that are better for the environment while satisfying consumer demands (U.S. EPA, 2008).

5.7 SUMMARY OF VOLUNTARY PUBLIC PRIVATE PARTNERSHIPS

Voluntary Public Private Partnerships are an integral part of the EPA's strategy to reduce GHG emissions in the U.S. Their span and scope is broad with over 14,000 organizations participating in 36 programs ranging from improving appliance efficiency to capturing and combusting agricultural methane emissions contributing to a reduction in 78 MMTCO₂E of GHG emissions in 2007. These partnerships address market inefficiencies including the lack of clear and objective information on technology opportunities; lack of awareness of products, services and transportation choices; low incentives to manufacturers for research and development; split incentives; and high transaction costs by providing a clearinghouse of technical information and best practices to improve the

decision making process for companies. While the benefits of such partnerships are definitely apparent, policy contention and debate remain regarding the cost effectiveness of the programs and how they compare with other policy mechanisms including regulation and taxation. In 2008, approximately \$152.9 million or 14% of EPA's budget was allocated to the objective of reducing GHG intensity mainly through climate protection programs (U.S. EPA, 2008).

The next chapter looks at one highly successful climate protection program – the SmartWay Transportation Partnership. I have applied the concept of System Dynamics as a means of eliciting the mental models of key stakeholders to qualitatively model and understand the importance of program structure in stimulating growth and maintaining sustainability. I have also further developed the model and demonstrated how System Dynamics modeling can be applied quantitatively in estimating future potential benefits of voluntary public private partnerships across a range of scenarios and assumptions.

6 SMARTWAY TRANSPORT PARTNERSHIP

The SmartWay Transport Partnership is an innovative collaborative voluntary program between the EPA and the freight industry designed to improve energy efficiency and lower GHG emissions and air pollution. Started in February 2004, the partnership aims to create strong market-based incentives that challenge companies shipping products, and the truck and rail companies delivering these products, to improve the environmental performance of their freight operations. In 2006, the trucking and rail industry consumed 37.9 and 4.2 billion gallons of diesel fuel, and contributed 404.6 and 51.5 MMTCO₂E to the atmosphere respectively (American Trucking Associations, 2008) (Association of American Railroads, 2007) (U.S. EPA, 2008). Overall, CO₂ emissions from trucking and rail freight accounted for 23.4% of the total transportation sector emissions and 6.4% of the total U.S. GHG emissions in 2006 (U.S. EPA, 2008). Ground freight is also a significant source of smog-forming emissions and other harmful air pollutants that impact public health. Through this voluntary partnership, EPA and its partners aim to reduce emissions by 33 to 66 MMTCO₂E annually before 2012.

6.1 BACKGROUND

In 2006, the total carbon dioxide (CO₂) emissions from the freight industry were 541.3 MMTCO₂E which made up 27.5% of the total transportation industry allocations and 7.7% of total U.S. emissions. In addition, emissions from the freight industry had increased by 52% from 1990 to 2006 and are expected to continue growing. Within the freight industry, emissions from trucks constituted about three quarters of the total (Figure 6-1). Notably, class 8 trucks consumed 78% of the fuel use among class 3-8 trucks despite making up only 42% of the class 3-8 trucking fleet (Figure 6-2). This makes the freight industry and in particular heavy trucks one of the most prominent targets for CO₂ emissions reductions.

The average fuel economy for combination trucks has however remained mostly constant from 1980 to 2006 (Figure 6-3). This is despite technology presently available that could increase fuel efficiency by at least 12% cost effectively and up to a potential of even 90% (U.S. DOE, 2000)(Elliott & Langer, 2006)(Ogburn, Ramroth, & Lovins, 2008). There are clearly significant market inefficiencies and barriers to the diffusion of technology into the heavy duty truck sector.

- **Lack of accurate, verifiable fuel economy information:** The structure of the truck manufacturing and component industry poses several obstacles to the flow of accurate and useful information. Combination trucks are often highly customized and produced in limited quantities. Component manufacturers operate independently of truck manufacturers resulting in it being more difficult to demonstrate and market their efficiency enhancements. In addition, there are no clear standards or methodologies for measuring the efficiency of heavy trucks nor are these easily replicable. This leads to much uncertainty regarding payback times of technologies which often have high initial capital costs associated with them.
- **Failure to incorporate costs of CO₂ emissions and other air pollutants:** While a price on carbon might affect some of the price and payback dynamics, it is unlikely that such a price will be incorporated at a significant enough price early enough to produce the needed change in behavior and uptake of technology. Complementary, non price based mechanisms including consumer purchasing pressure might provide the necessary push. This is presently limited due to the lack of information transparency regarding fuel economy and carbon emissions along the supply chain.

Thus there is a real need for the design of policy that adequately addresses these issues and resolves the market inefficiencies present. The EPA SmartWay Transport Partnership is an example

of an innovative public-private partnership policy that has successfully dealt with reducing carbon emissions in the freight transportation sector.

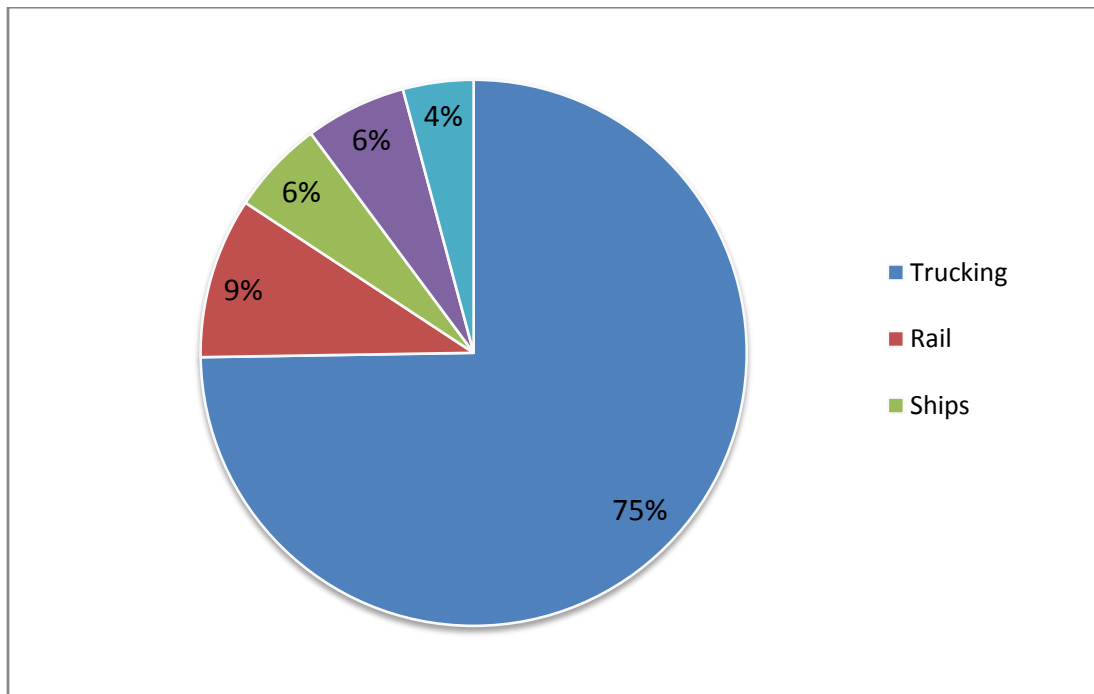


Figure 6-1: GHG emissions from domestic freight transportation 2006 (541.3 Tg CO₂-eq total) (U.S. EPA, 2008)

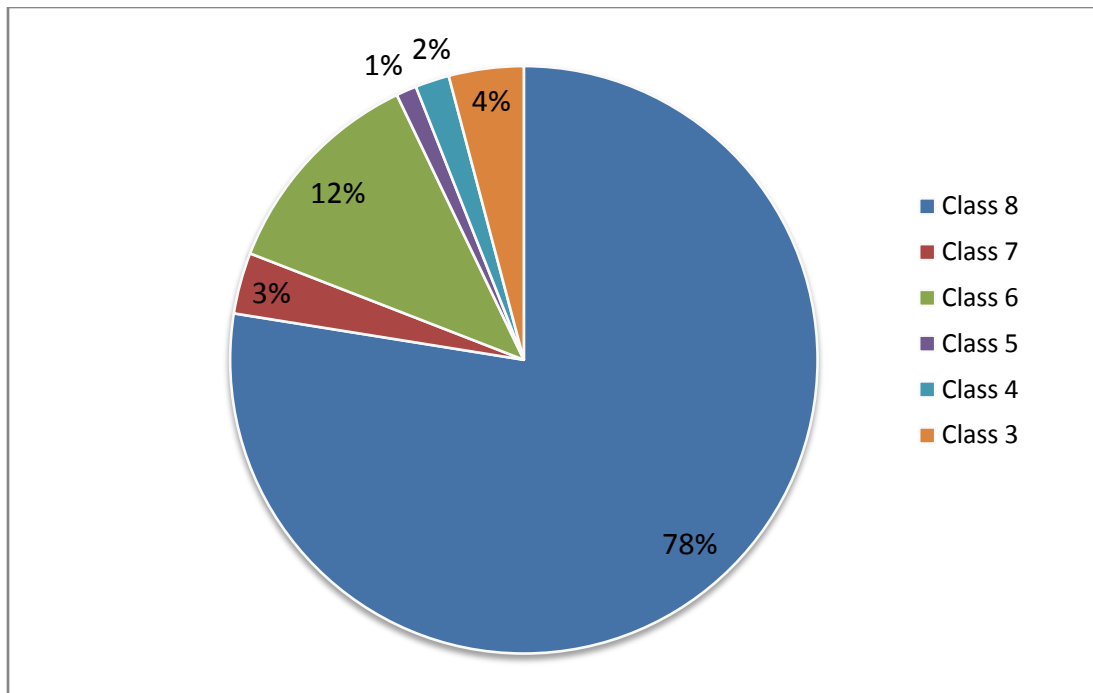


Figure 6-2: Percentage of fuel use by class 3-8 trucks (Davis, Diegel, & Boundy, 2008)

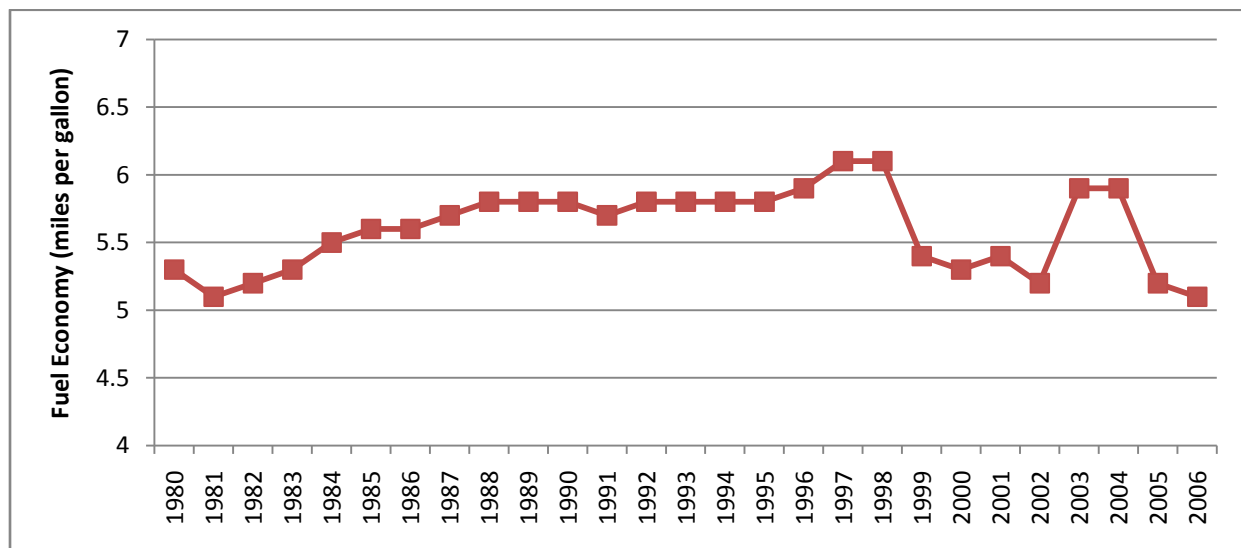


Figure 6-3: Fuel economy (miles per gallon) for combination trucks from 1980-2006 (Davis, Diegel, & Boundy, 2008)

6.2 HISTORY

In 2003, staff at the EPA's Office of Transportation and Air Quality developed an initial concept to build an innovative voluntary freight transportation program focused on energy savings and emission reductions. They worked for over a year in collaboration with a dynamic group of public

and private stakeholders to develop the foundation of the EPA SmartWay Transport Partnership. Members of the group included the American Trucking Association, Business for Social Responsibility, Canon USA, Coca Cola Enterprises, CSX, FedEx, H-E-B Grocery, Home Depot, IKEA, Interface, Nike, Norm Thompson Outfitters, Schneider National, Swift Transportation, UPS and YRC Worldwide.

