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Aveda's Product Distribution System:
A Strategic Assessment of Greenhouse Gas Emissions and Energy Consumption

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In the spirit of Aveda's environmental sustainability-driven mission, the teachings at the School of Natural Resources & Environment, and the personal values of the authors, the carbon emissions associated with the completion of this project (due to travel) have been offset using carbon credits. A total of 5 short tons (4.5 metric tons) were purchased from Native Energy for a total cost of $60.

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SECTION 1 – ABSTRACT

Aveda Corporation's product delivery system (PDS) is evaluated in terms of energy consumption and global warming potential (GWP). Two components of the PDS are analyzed in this study: the tertiary packaging (dunnage, plastic wrap, and cardboard boxes) and the transportation required to distribute products from Aveda's manufacturing facility in Blaine, Minnesota to specified salon and retail customers throughout the U.S. Computer models employing life cycle methodology were developed to quantify the energy consumption and GWP of the PDS, and recommendations are made to reduce the impact of the PDS. The recommendations are evaluated in terms of both environmental and business opportunity.

The total annual energy consumption for the PDS is found to be 36.4 million (MM) mega-joules (MJ) and the total annual GWP is 2,811 metric tons of CO_2 equivalents. This impact breaks down to 10.6 MM MJ of energy, and 714 metric tons CO_2 equivalents for tertiary packaging and 25.8 MM MJ of energy and 2,097 metric tons CO_2 for transport. The PDS energy consumption and GHG emissions associated with the tertiary packaging are correlated with the mass of the materials used, packaging fabrication processes and material composition, and transportation of the tertiary packaging materials from suppliers to Aveda's Blaine facility. The impact of the transportation is driven primarily by mode of transport and weight and distance traveled by shipments.

Recommendations evaluated to reduce the PDS impact include: utilize intermodal shipping to distribution centers (DC), reduce loose-pick shipments, ship direct from the Roseville DC to more retail stores, reduce transport inefficiencies, offset carbon emissions, use alternative fuel from Blaine to the new DC, enroll in the EPA SmartWay Transport Partnership Program, and implement a tertiary packaging PCR content requirement. If implemented, these recommendations (excluding carbon offsets) would reduce the PDS impact by approximately 9%, or 3.3 MM MJ and 285 metric tons CO_2 annually.

To protect the Aveda Corporation, proprietary data have been omitted and the names of facilities and distribution channels have been masked.

SECTION 2 – EXECUTIVE SUMMARY

There has been significant discussion among managers of leading sustainable enterprises and academics about the role of business and the environment, and about the feasibility of using environmental performance as a source of long-term competitive advantage. Aveda's efforts to lead the way as an environmental steward and to translate these efforts into brand enhancement and shareholder and stakeholder value is a working example of how business can do well by doing good. This project, therefore, is not only born out of Aveda's ongoing commitment to protecting natural resources, but also out of its efforts to find business value in environmental projects.

After commissioning a number of CERES environmental reports, and learning that as much as 60% of its energy consumption is related to transport activities, Aveda's Environmental Sustainability department was interested in the details of the impacts of its product delivery. The student research team worked closely with Aveda's Executive Director, Environmental Sustainability as well as with other key senior staff in the company's Transportation, Operations, Marketing, and Sales departments to gather data, analyze the product delivery system (PDS), and make recommendations. The team ranked its recommendations based on a weighting of environmental and business impact.

To protect the Aveda Corporation, proprietary data have been omitted and the names of facilities and distribution channels have been masked.

PRODUCT DELIVERY SYSTEM MODEL AND MODELING RESULTS

This study applies life cycle methodology to assess the total energy (expressed in mega-joules) and greenhouse gas (GHG) emissions (expressed in kg of CO_2 equivalents) associated with its PDS. The PDS under consideration in this study consists of the tertiary packaging and transportation routes required to deliver the packaging and products between the system model components, as defined in Figure ES-2.

A model was created using SimaPro (v 5.1) and Microsoft Access to evaluate the energy consumption and GHG emissions of the PDS. The model was populated with transportation data from a five-month period (October 2003 through February 2004) and with packaging data over a two-year period (2003-2004); all data was annualized.[1] The total annual energy consumption for the PDS (shown in Figure ES-1) was found to be 36.4 million (MM) meja-joules (MJ) and the total GWP is 2,811 metric tons of CO_2 equivalents. This impact breaks down to 10.6 MM MJ of energy

and 714 metric tons CO_2 equivalents for packaging, and 25.8 MM MJ of energy and 2,097 metric tons CO_2 for transport. The PDS energy consumption and GHG emissions associated with transportation were driven primarily by mode of transport and weight and distance shipped, while the impact of the packaging was correlated to the mass of the materials used, manufacturing processes used to make the packaging, and the material composition.

The 36.4 MM MJ represents a significant portion of Aveda's entire energy footprint. By comparison, according to the 2002 CERES report, Aveda's Blaine production facility uses approximately 39.3 MM MJ for utility use over the course of an entire year. Put another way, 36.4 MM MJ is equal to the energy in approximately 277,000 gallons of gasoline.

Figure ES-1 Total PDS Energy and GWP

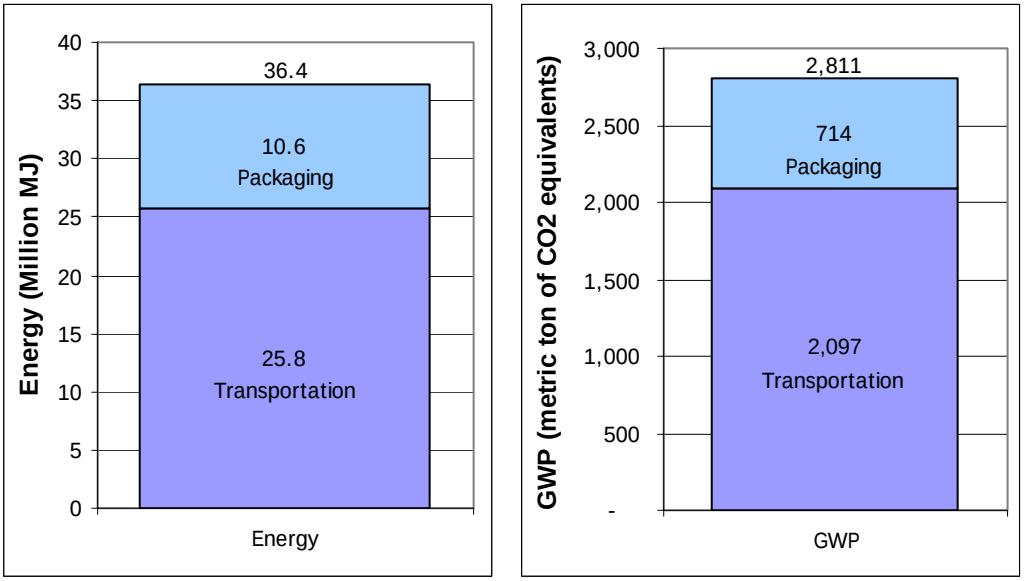
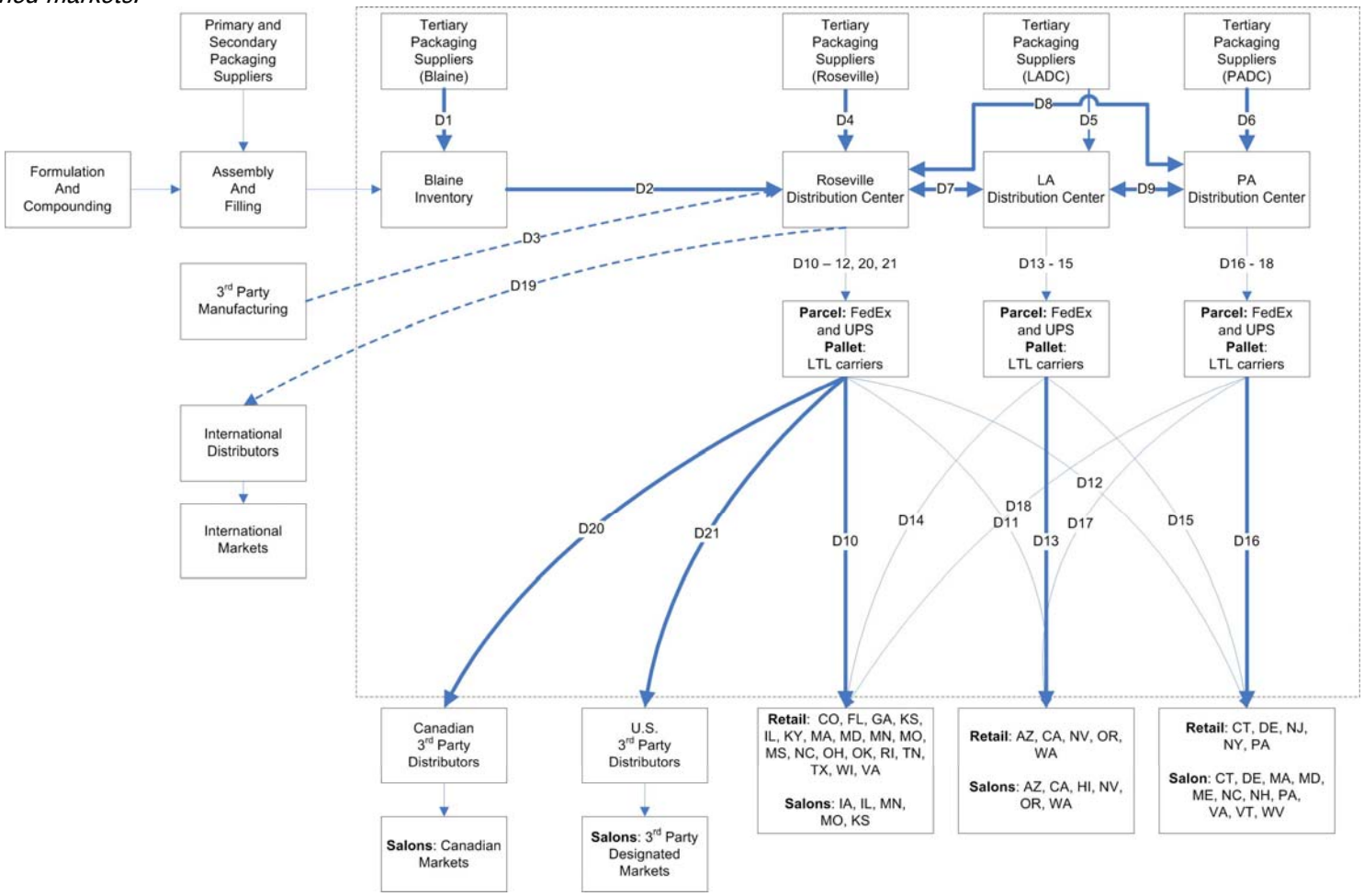


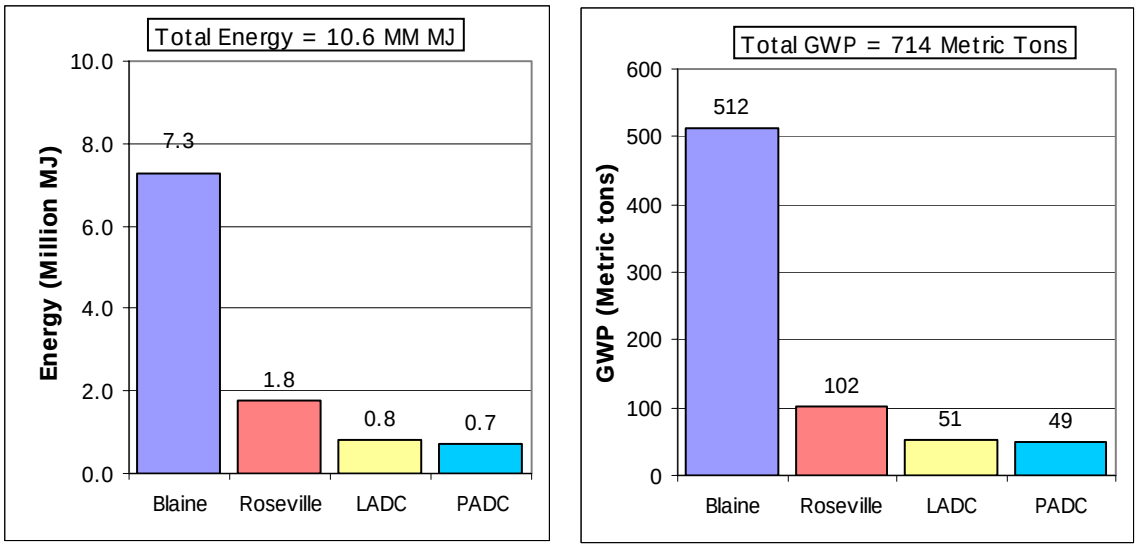
Figure ES-2 Overall material flow of Aveda's personal care products manufactured in Blaine and shipped to market via the company-owned and third-party distribution centers. The activities within the dashed-line rectangle represent the area of focus for this study. *Note: The two-way flow of material in D7, D8 and D9 are within the scope of study. D3 and D19 are outside the scope of study. Additionally, the thin lines (D11, D12, D14, D15, D17, D18) represent infrequent occurrences of products being shipped "out of region" to unassigned markets.*



PACKAGING MODELING RESULTS

Figure ES-3 shows the primary energy use and GWP associated with packaging use at the four Aveda-owned distribution centers (DC's). Notably, cardboard accounts for over 97% of tertiary packaging by weight. Dunnage accounts for 2.4% while plastic products such as plastic wrap and bubble wrap account for .05% of packaging by weight. Packaging purchased by the Blaine production facility accounted for 68.9% of the total energy impact of tertiary packaging, followed by Roseville (17%), LADC (7.5%), and PADC (6.6%). Of the 10.6 MM MJ total primary energy for annual packaging requirements, approximately 4% is related to the transport of tertiary packaging (such as pallets and corrugated cardboard shipping boxes) from suppliers. The remaining 96% of primary energy emanates from acquisition of raw materials, manufacturing and embodied energy of the packaging material. As shown in Figure ES-3, global warming emissions follow a similar pattern.

Figure ES-3 Primary Energy Use and Global Warming Potential Associated with Packaging use at Aveda-Owned DCs and Blaine Production Facility



TRANSPORTATION MODELING RESULTS

The total annualized energy and GWP from PDS transportation is 25.8 MM MJ and 2,097 metric tons of CO_2 equivalents, respectively. As shown in Figure ES-4, the impact from shipments leaving the Roseville facility is much larger than the other distribution centers because in addition to stores and salons, this DC ships products to the LADC, PADC and the eight third-party distributors in North America. Shipments out of the LADC and PADC are for retail and salon orders as well as a small quantity of inter-distributor shipments. Shipments out of Blaine represent the transportation from Blaine manufacturing to the Roseville Distribution warehouse,

which is about 10 miles away. Shipments labeled "other" represent third-party distributors to Roseville, or salons and retail to either LADC or PADC.

Figure ES-4 Total Annualized Transportation Energy and GWP For Products Leaving Aveda-Owned DCs[2]

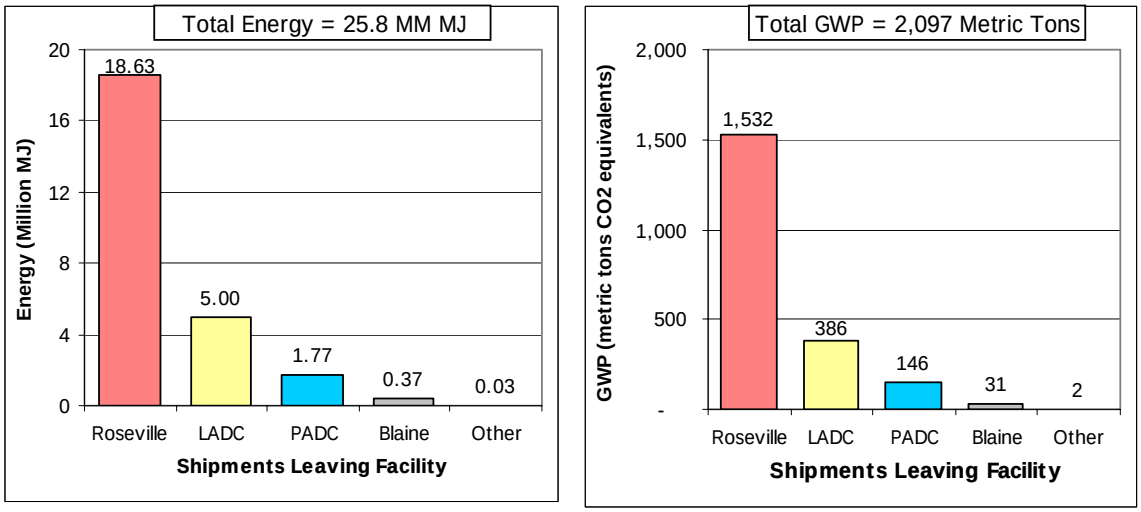


Figure ES-5 considers only retail and salon shipments. The impact from retail is predominantly due to shipments out of Roseville, reflecting the fact that this distribution center fulfills about 85 of the 130 stores including those in distant locations like Florida, Texas, and Massachusetts. The significant impact from salon orders out of LADC is driven largely by air shipments to Hawaii, which are about 4 times more impactful on a per "lb-mile" basis as traditional LTL shipments (Hawaiian shipments have since been switched to ocean shipping, as discussed in Section 7 of this report). If Hawaii shipments traveled via ocean, the LADC salon shipments would result in 1.23 MM MJ and 102 metric tons CO_2, which is similar to the salon network in Roseville and PADC. The majority of the impact out of PADC is due to salon orders because that distribution center only delivers to 18 retail stores that are all in close proximity.

Figure ES-5 Total Annualized Transportation Energy and GWP For Distribution Centers

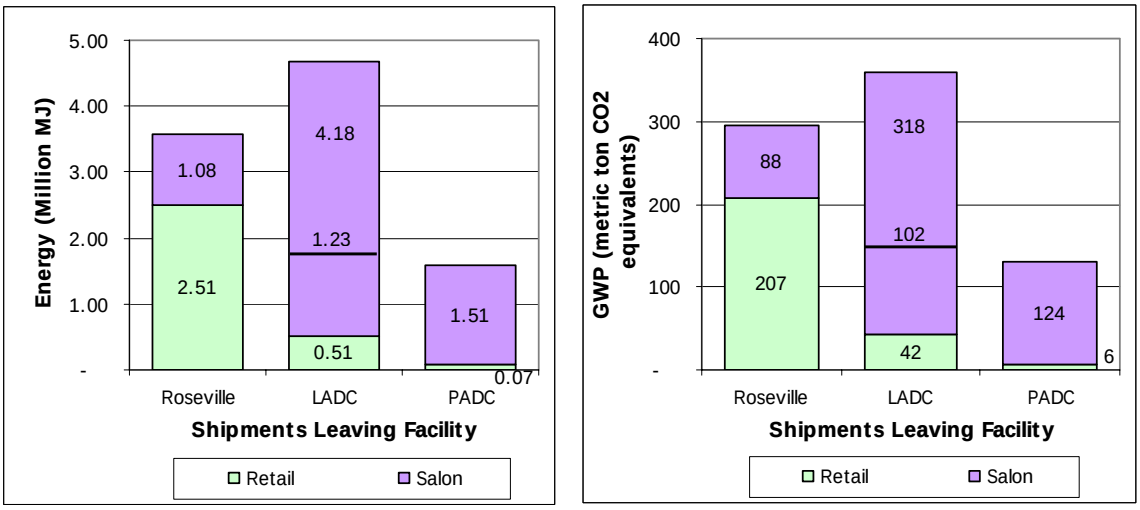
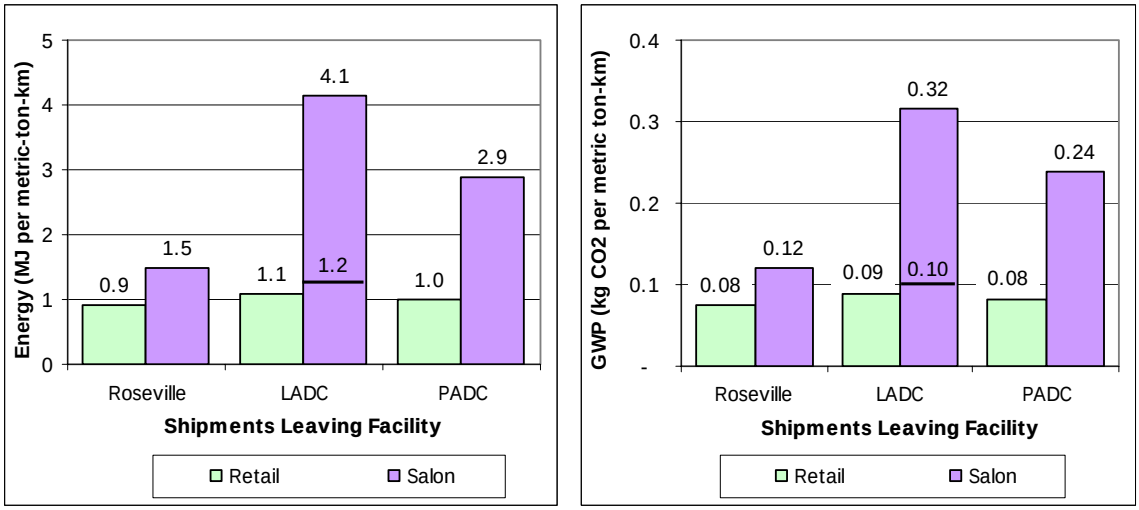


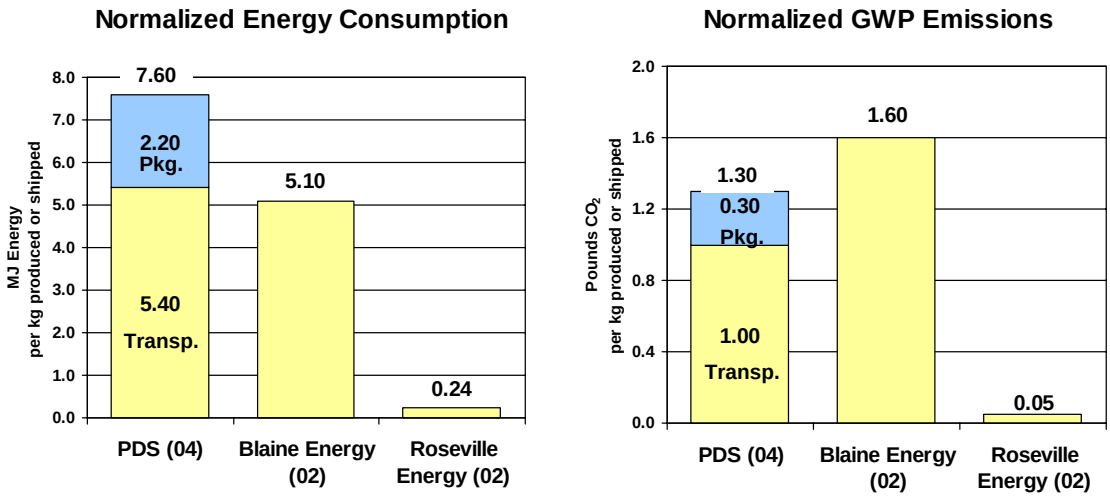
Figure ES-6 also considers only retail and salon shipments, but normalizes the shipments by weight and distance. As a result these graphs demonstrate the difference among the various modes of transport. Less than truckload (LTL) shipments are generally most efficient, as seen by the relatively low numbers for retail shipments. Parcel is slightly less efficient due to the use of UPS "brown trucks" which do not have the capacity of a tractor trailer and this is seen by the higher numbers for salon shipments. The PADC salon shipments are high because packages spend the majority of the route on the "brown trucks", while Roseville salon shipments may travel on UPS tractor trailers for a portion of the trip. Again, Hawaiian shipments out of LADC drives the average impact up dramatically, but as seen in the alternate line, if these shipments were transported via ocean, the average impact would be in line with other salon shipments.

Figure ES-6 Weight-Distance-Based Transportation Energy and GWP per DC



Aveda's CERES report indicates that 60% of energy and 50% of GHG emissions are due to transportation. Although PDS energy is different than the energy from electricity and gas, it is useful to compare the values to appreciate the impact that transportation and packaging have on a consumer products company like Aveda. Similarly, the PDS carbon emissions can be compared to those resulting from the electricity and gas usage in the facilities. As seen in Figure ES-7, the PDS has an impact on par with the electricity and gas usage in the Blaine manufacturing facility.

Figure ES-7 Comparison of PDS Energy and GWP to Facility Energy and Gas Use[3]



DATA ANALYSIS

The following observations were made about Aveda's PDS:

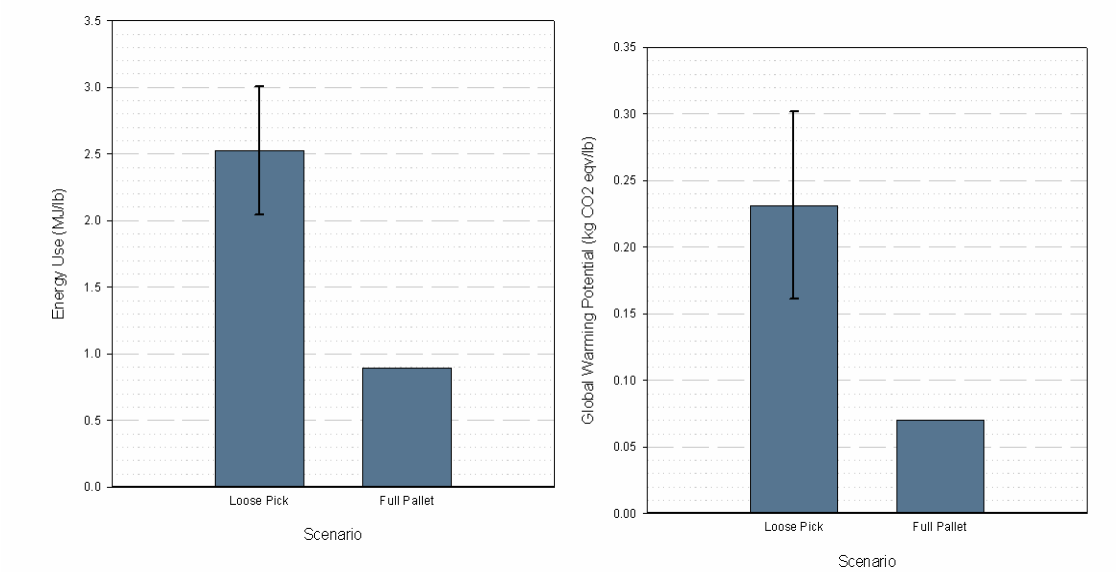
- 71% of PDS impact is due to transport. This impact is driven by the weight, distance and mode of transportation.
- Portions of the network which have high weights will have correspondingly high impact. This is seen in the impact of shipments leaving the Roseville DC because all shipments originate there.
- Portions of the network which require long distances will have correspondingly high impact. This is evidenced by Roseville retail shipments which travel to locations in TX, FL, and MA. Reducing the total miles traveled is a key way to reduce impact.
- Portions of the network which use inefficient modes of transport will have a correspondingly high impact. This is evidenced by the significant impact of LADC salon orders due to Hawaiian air shipments. It is also seen in the slightly higher impact of parcel shipments compared to LTL.
- Holding all variables equal, loose-pick packaging and parcel shipping requires two to three times more energy and emits close to three times the amount of metric tons of CO_2 equivalents of GHGs as compared to packing and shipping via full pallets.