Together, these stakeholders and the EPA designed a freight transportation program that addressed the goals and needs of both the freight industry and the EPA. The freight industry was interested in an improved public image, recognition for its efforts, and fuel savings to help companies in an extremely competitive industry. The EPA was interested in reducing emissions from diesel engines and improving energy security in the freight industry. The companies provided critical operational and technical insight into freight management and supply chain logistics. Their input helped the EPA to identify appropriate fuel saving technologies for heavy trucks and to develop a fuel and emissions tracking tool that carriers and shippers could use to track their performance. Most important, was the laying of a groundwork and designing of a program structure that made both good business and environmental sense.

Since program enrollment was going to be on a voluntary basis, it was important to make it attractive for companies to participate and work together towards a collaborative solution in addressing energy and environmental issues in the freight sector. This was thoroughly discussed and deliberated upon by the stakeholders involved. After much planning, the EPA formally launched the program with the full support of the trucking industry at the American Trucking Association's annual conference on February 9, 2004 with 15 initial charter partners.

6.3 PROGRAM STRUCTURE

The SmartWay Transport Partnership is catered to progressive corporations and organizations involved in shipping goods that recognize they can improve their business and the environment at

the same time. Companies that provide and hire freight delivery services become SmartWay Transport Partners by committing to improve the environmental performance of their freight delivery operations. SmartWay Transport Carriers commit to integrate innovative cost saving strategies into their fleet operations. SmartWay Transport Shippers commit to ship the majority of their goods with SmartWay Transport Carriers. Companies that meet SmartWay Transport Partnership requirements benefit from reduced operating costs and enhanced visibility. In addition, partners that demonstrate superior performance earn the right to display the SmartWay Transport logo. Logistics providers and industry affiliates are also eligible to participate in the program.

The SmartWay program provides technical assistance, helping partners benchmark and achieve their goals to improve energy efficiency and lower GHG emissions. The program also provides modeling tools, information exchange and data that identify fuel use, emissions output and the effectiveness of a broad range of technology, equipment controls and fuel-saving logistics management strategies. In addition, the SmartWay program has been working with financial institutions to provide flexible, reduced-interest loans to improve access to these fuel-saving technologies and pollution controls.

Moving ahead, the SmartWay program is looking to expand and cover a broader scope of transportation related emissions. It has begun to target the private household vehicle fleet through its SmartWay Certified Vehicle program that identifies consumer vehicles with favorable air pollution and GHG scores. Private household consumers are being exposed to the program through advertising done via SmartWay's New Leaf Campaign. The program has also continued to improve its services to the freight industry. One example is the newly rolled out SmartWay Tractor and Trailer certification system. In addition, the program staffs have been working on developing their next generation SmartWay 2.0 program. This new version is expected to include other modes of

freight transportation including sea vessels, as well as to incorporate transparent reporting and scoring methods that reflect the carbon footprint of carriers and shippers more accurately.

6.4 SYSTEM DYNAMICS MODEL

The MIT Center for Transportation and Logistics (CTL) initiated a study with the EPA SmartWay team in May 2008. The objectives of the study were to:

1. Evaluate the success of the program
2. Understand the key factors contributing towards the program's success/failure
3. Develop recommendations for how the success of the program could be sustained over the long run

The results of the study would provide guidance on how similar programs for the freight industry could be implemented in other countries or how the program could be used as a leading example of good program design practices for future voluntary partnerships. The MIT CTL team decided to use the concept of Systems Dynamics and develop a model of the SmartWay program to aid in understanding of the program dynamics and to be able to conduct simulations on various scenarios. Systems Dynamics is a perspective and set of conceptual tools that enables users to better understand the structure and dynamics of complex systems. It has been increasingly used to design more successful policies in companies and public policy settings. One of its key strengths lies in the eliciting of mental models of the various actors and participants in the system and integrating them to form a more accurate understanding of the complete system (Sterman, 2000).

The MIT SmartWay model focuses on the shippers, carriers and staff participation and interaction in the system. The MIT CTL team developed an initial framework for the model in May 2008. This was followed up with a visit to the SmartWay team in June 2008 where a series of interviews were conducted with the program staff. More interviews were conducted with selected partners enrolled in the program in October and November 2008 and the team presented our initial findings at the

SmartWay International Summit in December 2008. The model has since been updated and improved upon after feedback from the EPA and participants at the summit.

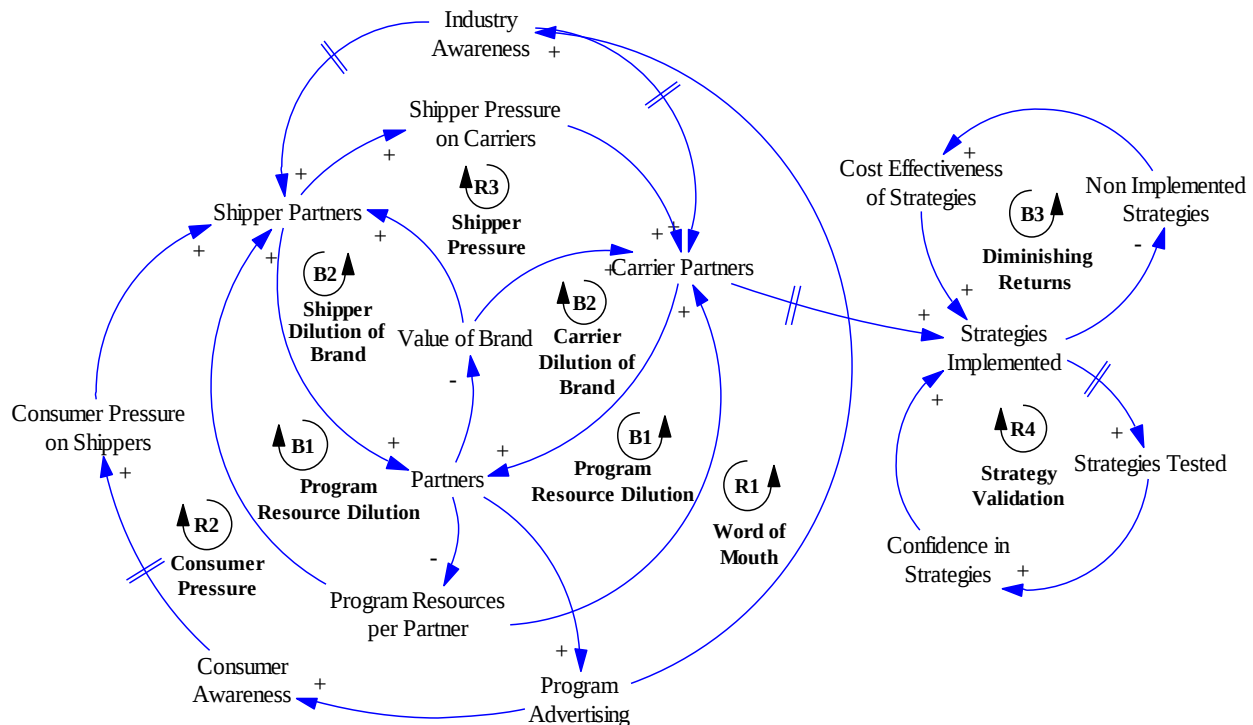


Figure 6-4: SmartWay Transport Partnership causal loop diagram

The causal loop diagram shown above in Figure 6-4 was developed after communication with staff and partners of the program about their experiences and understanding of the dynamics of the program. Key variables in the diagram are connected by arrows which denote the causal influences between them. The hashed lines represent delays in the causal effects of the system. Through this process, we have identified four main reinforcing loops explaining the factors of success behind the SmartWay program:

1. **Word of Mouth:** As the number of partners enrolled in the program increases, the level of program advertising increases as these partners highlight their involvement in the program during trade conferences, individual meetings with other companies and through promotional material such as newsletters and websites. In a 2007 tracking survey

conducted by Harris Interactive, the top six main sources of awareness for companies were through trade publication advertising, state or national trucking associations, magazines, industry conferences, the internet, and through colleagues or friends. Industry awareness as reported by the survey increased from 13% in 2005 to 32% in 2007 (Harris Interactive, 2007). As more companies become aware of SmartWay and as they realize a larger number of companies are enrolling in the program, they become more receptive to participating in it.

2. **Consumer Pressure:** Similarly, as partners are enrolled in the program, they communicate this information to consumers through marketing strategies including labeling, the internet and various forms of corporate social responsibility branding. The assumption here is that the more consumers learn and understand about the program, the greater the pressure they will put on shippers to enroll in the program through their purchasing decisions and direct communications. In 2008, awareness about the SmartWay program among consumers was estimated at around 13% to 20% depending on whether description aid is provided (Harris Interactive, 2008). The effect of eco-labels on consumer behavior is still highly debatable as well with various studies supporting both sides of the argument. However, there is a general consensus that more people are becoming aware and concerned about the issue of climate change and that companies recognize and are taking steps to tackle these concerns.
3. **Shipper Pressure:** One of the important features about the structure of the SmartWay program is the involvement of the shippers. While carriers are in direct control of their fleet, their incentives to exhibit corporate social responsibility practices are limited as compared to shippers who have direct contact with public consumers. The requirement for each shipper to have at least 50% of their shipments moved by carriers enrolled in the program has a huge multiplying and reinforcing effect with regards to program

participation. For example, Wal-Mart has offered fuel subsidies to carriers who enroll in the program and IKEA has made participation in the program a requirement for carriers that they work with. Many others companies solicit information about a carrier's participation in the SmartWay partnership in their requests for proposals and factor it in their decision making. Shippers in the program also tend to be strong advocates in encouraging their carriers to join the program. One suggested reason for this is that more efficient carrier performance leads to lower operating costs and greater savings which are distributed back to the shippers as well. The resulting increase in number of carrier partners leads to more publicity and advertisement for the program, industry awareness and subsequently both carrier and shipper partners who join the program.

4. **Strategy Validation:** While increasing participatory rates is one good indicator of the program's success, it is also important to look at strategies implemented by companies and the resultant reduction in CO₂ emissions. In general, most of these strategies are applicable to carriers. The SmartWay program provides a valuable service in this aspect as it serves not only to perform an initial screening of possible technological innovations, but also as an avenue for carriers to share their testing results with the community. Usually only larger carrier companies have the resources to experiment with new technologies. As these technologies become validated and proven to be cost-effective, they get shared with other companies through the SmartWay program, industry confidence in the strategies grows and smaller carrier companies start to implement them as well.

As can be expected, there are limits to growth in program participation and strategy implementation and these cannot increase forever. Three of these balancing loops are discussed below:

1. **Program Resource Dilution:** As more companies enroll in the program, the number of partner accounts each staff member has to handle increases. The amount of time each staff member has to dedicate to a partner decreases and the service he is able to render goes down. In addition, enrollment time for new partners is delayed as a result. Program staff have communicated via interviews that a ratio of 100 partners per staff would be ideally the amount of work they could handle effectively.
2. **Shipper/Carrier Brand Dilution:** Another possibility is that as more companies start to enroll in the program, it results in the program losing its initial appeal of innovativeness and elitism. At the onset, the program is attractive to “leaders” in the field of transportation efficiency and sustainability as they can brand themselves as being so through their involvement in the program. But once a sizable percentage of the industry is participating in the program, the logo and branding becomes more of a commodity, taking away part of its appeal.
3. **Diminishing Returns of Strategies:** Predictably, the “lowest hanging fruit” or strategies with the shortest payback and lowest upfront costs are typically selected first. Past a certain point, there are also technical limitations to the efficiencies which you can achieve and these usually experience diminishing returns with the number of strategies implemented. The current SmartWay recommended upgrade kit which includes a direct-fired heater, super single tires with aluminum wheels and a trailer aero kit estimates a combined fuel economy improvement of 17%. While technology is expected to improve exogenously over time, there is a theoretical limit regarding how much more efficient a vehicle can become.