- Salon shipments from LADC to Hawaii via air contribute greatly to the overall impact for the salon portion of the PDS. Air shipments from LADC to Hawaii account for 3% of the weight of all shipments out of LADC, but 64% of the impact (see figure 8).

- Total impact from the PADC is relatively low due to the short distances between the PADC and both salon and retail locations.

- Inventory disposition accounts for 4% of the total transportation impact (1,050,000 MJ and 86,300 kg CO_2 equivalents). As a frame of reference, 1,080,000 MJ and 88,000 kg CO_2 equivalents were required to transport shipments from Roseville to Central region salons.

Figure ES-8 Differences in Energy and GWP on a per pound of product delivered



The range of values found (error bar on the loose-pick column) when the delivery distance for the UPS brown truck was varies between 25 miles and 75 miles.

RECOMMENDATIONS

Eight recommendations are made that could reduce the energy use and GHG emissions to varying degrees, as described below. Each recommendation was evaluated in terms of its environmental and business impacts. To help Aveda prioritize which recommendations to implement, Table ES-1 summarizes the environmental, financial, operational, and customer impacts of each recommendation. In the table, environmental impact is weighted equally with the three business impact criteria combined to determine the "Overall Rating." This rating is a largely subjective assessment based on both quantitative and qualitative analyses. The recommendations include:

- Purchase carbon offsets through a vendor such as Native Energy. This would allow Aveda to financially support the creation of renewable energy to compensate for the

carbon emissions from its PDS. Offsetting the 2,811 metric tons of CO_2 equivalents (100% of PDS) would cost approximately $8,400 annually.

- Because rail transportation is more than three times more efficient than truck transportation, it is recommended that Aveda use intermodal shipping to its large distributors. Intermodal shipping combines truck and rail to eliminate the need to load and unload rail cars. This could potentially save 1.2 MM MJ and 111.6 tons CO_2 equivalents annually (3.3% of PDS) at a comparable cost and complexity of current operations.

- Due to the southwestern location of the LADC, shipments to retail stores in the northwest travel up to 54% more than a direct route from Roseville. If a majority of western retail stores were shipped direct, 434,000 MJ and 37,000 kg CO_2 equivalents (1.2% of PDS) would be eliminated at a comparable cost to current operations.

- By enrolling in the EPA's Smartway Transport Partnership Program, Aveda would encourage its current carriers to improve the efficiency of their trucks. If typical program requirements were met, 346,000 MJ and 31,000 kg CO_2 equivalents (0.9% of PDS) would be eliminated at no cost to Aveda. Further, the improved efficiency would apply to the carriers' other customers and thus provide additional environmental savings.

- It was found through this study that loose-pick shipments have a higher energy and GWP impact per kg shipped than LTL shipments. This is due to the additional packaging materials and the less efficient parcel transportation network. If just 1% of shipments were changed from parcel to LTL, this would save an estimated 0.029 MM MJ and 2.3 metric tons of CO_2 equivalents (0.1% of PDS) at a comparable cost to current operations. This is equivalent to approximately 1.4 cars.

- Currently, approximately 1% of the PDS impact results from the transport of goods between Blaine and Roseville. While the relocation of the facility will reduce the distance from 10 miles to about 1/8th of a mile, further reductions could be made by using an alternative fuel such as biodiesel for these shipments. While the overall reduction of environmental impact and associated costs would be minimal, using biodiesel would be a way to show leadership in the development of alternative fuels.

- Currently, Aveda purchases packaging material with an average of 80% post-consumer recycled (PCR) content. While this is an impressive level, the company does not have any contractual arrangements with packaging suppliers to ensure this PCR content level is maintained. While it would not offer energy or GHG reductions, it is recommended that Aveda adopt a PCR content requirement to future contracts to ensure that Aveda is getting the desired materials.

- Like many businesses, Aveda has the need to manage its inventory and accept customer returns. This requires shipping product unnecessarily around the country. In theory, if Aveda could eliminate these shipments completely, it could save 1,170,000 MJ and 95,000 kg CO_2 equivalents (3.2% of PDS). However a complete reduction would be costly in terms of finances, operation and customer service levels. In light of these costs, Aveda should aim to reduce these shipments each year by a small percentage.

Table ES-1 Recommendations to Reduce PDS Impact

		Business Impact			
Recommendation	**Environmental Impact**	**Cost Reduction**	**Operational Feasibility**	**Customer Impact**	**Overall Rating**
Carbon Offsets	●	◑	●	●	◕
Utilize intermodal shipping to DCs	●	◔	◔	◑	◑
Ship direct to select western region retail stores	◑	◕	◑	◕	◑
EPA SmartWay Program	◔	◕	◕	●	◑
Reduce loose-pick shipments / increase pallet shipments to salons	◑	◕	◑	◔	◑
Biodiesel transport from Blaine to the new DC	◔	◑	◑	●	◑
Implement tertiary packaging PCR content requirement	○	◕	●	●	◑
Reduce transport inefficiencies (Inventory Disposition, Out of Region Shipments, Product Returns)	◔	◕	◑	◑	◔

The purpose of the recommendations is to provide Aveda with various solutions to reduce its energy consumption and global warming impact. For business reasons, it would be difficult to implement every recommendation; however, the recommendations illuminate areas on which Aveda should focus its efforts. If implemented, these recommendations (excluding carbon offsets) would reduce the PDS impact by approximately 9%, or 3.3 MM MJ and 285 metric tons CO_2 annually.

Furthermore, because it is not possible to eliminate energy use and GWP entirely using existing technologies, carbon offsets would be the only way for Aveda to become carbon neutral.[4] Purchasing carbon offsets from Native Energy, a company with which Aveda already purchases carbon offsets, to offset the impact of the PDS under evaluation in this study would cost approximately $8,400 annually.

FUTURE INVESTIGATIONS

Aveda's business is constantly changing to meet the demands of customers, react to competition and reduce costs. The recommendations in this report are provided in the context of the state of the business in early 2004 and are limited to the PDS as defined above. However, since this project commenced, several business issues have arisen that may affect our analysis and

recommendations or that are outside the scope of this project. These issues should be considered for future study:

- Although Hawaiian shipments via air transport were modeled, Aveda has begun the transition to ocean for these shipments, which will significantly reduce the energy and GWP impact out of the LADC. As mentioned above, Aveda should complete this transition.

- Product return policy is changing due to various internal company policies. If Aveda begins shipping returned product back to its manufacturing facility, this would create additional energy consumption and GWP emissions. As Aveda continues to grow, it will need to take steps to better understand these returns by measuring the utilization of the company's return processes and actively limiting the amount of product being transported for disposal. For example, Aveda could consider shipping returns to local product-destruction or waste-disposal sites.

- The location for the LADC could change when the facility lease expires. Aveda should consider moving the facility to a more centralized location, such as in Nevada or Colorado, to reduce cumulative transportation distance to Western region salons.

- Distributors are increasingly asking for one stock keeping unit (SKU) per pallet to facilitate warehouse management. However, this results in use of additional pallets, and potentially decreased utilization of trucks. Aveda should consider this additional impact before agreeing to this customer request.

- While Aveda has a "no-air" policy for shipping, it is believed that overnight packages via air are being shipped by various departments throughout the company. While business demands may require occasional overnight delivery, the company should make further efforts to reduce this practice, considering the fact that air transportation is approximately eight times more impactful than ground transportation.

- Single use cartons are used for loose-pick shipping in Aveda's distribution centers. Several efforts have been made in the past to reduce this practice, but Aveda should continue exploring options for tote systems between Manufacturing and Distribution, especially in light of the new distribution center being built in 2005.

SECTION 3 – INTRODUCTION

3.1 CONSUMER PRODUCT PACKAGING PRIMER

Regardless of product type, packaging serves five purposes: to contain, inform, protect, transport and display the product.[5] The evolution of product packaging has no doubt increased the quality of life for consumers around the world, particularly due to the ease of shipping preserved, sterilized, and clean products. However, because packaging is intimately tied to products used in so many aspects of life, packaging constitutes as much as one-third of the non-industrial solid waste stream in most parts of the developed world.[6] According to a 2001 report from the U.S. Environmental Protection Agency, 73.5 MM tons of discarded containers and packaging entered the municipal solid waste stream. Whether by weight (32.0%) or by volume (30.0%), containers and packaging products are the dominant materials in the waste stream.[7] Further, this packaging both contains a great deal of embedded energy, and requires energy to transport it to market.

The variety of packaging can be organized into three categories:

- **Primary packaging** contains the product as received by the consumer (e.g., a shampoo bottle or perfume bottle).
- **Secondary packaging** organizes multiples of products (e.g., trays for tins of baked beans, carriers for beer bottles, and display packs) or serves as an outer wrapping that stores, informs, displays and/or protects the product (e.g., decorated carton, gift box).
- **Tertiary packaging** is the transport-packaging unit (e.g., corrugated cardboard cartons, wooden pallets, and plastic shrink wrap).

Personal care products (PCP) often require primary and tertiary packaging, and to some extent, secondary packaging is used for marketing or product disclosure. Relative to secondary and tertiary packaging, marketing and advertising groups invest considerably more effort into primary packaging development, since it reflects the image the company wishes to portray. The contents of a PCP bottle may only cost a few cents to manufacture, but the more elegant, ornate or fanciful the container, the higher the manufacturing costs and disproportionately higher price. On average, the cost of packaging soft drinks, perfumes, and cosmetics makes up 25% of the products' total cost, according to the Association of Plastics Manufacturing of Europe.[8]

Aveda has been a leader in transforming the market on PCP packaging. According to Mary T'Kach, Executive Director, Environmental Sustainability, Aveda's, "packaging, from an environmental perspective, far surpasses anyone in the industry."[9] This statement is backed by such recognition as packaging awards from the National Recycling Coalition and Cosmetic and Personal Care Packaging magazine. Bucking the PCP industry trend where expensive,

unsustainable packaging defines the product, Aveda has focused on providing high-quality PCPs in elegant, environmentally conscious primary and secondary packaging.

3.1.1 EFFORTS TO REDUCE PACKAGING

Through the introduction of legislation, the European Union has led the reduction of packaging entering the waste stream. In 1992, the European Parliament and the Council of Ministers adopted the Proposal for a Council Directive on Packaging and Packaging Waste which regulates the prevention of packaging waste, the re-use of packaging, and the recovery and recycling of packaging waste.[10] These laws have had positive results: the Association for Sustainable Use and Recovery of Resources in Europe reports the amount of packaging disposed in either landfill or by incineration decreased by more than a third between 1990 and 1997 in EU member states.[11]

Although the U.S. has lagged in addressing the increasing tide of packaging waste sent to landfills, some companies have led initiatives to reduce the amount of packaging that is used to ship and display their products. Companies like Patagonia, Nike and Microsoft have reduced both the material intensity and size of their primary and secondary packaging, thus not only reducing environmental impacts, but also saving money.[12] Similarly, Aveda has reduced and eliminated secondary packaging to a great extent. For example, display cartons are used only where product information exceeds what is available on the primary packaging.

3.1.2 EFFORTS TO INCREASE RECYCLED CONTENT

From Patagonia's fleece jackets to McDonald's napkins and paper bags, many companies manufacture or produce goods that contain a significant amount of post-consumer recycled (PCR) content, thereby closing the loop on various linear material flows. Not only are these products competitively priced, but they also perform as well as or better than conventional, non-PCR products. In addition, such buy-recycled campaigns can bolster a company's environmental image.[13]

Aveda has reduced the environmental impact of its primary and secondary packaging. In addition to reducing the material intensity and ensuring that materials are recyclable, the company has asked its suppliers to increase PCR content in its packaging.[14] Some of Aveda's primary packaging contains between 80 and 100% PCR content. Aveda is also testing non-hydrocarbon based materials for bottles and jars despite the challenges that unconventional packaging solutions pose in terms of shelf life and end use.[15]

In terms of tertiary packaging, Aveda purchases pallets from Stewart's Forest Products, a company that sources its wood from Forest Stewardship Council (FSC) certified lands.[16] There are 10 principles and 57 criteria that address legal aspects, indigenous rights, labor rights, multiple benefits, and environmental impacts surrounding forest management. These principles and criteria are designed for a variety of ecological systems around the world, but FSC encourages national working groups to adapt these principles and criteria to local ecological, economic and social conditions. In addition to the FSC, American Tree Farm System, CSA International, and Sustainable Forestry Initiative are three other certification organizations that provide tools to help conserve, protect and restore the world's forests. These four organizations vary in scope, governance and technical guidelines but all of them have the goal of continued improvement in forest management standards and integrate environmental, social and economic interests.[17] Additionally, Aveda purchases corrugated cardboard boxes (tertiary packaging) that contain PCR content.[18]

3.2 BACKGROUND ON ENERGY AND GHGS

This report focuses on both energy and GHGs because they are considered the most significant environmental impacts resulting from Aveda's PDS and two of the most critical environmental issues facing the world today. GHGs occur both naturally and as a result of human activities. Natural occurring GHGs include water vapor, carbon dioxide, methane, nitrous oxide, and ozone.[19] Often, GHGs such as carbon dioxide, methane, and nitrous oxide are often elevated due to human activities.[20] The world economy's dependence on non-renewable sources of energy (fossil fuels) is of concern because of the inherent volatility in supply as a result of political, social, and natural shocks as well as the finite and declining supply of such fuels. According to the International Energy Outlook 2004, the total world consumption of commercially traded energy will increase by 54% by 2025.[21] Meanwhile, the same report from the U.S. Energy Information Administration acknowledges that production of oil (and thus the fuel used in the transportation of Aveda's goods) is widely expected to peak within the next fifty years.[22] Furthermore, logistics systems worldwide increasingly value speed and reliability, which favor truck and airfreight, the most energy intensive modes of transportation.[23]

While energy consumption generally reflects the limited inputs required for Aveda's PDS, the GHGs reflect the damaging outputs resulting in the system. As fossil fuels are combusted, the carbon stored in them is emitted almost entirely as carbon dioxide (CO_2).[24] CO_2 accounts for 95% of GHGs from transportation.[25] The release of GHGs is of concern globally because since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide have

increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases strongly correlate with the increases in average global temperature recorded over that same time period.[26]

3.2.1 U.S. Contribution to Global GHG Emissions

The U.S. accounts for 24% of the 6,175 MM metric tons carbon equivalent (MMTCE) of total global carbon emissions based on 1997 estimates with a population that is only 4.6 % of the world total.[27] Overall, total U.S. emissions rose by 13% from 1990 to 2002, while the U.S. gross domestic product increased by 42% over the same period.[28] As the largest source of U.S. GHG emissions, CO_2 from fossil fuel combustion has accounted for a nearly constant 80% of global warming potential (GWP) weighted emissions since 1990.[29] Emissions from this source category grew by 17% from 1990 to 2002 and were responsible for most of the increase in national emissions during this period.[30]

3.2.2 Contribution of Transport of Goods to Energy and GHG Emissions

The U.S. transport system is the largest in the world.[31] Transport comprises the second largest use of energy, accounting for 27% of total U.S. energy use.[32] And because 97% of the energy that powers transportation is derived from petroleum, addressing transportation must be a part of any strategy to reduce energy consumption and GHG emissions.[33] Moving freight accounts for 20% of all energy consumed in the transportation sector. Trucks carry about 66% of all freight shipped in the US, while rail carries about 16% (water, pipeline, and air transport account for the rest).[34]

3.2.2.1 Ocean

Cargo ships are the most efficient method of shipping goods, generating the lowest carbon emission per ton-mile. However, there is still room for this mode to improve. Cargo ships use the lowest grade of fuel available, and thus have the highest emissions per gallon of fuel, with N_2O and SO_x being the largest contributors. Of total emissions from fossil fuel use, maritime ships contribute 2% of CO_2, 5% of SO_x, and 14% of N_2O. Furthermore, with 70% of ship emissions occurring within 400 km of land regions, there is concern over the impact of these emissions on coastal regions.[35]

Table 3A Emissions in CO_2 equivalents by mode for 70,000 ton-miles[36]

Mode	Metric tons CO_2
Ocean	1.0
Rail	2.0
Road	7.2
Air	58.2

3.2.2.2 Rail

According to the Association of American Railroads, rail makes more efficient use of land, helps to relieve traffic congestion in urban areas, is three times more fuel-efficient, and generates less noise as compared to truck.[37] A single freight train can carry the load of 500 trucks. In the U.S., 40% of freight moves via rail. Table 3A shows the differences in emissions by mode; road creates more than 3 times the metric tons of CO_2 than what is generates by using rail. If 10% of the freight in the U.S. currently moved by trucks were shifted to rail, the U.S. could save 200 MM gallons of fuel and 1.77 MM metric tons of CO_2 emissions each year, and prevent the release of 2.86 MM tons of GHGs (2600 MM kg).[38] 200 MM gallons of fuel is enough to power approximately 398,700 automobiles in the U.S for one year (see Appendix G for conversion).

3.2.2.3 Truck

Because truck transportation is the most flexible and very affordable, it dominates shipping in the U.S. The trucking industry has incorporated many fuel saving technologies such as aerodynamic cab extenders, governors on engines, and idle reduction, however there is still room for improvement. Among all modes used to move freight throughout the U.S., trucks use the most energy by far, at nearly 75% of total freight transportation.[39]

3.2.2.4 Air

Air is the most inefficient and costly of modes creating eight to ten times more emissions per ton-mile than trucks.[40] While most companies tend to avoid air shipping due to the associated high costs, increasing pressures on inventory levels and customer service make air an environmentally costly necessity. The industry has improved dramatically in terms of efficiency, but there is room to improve. From 1971 to 1998, aircraft achieved a 60% reduction in energy use through both technological and operational improvements, but it is estimated that aircraft fuel efficiency can be improved by 20% in the short term, and up to 50% in the long term.[41]

3.2.3 GHG and Energy Accounting Systems

The quantification of energy and GHG emissions in this report relies significantly upon data provided by Franklin Associates, which is a standard source for life cycle emissions and energy factors.[42] The specific assumptions and factors used in modeling are discussed further in the methodology section of this report.

Energy use, for the purposes of this study, includes the energy embodied in the fuel, as well as the energy required to mine the natural resources, refine the petroleum, and transport it into the transportation fuel network. Energy is also embodied in the various packaging materials, and

includes the energy used to source the materials and manufacture it into packaging as well as the transportation into the supply chain. The energy embodied in the trucks, planes, roads and other "downstream" activities are not included in the analysis.

GHGs, for the purposes of this study, are limited to carbon dioxide and methane. These are generally considered the most prevalent gases resulting from the combustion and use of fossil fuels. These GHGs are emitted through the mining, refining, and transportation of the fuel and packaging materials, but their greatest source is from the combustion of the fuel used in transportation. While GHGs for all of these activities is included in the analysis, it should be noted that the majority of impact occurs through combustion of fuel.

3.3 AVEDA BACKGROUND AND BUSINESS PROFILE

Horst M. Rechelbacher founded Aveda in 1978 in Minneapolis, MN with one shampoo. The mission he created continues today to, "...care for the world we live in, from the products we make to the ways in which we give back to society. At Aveda, we strive to set an example for environmental leadership and responsibility, not just in the world of beauty, but around the world."[43] A-Veda means "all-knowledge" in Sanskrit, and the company's name stands for sustainability and constant innovation.[44]

Aveda is a unit of The Estée Lauder Companies, Inc. (Estée Lauder), a $10 billion hair and body care consumer products company. As a global company, this Minnesota-based manufacturer, wholesaler, and retailer of hair care, skin care, makeup, perfume, and lifestyle accessories is known for its high quality beauty products and ability to create a sensory and serene experience at their retail stores and independent salons.

In 1997, Aveda was purchased by Estée Lauder. However, since the acquisition, Aveda's mission and core values have remained in tact, because a commitment to the environment is integrated into the company's mission and core business operations. Aveda strives to be an environmentally sustainable company by reducing its environmental footprint through monitoring its impacts on biodiversity, publishing annual CERES reports, and integrating conservation and sustainability principles into ingredient sourcing and product distribution practices. Aveda regards protecting biodiversity as one of its primary goals.

3.4 AVEDA ENVIRONMENTAL AND SOCIAL RESPONSIBILITY

Aveda's mission can be found posted throughout the company's headquarters in Blaine, Minnesota. It reads:

> "Our mission at Aveda is to care for the world we live in, from the products we make to the ways in which we give back to society. At Aveda we strive to set an example for environmental leadership and responsibility, not just in the world of beauty, but around the world."

According to the company, this mission, "positions Aveda as a catalyst for awareness and change at individual and collective levels."[45] As such, Aveda promotes numerous environmental initiatives to educate its customers about issues such as global warming, water and air pollution, habitat protection, toxins in the environment, and waste generation. The company also attempts to implement, "environmentally preferable business operations."[46] For these reasons, Aveda is particularly well-situated to implement the recommendations of this project.

Organizationally, Aveda has an Executive Director, Environmental Sustainability (ED) who is responsible for strategic environmental initiatives and who must evaluate and approve all new products for their environmental impact. The ED is also a member of Aveda's Executive Team. The Environmental Sustainability (ES) group at Aveda consists of four full-time staff. ES collaborates with other departments and organizations on projects including global GHG reporting through the Coalition of CERES, wind energy procurement, a "no air" shipping policy, and recycled content packaging, among many others.

Aveda has made significant progress in reducing the overall environmental impact of its tertiary packaging. For example, Aveda has developed a relationship with Stewart's Forest Products to sustainably source, reuse and recycle wooden pallets. Stewart's sources its wood from Forest Stewardship Council (FSC) certified lands, which adhere to 10 principles and 57 criteria that address legal aspects, indigenous rights, labor rights, multiple benefits, and environmental impacts surrounding forest management.[47] These principles and criteria are designed for a variety of ecological systems around the world; however, FSC encourages national working groups to adapt these principles and criteria to local ecological, economic and social conditions. Additionally, Stewart's refurbishes damaged wooden pallets, thus increasing their useful life up to ten years.

With regard to energy use and conservation, "Aveda views saving energy as an integral part of achieving our mission."[48] The company participates in the EPA Energy Star Program, and has taken measures to achieve energy efficiency such as upgrading roof insulation in the Blaine facility, upgrading its steam boiler with state-of-the-art burners, and purchasing an electric cart for grounds maintenance. According to the 2001 – 2002 CERES report, total energy use for all

Minnesota facilities, including shipping, was 161.1 MM MJ and 168 MM MJ in 2001 and 2002 respectively. It should be noted that the methodology used in the CERES report with regard to quantifying energy use from transportation was not comparable, nor as comprehensive as the methodology used in this master's project.[49]

In the spirit of Aveda's mission to set an example for environmental leadership and responsibility, the company endorses the ten principles of the Coalition for Environmentally Responsible Economies (CERES): protection of the biosphere, sustainable use of natural resources, reduction of waste, energy conservation, risk reduction, safe products and services, environmental restoration, informing the public, management commitment and assessment and reporting.[50] Every company that endorses CERES is obliged to produce an annual environmental report that meets the standard of the CERES Report Form. Aveda has published four reports since 1999, the most recent for the combined 2003 and 2004 fiscal years.

These reports, as well as interviews with company staff, reveal that Aveda has implemented many best practices to reduce the environmental impact of its operations, including waste reduction and increased efficiency. One of the greatest challenges the company faces is in reducing the amount of energy and GHG emissions associated with product packaging and transport. For example, according to the Aveda CERES 2001-2002 report, 50% of Aveda's GHG emissions result from transportation activities alone.

This report is not intended to replicate or refine the transportation analysis found in the CERES report. The analysis conducted for that report is intended to provide an estimated total of energy and GWP for reporting purposes. The purpose of this report is to provide more detailed analysis in order to provide recommendations for areas to reduce transportation impact. Furthermore, the methodology used by the two reports to calculate energy and GWP differed.

Energy content and carbon emissions for fuel are based off of generally accepted data published by the Energy Information Administration. Assumptions are then made to factor for the vehicles being used, specifically the fuel efficiency, the payload, and the utilization. Vehicle types were primarily Class 8 tractor trailers, though a couple carriers had unique truck types, notably UPS's brown delivery vans. Fuel efficiency of the various trucks was based on published data and follow-up interviews with Aveda's carriers. Payload was assumed to be weight-limited at 35,000 lbs, and based on Aveda personnel recommendation trucks were assumed to be utilized 100% of the time including return trips.

In contrast, the CERES report assumed the same fuel efficiency for all trucks, estimated the average modal split (% of shipments that travel by truck versus air or boat), assumed an 80% utilization of trucks, and assumed an average distance for all shipments. As a result, the ratios of shipment weight to energy and shipment weight to GWP is different between the two reports. The CERES methodology is useful to provide an estimated footprint of the entire system, but cannot provide analysis of the system to find inefficiencies.

This study required a compilation of research studies on packaging, transportation, and fuels. The majority of data for packaging came from Franklin Associates (2004), and for consistency, a second Franklin Associates study (1998) was used for primary energy factors for non-renewable fuels. In addition, the modeling program, SimaPro (v.5.1) was used for various packaging and transportation assumptions.[51]

SECTION 4 – PRODUCT DELIVERY SYSTEM

4.1 INTRODUCTION TO AVEDA'S SUPPLY CHAIN

4.1.1 BROAD OVERVIEW

The manufacturing operations are supported by a supply chain that is relatively complex due to Aveda's proprietary formulations and multi-dimensional criteria for its raw materials. Many of its raw materials, especially its plant-based ingredients, are sourced from remote areas of the world, including the Amazon, Southern Asia and South Pacific regions.[52] Additionally, Aveda supports ethical sourcing and organically grown products, thus limiting the number of suppliers available for the company.