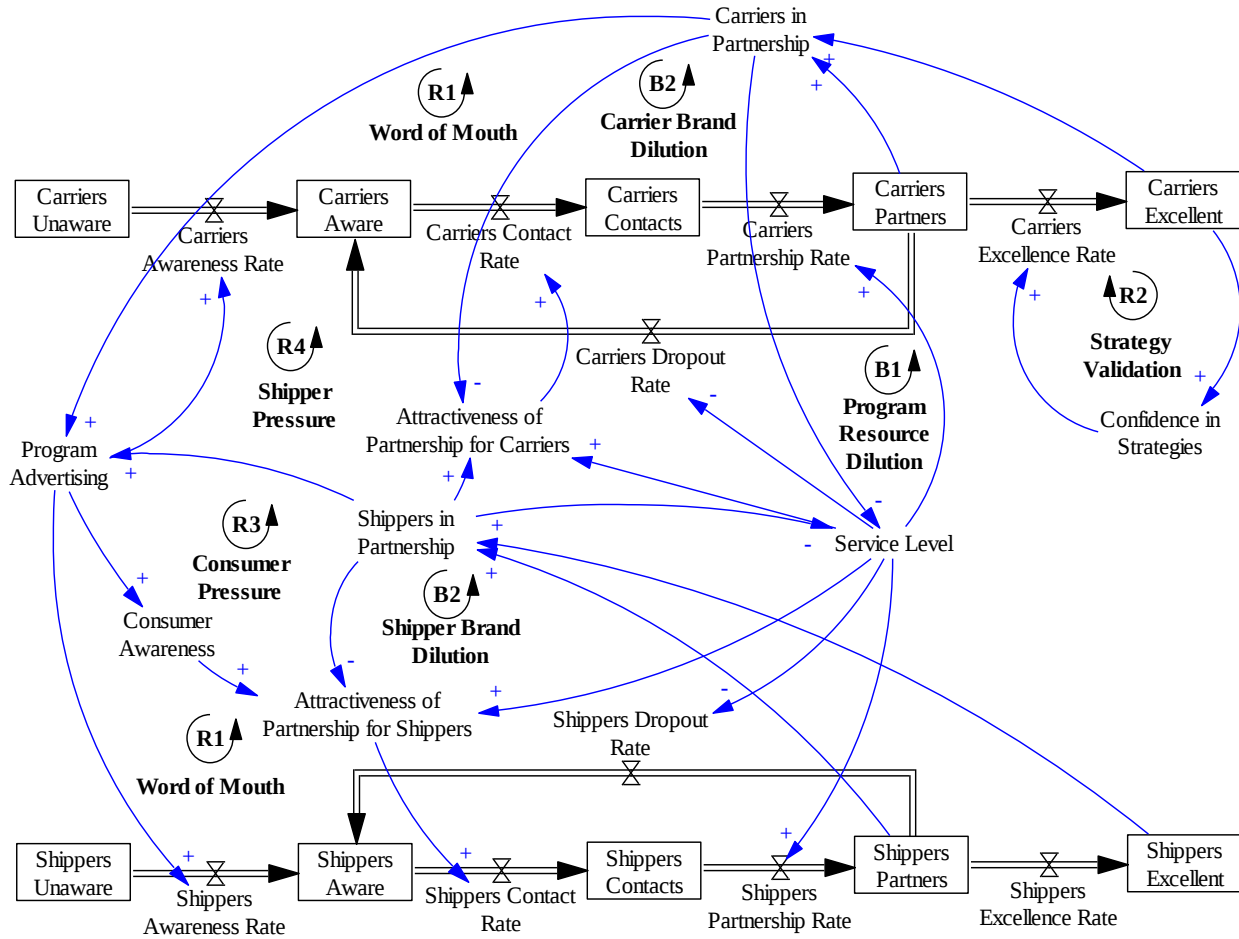


Figure 6-5: SmartWay Transport Partnership stock and flow diagram

Figure 6-5 shows a simplified stock and flow diagram that captures the main reinforcing and balancing loops of the SmartWay Partnership. This is an extension of the previous causal loop diagram (Figure 6-4) and is the foundation for our final model. Every carrier and shipper company is presumed to move through five stages. The initial stage is that of “unawareness”. Once a company has heard and learnt about the program, it moves to a stage of familiarity with the program, which we have titled “awareness”. If the company is interested in the program and makes a decision to learn more about the program with the intention to join, it becomes a “contact”. A proportion of these companies then continue to enroll in the program and become a “partner”. The final stage “excellence” is achieved when a carrier has implemented sufficient strategies to improve its fleet performance or a shipper has a certain proportion of its freight hauled by carrier partners. The

ideal objective of the program would be to shift as many companies as possible from the left to the right stocks where tangible emission reductions are achieved. Variables in the model were calibrated based on data we received about the program from the SmartWay team, interviews with partners, industry references as well as our own best estimations. The detailed model is attached in the Appendix.

Carriers are further broken down into large and small carrier companies. The large carrier companies represent the 300 largest Full-Truckload, Less-than-Truckload, and privately owned fleets in the U.S. These largest companies were estimated to manage about 19% of the total combination trucking fleet. While there were 564,699 registered carriers in 2006, only 4.2% of these owned more than 20 trucks (American Trucking Associations, 2008). These 23,717 smaller carriers are considered potential targeted participants for the program. Shippers in the model are the 3,000 companies that use the greatest amount of freight services in the U.S.

The main flow rates are described briefly here:

- **Awareness Rate** follows the Bass diffusion model used frequently in describing the adoption of new products (Sternan, 2000)(Mahajan, Muller, & Bass, 1995). Two main coefficients used are that to reflect the external advertising effect and the internal word-of-mouth effect. In addition, shippers and large carriers are directly recruited by the program. Shippers are more hesitant and those recruited go into the stock of awareness initially before flowing into the stock of contacts after a second round of recruitment. Large carriers are well aligned with the program and flow directly into the stock of contacts.
- **Contact Rate** is affected by non-linear effects of partnership costs, program services provided, concern about environment, shipper pressure, branding dilution and consumer pressure. There is also a delay associated with the time taken internally for companies to decide whether the program is a suitable fit and initiate contact.

- **Partnership Rate** is based on program data on the realization ratio of contacts that enroll to become partners and is also affected non-linearly by service level. There is a delay associated with enrollment that is inversely proportional to the service level.
- **Dropout Rate** is based on program turnover and is likewise affected non-linearly by the service level provided.
- **Excellence Rate** is affected by non-linear effects of payback time, interest rate and implementation ratio. There is a delay associated with the time taken for fleets to be upgraded.

Service level represents the proportion of time spent by staff to the ideal time required by the program. Partnership staff are involved in helping companies in the enrollment process, submitting their annual updates and providing technical and marketing assistance where needed. To cope with initial increases in time demands as partnership numbers rise, the number of staff is increased until a maximum that is constrained by the program budget. After that, service level declines to ensure that staff overwork is kept within a limit.

The CO₂ emissions reduced are annual savings from combination trucks in the program that have implemented technology strategies compared to the baseline. Cost effective strategies are modeled to increase efficiency compared to current standards steadily by 12% to 39% over the next ten years. The industry accepted Best Available Technology however is lagged behind laboratory standards though the lag time decreases as more trucks are equipped with and validate the technology strategies.

6.5 SIMULATION RESULTS

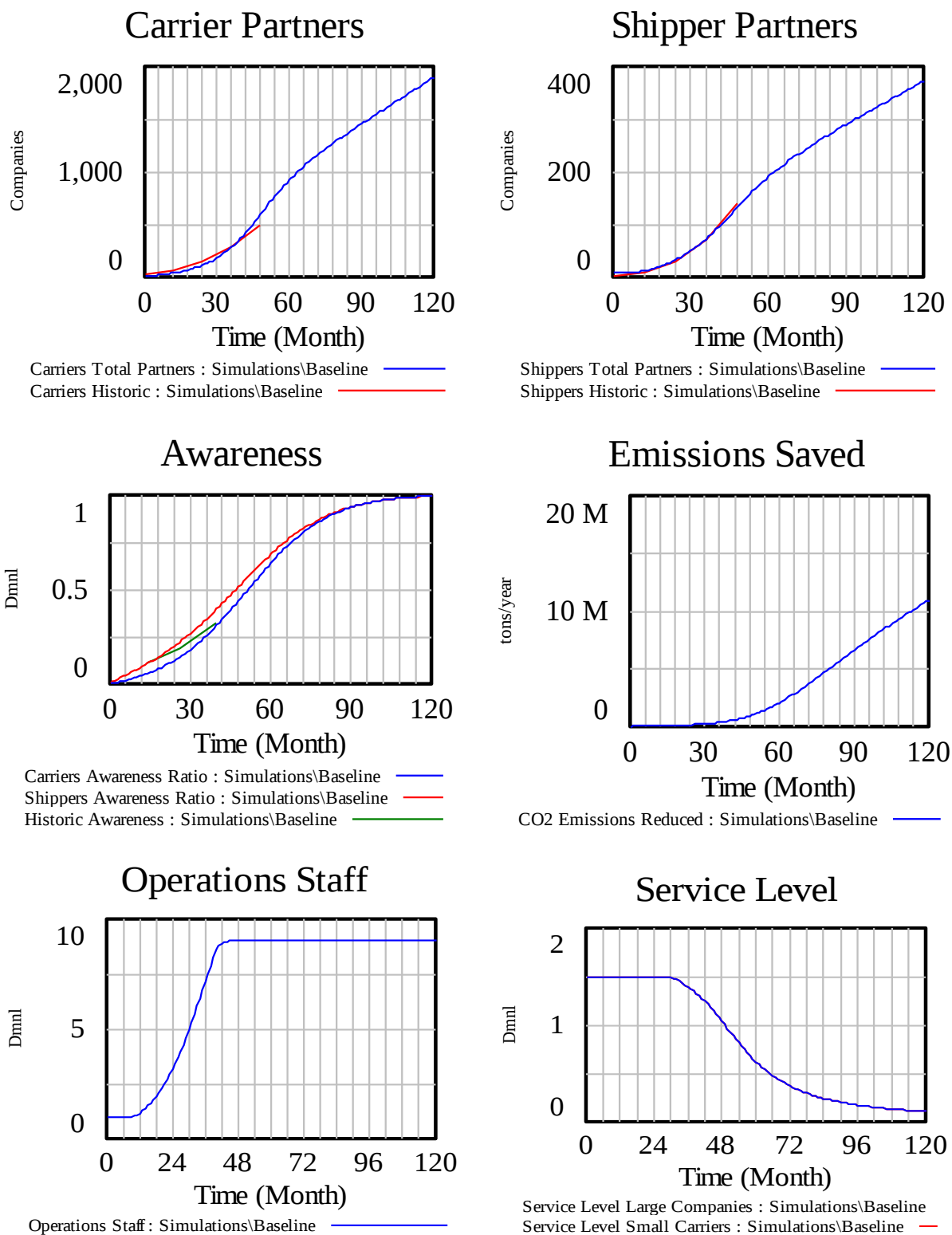


Figure 6-6: Baseline simulation of carrier and shipper partner growth, CO₂ emissions saved and service level

Figure 6-6 shows the baseline simulation of carrier and shipper enrollment, annual CO₂ emissions savings from combination trucks in the SmartWay program and the service level provided. The simulation results of the model demonstrate a close fit with historic data. The first observable takeaway is the strong initial exponential growth expected in the first six years of the program. This can be attributed to the key reinforcing loops described earlier including advertising through word of mouth about the program and shippers incentivizing or pressuring their carriers to join the program. Service level however starts to decline as the number of staff operating the program becomes constrained by the program's budget and there is not as much time as initially to provide for program services.

While growth in program enrollment slows down over time due to the program losing its attractiveness with declining service levels provided and dropout rates increasing as staff have less time to work with partners on their annual updates, the strong reinforcing loops in the program ensure that growth is still positive and sustained. The emissions saved from the program are expected to rise steadily as more carriers enroll in the program and implement the technological strategies recommended. The reinforcing effects from strategy validation start to factor in as a higher percentage of trucks get upgraded as well.