With the exception of hair colorants, hair sprays, Pure-Fume™ aromas, makeup, accessories and life style products, which together comprise a minority of product sales, all of Aveda's manufacturing and filling occurs at the Blaine, Minnesota facility.[53] This ISO 14001 certified facility includes a large raw materials warehouse, compounding tanks ranging in size from 100 to 5,000 gallon tanks, and a variety of filling lines. After the product is compounded, filled, and packaged, the products are shipped on pallets by short-haul truck to its Roseville, MN warehouse, located 10 miles south of the Blaine facility.[54] At Roseville, products are received and staged for shipment to customers. High-volume products, such as shampoos and conditioners, are often shipped as full pallets to Aveda's highest volume channels, including the Los Angeles Distribution Center (LADC), Pennsylvania Distribution Center (PADC), and eight U.S. and Canadian third-party distributors. Smaller orders are common, particularly to the approximately 3,000 salons, spas and retail stores throughout the U.S.

4.1.2 PROJECT SCOPE: PACKAGING AND TRANSPORTATION

This study focuses on 1) the total energy and GHG emissions associated with the manufacturing, shipping, and use activities of tertiary packaging, and 2) the total energy and GHG emissions associated with transporting Aveda's Blaine-manufactured products to market, including the associated burdens with fuel sourcing, manufacturing, and use. Section 6 of this report provides strategic recommendations on how the company can reduce its energy use and GHG emissions associated with its PDS.

4.1.3 DEFINITION OF THE PRODUCT DELIVERY SYSTEM

The Aveda PDS is broadly defined as the system employed for the distribution of the company's personal care products and accessories from its Blaine facilities to the Aveda consumer. For the purpose of this report, PDS refers specifically to the processing, transportation, and end-of-life activities associated with the tertiary packaging, as well as the transportation activities associated with the movement of the finished goods from Blaine to the market.

4.1.3.1 PACKAGING

Aveda has faced significant challenges in reducing the amount of cardboard waste associated with its tertiary packaging. With high-volume, low-mix orders, each stock keeping unit (SKU) is shipped in its original master carton on a full or mixed pallet. Relatively little waste is associated with this process because the product is kept in its original packaging. However, if a customer orders a particular SKU in a quantity fewer in number than in the master carton, the order must be reconfigured in new boxes. For example, typical low-volume, high-mix orders include between two and twenty SKUs of product, taken out of their original master cartons, and repacked in one or more new cartons. These smaller orders are also known as "loose-pick orders" and comprise 90% of salon orders. Given that salons within Aveda markets (i.e., the salons outside the third-party territories) account for approximately 40% of total sales, the number of loose-pick shipments from the Roseville DC, LADC and PADC is substantial.

Figure 4A Photo of loose-pick order before final packing and shipping

There are three types of loose-pick cartons, but the most common can accommodate a variety of product dimensions, thus requiring additional dunnage to ensure that the contents in the new configuration are not damaged during shipping. Approximately 60% of the master cartons are reused at the Roseville DC and LADC, while the remaining master cartons are discarded and recycled (no data is available for master carton reuse at PADC).

Of course, for full pallets and case-picks, the contents of the master cartons are not removed for loose-pick, and thus all the master cartons are used to ship product.

Loose-pick orders (shown in the picture above) are less efficient and more wasteful than full pallet shipments. Not only do loose-pick orders require a significant amount of labor, but they also generate a great deal of packaging waste. Establishing minimum order quantities could provide solutions along economic and environmental dimensions; however, many of the smaller salons have tight cash flows and little storage space, thus requiring them to place small quantity orders. Furthermore, Aveda enters into service level agreements (SLA) that require the company to provide any quantity of product within 48 hours of ordering. These SLA offer Aveda a competitive advantage in attracting salons to the Aveda network, but in turn require the company to maintain higher levels of inventory and use energy intense modes of shipping (i.e., air and truck).

4.1.3.2 TRANSPORTATION

Aveda's Transportation Network (ATN), the transportation component of Aveda's PDS, includes all transportation activities associated with the movement of raw materials, packaging, and packaged goods from suppliers, manufacturing, and warehouses to the end consumer. These activities are carried out by four modes—truck, train, air, and cargo ship. This report focuses on ATN related to:

- Movement of packaged goods from Blaine to Roseville,
- Movement of packaged goods from Roseville to regional distribution centers, third-party distributors, retail stores, and salons, and
- Movement of packaged goods from regional distribution centers to retail stores and salons.

Data availability, implementation feasibility, and modeling constraints were considered in determining the breadth of the system boundary. All aspects of primary and secondary packaging were excluded from the life cycle inventory, however as total shipment weight was considered in the transportation study, this will include primary and secondary packages. International shipments were excluded from this study; these activities are significant components of Aveda's operations and should be assessed in future studies.

4.1.4 FUNCTION AND FUNCTIONAL UNIT

4.1.4.1 PACKAGING

The function is defined as the tertiary packaging required to transport Aveda's personal care products and accessories to the market, which includes distributors, retailer stores, or salons/spas. The functional unit for Phase I of this study is the amount of tertiary packaging required to ship all products and accessories to the market over one year.[55]

4.1.4.2 TRANSPORTATION

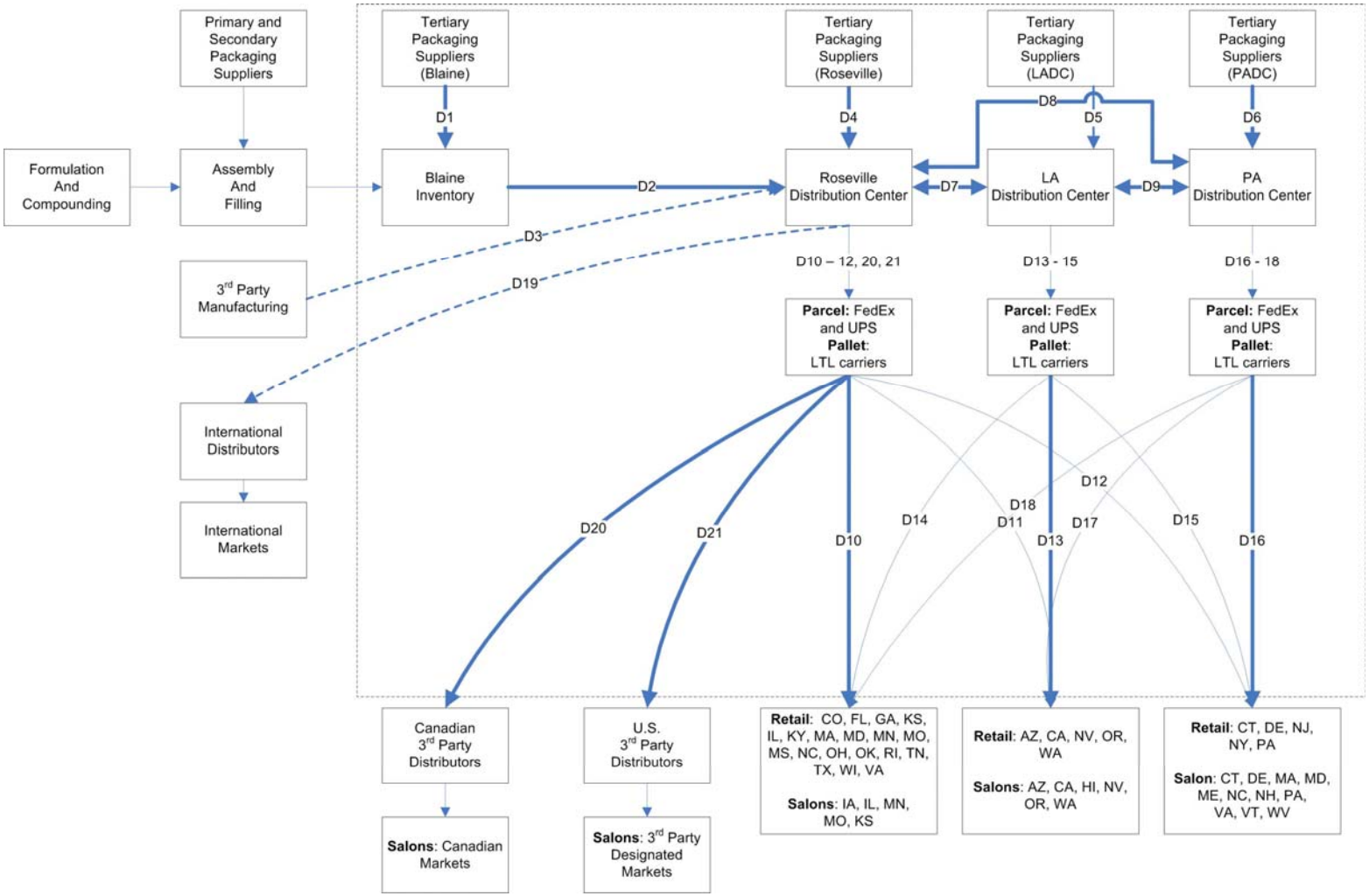
The function is defined as the delivery of Aveda's personal care products and accessories to the market, which may be a distributor, retail store, or salon.

4.2 SYSTEM MODEL OVERVIEW AND BOUNDARIES

The system model overview (Figure 4A) describes Aveda's PDS:

Figure 4B Material flow of Aveda's products manufactured in Blaine and shipped to market via company-owned and Third-party distribution centers.

The activities within the dashed-line rectangle represent the area of focus for this study. Note: The two-way flow of material in D7, D8 and D9 are within the scope of study. D3 and D19 are outside the scope of study. Additionally, the thin lines (D11, D12, D14, D15, D17, D18) represent infrequent occurrences of products being shipped "out of region" to unassigned markets.



4.2.1 FORMULATION AND COMPOUNDING

These activities are outside the scope of this study.

4.2.2 PRIMARY AND SECONDARY PACKAGING AND SUPPLIERS

These activities are outside the scope of this study.

4.2.3 ASSEMBLY, FILLING AND PACKING

These activities are outside the scope of this study.

4.2.4 TERTIARY PACKAGING SUPPLIERS (BLAINE)

Four tertiary packaging suppliers provide cardboard boxes to Blaine. These suppliers are located within a 10 mile radius. The life cycle energy and GHG emissions associated with manufacturing these packaging materials are included in the system model.

4.2.5 TERTIARY PACKAGING SUPPLIERS (ROSEVILLE)

Two tertiary packaging suppliers provide cardboard boxes, dunnage, and plastic wrap to Roseville. These suppliers are located in Illinois and Missouri. The life cycle energy and GHG emissions associated with these packaging materials are included in the system model.

4.2.6 TERTIARY PACKAGING SUPPLIERS (LADC)

One tertiary packaging supplier provides cardboard boxes, dunnage, and plastic wrap to LADC. This supplier is located in California. The life cycle energy and GHG emissions associated with these packaging materials are included in the system model.

4.2.7 TERTIARY PACKAGING SUPPLIERS (PADC)

Four tertiary packaging suppliers provide cardboard boxes, dunnage, and plastic wrap to PADC. These suppliers are located in New Jersey, Connecticut and Quebec. The life cycle energy and GHG emissions associated with these packaging materials are included in the system model.

4.2.8 ROSEVILLE WAREHOUSE AND DISTRIBUTION CENTER, LADC, AND PADC

The environmental burdens associated with operating the facilities are excluded from the scope of this study.

4.2.9 DISTRIBUTION 1

D1 includes the transportation of tertiary packaging materials between the supplier warehouses and the Blaine, MN manufacturing facility. All of the shipments utilize bulk trucks. A life cycle analysis for truck manufacturing is excluded from the model.

4.2.10 DISTRIBUTION 2

D2 includes the transportation of packaged finished goods from the Blaine facility to the Roseville warehouse, located 10 miles south of the plant. Multiple trailer loads are made each day between Blaine and Roseville.[56] The energy and GHG emissions associated with fuel sourcing, manufacturing, and use are included in the model. A life cycle assessment of the truck sourcing and manufacturing is excluded from the model.

4.2.11 DISTRIBUTION 3

A minority of Aveda's products, in terms of value, are manufactured by third-party manufacturers. D3 represents the transportation of third-party manufactured goods from various domestic and international locations to the Roseville DC. These activities are outside the scope of the project.

4.2.12 DISTRIBUTION 4, 5 AND 6

D4 includes the transportation of tertiary packaging materials between the supplier warehouses and the Roseville, MN warehouse. All of the shipments utilize bulk trucks. These activities are included in the model. However, a life cycle assessment of the truck sourcing and manufacturing is excluded from the model.

D5 includes the transportation of tertiary packaging materials between the supplier warehouse and the LADC warehouse. All of the shipments utilize bulk trucks. These activities are included in the model. However, a life cycle assessment of the truck sourcing and manufacturing is excluded from the model.

D6 includes the transportation of tertiary packaging materials between various tertiary packaging suppliers as described in section 4.2.7 and the PADC. All of the shipments utilize bulk trucks. These activities are included in the model. However, a life cycle assessment of the truck sourcing and manufacturing is excluded from the model.

4.2.13 DISTRIBUTION 7, 8 AND 9

D7, D8 and D9 describe the transportation of packaged finished goods among the Roseville DC, LADC and PADC. The predominant flow of material begins in Roseville and goes to either the LADC or the PADC, but a small percentage of finished products are shipped back to Roseville or between the two coastal DCs. The shipments are made predominantly by truck and infrequently by air. These activities are included in the model. However, a life cycle assessment of the trucks and airplanes is excluded from the model.

4.2.14 DISTRIBUTION 10, 11 AND 12

D10, D11 and D12 describe the transportation of packaged finished goods from Roseville DC to retail stores and salons around the country. D10 represents the dominant flow of product from Roseville, which includes shipments to retail stores in CO, FL, GA, KS, IL, KY, MA, MD, MN, MO, MS, NO, OH, OK, RI, TN, TX, WI, VA and salons in the IA, IL, KS, MN, MO.

D11 and D12 represent infrequent shipments to markets normally serviced by the LADC and PADC. LTL is the most common mode of transportation for all three routes. These activities are included in the model. However, a life cycle assessment of the trucks and airplanes is excluded from the model.

4.2.15 DISTRIBUTION 13, 14 AND 15

D13 represents the dominant flow of Aveda products from the LADC to West Coast markets, including retail stores in AZ, CA, NV, OR and WA and salons in AZ, CA, HI, NV, OR and WA. D14 and D15 represent infrequent shipments to markets normally serviced by the Roseville DC and PADC. LTL is the most common mode of transportation for all three routes. These activities are included in the model. However, a life cycle assessment of the trucks and airplanes is excluded from the model.

4.2.16 DISTRIBUTION 16, 17 AND 18

D16 represents the dominant flow of product from PADC to retail stores in CT, DE, NJ, NY, PA and salons in the CT, DE, MA, MD, ME, NC, NH, PA, VA, VT, WV. D17 and D18 represent infrequent shipments to markets normally serviced by the Roseville DC and LADC. LTL is the most common mode of transportation for all three routes. A life cycle assessment of the trucks and airplanes is excluded from the model.

4.2.17 DISTRIBUTION 19

D19 describes the transportation of Aveda products from Roseville to International distributors. The shipments are mainly made by rail and cargo ship. Note that D19 is not included within the scope of this study nor is the subsequent transportation from these distributors to salons and spas.

4.2.18 DISTRIBUTION 20 AND 21

Distribution 20 and 21 describes the transportation of packaged goods from Roseville to Canadian and U.S. third-party distributors. These shipments are almost entirely made by truck. The transportation from these distributors to salons and spas is excluded from the model.

Canadian third-party distributors include:

- CDC-A. Serves: Alaska and British Columbia Province.
- CDC-B. Serves: Alberta Province.
- CDC-C. Serves: Ontario and Quebec Provinces
- CDC-D. Serves: Nova Scotia, Newfoundland, New Brunswick and Prince Edward Island Provinces.

U.S. third-party distributors include:

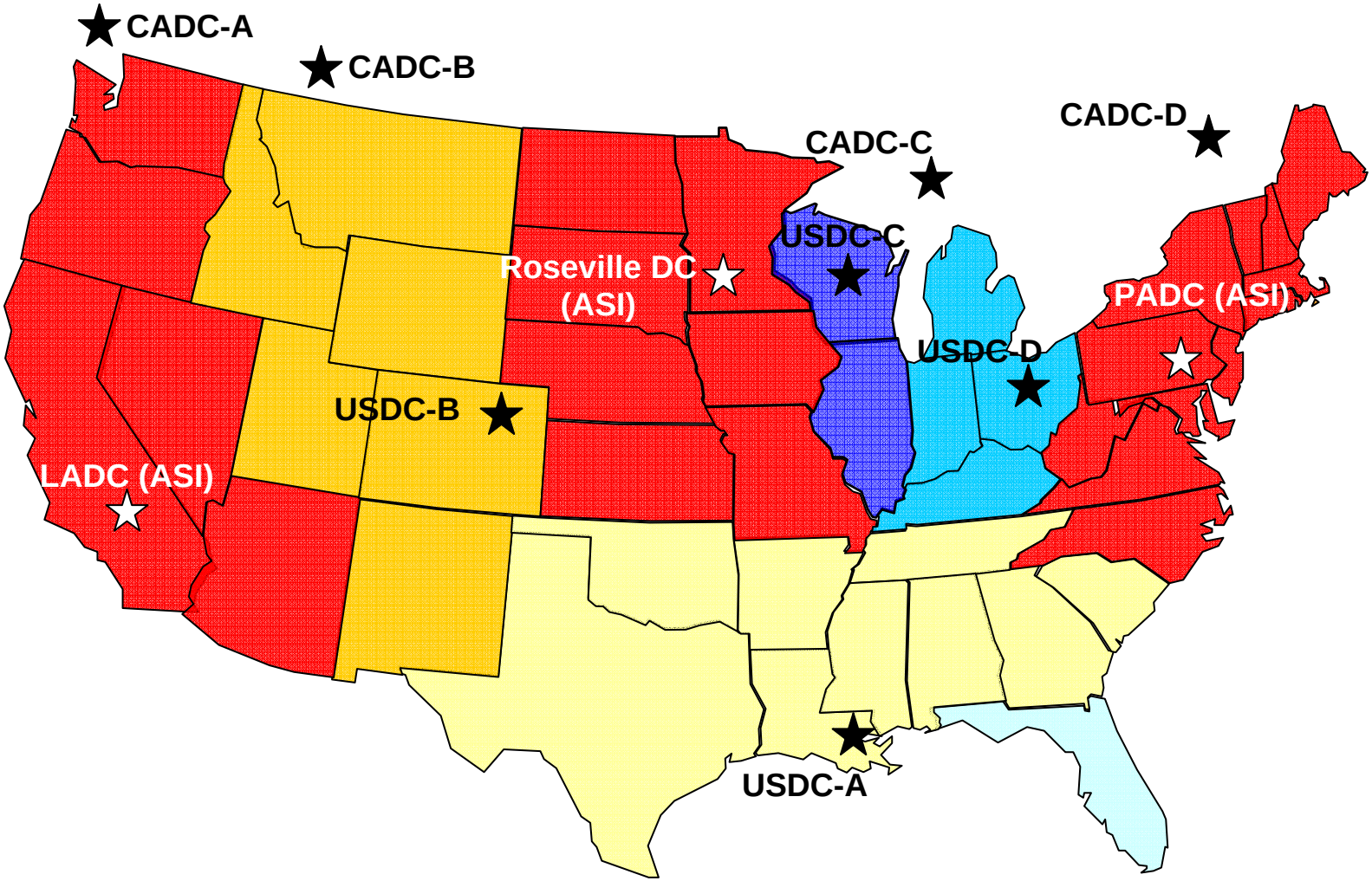
- USDC-A. Serves: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee and Texas
- USDC-B. Serves Colorado, Idaho, Montana, New Mexico, Utah and Wyoming
- USDC-C. Serves: Illinois and Wisconsin.
- USDC-D. Serves: Indiana, Kentucky, Michigan and Ohio.

4.2.19 MARKETS

The environmental burdens associated with the purchase and use of Aveda's products is excluded from this study.

See Figure 4B for a map of North America and the specific territories managed by Aveda DCs as well as those territories managed by third-party distributors.

Figure 4C Map of Aveda-owned and Third-party Distribution Centers in the US and Canada. The distribution channels for North America are divided between those states serviced by Aveda-owned distribution centers (Roseville DC, LADC and PADC) and states and provinces managed by third-party distributors. The states in red are managed by Aveda while the other states are managed by third-party distributors.



4.3 DESCRIPTION OF ALL TERTIARY PACKAGING MATERIALS USED THROUGHOUT THE PDS

Aveda uses several different types of tertiary packaging as part of its PDS, primarily corrugated cardboard boxes, plastic stretch wrap, kraft paper, newsprint, and wooden pallets. This packaging is used to ship products from the Blaine production facility to the three distribution centers within the ASI network, as well as from each of the distribution centers to the salon and retail locations. This section describes the predominant types of tertiary packaging used throughout the PDS. A complete list of tertiary packaging materials, including material constituents and recycled content, can be found in Appendix A.

4.3.1 SUMMARY OF FINDINGS

The following data describes annual average of materials purchased by Aveda, from calendar years 2002 and 2003 (the data provided by the packaging supplier to the PADC, however, describes only aggregate data from 2001 through 2003, so the PADC data included below is an annual average over these three years). The pallet data describes purchases from January 2003 to July 2004, and includes softwood pallets (42" x 48") and hardwood, international pallets (1000cm x 1,200cm), each type weighing 20 kg. All data have been rounded.

Table 4A Annual Average Tertiary Packaging Material Use at Aveda Facilities (Kg)

Packaging Type	Total
Cardboard (including corrugated, chipboard, corroseal, cohesive, and roll cores)	546,000
Post-Consumer Cardboard	280,000
Corrugated Containers	491,000
Total Cardboard	1,317,000
Cellulose Paper	6,000
Kraft Paper	23,000
Newsprint Paper	4,000
Total Dunnage Papers	33,000
Total Plastic (including stretch wrap and bubble wrap)	7,000

Only one packaging product contains 100% virgin content: plastic stretch wrap used at Blaine and Roseville facilities, which is made from 100% virgin LLDPE. According to Roseville staff, Aveda has investigated various alternatives to plastic wrap, such as spray-on adhesive, metal bands, and large rubber bands, but has been unable to identify a product with adequate performance. Additionally, research shows that plastic stretch wrap made from recyclable materials is not available on the market.

4.3.1.1 CARDBOARD

This category includes cardboard boxes in various sizes, which are used to ship products to customers. This category also includes self-adhesive, corrugated sheets that are used to protect glass products.

In 2003, the Blaine facility recycled 229,000 kg of corrugated cardboard and the Roseville DC recycled 40,600 kg of corrugated cardboard. Recycling data for 2002 was not available; additionally, both facilities pool their resources for long periods of time thus the data includes materials purchased in the previous year. The greater than five-fold difference between the two facilities stems from the fact that Blaine receives larger volumes of incoming packaging supplies, raw materials, and office supplies/equipment (note: incoming raw material/supplies to Blaine is outside of scope, except for tertiary packaging). Few of these cardboard boxes can be reused since they were designed to accommodate the dimensions and weight of the raw materials and supplies, not the value and mass of Aveda finished products.

4.3.1.2 PLASTIC

This category includes plastic wrap dispensed from both machine and manual sources. Material constituents are low-density polyethylene (LDPE) and linear low-density polyethylene (LLDPE). The plastic wrap is used to secure boxes onto pallets prior to shipment. These figures do not include plastic packing tape, which was determined to be negligible. Note also that the LADC uses approximately 30 kg of bubble wrap per year, which is also negligible and included in this category.

In 2003, the Blaine facility recycled 5,000 kg of plastic wrap and the Roseville DC recycled 1,200 kg of plastic shrink wrap. As described above, recycling data for 2002 was not available; additionally, both facilities pool their resources for long periods of time thus the data includes materials purchased in the previous year. The greater than four-fold difference between the two facilities stems from the fact that Blaine receives larger volumes of incoming supplies (note: incoming raw material/supplies to Blaine is outside of scope, except for tertiary packaging). Additionally, shrink-wrap cannot be reused.

Figure 4D Photo of Kraft Paper Dispenser at the Roseville DC.

4.3.1.3 KRAFT PAPER

This category includes Kraft Paper (see Figure 4C), RanPak, and KimPak Wadding, which are used to fill empty space in package shipments and to cushion products to protect them from damage. The category also includes paper bags in which some smaller products are placed prior to shipment.

4.3.1.4 NEWSPRINT

This category includes newsprint that is used to fill empty space and provide cushioning. Newsprint is used at the LADC and PADC only.

4.3.1.5 PALLETS

Between January 2003 and July 2004, the Blaine facility purchased on a monthly basis approximately 800 40” x 48” softwood pallets and 200 hardwood pallets for use in domestic shipments (hardwood is used for foreign shipments), totaling 245,000 kg on an annual basis. This may seem relatively low; however, the company reuses all incoming pallets from suppliers and refurbishes all pallets to increase useful life.

4.3.2 PACKAGING INTENSITY

As described below, this report includes transportation data for a five month period, which has been annualized. Note that this analysis is based on available data which includes packaging data that is annualized from a two-year average, while the transportation data is annualized from a five-month average.

4.4 DESCRIPTION OF AVEDA'S TRANSPORTATION NETWORK

As described above, Aveda's distribution network is complex and involves four modes of transportation and countless nodes, including eleven distribution centers across North America. The data provided for the analysis of the transportation network was provided by Aveda's transportation department, which oversees the inbound and outbound transport of products for the three Aveda owned distributors and the outbound logistics to eight third-party owned distribution centers in North America and eleven international DCs. The data covers the five months from October 2003 through February 2004, which was assumed to be a representative sample because it includes both the busy holiday season as well as the slow winter period. Quantities have been adjusted to provide annualized estimates.

4.4.1 TRUCK

The vast majority of Aveda's products are shipped to customers via truck, which is the most common mode of transportation for goods in the U.S.[57] The major categories of shipment by truck are parcel, Less Than Load (LTL) carrier, and Truck Load (TL) carrier.

4.4.1.1 PARCEL

Over 99% of parcel shipments are via UPS. Fed-Ex is used for occasional shipments containing products with volatile or combustible compounds such as hairspray as well as for occasional shipments requiring overnight service. UPS and FedEx receive shipments and then transport them to regional zone hubs where they then reorganize freight and send it out to the final destination in the most efficient way possible while maintaining customer service levels. A more detailed analysis of this data and the methodology used to calculate it will be provided in Section 5. PADC has the most shipments going via UPS because there is a high concentration of salons in the Northeast that are relatively small and do not order large enough quantities to justify LTL.

UPS and FedEx shipments originating from and ending at the Blaine facility were excluded from analysis because they are due to sales, marketing, and research activities and are outside our project scope.

4.4.1.2 LESS THAN LOAD (LTL) AND TRUCK LOAD (TL)

LTL carriers receive shipments at Aveda's Roseville facility and manage the routing of each truck to maximize its utilization, often reorganizing pallets of freight at a local hub. LTL carriers are only able to accept shipments by the pallet-load; therefore Aveda uses LTL predominantly to ship to LADC, PADC, and retail stores, but only for a minority of salon orders. TL shipments occur

when a distributor orders a large enough quantity (over 30,000 lbs or 13,600 kg) to warrant a dedicated shipment. These shipments have the most direct routing. TL shipments are currently limited to third-party distributors (see Table 4B) and some orders for LADC and PADC.

Aveda ships to 10 different distributors located across the US and Canada. The approximate distances are shown below in Table 4B for each of the distributors.

Table 4B Roseville Distributor Shipments

Distributor	Distance (miles)
PADC	420
LADC	850
USDC-A	932
USDC-D	950
USDC-C	950
USDC-B	1,187
CADC-C	1,193
CADC-B	1,805
CADC-A	1,825
CADC-D	2,097

Aveda determines the delivery schedule for the 130 plus retail stores it owns. Higher-volume retail stores receive shipments on a weekly basis, while the remainder receives shipments once or twice a month. Stores are served by the closest DC to reduce travel distance and cost.

4.4.2 Air

Aveda limits the use of air shipments to minimize costs. However, due to the nature of their distribution system, Aveda occasionally ships via air to serve certain customers. The largest portion of domestic air transport is utilized to serve customers in Hawaii. When the data for this project was collected, Aveda shipped to Hawaii via air in order to provide service within 2 days. While salons are charged a flat fee per order for shipments, Aveda spent on average $85 per order, plus an additional $100 for hazardous (hairspray) orders.[58] Therefore, a large financial incentive existed to shift these shipments to ocean or drastically increase the cost of shipping for these customers. In mid-2004 Aveda began shipping to Hawaii via ocean.

4.4.3 Ocean

Aveda initiated a pilot program in June 2004 to ship orders to Hawaii by boat rather than airplane (a similar program is in place for orders to Puerto Rico). This change in transportation mode would increase delivery times from two days to thirteen days, but would also reduce costs by a factor of four and significantly reduce the GHG emissions associated with shipping product to Hawaiian and Puerto Rican customers.

It should be noted that shipping to Puerto Rico via ocean poses some unique challenges. Certain shipments have been impounded for a variety of reasons, including paperwork not being completed correctly and taxes not being properly reported or paid. These problems have led to significant delays and compromised Aveda customer service levels for Puerto Rican customers.[59]

4.4.4 TRAIN

For large orders to Asia, Aveda ships products from Roseville via rail to a container ship port in Vancouver, British Columbia, where the cargo is loaded onto a container ship and transported to Korea, Japan, Taiwan, Hong Kong, Malaysia, and Australia. Large orders destined for Europe are sent by rail to a container ship port in Montreal and then shipped to Iceland, the United Kingdom, the Netherlands, Germany or Italy. While a combination of train and ship are relatively more efficient than truck, these transportation modes are limited to international orders, which are outside of the scope of this project. Aveda currently does not use rail to ship products to any destinations within the United States.

4.5 DESCRIPTION OF TRANSPORT PATHS

4.5.1 BLAINE FACILITY

Aveda's Blaine facility receives secondary and tertiary packaging material from three suppliers. See Table 4C for the distance from each supplier to the Blaine facility. This material is transported by truck. Blaine receives 2-3 shipments per week from Supplier A, 1 shipment every 7-10 days from Supplier B and 2 shipments per week from Supplier C. Once the product has been packed in the secondary and tertiary packaging it is palletized and loaded onto a class 8 tractor trailer and shipped to the Roseville facility.

Table 4C Distance from Supplier to Blaine Facility

Supplier	Miles to Blaine
Supplier A	9
Supplier B	10
Supplier C	10

Aveda contracts the use of a truck and four trailers to ship finished, packaged product from Blaine to Roseville, located ten miles away. Multiple truckloads are shipped per day and the trucks return empty. The metric ton-miles per year will be reduced by approximately 98% when Aveda replaces the Roseville DC with a new DC in Blaine, which will be located approximately 1/8 mile from the current compounding and filling operations.

All product manufactured in the Blaine facility is shipped to Roseville before it is sent to customers. However, the Roseville facility also receives a minority of its products, in value terms, directly from third-party vendors. The transport of these additional products from vendors to Roseville is outside the scope of this project.

4.5.2 ROSEVILLE FACILITY

The Roseville facility ships orders by truck to two Aveda-owned DCs, to Midwest salons, to a majority of Aveda retail stores, and to four U.S. and four Canadian third-party distributors. Shipments are made on full or mixed pallets which impacts the number of pallets that can be shipped on one truck. Mixed pallets are composed of varying sized boxes (see Figure 4D), which often prevent stacking. For example, an LTL carrier loaded with all mixed pallets might only be able to carry 24 pallets; whereas an LTL truck loaded with full pallets can carry upwards of 38.

In addition, trucks are limited by weight capacity laws. The maximum weight varies by state, but Aveda ships a maximum of 35,000 pounds per truck.

Figure 4E Photo of Mixed Pallets Loaded

At the time of writing, Aveda is building a new distribution center in Blaine, immediately down the road from the manufacturing facility. The distance from dock-to-dock is estimated to be approximately 1/8 of a mile. The Roseville facility will be closed a few months after the new facility is fully operational.

4.5.2.1 DISTRIBUTION CENTERS

Roseville ships processed orders to two DCs: the LADC in Southern California, which is wholly-managed by Aveda, and the PADC in Eastern Pennsylvania, which is owned and operated by Estée Lauder. Aveda is only 1 of 15 brands that is distributed out of the Estée Lauder PADC, and a limited quantity of Aveda's product is shipped direct from third-party vendors to the PADC.

From the LADC, a majority of salon shipments, most of which are loose-pick, go by UPS to roughly 800 west coast salons. The other salon shipments, most of which are loose-pick, are transported to 20 Lifestyle Salons. The LADC also ships to 27 retail stores in California, Nevada, and Arizona by LTL carriers and has started shipping to the 7 stores in OR and WA; the majority of these shipments are full case. From the PADC, a majority of salon shipments go by UPS to roughly 1,000 Northeast salons, most of which are loose-pick. The other salon shipments go to 30 Lifestyle Salons, most of which are loose-pick. PADC also ships to 18 retail stores in Connecticut, New York, New Jersey, Pennsylvania, and Delaware by various LTL carriers, most of which are full case.

4.5.2.2 Roseville direct to Salons and Retail

Aveda ships from Roseville direct to Midwest salons and 78 retail stores in the Midwest, South, and East. Roseville formerly shipped to the 7 stores in the Pacific Northwest; however those are now being fulfilled out of the LADC. From Roseville, a majority of salon shipments, most of which are loose-pick, go by UPS to roughly 700 Midwest salons. The other salon shipments, most of which are loose-pick, go to 20 Lifestyle Salons via LTL carriers. Shipments to 78 retail stores nationwide are by LTL, most of which are full case.

4.5.2.3 Roseville to Third-party Distribution

Aveda ships its product by truck, containing either full or mixed pallets, to four U.S. third-party distributors.

4.5.2.4 Roseville to International

Aveda ships all of its international shipments out of its Roseville facility. A majority of these shipments go by container ship and the rest go by air. While these shipments are significant, they are excluded from the analysis in this report because international shipping options are largely out of Aveda's control.

4.5.3 DC-to-DC (Inventory Disposition) and Out-of-Region Shipments

On occasion, shipments occur between DCs in order to maintain adequate levels of inventory. This is referred to as "inventory disposition," which is a necessary aspect of the business, given the challenges of maintaining high customer service levels. There are several business reasons for inventory disposition. For example, if a product is low in stock at a particular DC, and the company is not ready to produce an additional batch in Blaine, Aveda will ship the product to that DC from one of the other two DCs that has it in stock. Further, discontinued products (i.e.,

products that are no longer being manufactured, but still being sold), are dispersed among the three DCs according to historic demand levels. Since these particular SKUs are not being backfilled as they are shipped out, an uneven level of product arises across the DCs. Aveda will often consolidate these SKUs to the Roseville DC to save space at the LADC and PADC.

SECTION 5 – MODELING AND RESULTS

5.1 INTRODUCTION

Upon completion of data gathering, the PDS was modeled to determine the total energy use and global warming potential (GWP). The models for packaging and transportation were created separately because the packaging and transportation data was provided by Aveda in different formats, and different software was required for each analysis. Therefore, the analysis of the packaging and transportation data is discussed separately in this section. All data, unless otherwise noted, is presented on an annualized basis, although the packaging data is an average of purchases of packaging materials over the two calendar years of 2002 and 2003, while the transportation data describes transportation from the five month period of October 2003 through February 2004. Aveda personnel involved in this project have advised that, when annualized, the data from these periods are representative of annual transportation activities and packaging use.

Two impact categories were modeled: global warming potential (GWP) (expressed in kg of carbon dioxide equivalents) and primary energy use (expressed in MJ). GWP is a measure of how much of a given mass of a certain GHG is estimated to contribute to global warming. Carbon dioxide equivalents for a gas are calculated by multiplying the tons of the gas by the associated GWP. The gases that affect GWP include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The GWP for CH_4 is 21 and for N_2O 310.[60] This means that emissions of one ton of CH_4 and N_2O respectively are equivalent to emissions of 21 and 310 tons of carbon dioxide. For the purposes of this model, only CO_2 and CH_4 were considered because these gases are the primary gases emitted in transportation and packaging, and constitute over 99.5% of the impact to GWP. For further justification of the decision to model only CO_2 and CH_4 see Appendix A ("Consideration of Global Warming Emissions").

5.2 PACKAGING MODEL AND RESULTS

Aveda's packaging system was described in Section 4 of this report. This section (5.2) of the report specifically covers modeling of Aveda's packaging use and summarizes the data used in the model, the major assumptions required to complete the model, and the results of the model. A complete set of data and assumptions is provided in Appendix A.

5.2.1 PACKAGING DATA

The majority of the packaging data was provided by Aveda's records and through packaging suppliers (see section 4.2). The distances from suppliers to Aveda facilities vary greatly and impact the GWP and energy use (see Table 5A) to varying degrees. Blaine suppliers are located

between 7 and 21 miles from the Blaine facility, Roseville suppliers are located between 13 and 18 miles from the Roseville facility, PADC suppliers are located between 67 and 513 miles from the PADC facility, and the LADC supplier is located 12 miles from LADC. Gaps in data were filled with data from alternative reference sources and assumptions. To address the large number of packages used by the Blaine facility, packaging data were summarized by type (i.e., packages of various sizes were summed together according to the quantity purchased). See Appendix A for a listing of all packaging data modeled.

Table 5A Packaging Suppliers Distances from Aveda-Owned DC

Supplier	Miles From DC
Blaine	
Supplier A	7
Supplier B	19
Supplier C	21
Supplier D	21
Roseville	
Supplier E	13
Supplier F	18
PADC	
Supplier G	437
Supplier H	513
Supplier I	163
Supplier J	67
LADC	
Supplier K	12

5.2.2 Packaging Input Parameters

A model of the annual impacts for production and delivery of packaging material to Aveda manufacturing and distribution centers was developed using SimaPro (v. 5.1), a life cycle assessment modeling software tool. The package production inventory data, national average package composition data, and recycled content for typical packages were based on a Franklin Associates Study conducted for the Oregon Department of Environmental Quality in 2004.[61] The annual packaging material requirements (average annual quantity purchased by each Aveda-owned facility – Blaine, Roseville, LADC, and PADC) were entered into the model, and the total GWP (expressed in kg of CO_2 equivalents) and primary energy (expressed in MJ) were calculated for the total packaging used at each of the Aveda facilities.

5.2.3 Packaging Modeling Results

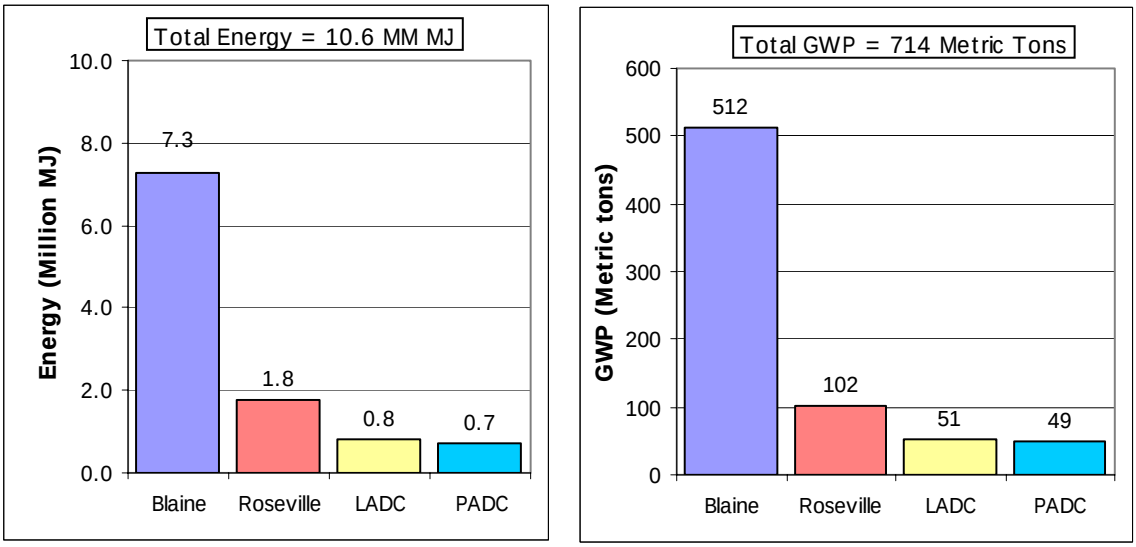
The packaging modeling results confirmed preliminary analysis of the PDS and did not expose any critical inefficiency in the system. Given the annual average packaging material use at Aveda facilities, the total life cycle results were calculated. The parameters for the life cycle start with raw materials and end when packaging supplies are delivered to Aveda facilities. The data

collected shows that Blaine uses the most cardboard per year with Roseville, PADC, and LADC following respectively; Blaine's usage is 75% of the total cardboard used among all Aveda facilities. These results are somewhat surprising: one would expect the Roseville DC to use more cardboard since it fills and packages customer orders (i.e., loose-pick, mixed pallets, etc.), however, the packaging of the master cartons at the manufacturing facility account for more of the total cardboard usage. Additionally, purchasing data shows that Blaine and PADC do not use plastic (stretch wrap and bubble wrap), however, observation at the facilities confirms otherwise. Nonetheless, the quantity of plastic used is minimal, and therefore the GWP effect would be minor. Lastly, Roseville and Blaine account for 84% of the total annual paper used at Aveda facilities. The extensive use of paper at Roseville stems from the dunnage associated with the loosepick orders (by volume, paper accounts for 20 – 30% of a typical loose-pick box).[62]

The use of wood in this model is treated as the use of a material resource (not as a fuel, thereby excluding wood from the energy analysis) and wood is considered carbon neutral – carbon emissions associated with wood combustion are excluded from the global warming gas assessment. Although the impact of pallets was not fully quantified in the analysis, Section 7.4 qualitatively explores the issues arising from the over-use of pallets in the Aveda PDS.

The Blaine Production Facility accounts for the greatest amount of GWP and primary energy use because all manufactured products are packaged in Blaine prior to being transferred to Roseville. Roseville uses additional packaging for the loose-pick operation (see Figure 5A). As mentioned before, Blaine might be billed for packaging that is actually used at Roseville. Roseville and Blaine are also supplying product to the PADC and LADCs, thus capturing some of the GWP and energy use associated with PADC and LADC. The figure below shows the primary energy use and GWP associated with the four Aveda-owned DCs.

Figure 5A Primary Energy Use and Global Warming Potential Associated with Aveda-Owned DCs and Blaine Production Facility



As shown above, the greatest primary energy use and GWP is associated with Blaine. Looking at the total primary energy use from the Aveda-owned DCs, approximately 4% of the total primary energy use (10.6 MM MJ) for annual packaging requirements is related to the transport of tertiary packaging from suppliers and tertiary packaging materials. The remainder results from the energy required to produce packages and acquire the associated raw materials. The graph to the right, GWP, follows a similar pattern.

5.3 Transportation Model and Results

The transportation system is described in detail in Section 4 of this report. The focus of this section is to summarize the data used for modeling, the major assumptions required to complete the model, and the results of the model. A complete set of data and assumptions is provided in Appendix B. The energy associated with transportation includes the energy embodied in the fuel consumed and the energy required to source, refine and transport that fuel. Transport energy reflects the energy required to ship products and the associated primary, secondary, and tertiary packaging. The GWP associated with transportation includes the GHGs emitted from combustion of fuel as well as gases emitted from the sourcing, refining and transportation of fuel.

5.3.1 Transportation Data

The Aveda transportation team provided data in May of 2004. As mentioned in Section 4 of this report, Aveda ships its product by Truckload (TL) and Less-than-Truckload (LTL) via a number of various carriers, and ships parcels via United Parcel Service (UPS) and FedEx. Aveda tracks these

shipments in separate databases, and therefore the files were merged to build the model. More specifically, the following three data files provide the basis of the model:

- LTL Shipments: All LTL shipments for Roseville, LADC and PADC for the period of October 2003 through February 2004 (five months). This file provides carrier name, the weight of each shipment, shipping origin company name and address, and shipping destination company name and address. Several carriers do not report LTL shipments and thus were excluded from this data set, specifically: "Carrier A" for some retail store deliveries out of LADC; "Carrier B", which services retail stores out of PADC; and "Carrier C", which services salons out of PADC. Shipments for these carriers are included in a separate data source listed below and are included in the model;
- Parcel Shipments: All UPS and FedEx shipments paid for by Aveda. This file provides carrier name, the weight of each shipment, shipping origin company name and address, and shipping destination company name and address. It appears that customer returns are not included in this data set.
- Carton Totals: Summary file for all outbound shipments. This data repeats some of the LTL shipping data and the UPS/FedEx data, but was used to provide the TL shipments to other distributors, as well as total LTL shipments from "Carrier A", "Carrier B", and "Carrier C".

For modeling the LTL data several modifications are made to ensure the entire PDS system is accounted for. First, "Carrier A", "Carrier B", and "Carrier C" are incorporated using the Carton Totals. For each carrier the total weight is distributed evenly to the stores each distributor services, except for those stores that receive shipments once a week instead of once every other week. These stores are assumed to receive twice as much weight as other stores. Details of the data used for these three LTL carriers are provided in Appendix B. For modeling the UPS and FedEx data, reasonable assumptions were made, based on website research and discussions with experts, about the mode of transport used in the parcel network. Details of these assumptions are described in Appendix B. Lastly, TL shipments were added to the file, which accounted for a majority of shipments to third-party distributors.

With all shipments included in the file, the data were then coded to allow for detailed analysis. The following coding system was used:

From Code:

- Blaine – If shipped from Blaine (MN manufacturing facility)

- Roseville – If shipped from Roseville (MN distribution facility).
- LADC – If shipped from the LADC
- PADC – If shipped from the PADC
- Retail – If shipped from one of the listed retail stores provided by Aveda
- Salon – If shipped from a salon. Salons were identified by a list of Aveda Services Inc. serviced salons and through the online salon directory at Aveda.com.
- Third-party US – If shipped from one of the third-party U.S. distributors
- Third-party CA - If shipped from one of the third-party Canadian distributors

To Code:

- Blaine – If shipped to Blaine (MN manufacturing facility)
- Roseville – If shipped to Roseville (MN distribution facility).
- LADC – If shipped to the LADC
- PADC – If shipped to the PADC
- Retail – If shipped to one of the listed retail stores provided by Aveda
- Salon – If shipped to a salon. Salons were identified by a list of Aveda Services Inc. serviced salons and through the online salon directory at Aveda.com.
- US DC – If shipped to one of the third-party U.S. distributors
- CA DC - If shipped to one of the third-party Canadian distributors

Shipment data for LTL and TL did not include the shipping distance, but instead included the origin and destination zip codes. Therefore, driving distance was calculated using the online service Mapquest.com as well as by calculating distance based on the coordinates of each zip code. The methodology for determining distance is provided in detail in Appendix B.

5.3.2 Transportation Input Parameters

Modeling the energy and GWP impacts of transportation requires the use of many industry standards, notably for the fuel and vehicle characteristics. A detailed overview of the various assumptions and parameters used for modeling is included in Appendix B, but the following (also mentioned in Section 3) provides a summary.

Energy content and carbon emissions for fuel are based off of generally accepted data published by the Energy Information Administration. Assumptions are then made to factor for the vehicles being used, specifically the fuel efficiency, the payload, and the utilization. Vehicle types were primary Class 8 tractor trailers, though a couple carriers had unique truck types, notably UPS' brown delivery vans. Fuel efficiency of the various trucks was based on published DOT data and follow-up interviews with Aveda's carriers. Payload was assumed to be weight-limited at 35,000 lbs, and trucks were assumed to be utilized 100% of the time including return trips.

Global warming potential values for CO_2 and CH_4 are taken as reported by the Intergovernmental Panel on Climate Change's (IPCC) Third Assessment Report.[63] Franklin Associates estimates for the combustion of fuel have been used for consistency with packaging model calculations.[64] Fuel combustion impacts, including CO_2 and CH_4 emissions resulting from fuel combustion (including upstream), crude oil extraction requirements, total primary energy, and total global warming potential are shown below in Table 5B.

Table 5B Fuel Combustion Impacts

Fuel	Vehicle	CO_2 (kg/gal)	CH_4 (g/gal)	Crude Oil (kg/gal)	Energy (MJ/gal)	GWP (kg CO_2 eqv./gal)
Diesel	Truck	12.6	14.7	3.52	158	13.0
Jet Fuel	Cargo Plane	11.0	14.1	3.41	153	11.3
Fuel Oil	Freighter	13.8	16.8	3.93	177	14.1
Diesel	Locomotive	12.6	14.7	3.52	158	13.0

Four types of trucks are predominant in the PDS and are thus used in this model; tractor trailers, dual trailers, straight trucks, and parcel delivery trucks. The fuel efficiency of trucks are as published by Davis and Diegel.[65] The majority of LTL and TL carriers use standard tractors with 53-foot trailers, which are classified by the DOT as "class 8" trucks or "tractor trailers". Some carriers use standard tractors with dual 28-foot trailers, which are also classified by DOT as "class 8" trucks, but for purposes of this model are assumed to have a larger payload. A couple carriers use "straight trucks" which are classified as "Class 7" by the DOT. Lastly, the "brown trucks" used by UPS, are assumed to be "class 2" trucks/vans. When additional data is unavailable, all transportation and product delivery operations are modeled assuming class 8 trucks are used for the full delivery distance. Generally these vehicles are used for the vast majority of transportation distances for the carriers studied. Exceptions are noted in Appendix B.

Shipments to Puerto Rico are assumed to travel by class 8 trucks to Miami then by boat to Puerto Rico. Puerto Rico salons are responsible for arranging to pick up products from the Puerto Rico

port in San Juan. Fuel consumption rates and payload for ocean freight are as stated by the U.S. Maritime Administration.[66]

5.3.3 Transportation Modeling Results

The total annualized energy and GWP from PDS transportation is 25.8 MM MJ and 2,097 metric tons of CO_2 equivalents respectively. The impact from shipments leaving the Roseville facility is much larger (18.63 MJ, 1,532 GWP, 73% of total) than the other distribution centers (see Figure 5B). Due to the addition of stores and salons, Roseville ships inventory to the LADC, PADC and the eight third-party distributors in North America. Shipments out of the LADC and PADC are for retail and salon orders as well as a small quantity of inter-distributor inventory shipments. Shipments out of Blaine represent the transportation from Blaine manufacturing to the Roseville Distribution warehouse, approximately ten miles. Shipments labeled "Other" represent third-party distributors to Roseville, or salons and retail to either LADC or PADC.

Figure 5B Total Annualized Transportation Energy and GWP For Products Leaving Aveda-Owned DCs[67]

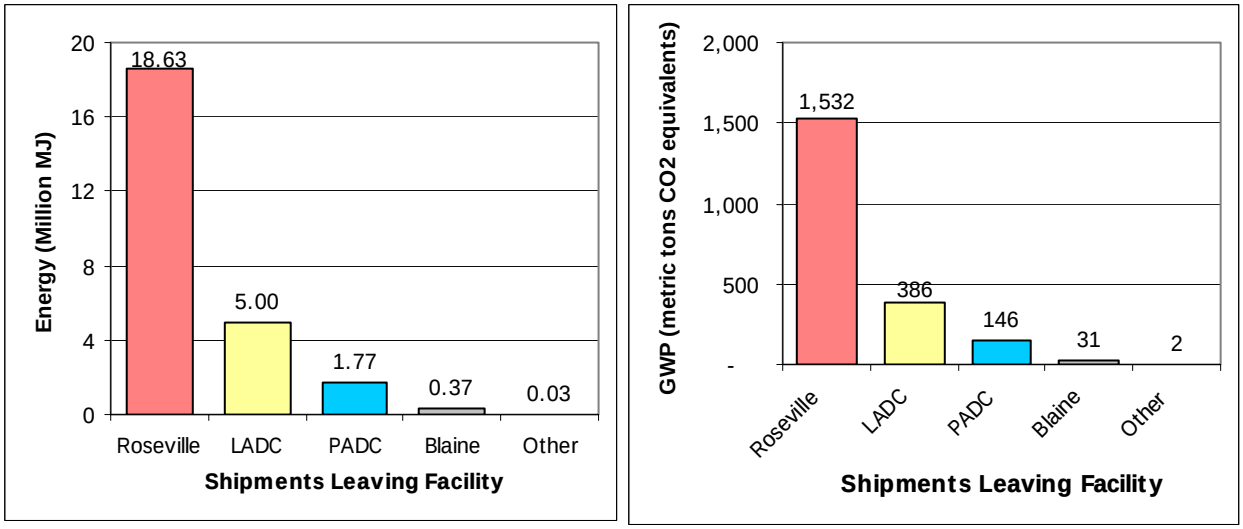


Figure 5C, below, illustrates shipments to retail and salon only. The total impact from retail shipments, indicated by the lower portions of the bars, is 3.1 MM MJ and 255 metric tons CO_2 equivalents. Roseville constitutes a majority of the impact (2.51 MJ, 207 GWP, 81%) reflecting its fulfillment of about 78 of the 130 stores including stores in distant locations like Florida, Texas, and Massachusetts. The total impact from salon shipments, indicated by the upper portions of the bars, is 6.77 MM MJ and 530 metric tons CO_2 equivalents. The significant impact of salon orders out of LADC (4.18 MJ, 310 GWP, 62%) is driven largely by air shipments to Hawaii, which

are 10 times greater impact on a per "lb-mile" basis as traditional LTL shipments. As shown by the alternate line, if Hawaiian orders were shipped via ocean, the salon impact would be in line with the other distribution centers (1.23 MM MJ and 102 metric tons CO_2). The majority of the impact out of PADC is due to salon orders (1.51 MJ, 124 GWP, 22% of total PADC) because that distribution center only delivers to 18 retail stores, all of which are in close proximity (New York City, part of PA, CT and DE), whereas it delivers to over half of the salons in the ASI network.