6.5.1 NO SHIPPERS SCENARIO

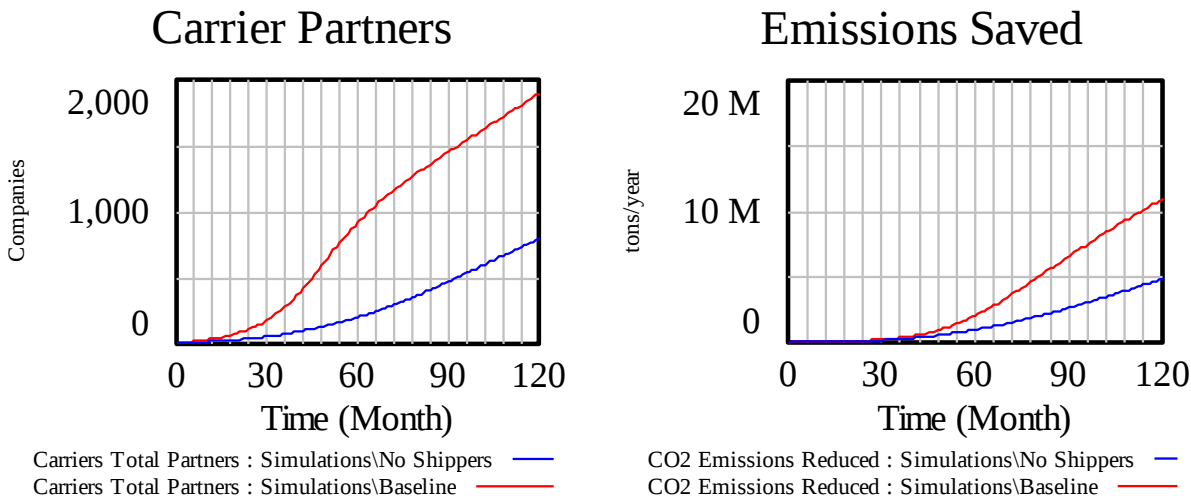


Figure 6-7: No Shippers scenario simulation

The first scenario we simulated was if the program had been designed without the inclusion of shippers. The results as shown in Figure 6-7 are that growth in carrier enrollment would be much slower. As a result, CO₂ emissions reductions over the time frame examined are lower as well.

Despite the fact that program staff would be able to handle a greater number of carrier partners if shipper partners were not involved, we realize that the beneficial reinforcing effect that shipper partners have on the program far outweighs the costs of incorporating them into the program. This is because each shipper works with a large number of different carrier companies. Due to the requirement for each shipper to achieve a certain percentage of its goods being moved by carrier partners, there is an incentive for shippers to put pressure or incentivize the carriers they contract work out to join the program.

Focusing on attracting shippers to participate in the program results in a greater return on resources due to the leverage they can exert on carriers to join the program through their purchasing power in the market as consumers of trucking services. In addition, they assist the EPA by raising awareness about the program through their regular meetings with the carriers they work with, listing it on their requests for proposals and advertising about the program on their websites

or through traditional media channels. It would have been much more difficult for the EPA to reach out and attract carriers to participate in the program initially without the support of shippers. A key take away from this scenario is how the structure of a program can dramatically affect its growth. This should be noted in the design of any future voluntary public private partnerships that usually face challenges in growing enrollment. The suitable use of market dynamics in a program's design as demonstrated through the SmartWay program can be crucial to its success. Looking ahead, it is important for the program to continue to develop in a manner that still remains attractive for shippers in order to benefit from this key reinforcing dynamic.

6.5.2 DOUBLED STAFF CAPACITY, LARGE COMPANY FOCUS AND NO MAINTENANCE TIME SCENARIOS

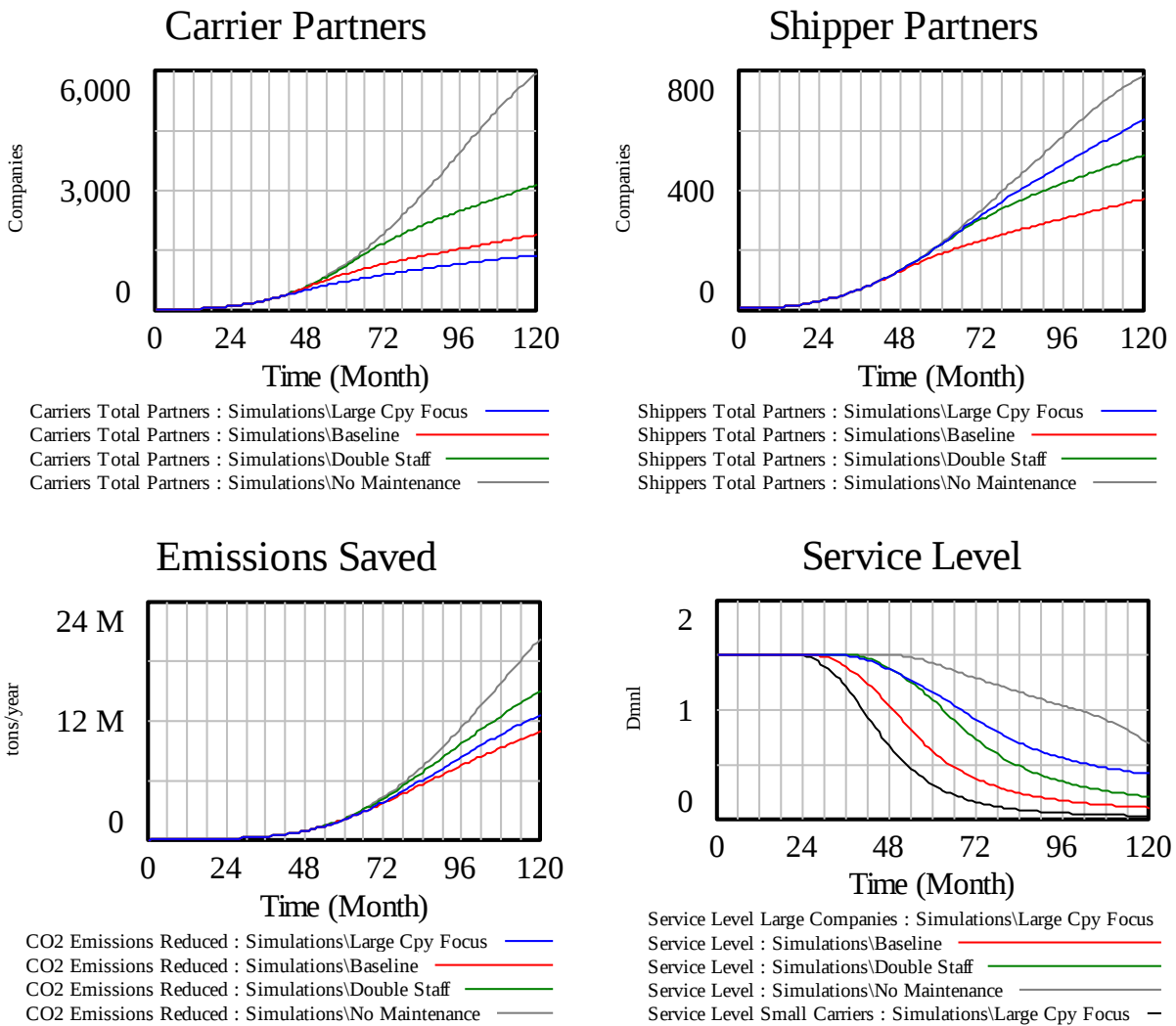


Figure 6-8: Doubled Staff Capacity, Large Company Focus and No Maintenance Time scenario simulations

The second set of scenarios we simulated was to investigate the balancing loops due to limited program resources further. The results shown in Figure 6-8 indicate that partnership growth is indeed limited by the number of program staff once enrollment numbers start to become overwhelming. This leads to decreased service levels that increase enrollment delays, dropout rates and reduces the attractiveness of the program. Simply doubling the number of staff is a quick and easy fix but merely delays the time before which service levels start to deteriorate. The staffing

capacity of the program is also constrained by the budget allocated to it and we realize from the simulations that doubling the number of staff does not necessarily lead to twice the amount of CO₂ emissions being saved.

Another possible alternative would be to focus more attention on large carriers and shippers. A roughly 60%-40% split in time allocated to large companies and small companies gave the optimized amount of CO₂ emissions savings. This allows the program to maintain a higher service level for the large partners at the expense of neglecting smaller partners. The results are marginally better than those in the baseline scenario as while the larger carriers have bigger trucking fleets and the larger sized partners are most influential in raising awareness about the program and recruiting others, small carriers still operate the majority of the trucks in the industry and need to be targeted as well. In addition, smaller carriers are often the ones operating the least fuel efficient trucks and would benefit the most from learning and implementing the technological strategies.

A better solution would be to reduce the enrollment and maintenance time required by the program. Halving the enrollment and maintenance times per partner has an equivalent effect as doubling the number of staff. While reducing or eliminating enrollment time is not always possible, reducing the maintenance time is and even eliminating it entirely leads to significant increases in program capacity and CO₂ emissions savings. This can be achieved through streamlined partner management processes and automated partner tools and systems. Hence investing in resources to complete next generation models, databases and systems that reduce maintenance time is likely to be more effective in the long run than quick solutions.

6.5.3 NO STRATEGY VALIDATION SCENARIO

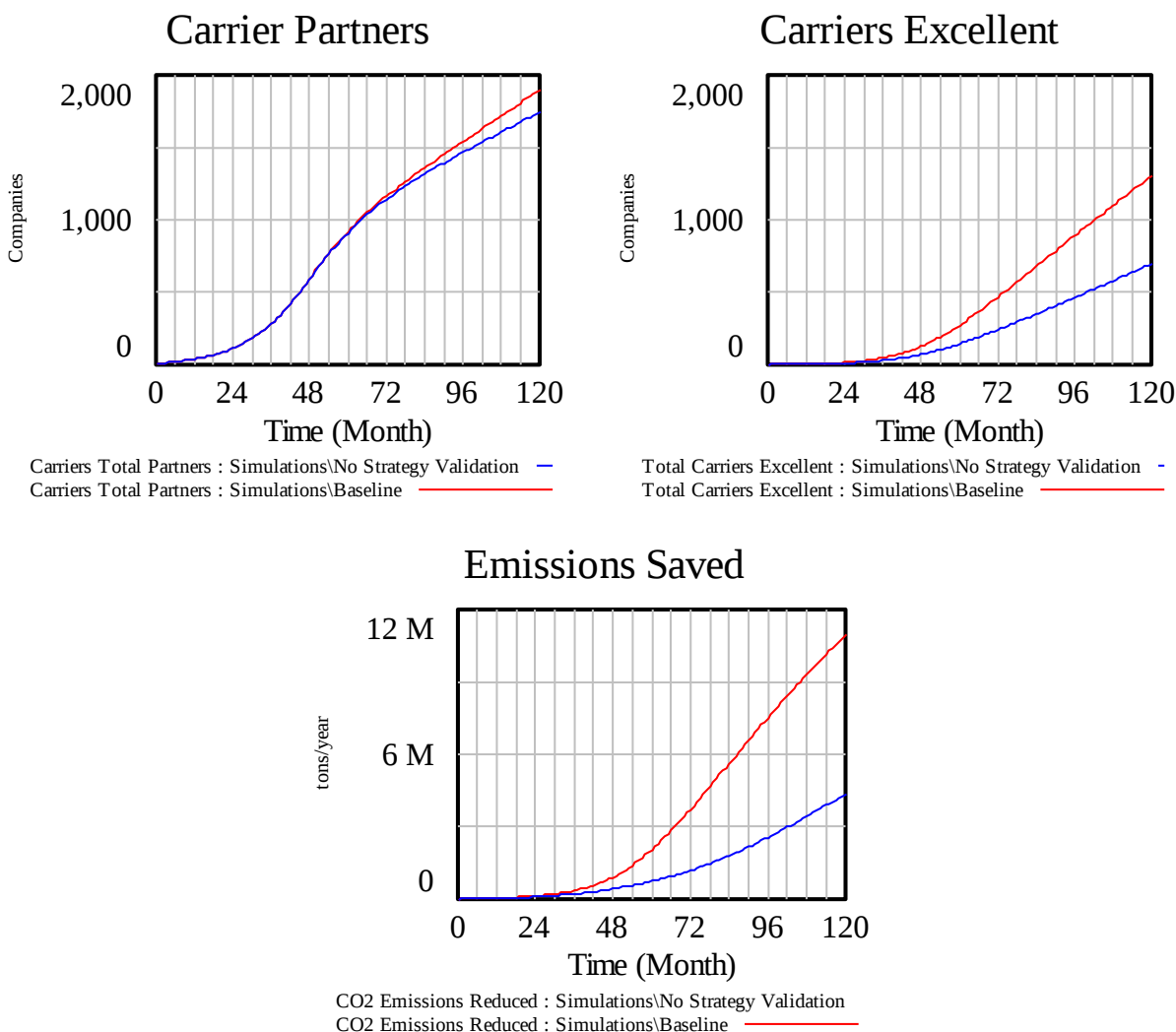


Figure 6-9: No Strategy Validation scenario simulation

The fourth scenario was designed to highlight the importance of the SmartWay program in providing a platform for the validation and sharing of freight efficiency strategies. In this scenario, the SmartWay program does not emphasize the highlighting and sharing of technology verification results. While the enrollment rates in the program are not affected significantly by the lack of knowledge diffusion, the CO₂ emissions reduced as a result of the program are. The reason for this is because many smaller carrier companies do not have the time and resources to test and validate vehicle technologies by themselves. The program saves them the effort by testing some of the

technologies in the EPA vehicle laboratories as well as getting larger and more experienced carrier companies to share about the successes they have had in implementing the technologies. From a societal perspective, this is also more efficient as various companies do not have to waste unnecessary resources re-testing technologies which have already been proven and verified. The sharing of best practices and validation of vehicle technologies is one of the key components for the success of the program in reducing CO₂ emissions.

6.6 PROGRAM POLICY EVALUATION

The SmartWay program is an excellent example of how voluntary public private partnerships can be successful in meeting environmental goals. With over 1,400 partners enrolled in a span of five years, it has one of the highest membership numbers among all of the EPA sponsored climate change programs and has contributed to the achievement of significant reductions in CO₂ and other mobile air pollutants including nitrogen oxides and particulate matter in the freight industry. Policy intervention was clearly necessary due to the evident market failures present in the freight industry. These operational inefficiencies have resulted both from a lack of knowledge sharing to promote technological diffusion as well as a failure to adequately price the social cost of mobile emissions. This failure in the market is especially apparent in the heavy trucking sector where average fuel economy has not improved over the past 25 years despite technology that could make instant improvements being readily available at cost effective prices.

Policy intervention in itself is not a quick miraculous fix. The design of good policy requires a systemic understanding of the dynamics at play among the key stakeholders and is a thoughtful process. There is a whole spectrum of policy choices that entail different levels of intrusion to businesses which policymakers have to choose from (Figure 6-10). The application of grants and tax incentives while often seen favorably by industry are costly for the government and have the weakness of requiring policymakers to “pick winners” among different technologies or companies. On the other end of the spectrum, stricter regulations are usually opposed vehemently by industry

and the resulting contention can lead to delays in the passing of suitable legislation and the waste of valuable time and resources in the process. Public private partnerships lie somewhere in the middle of this spectrum and seek to address the given issue using a collaborative approach with industry stakeholders. One benefit as can be seen from the SmartWay program is that greater co-operation between government and industry can result in innovative and effective policy design that addresses the desired issues successfully without being unnecessarily intrusive to the market.

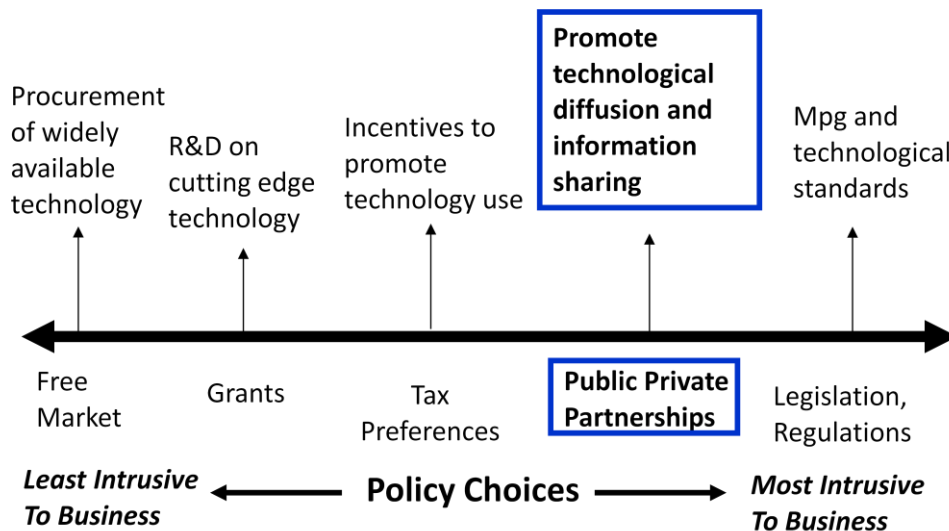


Figure 6-10: Freight transportation policy choices (adapted from SmartWay/ICF presentation)

In addition, these various policy choices can often supplement one another. For example, voluntary programs like SmartWay can complement regulations by achieving early adoption of new technology and strategies well in advance of when new regulations take effect. This is especially important in the trucking sector where the replacement of existing fleets takes a long time of up to ten years or a million miles travelled. The SmartWay program addresses this legacy fleet in the short term and helps in building the case that truck efficiency improvement can be achieved cost effectively which can help pave the way for future regulation.

Partner companies interviewed were strongly supportive of the SmartWay program and attributed it to getting them learning about and implementing strategies to improve their freight efficiency. This was achieved by the program requiring partner companies to complete the FLEET partnership model, filtering out and sharing technologies with partners that were cost effective, and arranging for financial loans to be made available to fund technological upgrades. Many partners also highlighted the fact that the program being voluntary rather than regulatory in nature was highly desirable from their standpoint and the strong involvement of industry participation in the design and planning process of the program contributed to its attractiveness and success. Other benefits of the program raised included the fostering of closer carrier and shipper relationships and the personal guidance provided by the program staff in helping companies to evaluate and understand their current environmental performance.

An obstacle commonly facing voluntary public private partnerships as well as other public policies is justifying their effectiveness. The Program Assessment Rating Tool was developed in 2002 by the Office of Management and Budget as a tool for formally evaluating the effectiveness of Federal programs. It is structured as a questionnaire and covers four critical areas of assessment – purpose and design, strategic planning, management, and results and accountability. Each of the four sections is scored from 0 to 100 and the scores are then combined to achieve an overall qualitative rating that ranges from *Effective*, *Moderately Effective*, *Adequate*, to *Ineffective* (Office of Management and Budget, 2004). In 2004, the EPA Climate Change Programs were assessed together as a whole and received an assessment rating of *Adequate*. While scoring well in the areas of purpose, design and strategic planning, the program was assessed to be below par in terms of management, results and accountability (U.S. EPA). As noted in the program assessment report, key challenges lie in demonstrating the link between program activities and near term GHG reduction as well as monitoring the performance of the program.

In this chapter, we have demonstrated the potential use of Systems Dynamics as a tool in designing policy and to possibly quantify the benefits of policy choices. This is particularly useful in the analysis of voluntary programs where results may not be deterministic and benefits only start to become evident once the program has gained sufficient momentum. Insufficient foresight or the lack of applied systemic thinking may lead to these programs being cut prematurely or not even implemented to begin with when they are in fact able to generate tangible mid to long term results. While the numerical analysis involved may not be the most rigorous around, its strengths lie in the capturing of mental models to understand the key systemic causal linkages and reinforcing and balancing loops that make the results robust over a range of parameter uncertainty. The methodology can also be utilized to address questions regarding additionality in whether the technology strategies would have been implemented in status quo. An example of this is in the “no strategy validation” scenario where reinforcing loops from technology verification and knowledge sharing were removed showing significant reductions in the adoption of technologies.

6.7 DISCUSSION

Moving ahead, it is important to address the issue of monitoring program performance through suitable and accurate data collection. One way this is being done is through the improvement of the FLEET model that companies submit and update as part of the membership requirements to better capture the efficiency improvements that have been undertaken by companies since their enrollment. As the new administration pushes for tighter controls of GHG emissions via a possible cap and trade program as well as increases its focus on energy efficiency solutions, the SmartWay program has an increasingly valuable complementary role to play. From what we have seen in historic trends, putting a price on carbon will not necessarily clear the inefficiencies in the market as the lack of knowledge sharing and information asymmetries between consumers and suppliers of goods and services still act as obstacles to change. In addition, passing of new regulation will take time as the legislative process is tedious and time consuming. Furthermore, the final regulations

passed might not even be strong enough to affect market and behavioral change. In the case of the trucking industry, the legacy fleets have a long turnover time meaning that the impact of regulations would take even longer to phase in.

It is noteworthy that the SmartWay program is continuing to expand to more areas within the transportation sector which will allow it to address a larger scope of emissions. These initial expansion initiatives include covering personal transportation modes as well as short sea freight shipping. The program is also looking to further enhance information transparency across the supply chain through the introduction of more detailed carbon metrics in the model. While more information is definitely a plus in promoting efficiency in the market, it will initially be very challenging to capture carbon relevant information in a useful and accurate way.

The SmartWay program serves as a useful case study for the successful implementation of voluntary public private partnerships to meet societal goals. Policymakers both in the U.S. and around the world can definitely learn valuable lessons on how the structuring of a voluntary program with the right market incentives can help to stimulate an industry and reduce inefficiencies. It is important to take a systemic approach towards the design of such programs and to establish communication and feedback channels with key stakeholders to better understand their mental models.

7 CONCLUSION

Globally, there is strong and growing consensus about the impact of climate change on our society. From a political economist's perspective however, a number of obstacles stand in the path of addressing this challenge. One major reason is that the benefits from mitigating climate change are diffuse and only realizable in the future while costs are immediate and concentrated among a few actors, creating a classic collective action problem. Nonetheless, there is reason for optimism as governments, corporations and individuals have started to take steps to deal with this problem. A top-down approach generally agreed upon by most stakeholders is the need to put a price on GHG emissions and internalize the current environmental externality. This strategy has been implemented through recent cap and trade schemes like the EU ETS and RGGI with mixed results thus far. However, a comprehensive and concerted global effort to put a price on GHG emissions is definitely one of the needed steps in mitigating climate change.

This thesis has looked at the potential of labeling products with life cycle GHG emission information as a bottom-up, complementary and non-economic focused alternative. The premise is that by improving the transparency of product carbon footprint information, a market for low carbon intensive products can be created which companies would cater to if sufficient demand arises. The main drawback is that currently the understanding and awareness about product carbon footprints is low among consumers and there is still much uncertainty regarding the price premium that consumers will pay for carbon-friendly products. Despite this fact, from the case studies analyzed, it is evident that many of the strategies for companies to reduce the carbon intensity of their products are focused on improving supply chain efficiency and are inherently cost effective. Conducting life cycle assessments to measure their product carbon footprints aids companies in uncovering these opportunities which typically can result in 10%-20% emission reductions. As more companies start conducting such assessments and communicating their results, awareness among consumers will definitely rise over time. Hence while the effect of a carbon label on a product's market share may

still remain inconclusive, the benefits accrued to companies from improved efficiency and to society from heightened awareness about climate change are likely to be tangible and significant.

An examination of the history in the development of the nutritional label and various eco-labels in the U.S. has highlighted the importance of government intervention to prevent companies from misleading consumers with unsubstantiated product health or environmental claims. It is important for labeling standards to be clear and consistent if consumers are expected to make meaningful decisions based on these labels. One key take away from this review is the benefit the government can provide in helping to develop standards and guidelines in the early stages of a labeling movement. Presently, a number of different carbon labeling initiatives exist worldwide, many of which have begun only in recent years. The most prominent of which is by the Carbon Trust in the UK. Most of these initiatives have been started by non-profit organizations, a few of which are government affiliated as well. It can be observed that attracting large and established companies to participate is often important for these initiatives to gain publicity which aids in sustaining their growth. In addition, backing from the government or well established academic institutions or non-profit organizations lends to the initiative's credibility which is a major factor for companies in deciding whether enroll during the early stages of an initiative. It is recommended that carbon labeling initiatives use "seal of approval" formats to attract corporate participation initially and transition to an "information disclosure" format once consumers understand the meaning of a carbon footprint better.

In the U.S., voluntary public private partnerships are a potential model that a carbon labeling initiative can be built on. The EPA currently has 36 such climate partnership programs which contributed to the prevention of 78 MMTCO₂E in 2007. These partnerships benefit from the support which the government provides and are more attractive to companies than alternatives like regulation and taxes. The SmartWay Transport Partnership which focuses on improving the

transportation efficiency associated with freight movements is a potential program that a future supply chain based carbon label can be built from. A study of the program using System Dynamics has demonstrated the importance of a well designed structure in attracting participation and the reinforcing effects which large established companies bring to a program's success and growth. System Dynamics modeling has also been shown to be a useful tool for predicting and quantifying the impact of voluntary public private partnerships. This can serve useful in the design phase of new programs by both allowing stakeholders to discuss and determine how best it should be structured as well as demonstrating its potential benefits to policy makers.