Figure 5C Total Annualized Transportation Energy and GWP To Retail and Salon For Distribution Centers

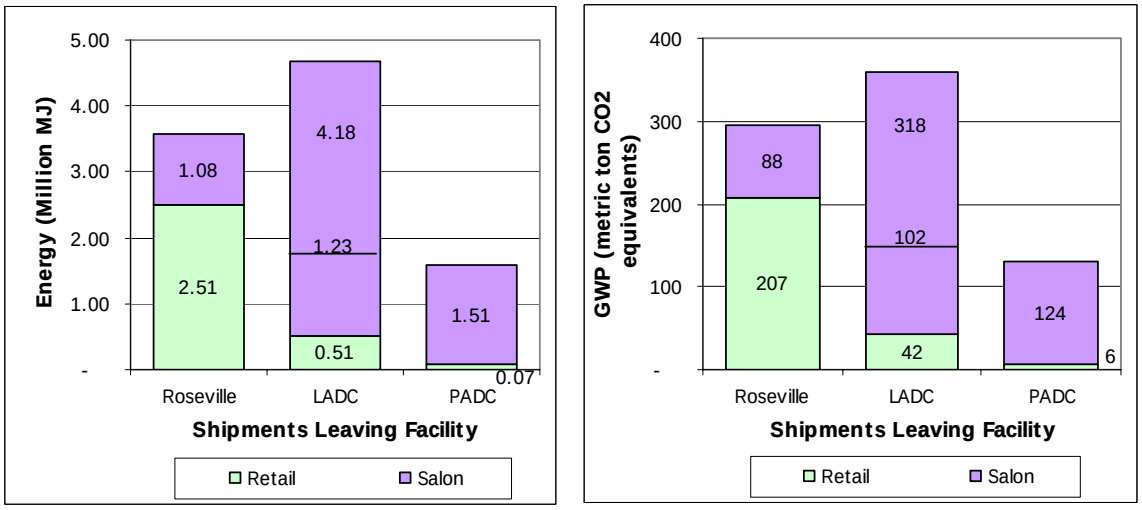


Figure 5D, below, illustrates transportation impact for shipments out of the three distribution centers on a per kg basis. Total impact is driven primarily by mode of transport and distance shipped. Because LADC services Hawaii, shipments made by air, LADC salon impact is far greater than any other PDS transport impact (4.4 MM MJ, 0.33 metric tons CO_2 equivalents, 17% of total transport impact). Again, the alternative line shows that the impact out of LADC would be in line with the other distribution centers if Hawaiian orders were shipped via ocean, though still greater due to the long distance to Hawaii (1.3 MM MJ and 0.11 metric tons CO_2). Additionally, retail shipments out of Roseville account for more impact than salon orders even though there are only 78 stores compared to about 400 salons serviced out of Roseville. As mentioned earlier, this results from Roseville servicing retail stores in distant markets such as Florida.

Figure 5D Weight-Based Transportation Energy and GWP for each DC

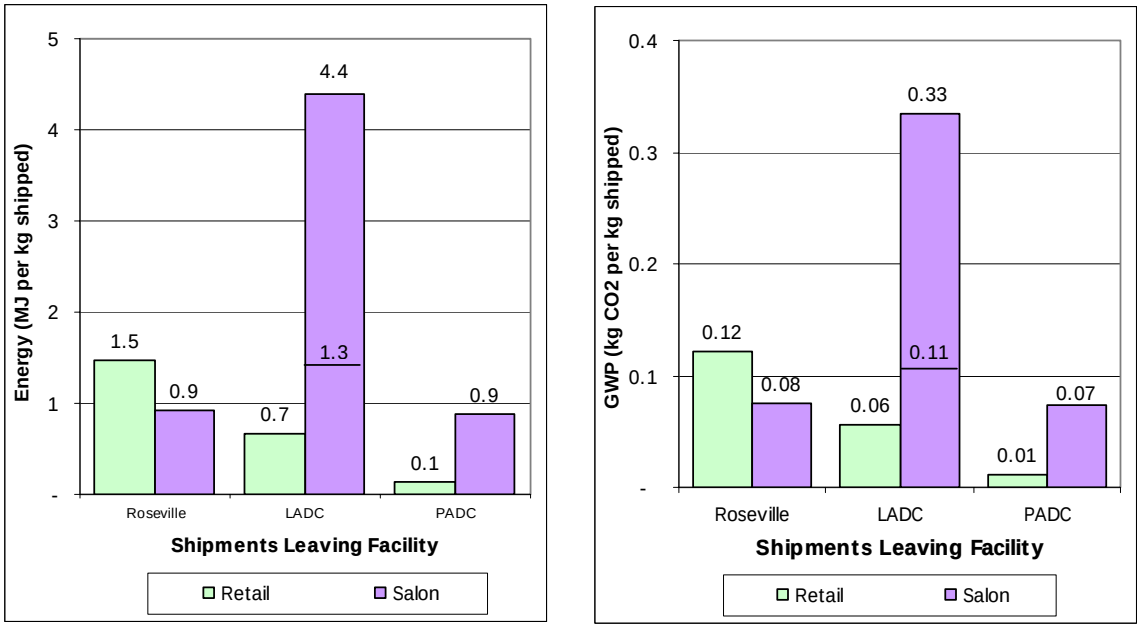
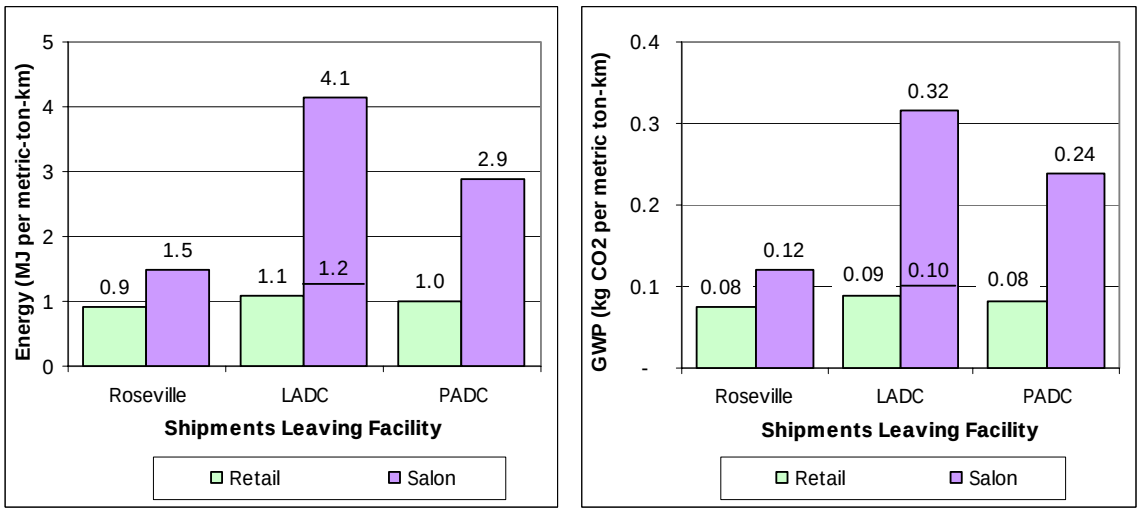


Figure 5E, below, illustrates weight-distance based impact of transportation out of each distribution center. LADC constitutes both the greatest salon impact (4.1 MM MJ, 0.32 MM metric tons CO_2 equivalents, 8.5% of total salon impact) and the greatest retail impact (1.1 MM MJ, 0.09 MM metric tons CO_2 equivalents, 30% of total retail impact).

Figure 5E Weight-Distance-Based Transportation Energy and GWP per DC

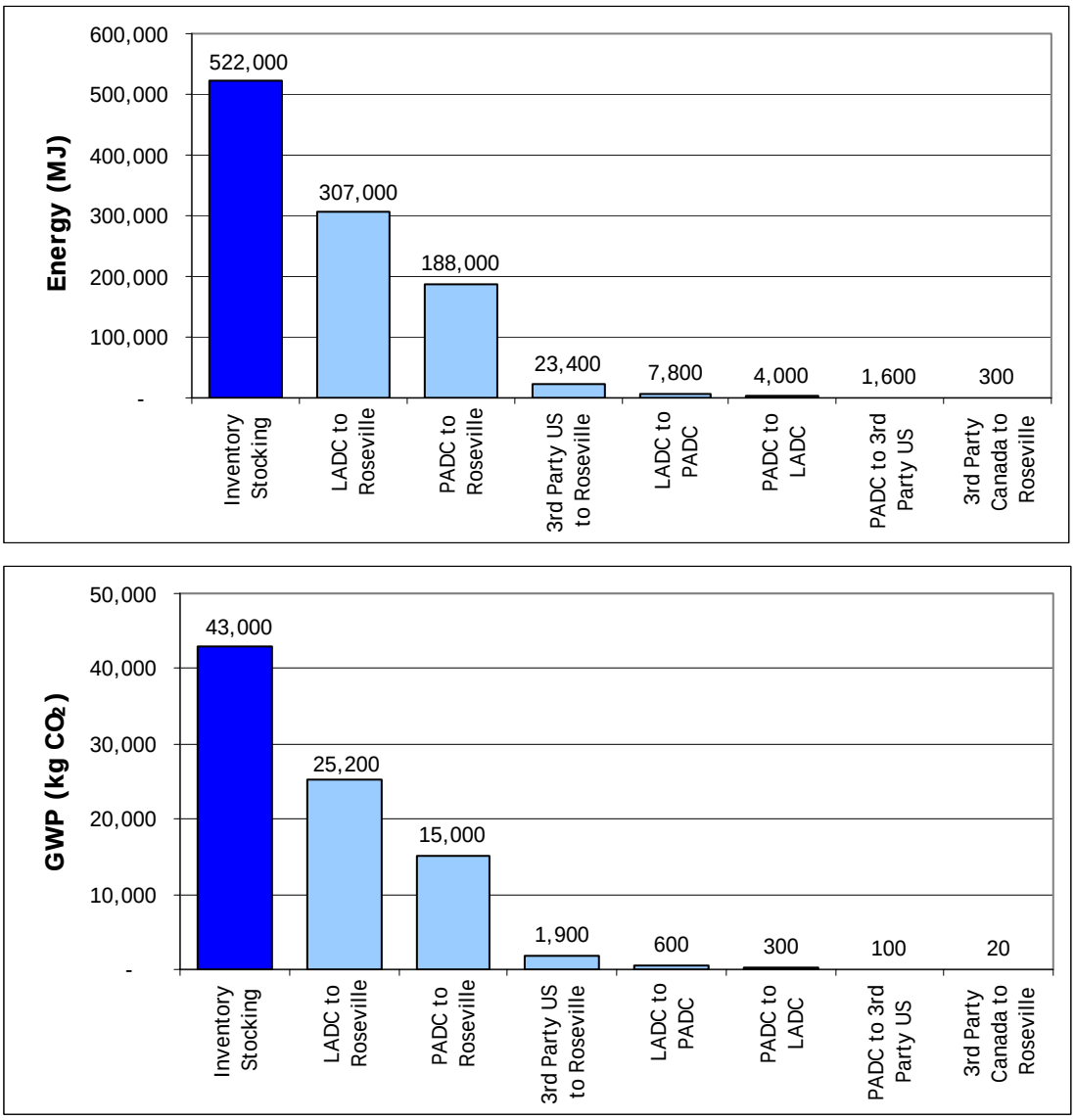


From several conversations with Aveda representatives, the routing of LTL and parcel (UPS/FedEx) trucks is comparatively direct.[68] However, the parcel network generally uses more

hub locations resulting in the average shipments encountering more stops and a slightly longer route than an LTL shipment. For example, a shipment from Roseville to Ypsilanti, Michigan would go through a hub in Chicago and then Ann Arbor, while an LTL shipment might only stop in Chicago. Therefore, there is a slight advantage to using LTL in order to reduce the distance packages travel. This advantage results from differences in mode and efficiency (e.g. Use of low volume delivery trucks for parcel or use of air shipment for some parcel orders). Again, the LADC salon figure is heavily impacted by the higher impact air shipments, but are in line with the Roseville DC when Hawaiian orders are shipped via ocean. The higher impact of PADC salon orders is due to the fact that a larger proportion of the trips are spent on inefficient UPS "brown trucks".

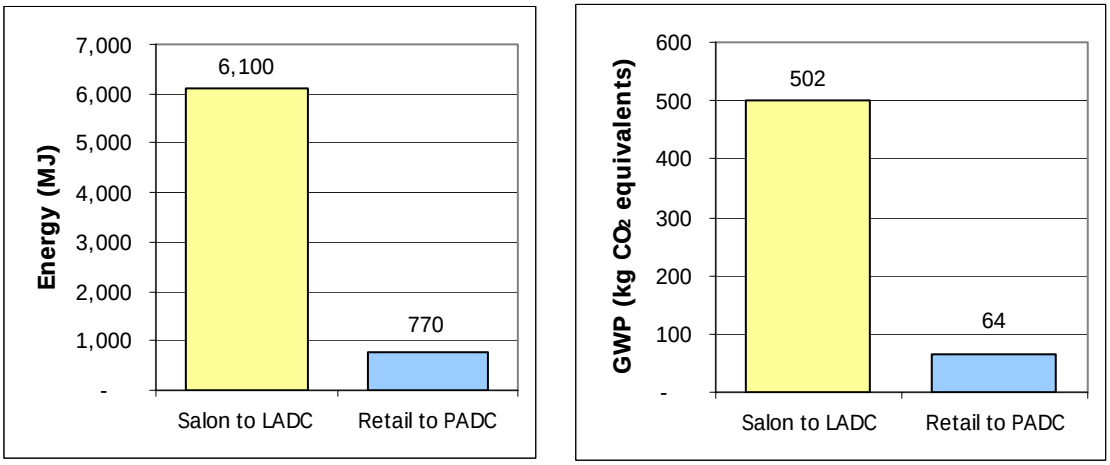
In addition to shipments to distributors, retail stores and salons, there are also shipments among distributors that are not standard (see Figure 5F). These shipments result in a total annualized energy impact of 532,000 MJ and a total GWP impact of 43,600 kg CO_2 equivalents. These shipments have been explained by Aveda personnel as inventory disposition (re-aligning inventory among distributors), other non-recurring events, and consolidation of low-running SKUs. While these shipments account for just 2% of total transport energy and GWP, they are essentially pure waste. For comparison, the total impact of LADC to Retail shipments is 507,000 MJ and 41,700 kg CO_2. This inefficiency is actually higher to reflect the un-needed original shipments to that facility. If these shipments were accounted for, the impact would be 1,050,000 MJ and 86,300 kg CO_2 equivalents, or 4% of the PDS similar to the 1,054,000 MJ and 86,120 kg CO_2 equivalents required to transport shipments from Roseville to Central region salons.

Figure 5F Annualized Energy and GWP Impact From Inter-Distributor Shipments



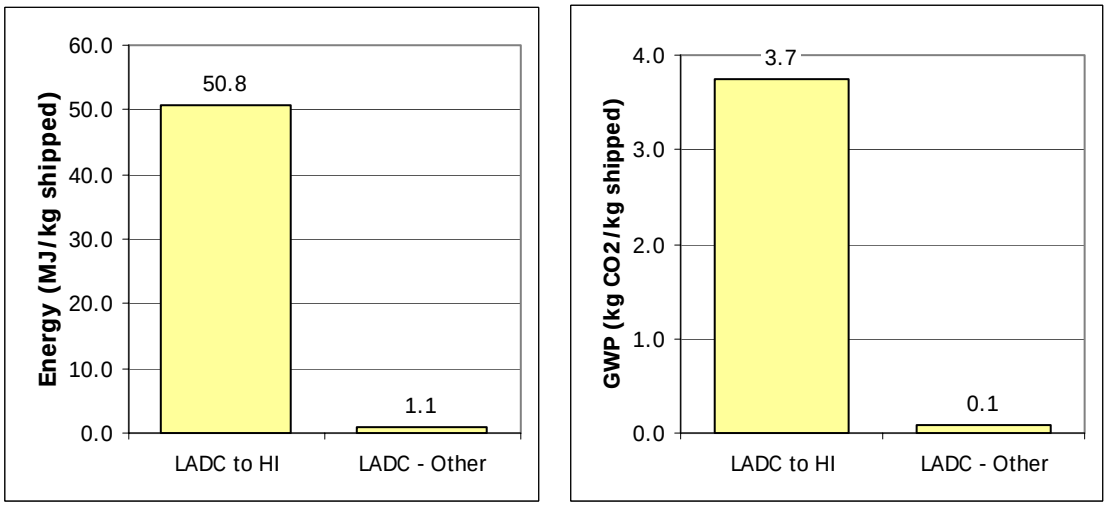
The data provided by Aveda also appears to show customer returns via LTL carriers. Discussions with Aveda personnel indicate that there are more significant quantities of returns via UPS, on the order of several packages per day, however they were not reported in the data provided for this project. Again, these shipments are pure waste, and when the data are doubled to account for incorrectly sending the packages to the customer, as shown in Figure 5G, the impact is 6,870 MJ and 566 kg CO_2 equivalents.

Figure 5G Annualized Energy and GWP Impact of Customer Returns



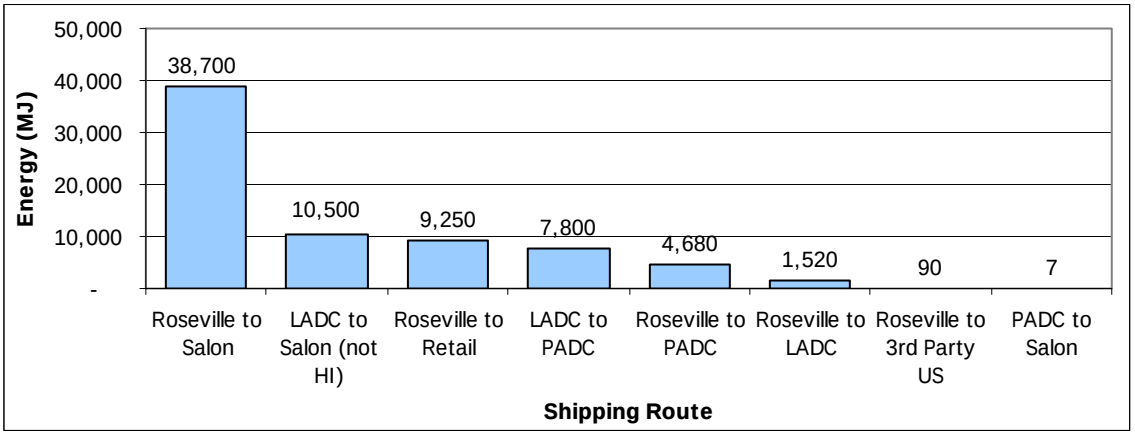
Shipments by air have a large impact on energy and GWP due to the high consumption of fuel. In the data provided by Aveda, all shipments to Hawaii traveled by air. However, since this project began, Aveda has switched most of its Hawaiian shipments to ocean which has dramatically reduced the impact of these shipments. While Hawaiian shipments out of LADC account for just 3% of weight (59 metric tons), they account for 64% of energy (3 MM MJ) and 61% of GWP (222 metric tons CO_2 equivalents). As seen in Figure 5H, the energy impact on a per kg shipped basis for Hawaiian air shipments is 46-times greater than non-air shipments (and a 37-times greater GWP impact). As noted in Section 3, air is about eight times more impactful on a weight-distance basis than truck. Section 7 of this report will further explore the impact of switching these shipments to ocean.

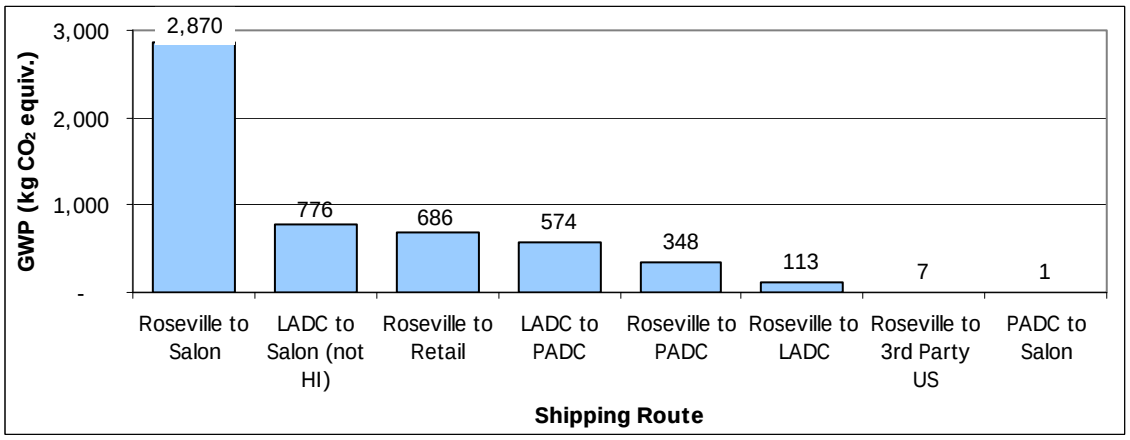
Figure 5H Energy and GWP Impact of Air Shipments from LADC to Hawaii



Additional shipments via air are shown in Figure 5I. It is unclear why these shipments occurred considering the company's "no-air" policy; however Aveda personnel indicated that on seldom occasions a customer will require overnight service. The impact from these shipments is 72,500 MJ and 5,380 kg CO_2 equivalents.

Figure 5I Energy and GWP Impact of Air Shipments Excluding Hawaii

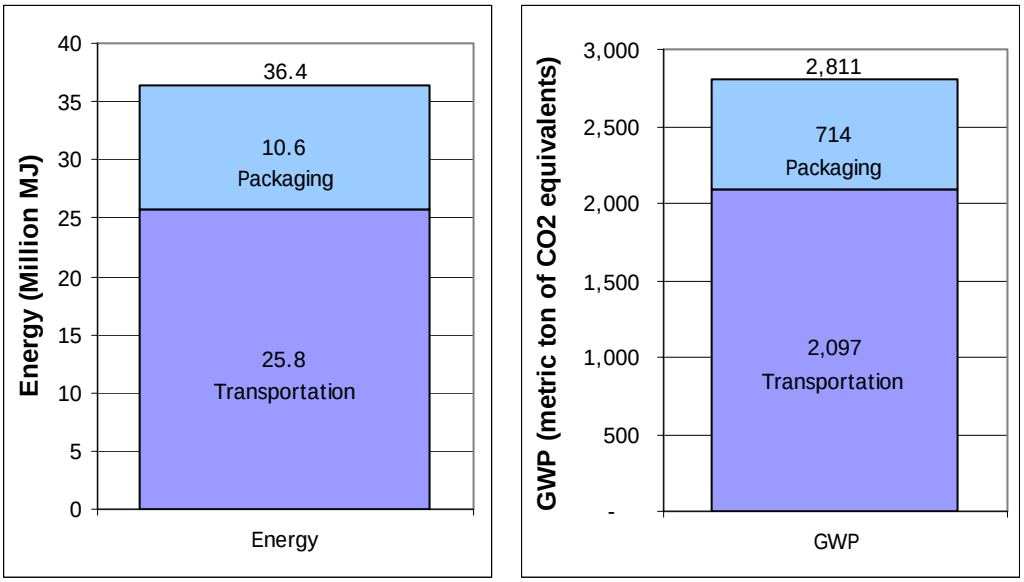




5.4 SUMMARY OF PACKAGING AND TRANSPORT IMPACT

The total combined, annualized energy and GWP for packaging and transportation in the PDS, illustrated below in Figure 5J, is 36.5 MM MJ and 2,811 metric tons of CO_2 equivalents respectively. The proportion of energy and GWP due to transportation is 70% and 74% respectively, and for packaging 30% and 26% respectively. This energy use is approximately equivalent to the same amount of energy in 275,000 gallons of gasoline, and the GWP is approximately equivalent to the GWP contribution of 500 automobiles over the course of one year.[69]

Figure 5J Total PDS Energy and GWP Impact



SECTION 6 – RECOMMENDATIONS

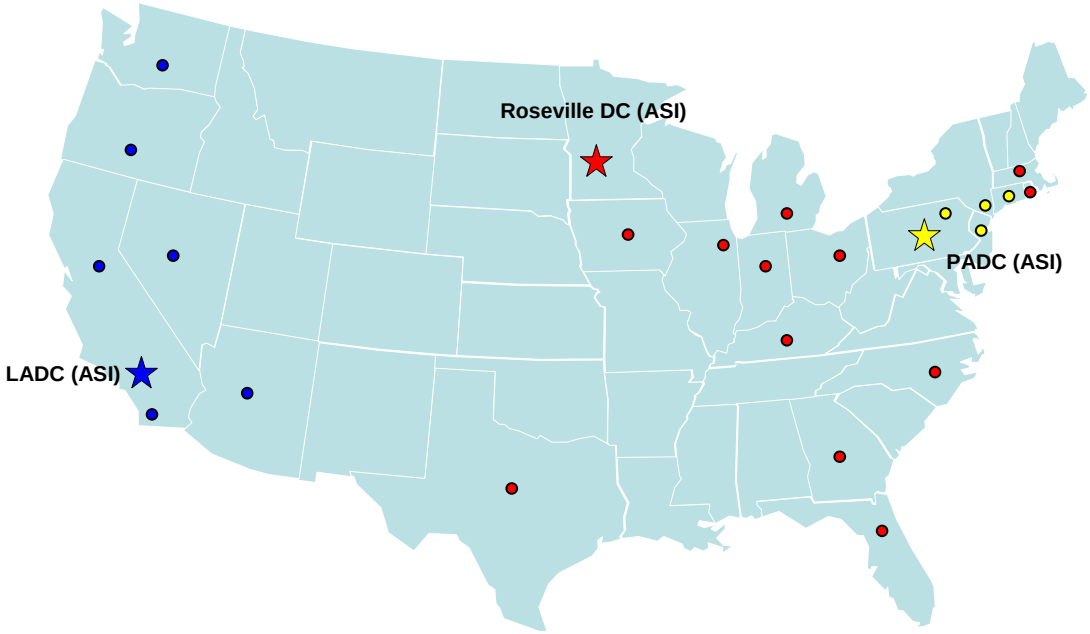
Through extensive interviews, three site visits, and many iterations of modeling, the University of Michigan team has developed eight primary recommendations. Several other secondary recommendations are discussed in Section 7. Neither section 6 recommendations nor section 7 secondary recommendations are presented in any priority order, however an ordered list is provided at the end of this section.