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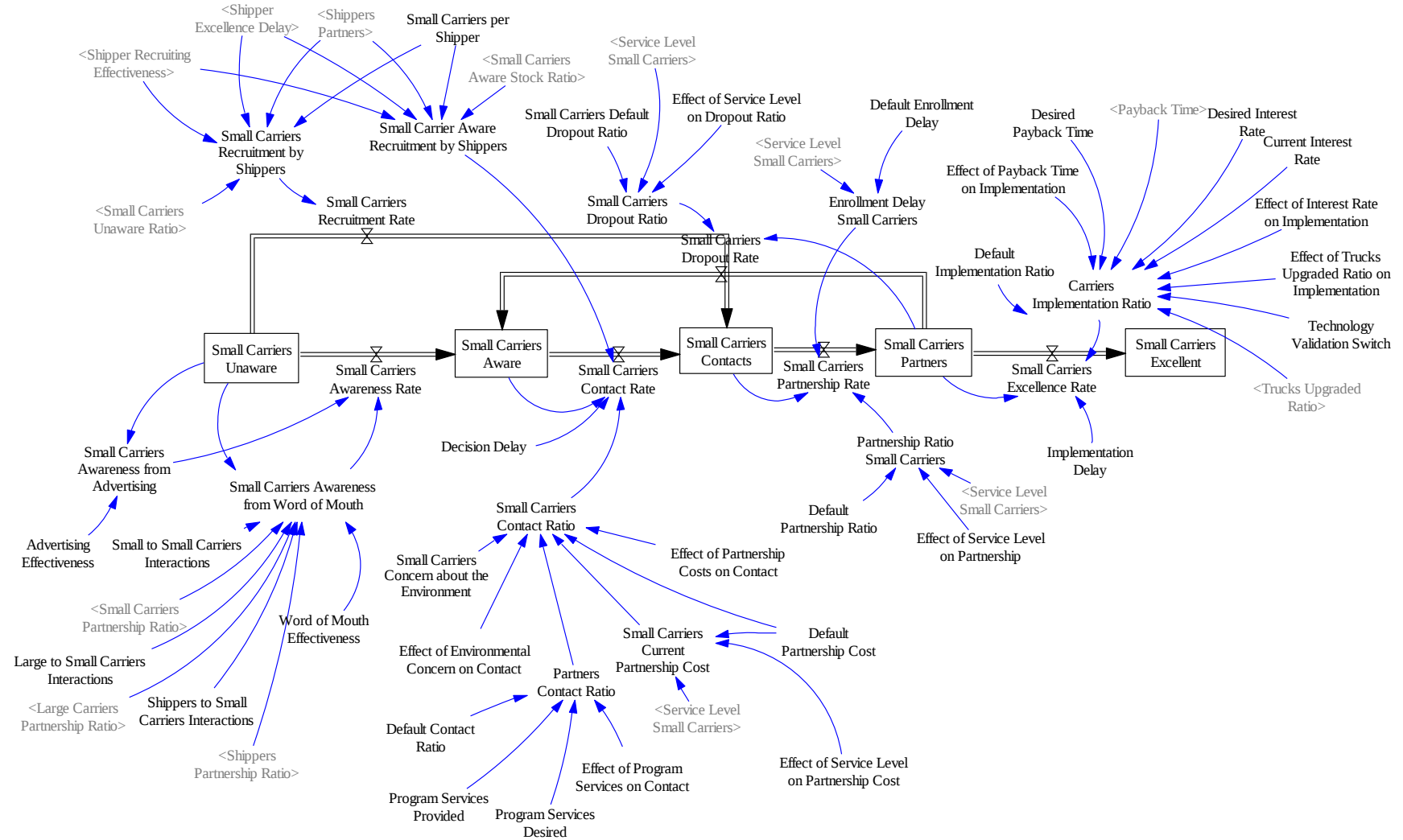
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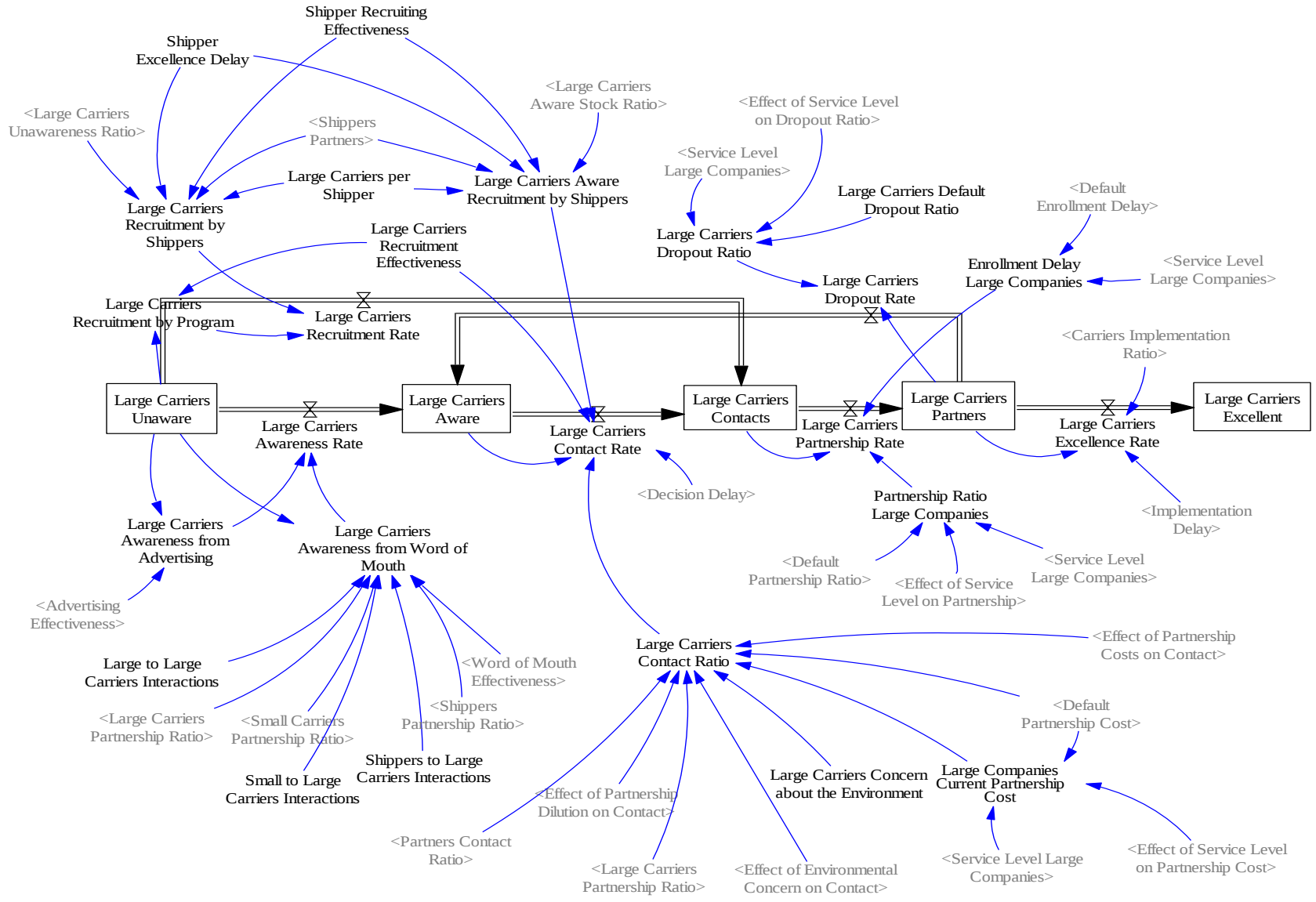
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APPENDIX

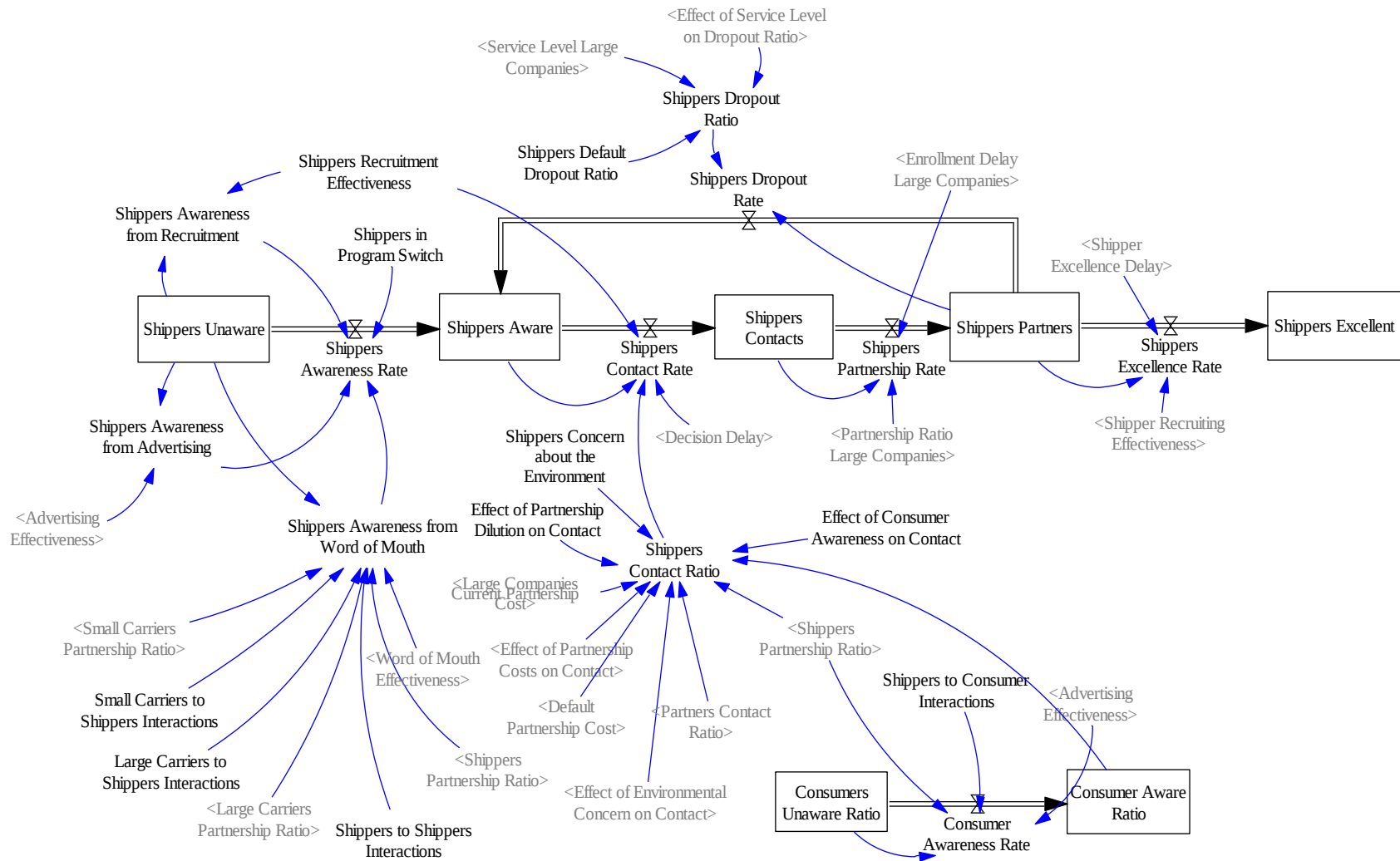
A. SMALL CARRIER MODULE



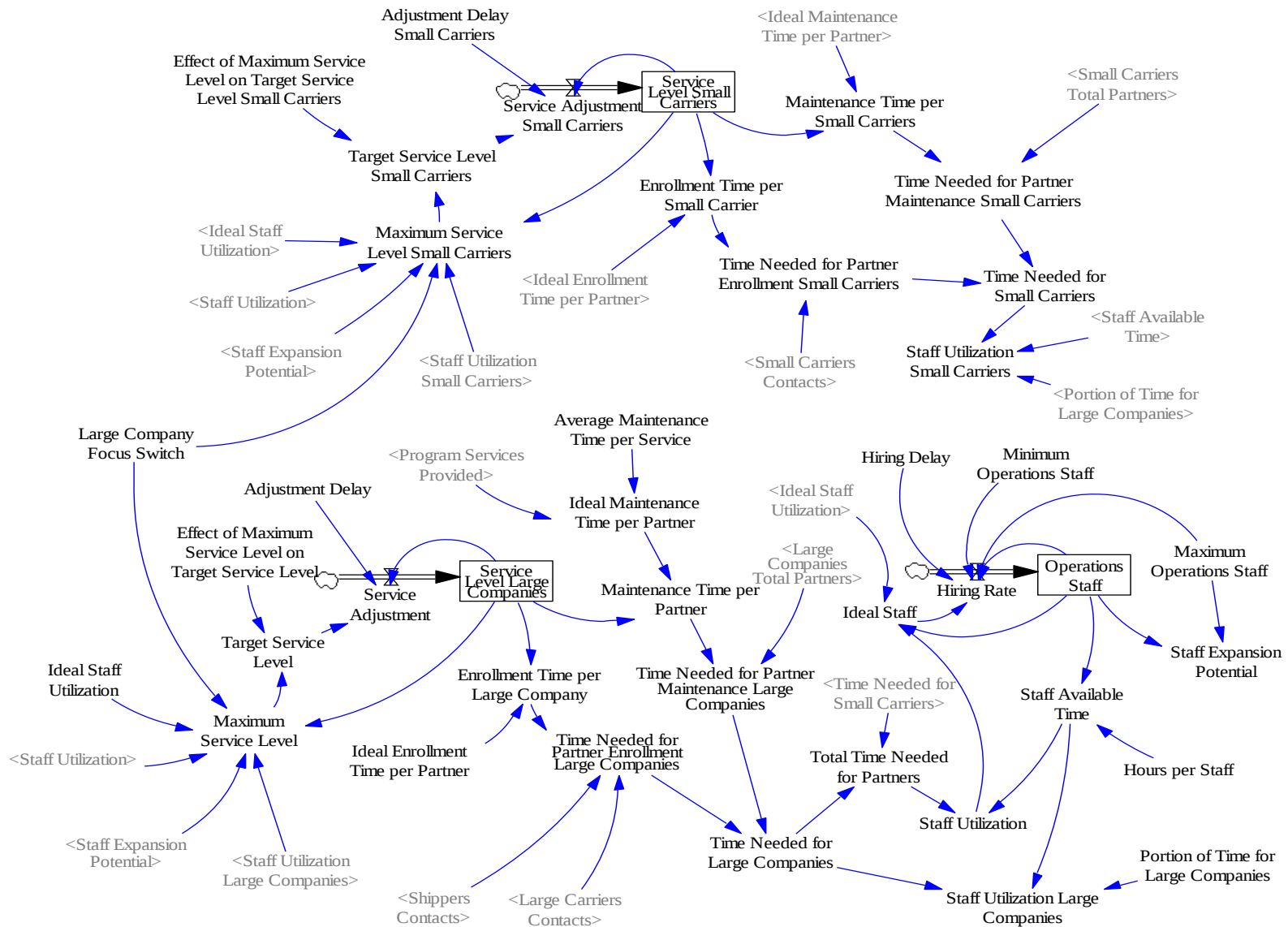
B. LARGE CARRIER MODULE



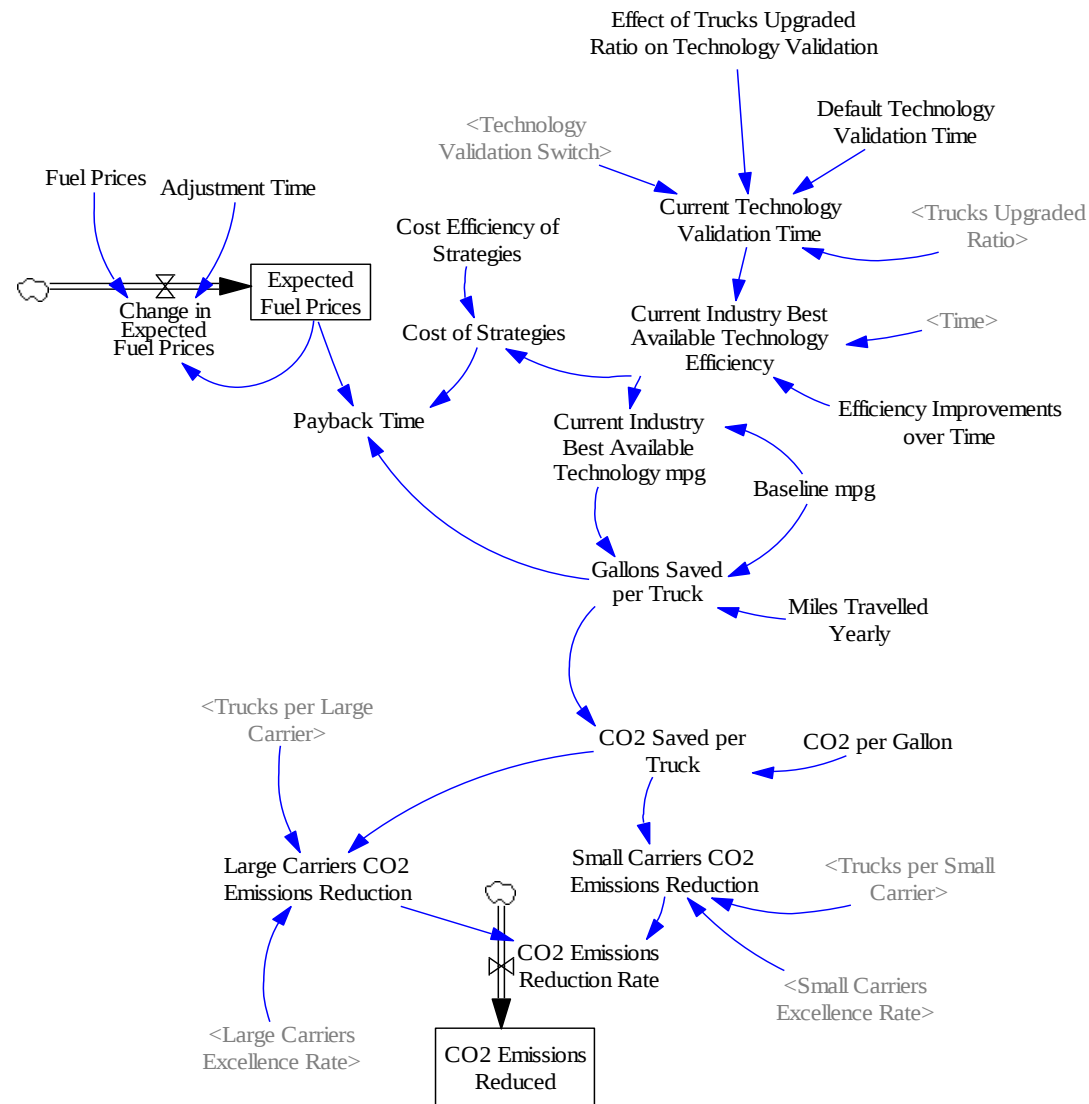
C. SHIPPER MODULE



D. SERVICE LEVEL MODULE



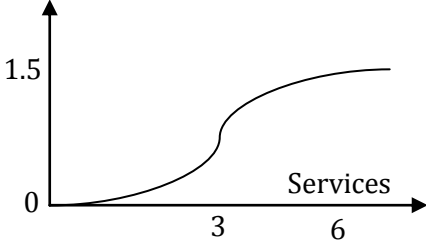
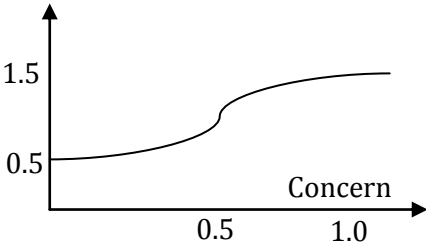
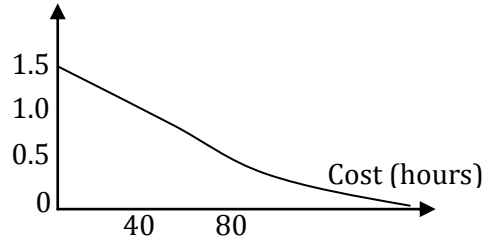
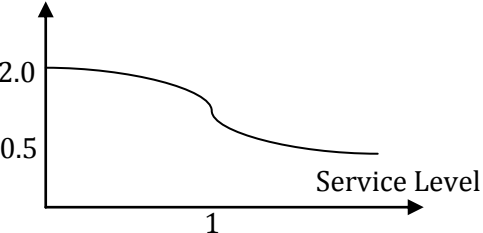
E. TECHNOLOGY VALIDATION MODULE

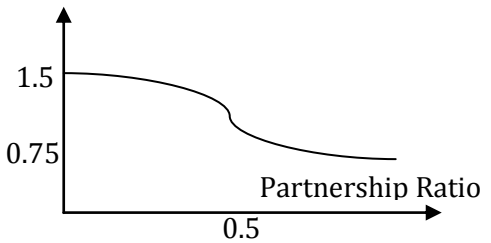
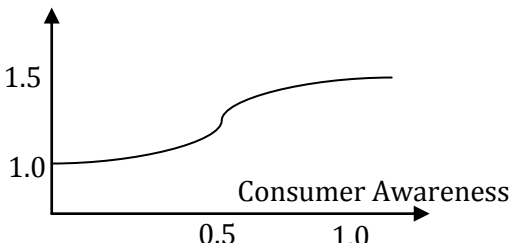


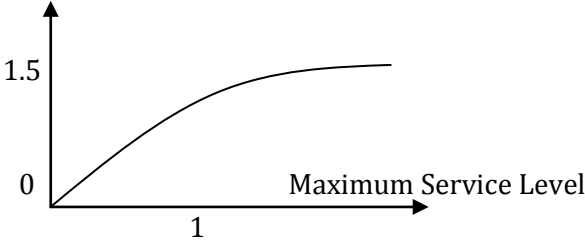
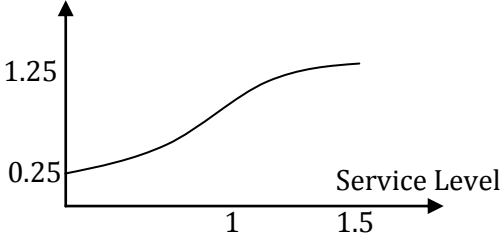
F. SMARTWAY MODEL DOCUMENTATION

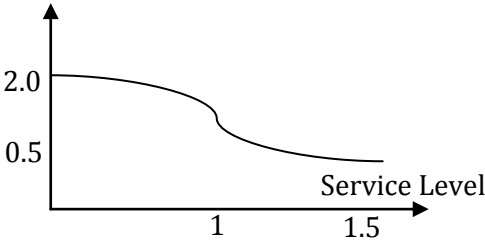
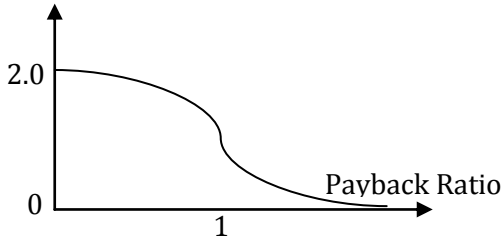
Concept/Variable	Comment	Model
Time Step	Month	Endogenous
Shipper stocks and flows	Shippers are companies that have freight which requires hauling. This model considers the 2000 largest companies that need freight services. Shipper companies fall into one of five discrete categories (initialization values): <i>Shippers Unaware</i> (1993), <i>Shippers Aware</i> (0), <i>Shippers Contacts</i> (0), <i>Shippers Partners</i> (7) and <i>Shippers Excellent</i> (0). Unaware companies are those that do not know about the program. Aware companies are familiar with the program. Contact companies have initiated contact with the program staff and are registered on the program's database but have not made a commitment to join or fulfilled the program requirements. Partner companies are officially in the program and the stock is initialized based on the number of charter partners. Excellent companies have achieved a state of excellence in the program. For shippers this refers to having a majority of their goods hauled by carriers in the program. Carriers who achieve excellence are those who have implemented technology strategies into their fleet.	Endogenous
Carrier stocks and flows	Carrier companies own and operate trucking fleets. For purposes of the model, they are divided into large and small companies. Large companies refer to the 300 companies owning the largest trucking fleets in the nation. The total number of combination trucks registered in 2004 was 2.01 million with the largest companies estimated to own about 19% of the trucks. This gives an average number of <i>trucks per large carrier/small carrier</i> of (1273, 70). Number of small carriers is based on American Trucking Trends estimate of 4.2% of the 564,699 registered carriers having fleet sizes > 20. They are further sub-divided into one of the same five discrete categories (initialization values: small, large): <i>Carriers Unaware</i> (23417, 292), <i>Carriers Aware</i> (0, 0), <i>Carriers Contacts</i> (0, 0), <i>Carriers Partners</i> (0, 8) and <i>Carriers Excellent</i> (0, 0).	Endogenous
Small Carriers Awareness Rate	Awareness rate is modeled after the Bass diffusion model used often in the adoption of new products. The probability that a potential carrier will learn about the program is a result of exposure to advertising and from word of mouth. The awareness from advertising is the product of the stock of unaware carriers and the <i>advertising effectiveness</i> (0.0008). The awareness from	Endogenous