6.1 RECOMMENDATION 1 - SHIP DIRECT FROM ROSEVILLE TO ALL RETAIL STORES OR TO SELECT WESTERN REGION RETAIL STORES ONLY

6.1.1 PROBLEM DEFINITION

Aveda's retail network is composed of 130 Aveda owned stores. Aveda's LADC, located in Southern CA, services 34 western region retail stores including stores in Arizona, Nevada, and California and as of late 2003 it also services stores in Oregon and Washington. Aveda's PADC, located in Eastern PA, services 18 eastern region retail stores in the states of Connecticut, New Jersey, New York, Pennsylvania, and Delaware. The Roseville DC ships to 78 stores in the Midwest and South, and a few stores on the east coast.

Figure 6A Map of existing retail distribution system



Rationale for this transport system is based on the premise that three regional distribution centers allow for superior customer service levels and allow Aveda to secure inexpensive transport contracts for shipments from Roseville to LADC and PADC via contracted carrier.

However, use of these regional distribution centers increases the total shipping distance--because the routes are indirect--and therefore the environmental impact of getting product to market.

For example, the Aveda retail store located in the Scottsdale, Arizona Fashion Square Mall orders weekly from the LADC. The product travels from the Roseville DC to LADC (1,825 miles) where it is held as inventory, and then from LADC to Scottsdale, AZ (391 miles) for a total 2,216 miles. A direct Roseville to Scottsdale shipment (1,835 miles) would reduce vehicle miles by approximately 17%.

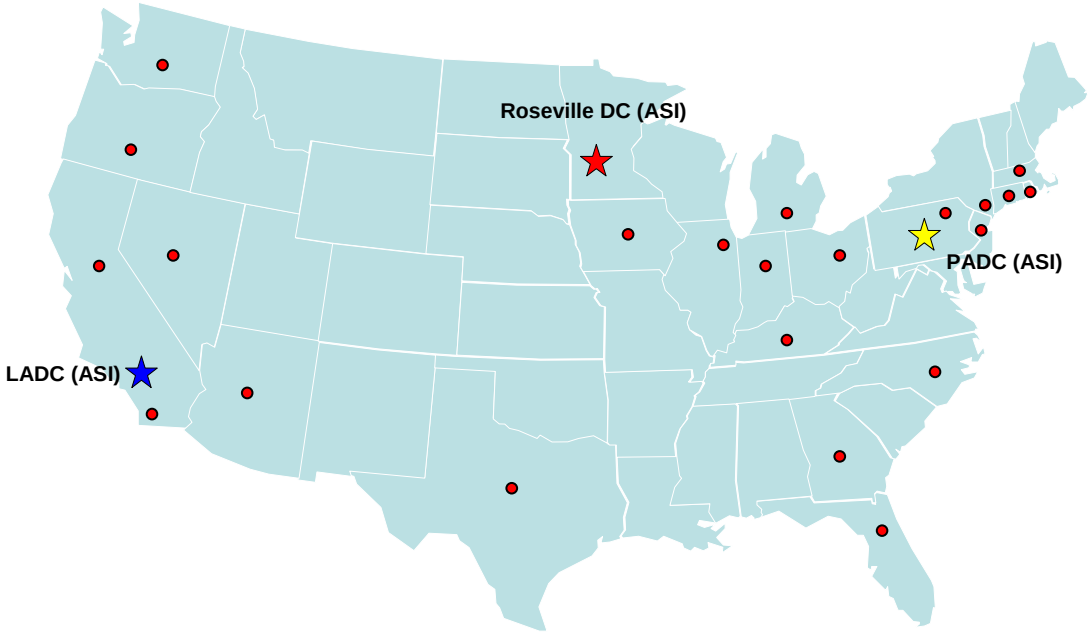
6.1.2 PROPOSED SOLUTION

Aveda can reduce mileage associated with indirect shipping by shipping directly from Roseville to all retail stores (Scenario A), or by shipping direct from Roseville to select retail stores in the western region (Scenario B). Scenario A provides the greatest environmental benefit but costs approximately 25% more than the current distribution system. Scenario B provides nearly the same environmental benefit as Scenario A, is slightly more feasible operationally, and is comparable to current costs. In both scenarios, Roseville would continue to service its current retail stores.

Scenario A

Scenario A would entail shipping direct from Roseville to all retail stores in the LADC and PADC region (Figure 6B). This scenario provides the greatest reduction in Energy and GWP because it suggests the most direct routes.

Figure 6B Scenario A Map of the direct routes from Roseville to all retail stores



The following benefits are associated with Scenario A:

- Most direct routes, fewest vehicle miles, lowest environmental impact
- Reduction of inventory disposition (particularly of low running SKUs) resulting from centralized distribution in Roseville
- Significant reduction or elimination of return shipments of obsolete products to Roseville distribution center
- Fewer damaged products associated with additional loading/unloading at distribution centers
- Shifted capacity utilization to the new Blaine facility where excess capacity will exist
- Low customer impact

Scenario A Mileage Distribution

As figure 6C and 6D illustrate below, current system mileage associated with shipping product to 34 retail stores in the western region is significantly higher for each store than it is under the direct shipping of Scenario A. However, mileage reduction is concentrated in the 24 WA, OR, AZ, NV, and Northern CA stores. These 24 stores account for 96% of the mileage reduction (16,374 miles) and the remaining 10 Southern CA stores account for only 4% (672 miles). Top impact store is River Park Square in Spokane, WA (Store #735) which currently requires shipping product 56% greater distance than if materials were shipped direct from Roseville. Even the Stoneridge Mall store in Pleasanton, CA, the 23rd least efficient store, currently requires shipping

product 11% greater distance than if there was a direct to retail system. However, for stores in Southern CA, such as the Century City Los Angeles store (# 737), Scenario A reduces mileage by only about 1%.

Figure 6C Western region comparison of current system mileage vs. Scenario A (stores 1-13)

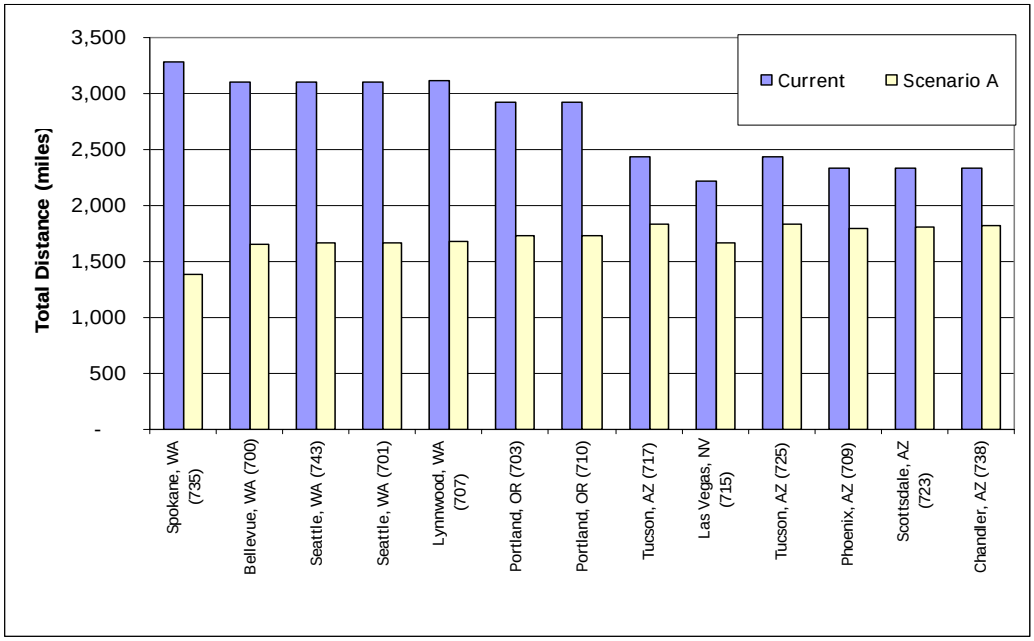
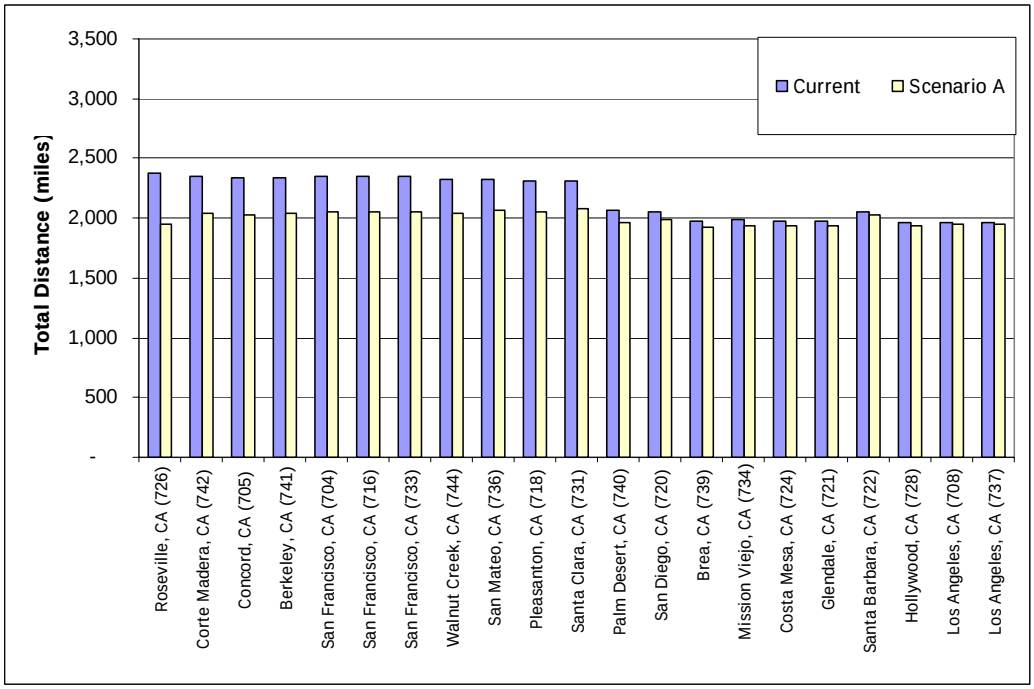
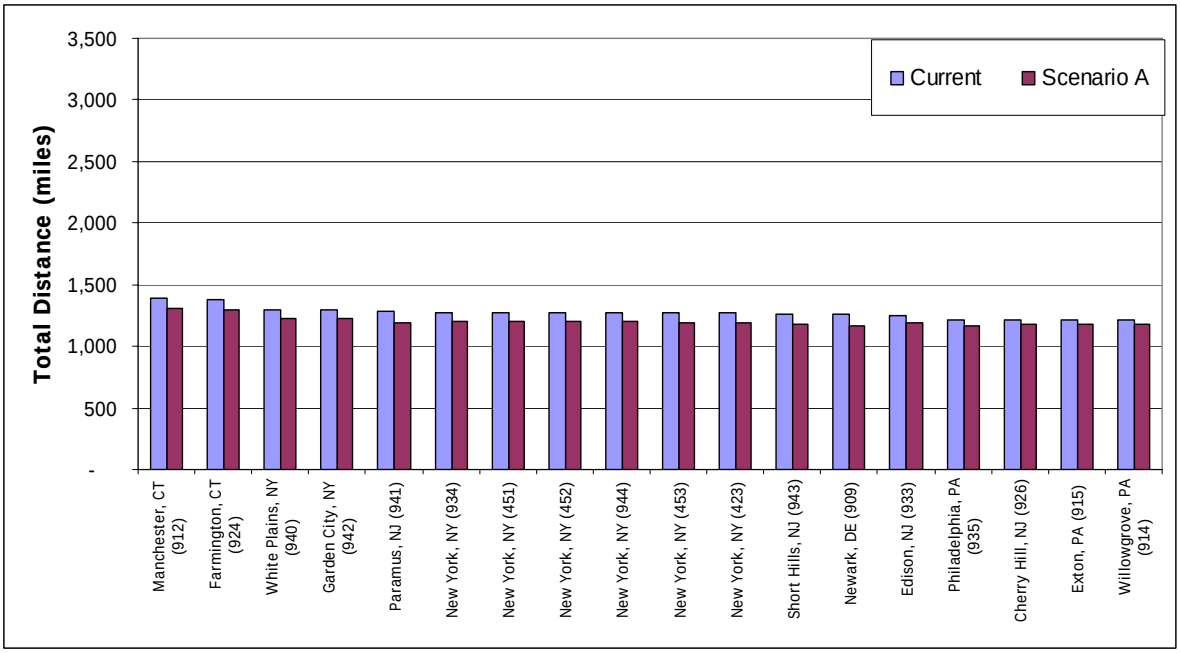


Figure 6D Western region comparison of mileage for current system vs. Scenario A (stores 14-34)



As figure 6E illustrates below, current system mileage associated with shipping product to 18 retail stores in the eastern region is slightly higher for each store than that of Scenario A. However, unlike in the LADC region, in the PADC region, impact is more evenly distributed with all 18 stores contributing similar inefficiencies to the network. Top impact store is Christiana Mall in Newark, Delaware which currently requires shipping product 7% greater distance than it would in a direct shipping model, and the most efficient store is Willowgrove, PA which requires shipping product 3% greater distance than it would in a direct shipping model (Figure 6E).

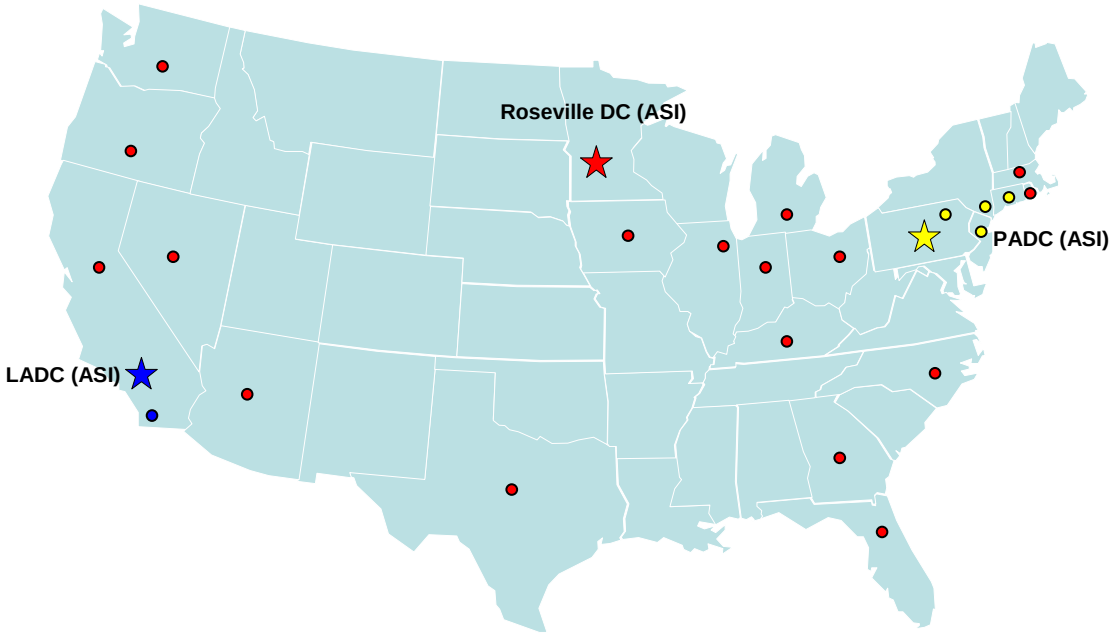
Figure 6E PADC Region comparison of mileage for current system vs. Scenario A



Scenario B

Scenario B entails shipping direct from Roseville to retail stores in WA, OR, NV, AZ, and Northern CA (Figure 6F). Scenario B is a modified version of Scenario A. Instead of shipping all retail stores direct, as Scenario A specifies, Scenario B specifies that only stores which are cost effective and high impact environmentally are shipped direct from Roseville (See section 6.1.3 for environmental impact, and 6.1.4.1 for cost).

Figure 6F Scenario B-Direct from Roseville to WA, OR, NV, AZ, and Northern CA stores



The following benefits are associated with Scenario B:

- Significantly reduced vehicle miles and environmental impact
- Relative ease of implementation. Network can operate in a very similar manner as current network.
- Reduction in inventory disposition (particularly low running SKUs) resulting from centralized distribution in Roseville
- Some reduction of return shipments of obsolete products to Roseville distribution center
- Fewer damaged products associated with additional loading/unloading at distribution centers, resulting in fewer damaged goods
- Shifted capacity utilization to the new Blaine facility where excess capacity exists
- Low customer impact
- Comparable cost

Scenario B Mileage Distribution

Routing for Scenario B is the same as the current state for all stores in the Eastern region and in Southern CA; direct shipping to these stores is not cost or environmentally effective (See section 6.1.1). As documented in Figure 6C and 6D for Scenario A, shipping to stores in WA, OR, AZ, NV and Northern CA directly reduces mileage by as much as 57%.

6.1.3 ENVIRONMENTAL IMPACT:

As stated in section 5.3, the annual energy consumption of Aveda's entire transportation component of the PDS system is 25.8 MM MJ and the total Global Warming Potential is 2,097 metric tons CO_2. The retail portion of energy consumption in the transportation component of the PDS system is 6.33 MM MJ (24.5% of total transportation energy) and GWP is 522 metric tons CO_2 (24.5% of total transportation CO_2). Scenario A would provide a reduction of 8% in Energy and GWP compared to the current total retail network, while Scenario B would provide a reduction of 7% in Energy and GWP (Figures 6G and 6H).

As mentioned above, Scenario A includes direct shipment to all retail stores in the Aveda PDS. Scenario B uses the current PADC system for eastern region retail stores, the current LADC system for Southern California stores, and direct shipping to Washington, Oregon, Arizona, Nevada and Northern California stores.

Figure 6G Energy consumption of total retail distribution system under current system, Scenario A, and Scenario B

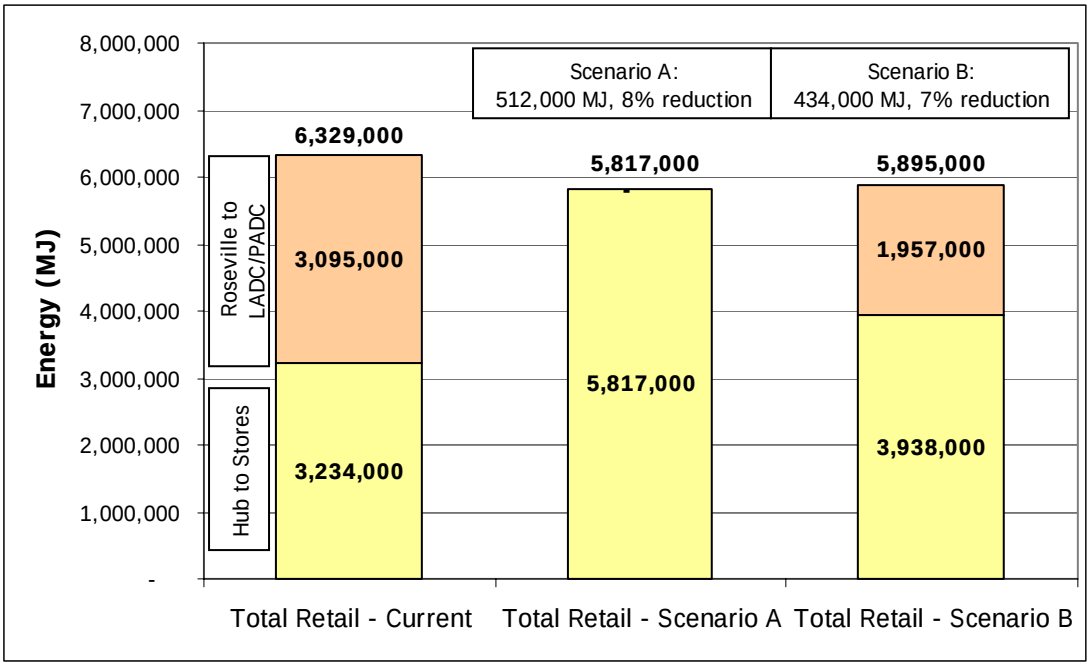
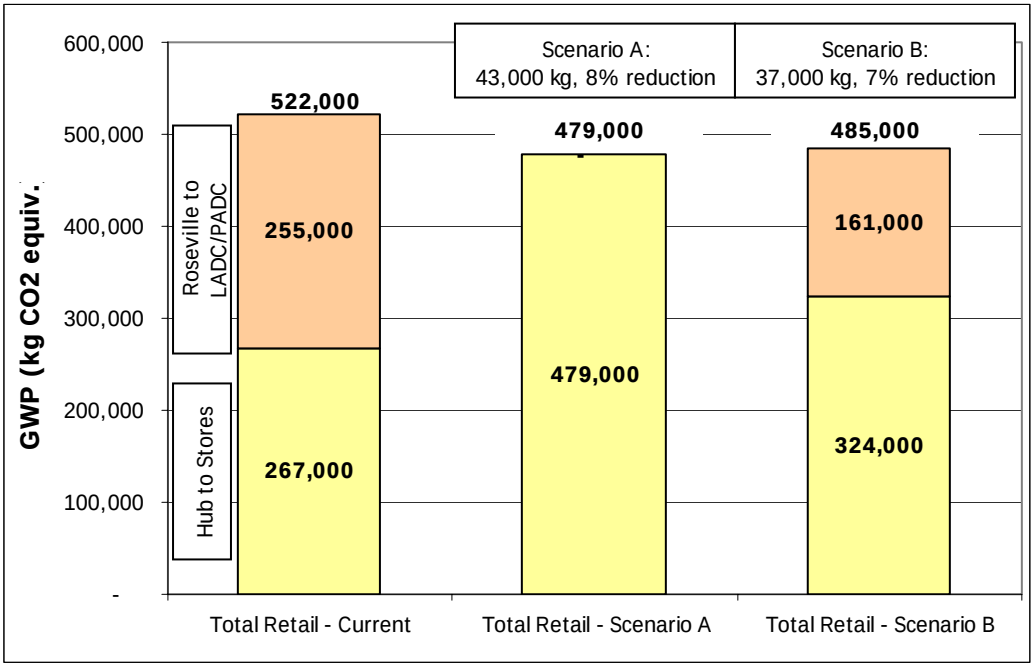


Figure 6H GWP impact of total retail distribution system under Current system, Scenario A, and Scenario B



Roseville to Western Region

Current energy consumption and GWP for western region retail stores (CA, NV, AZ, OR, WA), serviced through LADC, is 2,763,000 MJ and 228,000 kg CO_2, respectively (Figure 6I and 6J)[70]. Our model reveals that energy consumption for Scenario A direct shipments to all western retail stores is 2,303,000 MJ, and 190,000 kg CO_2, or approximately 17% less energy and GWP for western region retail shipments than current system. The reduction in Energy and GWP is driven by the relative geographic isolation of the LADC; it is located fairly far south and west of many of the retail stores it services and therefore any shipments going to retail stores north or east backtrack, or are "inefficient" from a transport perspective.

Our model reveals that energy consumption and GWP for Scenario B is 2,329,000 MJ and 191,000 kg CO_2, or approximately 16% less energy and GWP for western region retail shipments than the current system (Figure 6K and 6L). This reveals that Scenario B provides almost the same environmental impact as Scenario A because only Southern California stores are no longer shipped to directly.