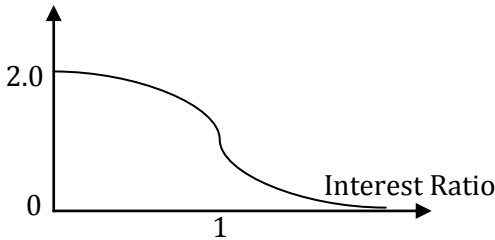
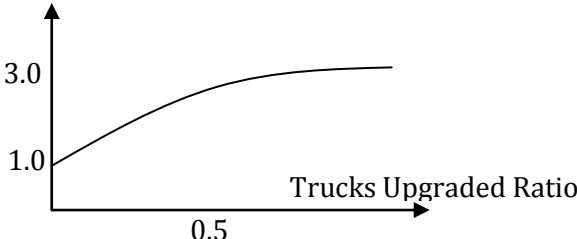
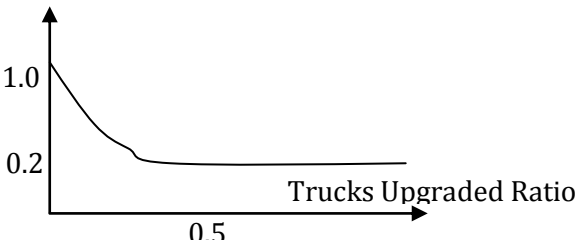
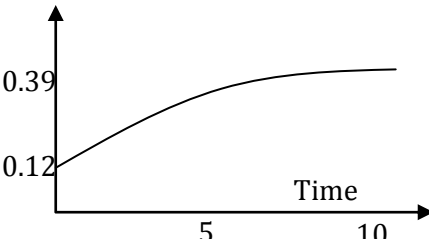
	word of mouth follows the logistic model and is the product of the stock of <i>small carriers unaware</i> , the <i>word of mouth effectiveness</i> (0.22), the <i>small /large/shippers to small carriers interactions</i> (0.05, 0.25, 0.7) and the <i>small carriers/large carriers/shippers partnership ratio</i> .	
Large Carriers Awareness Rate	Similar to <i>small carriers awareness rate</i> . The <i>small/large/shippers to large carriers interactions</i> are (0, 0.25, 0.75).	Endogenous
Shippers Awareness Rate	Similar to <i>small carriers awareness rate</i> . The <i>small/large/shippers to shippers interactions</i> are (0, 0.2, 0.8). Shippers are more difficult to recruit and initial recruitment raises awareness about the program before a second round of recruitment leads to them initiating contact. This additive effect is modeled by the product of the stock of <i>shippers unaware</i> and the <i>shippers recruitment effectiveness</i> (0.0045).	Endogenous
Small Carriers Recruitment Rate	Small carriers are recruited into the program by shippers they work with and flow into the <i>small carriers contacts</i> stock. This flow is estimated based on the product of the number of <i>shippers partners</i> , the <i>small carriers per shipper</i> (25), the <i>small carriers unaware ratio</i> , the <i>shippers recruitment effectiveness</i> (0.12) divided by the <i>shippers excellence delay</i> (12).	Endogenous
Large Carriers Recruitment Rate	Large carriers are similarly recruited by shippers with the <i>large carriers per shipper</i> being (4). In addition, large carriers are also recruited directly by program staff. This additive effect is the product of the stock of <i>large carriers unaware</i> and the <i>large carrier recruitment effectiveness</i> (0.0028).	
Carrier contact rate – small /large	The carrier contact rate is due to additive effects of direct recruitment by shippers and the product of the <i>small/large carriers contact ratio</i> and the stock of <i>small/large carriers aware</i> divided by the <i>decision delay</i> (3). The <i>carriers contact ratio</i> is affected by multiplicative non-linear effects of <i>program services provided</i> by the program, <i>company's concern about the environment</i> , and the <i>current partnership cost</i> . In addition, the <i>large carriers contact ratio</i> is affected by <i>partnership dilution</i> . The <i>default contact ratio</i> is (0.005).	Endogenous
Shippers contact rate	The contact rate for shippers is similar to that for large carriers but with additional non-linear effects due to <i>consumer awareness</i> about the program and additive effects of direct recruitment by the program.	Endogenous

Effect of Program Services on Contact	The greater the number of <i>program services provided</i>, the higher the value the program has for companies (non-linear). Increasing the number of <i>program services provided</i> however also increases the <i>maintenance time per partner</i> as well. 	Endogenous
Effect of Environmental Concern on Contact	The greater the concern companies have about the environment, the greater their interest in the program (non-linear). The default <i>small/large carriers/shippers concern about the environment</i> are (0.2, 0.5, 0.7) 	Exogenous
Effect of Partnership Costs on Contact	The greater the costs of partnership for the companies, the less interested they are in joining the program. These costs are mostly in terms of man-hours and are reduced by staff assistance (non-linear). 	Endogenous
Effect of Service Level on Partnership Cost	The lower the service level, the greater companies have to rely on their own resources to fulfill the partnership requirements and the higher the resulting costs on joining the partnership (non-linear). The <i>default partnership cost</i> is (40). 	Endogenous

Effect of Partnership Dilution on Contact	Brand dilution is potentially of significance especially to large carriers and shippers. As more companies join the program, the marketing appeal associated with being a leader in the field declines (non-linear). 	Endogenous
Consumer Awareness Stocks	These stocks reflect the proportion of consumers that are aware about the program. Consumer awareness is affected by program advertising and marketing by shippers to consumers. Awareness due to marketing by shippers is the product of the shippers to consumer interactions (0.01) and the shippers partnership ratio.	Endogenous
Effect of Consumer Awareness on Contact	As more consumers become aware of the program, it becomes more attractive for shippers to enroll in it (non-linear). 	Endogenous
Staff Utilization	This is the ratio of the <i>total time needed for partners</i> and the <i>staff available time</i>. The unit used is hours/week. The <i>total time needed for partners</i> in the program is the sum of the <i>time needed for partner enrollment</i> and the <i>time needed for partner maintenance</i>. The <i>staff available time</i> is the product of the stock of <i>operations staff</i> and the <i>working hours per staff</i> (40).	Endogenous
Time Needed for Partner Enrollment	The <i>time needed for partner enrollment</i> is the product of the <i>small/large carriers/shippers contacts</i> and the current <i>enrollment time per partner</i>. The <i>enrollment time per partner</i> is the product of the <i>service level</i> and the <i>ideal enrollment time per partner</i> (1).	Endogenous
Time needed for Partner Maintenance	The <i>time needed for partner maintenance</i> is the product of the <i>total partners</i> and the <i>maintenance time per partner</i>. The <i>maintenance time per partner</i> is the product of the <i>service level</i> and the <i>ideal maintenance time per partner</i> which is the product of the <i>average maintenance time per service</i> (0.15) and the number of <i>program services provided</i> (3).	Endogenous

Service Level	The current service level offered by the program. This reflects the amount of time the staff can provide for program services over the ideal time required. The service level has an adjustment delay (6) and is goal seeking towards the target service level. The resulting effect is that the program hires as many staff as needed to maintain service levels until a maximum number of staff is reached and the service level declines after that.	Endogenous
Effect of Maximum Service Level on Target Service Level	The target service level depends on the maximum potential service level provided by the program. This is modeled using a fuzzy maximum relationship. The program aims to provide as high a service level as possible kept below 150% (non-linear). 	Endogenous
Maximum Service Level	The maximum service level looks at the service level provided at the current staff utilization and determines what the service level could be provided at a <i>maximum operations staff</i> level (9).	Endogenous
Operations Staff	The current number of staff operating in the program. Initialized at 1. The hiring rate is goal seeking to set the number of staff so that staff utilization is closest to that of <i>ideal staff utilization</i> (1). The <i>hiring rate</i> has a <i>hiring delay</i> (2) and is bounded by the <i>minimum and maximum operations staff</i> (1, 9).	Endogenous
Partnership Rate	The partnership rate is modeled using a first order enrollment delay. The <i>default partnership ratio</i> is (0.3) based on program data of contacts that eventually enroll and is affected by non-linear effects of service level.	Endogenous
Effect of Service Level on Partnership	The lower the service level, the less attracted companies are in joining the partnership. This is modeled close to linearly in the middle regions and flattening out at the low and high ends (non-linear). 	Endogenous
Enrollment Delay	The enrollment delay is inversely proportional to the	Endogenous

	service level. The <i>default enrollment delay</i> is (1).	
Dropout Rate	The dropout rate of the program is the product of the stock of partners and the dropout ratio. The default dropout rates for small/large carriers and shippers are (0.005, 0.001, 0.001).	Endogenous
Effect of Service Level on Dropout Ratio	As the service level decreases, companies are more likely to dropout as their needs in the program are not being met (non-linear). 	Endogenous
Carriers Excellence Rate – Small/Large	The carriers excellence rate is the product of the <i>carriers implementation ratio</i> and the stock of <i>carriers partners</i> divided by the <i>implementation delay</i> (6). The <i>carrier implementation ratio</i> is affected by multiplicative effects of <i>payback time</i> , the <i>capital loans interest rate</i> and the <i>trucks upgraded ratio</i> . The default implementation ratio is (0.01).	Endogenous
Shippers Excellence Rate	The shippers excellence rate is the product of the <i>shipper recruitment effectiveness</i> (0.1), the stock of <i>shippers partners</i> divided by the <i>excellence delay</i> (12).	Endogenous
Effect of Payback Time on Implementation	The higher the ratio of the current <i>payback time</i> to the <i>desired payback time</i> (3), the less likely carriers are going to make the capital investments to implement efficiency technologies (non-linear). 	Exogenous
Effect of Interest Rate on Implementation	The higher the ratio of the current capital loans <i>interest rate</i> to the <i>desired interest rate</i> (0.05), the less likely carriers are going to make the capital investments to implement efficiency technologies (non-linear).	Exogenous

		
Effects of Trucks Upgraded Ratio on Implementation	The higher the ratio of trucks in the program that have implemented efficiency technologies, the greater the confidence that companies have on the realistic payback times of the investments (non-linear). 	Endogenous
Effects of Trucks Upgraded Ratio on Technology Validation	The higher the ratio of trucks in the program that have implemented efficiency technologies, the shorter the time that new technologies take to get validated. The <i>default technology validation time</i> is (5). This is modeled is exponentially decreasing. 	Endogenous
Efficiency Improvements over Time	Data showing the potential improvements in truck efficiency technology up till 2015. Based on report by ACEE. 	Exogenous
Payback Time	Calculated by the <i>cost of strategies</i> divided by the savings from fuel efficiency. <i>Cost of strategies</i> is the product of the <i>best available technology efficiency</i> at that point in time multiplied by the <i>cost efficiency of</i>	Exogenous

	<i>strategies</i> (\$372/%). The savings from fuel efficiency is calculated based on <i>gallons saved per truck</i> at the more efficient mpg compared to the <i>baseline mpg</i> (6.0). <i>Fuel prices</i> are modeled using historical data from EIA up till 2008 and are exponentially smoothed over a 6 month period.	
CO2 Saved per Truck	This is the amount of CO2 a truck using the current industry best available technology will save in a year. It is the product of gallons saved per truck and kg-CO2 per gallon (10.1).	Exogenous
CO2 Emissions Saved Off Baseline	The total CO2 saved compared to if all trucks were still operating at baseline mpg. Takes into account trucks in the partnership from carriers that have achieved excellence. Based on <i>trucks per large/small carrier</i> as (1273, 70).	Exogenous