Figure 6I Energy reduction of Western retail distribution system under Current system, Scenario A, and Scenario B

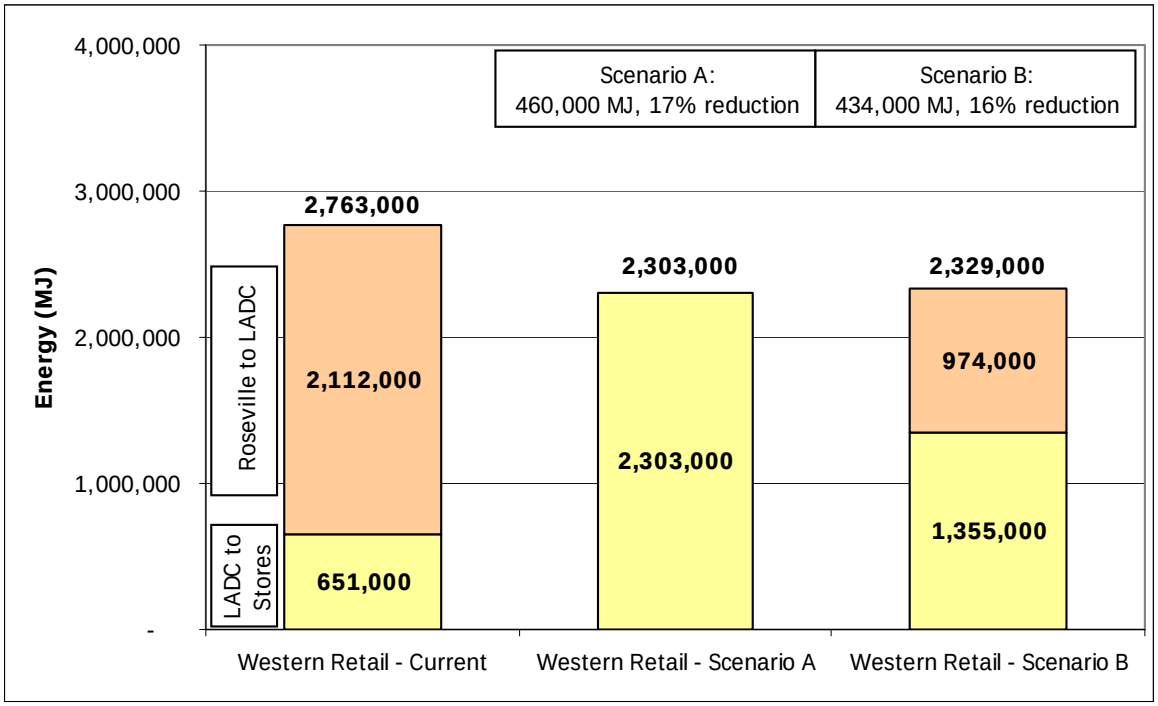
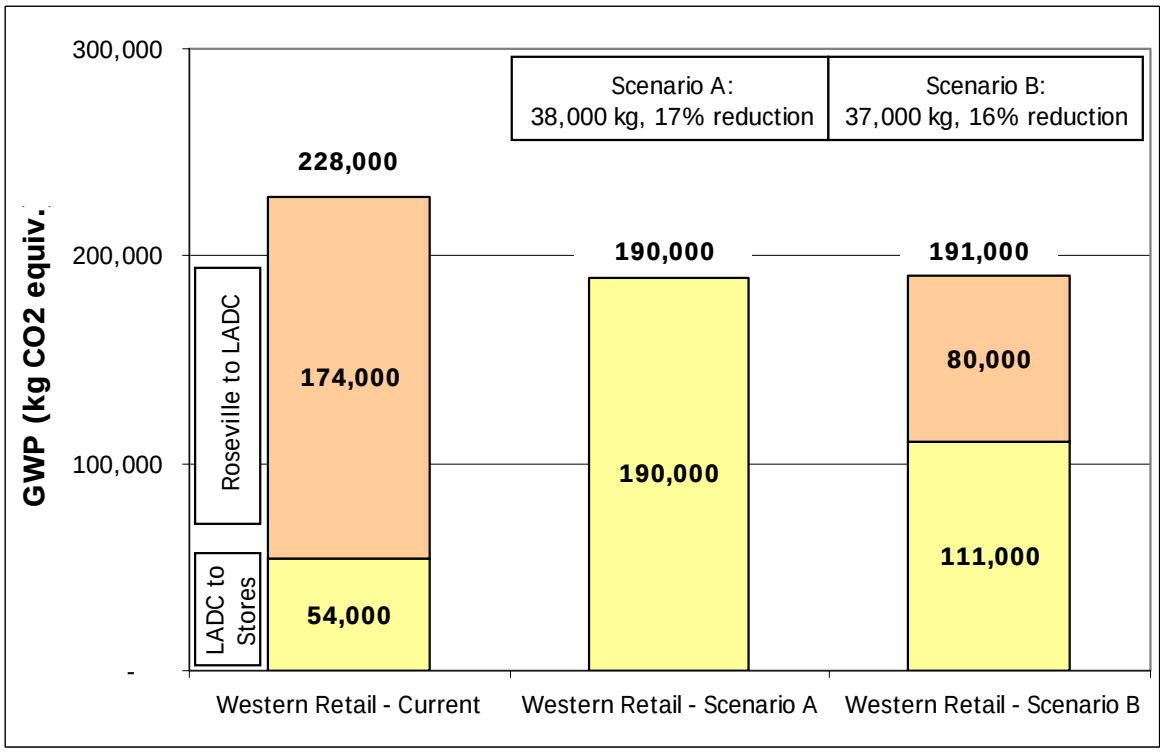


Figure 6J GWP impact of Western retail distribution system under Current system, Scenario A, and Scenario B



Roseville to Eastern Region

Current energy consumption and GWP for retail stores serviced by PADC (CT, DE, NJ, NY, PA) is 1,055,000 MJ and 87,000 kg CO_2, respectively (Figures 6K and 6L).[71] Our model reveals that energy consumption for Scenario A direct shipments to all eastern region retail stores is 1,003,000 MJ, and 82,000 kg CO_2, or approximately 5% less energy and 6% less GWP than current eastern region retail shipments. Reductions in the Eastern region are significantly less than in the western region because routing is more direct, and total vehicle ton miles are much lower.

Figure 6K Energy reduction of Eastern retail distribution system under Current system, Scenario A, and Scenario B

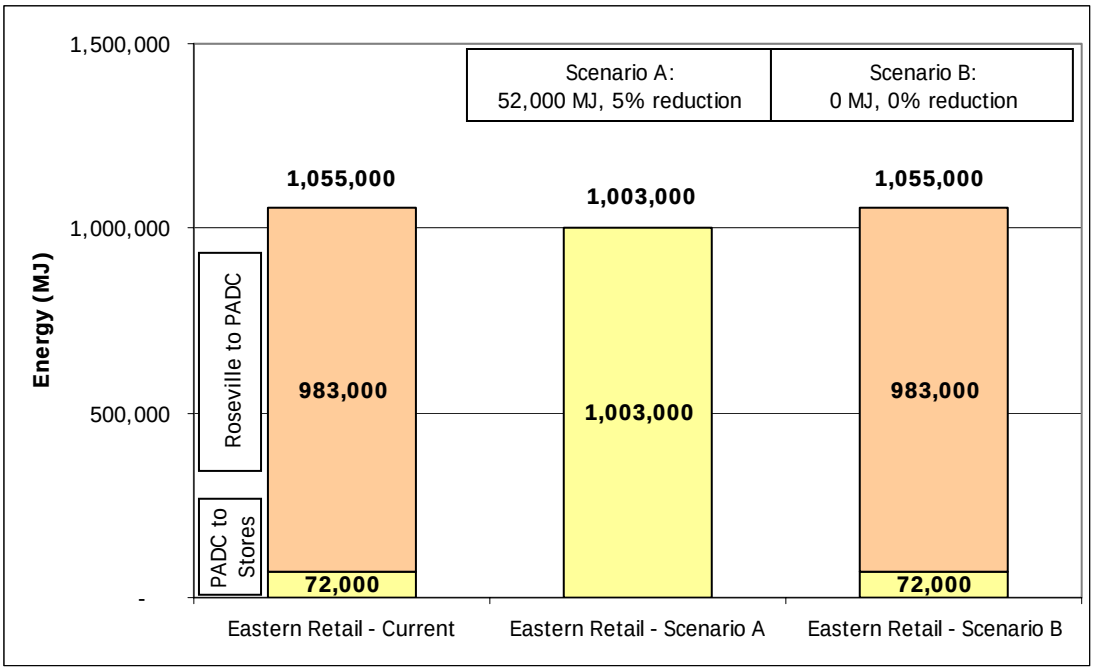
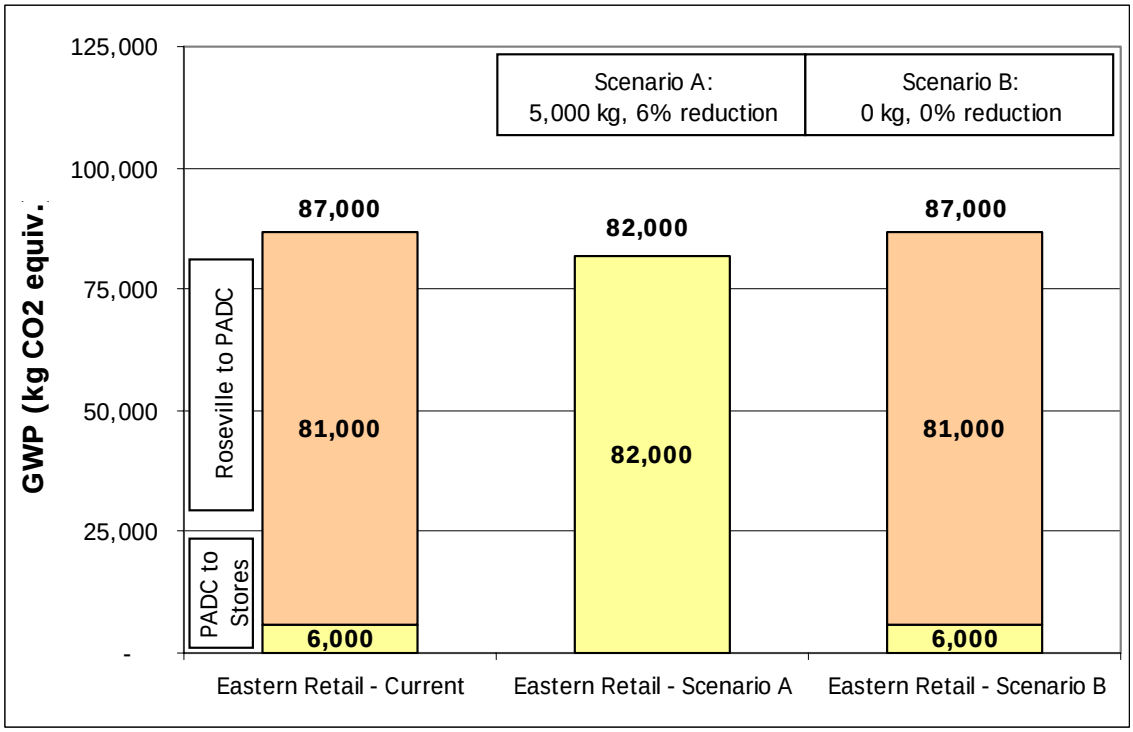


Figure 6L GWP impact of Eastern retail distribution system under Current system, Scenario A, and Scenario B



6.1.4 BUSINESS IMPACT OF SOLUTION:

6.1.4.1 FINANCIAL IMPACT

A cost analysis was performed and intended as a preliminary estimate rather than to determine actual costs. While this analysis has been discussed with the client in detail, only summary data can be provided here due to the proprietary nature of its service contract. More detailed cost analysis was not possible due to the many specific requirements that would need to be finalized through contract negotiations. Furthermore, shipping amounts were rounded to ease calculations and discussion with suppliers and Aveda personnel. The costs are provided only for the Eastern and Western portion of the retail network because the remaining stores currently serviced out of Roseville are expected to remain the same.

Current System

In the current system transport costs are constituted by 3 major drivers.

- The transport cost of shipping inventory from Roseville to LADC and PADC
- Labor costs of unloading inventory at LADC or PADC
- Transport costs of shipping product from the DC to the retail store

The price for shipping inventory form among distribution centers is based on the fact that a full truck is contracted and packed to capacity, which is between 35,000 and 40,000 lbs. This cost does not include the usual LTL surcharges to guarantee delivery hours.

The labor costs of unloading inventory is difficult to estimate, but it is important to include in the analysis because by transferring inventory from Roseville to PADC or LADC requires additional labor to restock in the DC. Aveda personnel provided an estimate for this, however these costs would not necessarily be realized in full because the facility may not actually reduce staff.

The transport costs from the DC to the retail store via LTL is based on current contract rates, however this includes a significant surcharge (roughly 100%) to guarantee delivery times (i.e., a guarantee that a store will receive shipment between 1pm and 4pm on Mondays). Aveda is reportedly starting to eliminate these surcharges because the LTL carriers are usually able to meet the service levels without extra effort. However, it is likely that the longer LTL routes proposed under the scenarios would require the delivery guarantee. For purposes of this analysis, it was assumed that the current LTL costs will continue in the future. Aveda provided the estimates for the new LTL routes and are assumed to be close to actual rates with the surcharge.

The current cost of the LADC region stores is shown in Table 6A. All product shipped from Roseville to the LADC is handled by labor at the LADC and then shipped to 34 western region retail stores via LTL carrier. Total cost for the current western retail system is estimated at $518,400.

All product shipped from Roseville to the PADC is handled by labor at the PADC and then shipped to 18 eastern region retail stores via LTL carrier. Total cost for the current eastern PADC system is estimated at $101,000.

Scenario A

Scenario A requires direct shipping to all retail stores. Shipments from Roseville to the LADC as well as the labor costs to unload the inventory are eliminated. All shipments to the 34 western region retail stores are via LTL carrier out of Roseville. Total cost for the Scenario A western retail system is estimated at $605,000.

Shipments from Roseville to the PADC as well as the labor costs to unload the inventory are eliminated. All shipments to the 18 PADC region retail stores are via LTL carrier out of Roseville. Total cost for the Scenario A PADC retail system is estimated at $165,000.

Scenario B

Scenario B requires direct shipping to many of the LADC region retail stores, but keeps the current PADC system. Shipments from Roseville to the LADC are reduced, as well as the labor costs to unload the inventory, to the amount needed to fulfill the 10 southern California retail stores. Shipments to the remaining 24 western region retail stores are via LTL carrier out of Roseville. Total cost for the Scenario B western retail system is estimated at $511,400. Scenario B costs for PADC region stores are the same under the current system and estimated at $101,000.

Total Costs of the Three Scenarios

Based on the above cost information and the approximate weights, the current transportation costs for the Western and Eastern retail network is $619,000 (Table 6A). Scenario A, which eliminates shipments to LADC and PADC as well as the labor required in those facilities and increases the LTL costs to service the stores, results in a cost of $770,000 (24% increase). Scenario B, which reduces the shipments to the LADC and the labor required at the LADC, but maintains the current PADC network, results in a cost of $612,400 (1% decrease). While Scenario A costs are significantly higher, Scenario B costs are comparable to the current costs. Again, actual costs may differ when contract details and weights are finalized.

Table 6A Cost of LADC region under Scenarios A and B

Current	Estimated Costs
LADC	$518,400
PADC	$101,000
TOTAL	**$619,000**

Scenario A: Direct to All Retail	Estimated Costs
LADC	$605,000
PADC	$165,000
TOTAL	**$770,000**

Scenario B: Direct to Some LADC Retail	Estimated Costs
LADC	$511,400
PADC	$101,000
TOTAL	**$612,400**

6.1.4.2 Operations Impact

To implement either recommendation A) Direct to all Retail or B) Direct to WA, OR, AZ, NV, Northern CA, the operational strategy at each of the three Aveda-owned DCs will need to be

slightly modified. Capacity utilization will change, as will the management of inventory and changes in labor. Table 6B presents a partial list of both the positive and negative changes to each DC.

Table 6B Impact of Scenario A and B on Facility Operations

Facility	Pro	Con
Roseville	Inventory consolidation reduces future need for inventory disposition	Increased staff
	Increased capacity utilization	
LADC	Inventory consolidation offers many benefits	Lower capacity utilization
	Reduced staffing	Longer lead time for some customer orders
	Free up space for salon expansion	
PADC	Inventory consolidation offers many benefits	Longer lead time for some customer orders
	Reduced staffing	NYC area stores have unique challenges that a local carrier can best address.
	Additional capacity at PADC for salon expansion	
	Elimination of unnecessary loose-pick packaging	

6.1.4.3 Customer Impact

Scenario A

Based on interviews with Aveda staff, using LTL to deliver product directly to all the retail stores on a weekly or bi-weekly basis should have minimal to no impact on customer service levels.[72] This is due to the fact that retail stores provide a two-week lead time between order placement and order receipt, which is sufficient for order fulfillment and shipment. However, it is understood that many retail customers do not submit orders on time, therefore if either scenario were implemented, stores would need to more strictly adhere to the order schedule.

Scenario B

Similarly, Scenario B would have minimal impact to the retail stores affected by the new delivery routes assuming they adhere to the current order schedule. Stores in the PADC region and southern California would see no changes to the current system.

Table 6C Summary of recommendation environmental impact, cost, and operational feasibility

	Scenario A	Scenario B
Environmental Impact	• 512,000 MJ (-8%) • 43,000 kg CO_2 (-8%)	• 434,000 MJ (-7%) • 37,000 kg CO_2 (-7%)
Financial Impact	• $150,000 (+24%)	• -$6,600 (-1%)
Operational Impact	• Improve inventory management • Improve space in LADC and PADC • Challenge of delivering to NYC stores	• Improve inventory management • Improve space in LADC
Customer Impact	• Require LADC and PADC stores to better adhere to order schedule	• Require LADC stores to better adhere to order schedule

6.2 RECOMMENDATION 2 - UTILIZE INTERMODAL SHIPPING TO DISTRIBUTION CENTERS

6.2.1 PROBLEM DEFINITION

Aveda currently ships to all of its distribution centers using class 8 trailers. Trailers offer the most flexible and often the quickest mode of shipping, however GHG and energy models reveal that, relative to tertiary packaging (10.7 MM MJ and 714 metric tons CO_2), transportation (25.8 MM MJ and 2097 metric tons CO_2) is the largest contributor (71%) to the environmental impact associated with Aveda's PDS. Shipping freight by rail is the most environmentally preferable method for shipping product from Roseville to points throughout the U.S. and Canada. However, rail alone is not an attractive option due to the time-sensitive nature of Aveda's shipments as well as the labor costs associated with transferring cargo between truck trailers and rail containers.

Intermodal shipping combines the most efficient features of both rail and truck shipping. Freight trains efficiently carry cargo for long distances over high-volume corridors while trucks provide the flexibility necessary to move cargo between rail terminal and the cargo's origin and destination. Furthermore, the cargo remains within the same trailer throughout the shipment, minimizing labor cost and shipping delays. According to the U.S. EPA SmartWay program, intermodal logistics provide greater economic and environmental benefits as the distance of shipping distances increase. Relative to shipping by truck, intermodal logistics provide a 65% reduction in GHG emissions for shipments greater than 1,000 miles.[73]

Intermodal logistics are managed by third-party companies called Intermodal Marketing Companies (IMC), which contract with truck carriers and railroad companies on the behalf of the customer. According to the Intermodal Association of North America, the leading industry trade association representing the combined interests of the intermodal freight industry, over four hundred companies offer intermodal services in the U.S. Some of these companies focus on particular routes, while others provide national and international coverage.

Despite the challenges faced by the rail industry, the intermodal industry has grown steadily over the past years: total intermodal traffic increased in the US by 6.4% from 2002 to 2003, in terms of domestic and international shipments.[74] Trailer traffic and rail shipments also increased (trailer traffic comprises approximately 20% of total moves and rail provides 80%).[75] Recent technological advancements have made intermodal logistics more competitive, particularly with increased speeds of transferring trailers and containers between truck and rail.[76] Additionally,

railroad companies invest a total of $5 billion a year to expand capacity on heavily-used routes to accommodate the surge in intermodal volumes from intermodal shippers.[77]

Given that significant environmental and cost benefits of intermodal logistics are achieved with distances greater than 1,000 miles and a minimum cargo level of a full truckload, the team focused on evaluating the feasibility of using intermodal logistics to ship from Roseville DC to each of six domestic distribution centers across the country.[78] Table 6D lists the routes from Roseville to each of its six domestic distribution centers, the distances traveled by truck carriers, and whether intermodal is available for shipping. The distances from Roseville to USDC-C and to USDC-D were too short for intermodal to be an effective shipping strategy, thus leaving possible intermodal options as Roseville to LADC, USDC-A, USDC-B and PADC.

Table 6D Mileage and mode comparison between current shipping strategy and intermodal logistics

Route	Approximate Truck TL mileage	Intermodal available?
Roseville to PADC	1,200 miles	Yes
Roseville to LADC	1,800 miles	Yes
Roseville to USDC-A	1,200 miles	Yes
Roseville to USDC-D	700 miles	No
Roseville to USDC-C	300 miles	No
Roseville to USDC-B	800 miles	Yes

The Truck TL mileage is based on interviews with carriers currently used by Aveda.

6.2.2 Proposed Solution

Based on environmental and operational impacts described below, we propose that Aveda begin phasing in intermodal shipping for 25% of shipments from Roseville to LADC, USDC-A and PADC. We recommend that Aveda start with the route that seems most logistically amenable to a switch, and then expand to other routes. Increasing the amount of rail in Aveda's distribution mix will help Aveda move closer to its environmental mission with minimal impact on business operations. Contact information for potential intermodal carriers for each of these routes is provided in Appendix C.

6.2.3 Environmental Impact

The team modified the computer model described in Section 5 to determine the environmental impact of switching from truck to intermodal for the four DCs described in Table 6E. The assumptions in the model are as follows:

- The distances from both Roseville to PADC and Roseville to USDC-A for both shipping strategies (truck and intermodal) were within 5% of each other.
- The distances from Roseville to USDC-B and LADC were substantially different because westbound rail cargo leaving St. Paul travels south and east to Chicago before turning

around and heading west. This extra leg can add up to 800 miles of extra travel. Although intermodal covers more distances than truck alone, the efficiency of the rail system more than compensated for the extra mileage. (Note: Should Aveda pursue this strategy, the team recommends that Aveda find an intermodal company that utilizes the rail lines that connect to the rail terminals west of St. Paul, such as Topeka KS.)

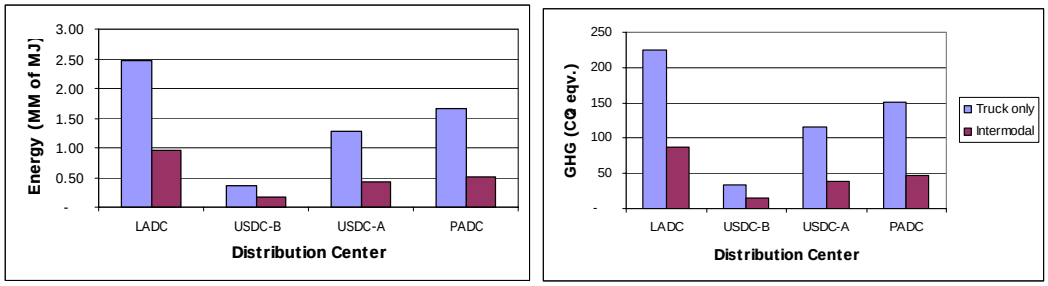
- Since intermodal containers have similar dimensions and weight limitations as typical truck trailers, we assumed that the maximum weight of 35,000 lbs in the conventional trucking system would apply to the intermodal for ease in comparing the two systems. This weight limit is a conservative figure for intermodal, since intermodal weight limits reach 45,000 lbs.

Based on these assumptions, switching from the current truck strategy to intermodal shipping for LADC, USDC-B, USDC-A and PADC will result, on average, in a 64% reduction in both energy and GHG emissions (Table 6E and Figure 6M) or 1.2 MM MJ and 111.6 tons CO_2 equivalents annualized savings.

Table 6E Energy and GWP reductions associated with switching from truck to intermodal logistics for each of the four distribution centers >1000 miles from Roseville.

Unit	LADC	USDC-B	USDC-A	PADC
Current Truck System (annualized)				
Energy (MM MJ)	5.928	0.881	3.05	3.98
GWP (tons CO_2 eqv.)	537	79.2	276	360
Savings from Switching all shipments to Intermodal (annualized)				
Energy (MM MJ)	2.31	.408	1.01	1.22
GWP (tons CO_2 eqv.)	209	36.0	91.2	110
% Impact Reduction by Switching to Intermodal for all Shipments				
Energy (MM MJ)	61%	54%	67%	69%
GWP (tons CO_2 eqv.)	61%	54%	67%	69%
Annualized Savings by Switching 25% of shipments to intermodal				
Energy (MM MJ)	0.577	0.102	0.253	0.305
GWP (tons CO_2 eqv.)	52.2	9.00	22.8	27.6

Figure 6M Environmental Impact Reductions from Implementing an Intermodal Distribution Strategy



6.2.4 BUSINESS IMPACT

6.2.4.1 FINANCIAL IMPACT

Given the competition in the shipping industry, the cost differences between Aveda's current trucking strategy and intermodal logistics are minimal (Table 6F). Intermodal is more cost effective than truck for shipping to LADC, but slightly more expensive for USDC-B, USDC-A and PADC. However, Aveda has the opportunity to negotiate lower shipping rates with a variety of intermodal companies, much like the company has done with UPS for truck shipping,

Table 6F Comparison of shipping costs and delivery times between Aveda's current trucking carriers and four intermodal logistics companies

	Number of full TL shipments per week	Current trucking service rates	Intermodal Carrier 1 Quote *	Intermodal Carrier 2 Quote *	Intermodal Carrier 3 Quote**	Intermodal Carrier 4 Quote**
Roseville to LADC	2-3	$2,400 3 days	$1,872 7-9 days	$1,925 9 days	$2,100 7-8 days	n/a
Roseville to USDC-B	1	$1,515 2 days	n/a	$1,605 7 days	$1,975 3-4 days	n/a
Roseville to USDC-A	3	$1,551 2 days	$1,693 3-4 days	n/a	$2,300 6-7 days	n/a
Roseville to PADC	2-3	$1,700 2 days	$1,637 4-5 days	$1,895 6 days	$2,300 6-7 days	$1845.71 2 days

* does not include fuel surcharge
** includes fuel surcharge of 13%

6.2.4.2 OPERATIONS IMPACT

Switching to intermodal for at least 25% of the shipments will have minimal impact on Aveda's distribution operations. At Roseville, trailers destined for intermodal will need to be braced to ensure the product is not damaged during shipping, which reduces the volume capacity of the trailer by 9%, which amounts to a footprint loss of two to four pallets.[79] This loss is only significant if the pallets cannot be stacked, otherwise, intermodal trailers can be loaded with far more pallets than a standard truckload because intermodal trailers can carry up to 45,000 lbs, while truckloads are limited to 35,000 lbs (due to various limits set by different states).

At the destination points, distribution center management will need to adjust staff schedules to accommodate new dates of arrival. Currently, the management at LADC and USDC-A increase staff levels to accommodate incoming truckloads of cargo from Roseville.[80] At LADC, for example, one Aveda staff person arrives two hours early in order to unload the truck that arrives from Roseville. Order due dates and shipping dates can remain the same but the dates of delivery will shift slightly.

6.2.4.3 Customer Impact

Since each distribution center holds at least six weeks of inventory for most SKUs, then the slight shipping delays associated with intermodal logistics will increase risk of stockout minimally.

6.3 Recommendation 3 – Reduce Inventory Disposition, Returns and Out-of-Region Shipments

6.3.1 Problem Definition

Transport waste is defined as transport that does not move goods directly from production to market. This waste creates unnecessary expense and environmental impact and occurs in three areas of Aveda's PDS system: Inventory disposition, out of region shipments, and product returns.

6.3.1.1 Inventory Disposition

Inventory disposition is defined as the shipment of inventory between DCs to fill inventory gaps and to even out the distribution of inventory at the three DCs. It also includes shipments of obsolete products back to Roseville. Observation at the Roseville site highlighted at least ten full pallets of returned product, and other anecdotal evidence suggests that there is a significant amount of product returns in the inventory disposition data. Inventory disposition is typically transported by pallet via LTL. The most significant inventory disposition from October 2003-October 2004, in terms of vehicle ton miles, occurred on the route from LADC to Roseville, with approximately 106,000 kg shipped for a total of 206,000 metric ton miles. The PADC to Roseville route shipped approximately the same weight, 105,000 kg, but because of the shorter route, has significantly fewer metric ton miles, 126,000. The third most significant inventory disposition was between third-party distributors and Roseville with 15,800 ton miles (Figure 6N). Inventory Stocking is the initial movement of the dispossessed inventory from Roseville to the DC (Figure 6O).

Figure 6N Inventory Disposition, Weight by route

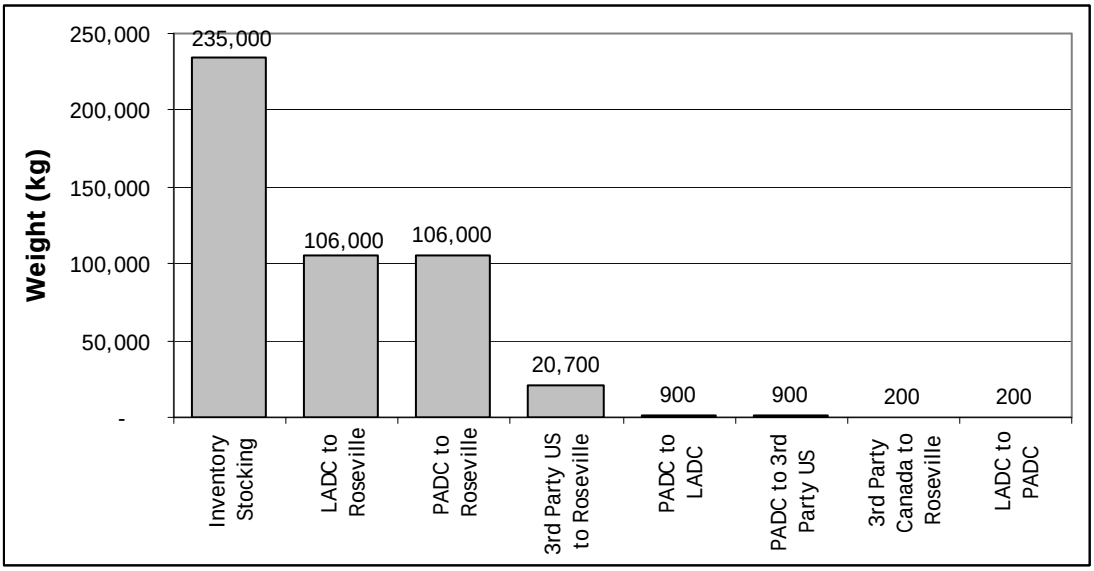
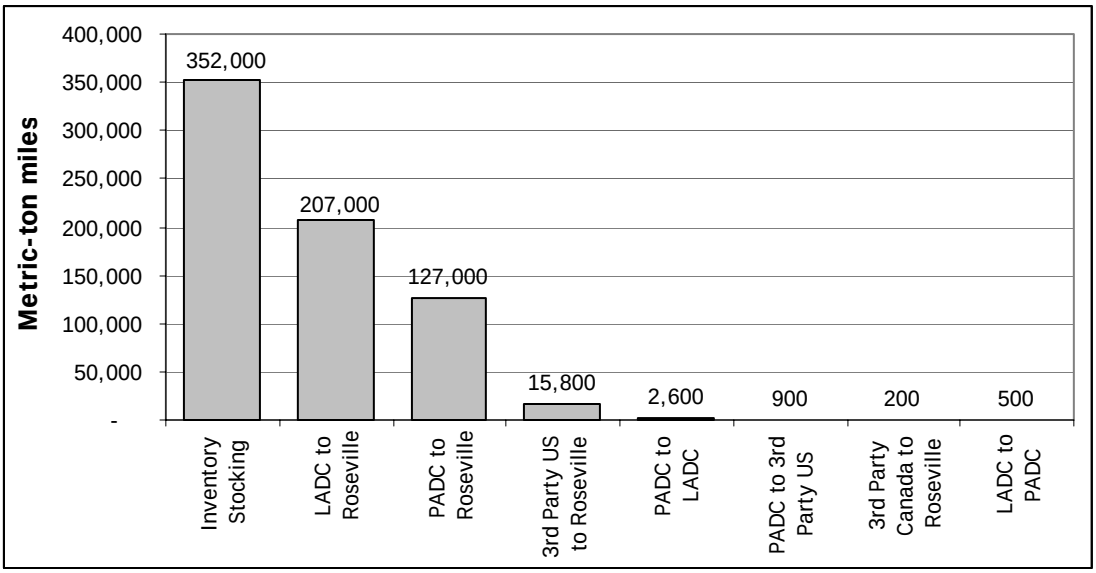


Figure 6O Inventory Disposition, Metric Ton-Miles by route



6.3.1.2 OUT OF REGION SHIPMENTS

Out of region shipments are defined as a shipment by a DC to an out of region salon or retail store, although out of region shipments to salons are much more common. For example, when LADC services a salon order in New York, the shipment is considered out of region. Out of region shipments occur as a result of an out of stock product at a primary distribution center, which are defined by Aveda. Customer service representatives can split orders and ship the out of stock item from an out of region distributor. As seen in Figure 5N, the three most significant out of region routes by weight are PADC to third-party Salon (23,100 kg), LADC to Roseville retail stores (5,330 kg), and LADC to Roseville salon (4,410 kg). Figure 6P shows these same routes in terms of metric ton-miles, which generally corresponds with environmental impact. Because of the varying distances traveled, weight will not necessarily correspond to metric ton-miles or environmental impact (Figure 6Q).

Figure 6P Out of Region Shipments, Weight by route

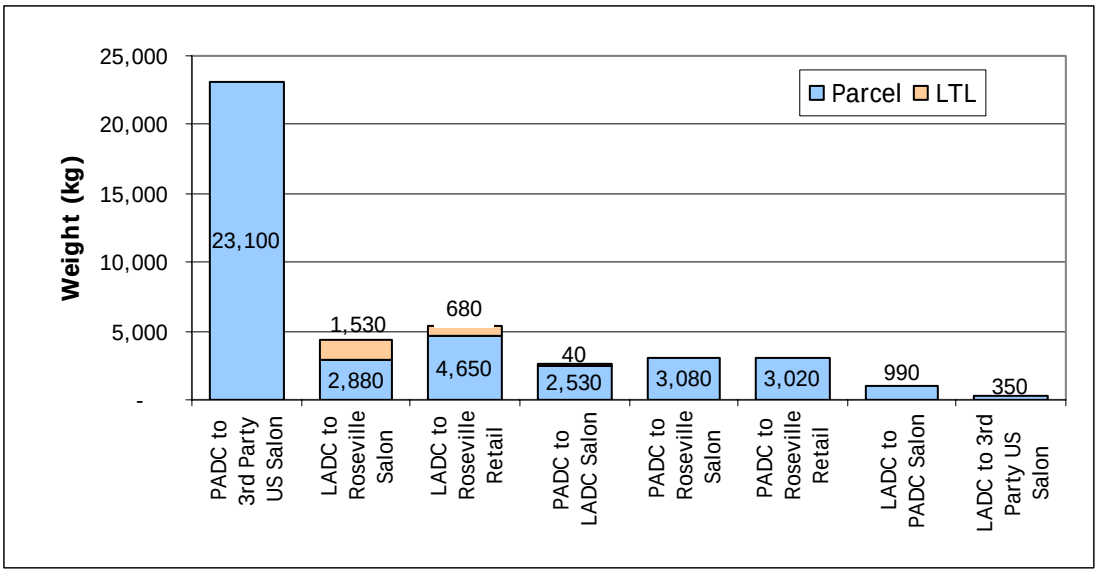
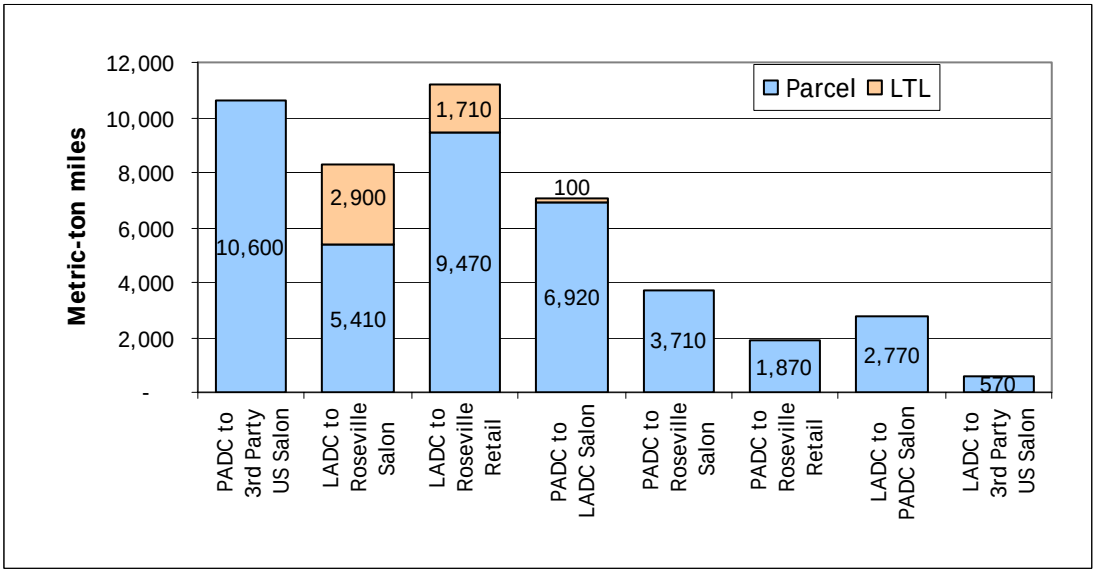


Figure 6Q Out of Region Shipments, Metric Ton-Miles by route

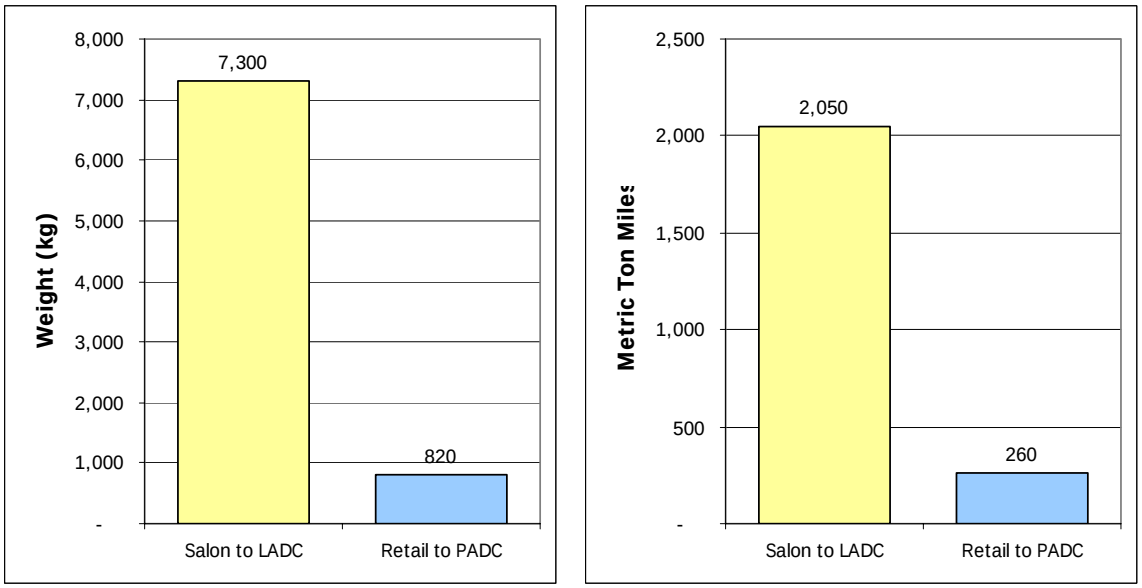


6.3.1.3 Product Returns

Product returns are the shipment of damaged goods or incorrect orders. For the purpose of this report we do not include obsolete products in the product returns. Product returns occur in larger quantities from DCs and in smaller quantities from salons and retail stores. Data for product returns is difficult to obtain because there is no coding for this type of shipment and it falls into other categories of data. Aveda personnel have indicated that the company receives “one or two” customer returns via UPS daily, however these shipments were not captured in the data set

provided for this project. Therefore, it is expected that customer returns are actually higher than indicated in Figure 6R.

Figure 6R Product Returns, Weight and Metric Ton-Miles by route



6.3.2 PROPOSED SOLUTION

Interviews with operations managers reveal that Aveda has reduced the amount of inventory disposition, out of region shipments, and product returns over the past five years.[81] While we recognize that Aveda's strategy in the salon market will make it difficult to reduce further inventory disposition, out of region shipments, and product returns, we recommend that Aveda could focus on two areas to continue the improvement trends made thus far:

- SKU rationalization—Aveda has hundreds of SKUs, many of which are held as inventory at all three DCs. Because some of these SKUs have limited sales, it is difficult to estimate the quantity required and infrequent manufacturing of these SKUs results in long lead times before inventory is replenished. We recommend that Aveda consolidate it's low running SKUs at Roseville, and ship those items direct to customers. Since we did not have access to the sales by SKU data, we do not know where the cut-off should be, but given the wide variety of products, we expect that anywhere between 1 and 5% of the SKUs could be candidates for consolidation.

- Tracking, monitoring, and analyzing inventory disposition, out of region shipments, and product returns – Currently, Aveda does not have any system that captures these wasteful movements of freight. We recommend that software be upgraded or modified to track this data closely and have the results reported to management on a regular basis.

6.3.3 ENVIRONMENTAL IMPACT

The environmental impact resulting from inventory disposition consists of the transportation of the various shipments described above as well as the original shipment of the inventory, shown in Figure 6S and 6T as "Inventory Stocking." The resulting energy impact is 1,054,000 MJ and the GWP is 86,120 kg CO_2.

Figure 6S Energy Consumption (MJ) of Inventory Disposition

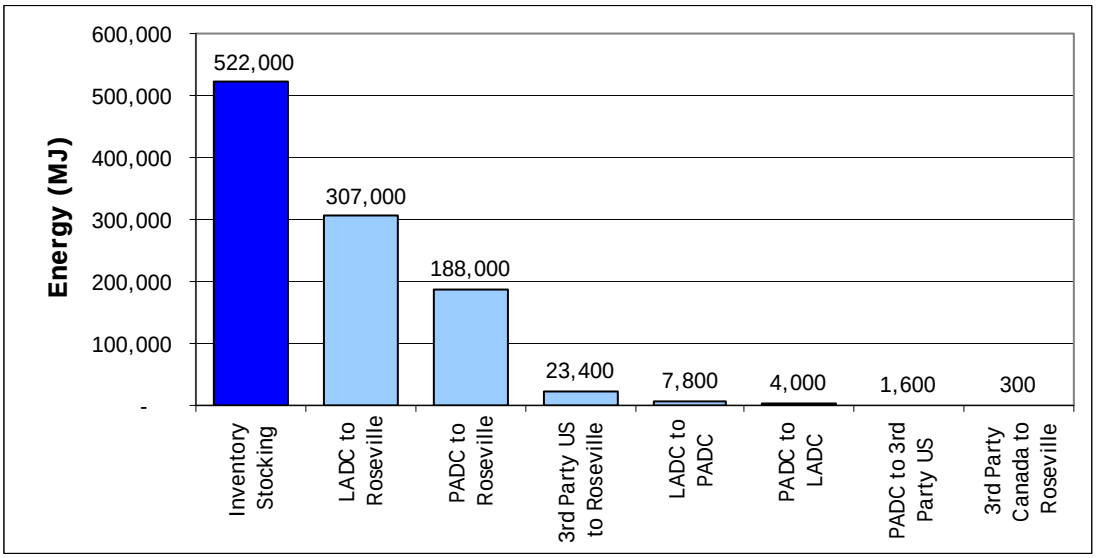
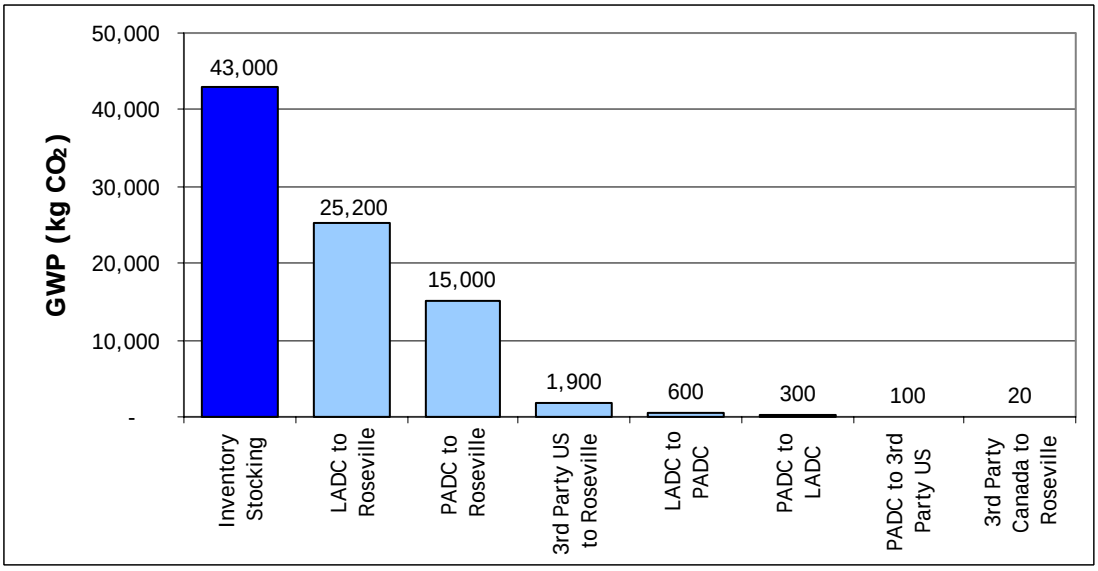


Figure 6T GWP of Inventory Disposition



The environmental impact resulting from out-of-region shipments is based on the additional transport required in shipping products back across the country. There is potentially additional impact due to shipping to a different distributor, but it is difficult to quantify this additional

impact. The resulting energy impact is 106,990 MJ and the GWP is 8,750 kg CO_2 (Figures 6U and 6V).

Figure 6U Energy Consumption (MJ) of Out of Region Shipments

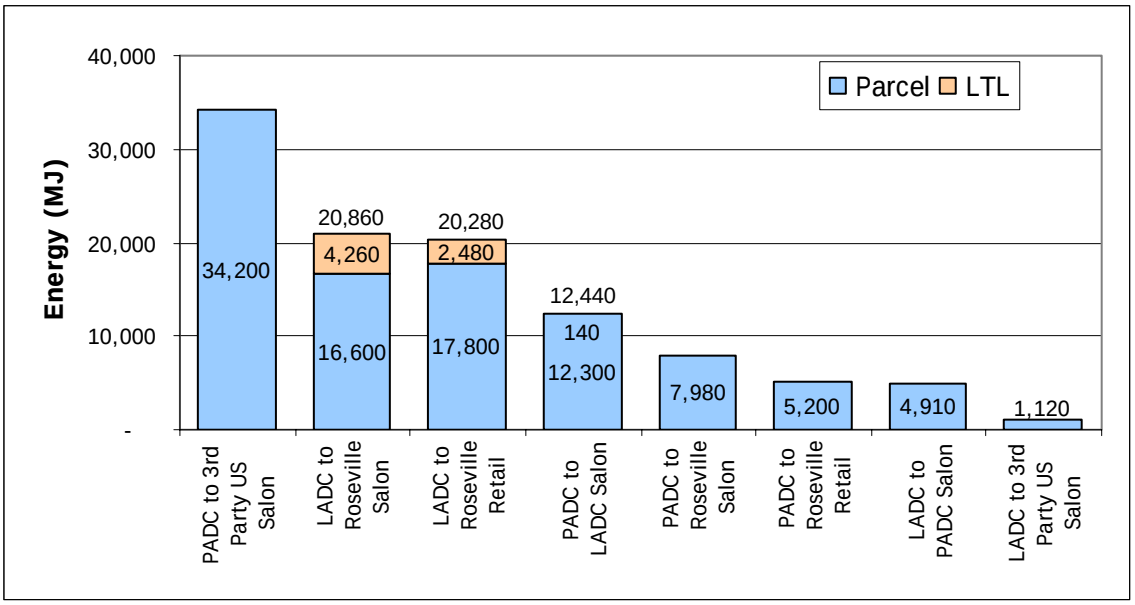
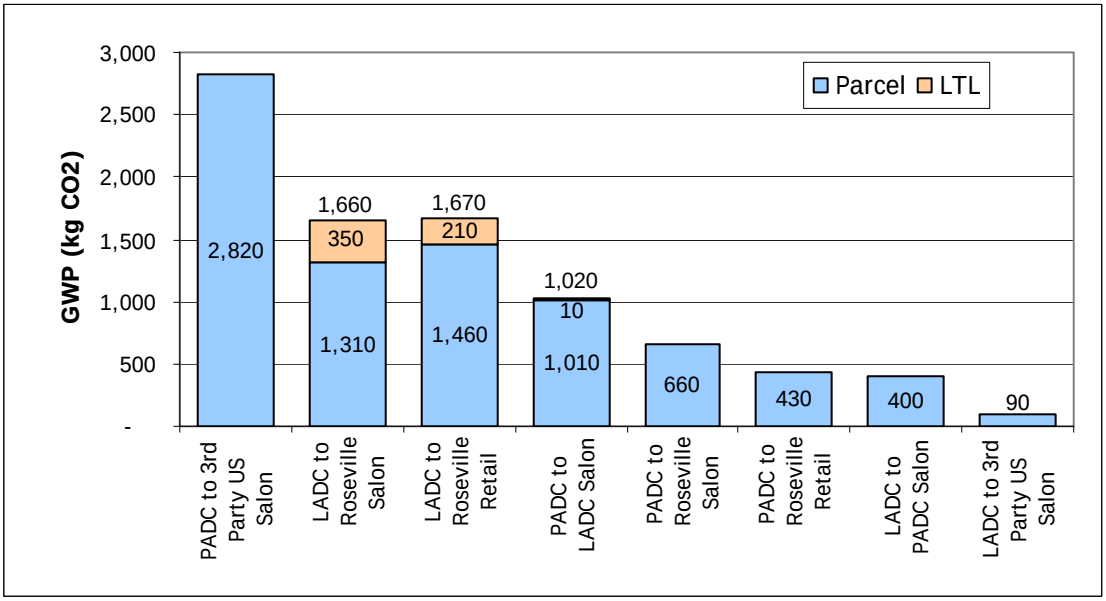


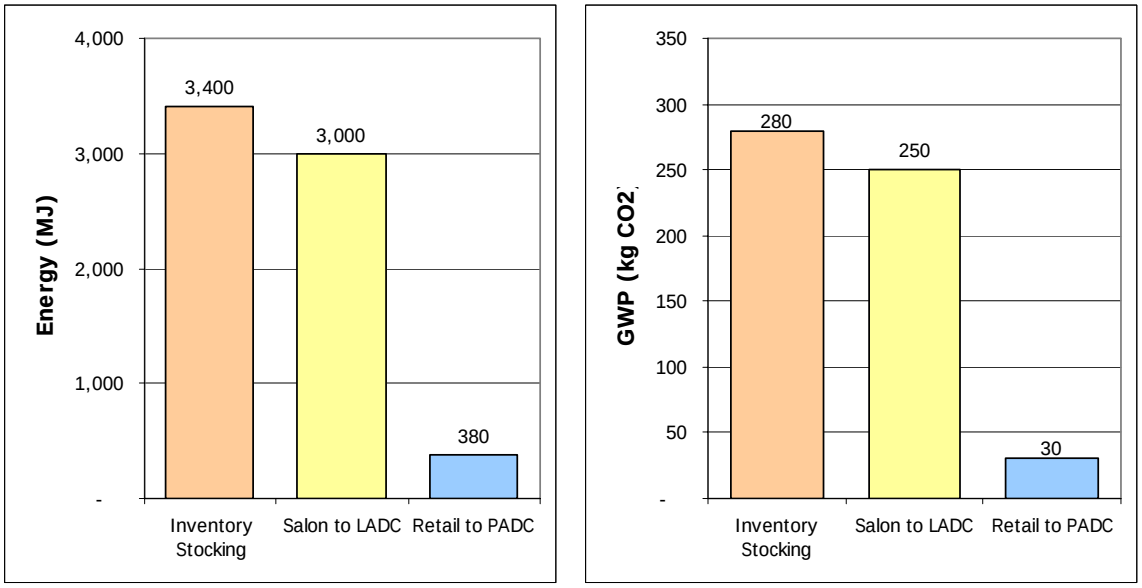
Figure 6V GHG Impact of Out of Region Shipments



The environmental impact resulting from product returns consists of the transportation of the various shipments described above as well as the original shipment to the customer. This means the inventory stocking results in a doubling of the environmental impact. The resulting energy

impact is 6,780 MJ and the GWP is 560 kg CO_2 (Figure 6W). However, as noted above, there are additional UPS returns that are not captured in this data.

Figure 6W Energy Consumption and GHG Impact of Product Returns



As stated in section 5.3, the annual energy consumption of Aveda's entire transportation component of the PDS system is 25.8 MM MJ and the total Global Warming Potential is 2,097 metric tons CO_2. The environmental impact of Inventory disposition is 1,054,000 MJ and 86,120 kg CO_2, Out of Region Shipments is 106,990 MJ and 8,750 kg CO_2, and Product returns is 6,780 MJ and 560 kg CO_2. Total environmental impact for all three transport inefficiencies is 1,167,770 MJ and 95,430 kg CO_2, or approximately 4.5% of the transport component of the PDS.

6.3.4 Business Impact

6.3.4.1 Financial Impact

The cost of transport for inventory disposition is estimated at $109,000 to $198,000. The difference between the low and the high cost is constituted by the rate used. The high LTL rate includes a surcharge to guarantee delivery day. Because inventory disposition does not necessarily require guaranteed delivery, we included the low rate. Parcel rates were estimated by Aveda, and a low rate (20% less) was created arbitrarily, although the parcel shipments affect the total costs only slightly. The TL rates for third-party is unknown and thus the range between what Aveda receives for PADC and LADC was used. These figures are intended to be estimates used to understand the financial impact of the environmental inefficiency, and are not intended to represent exact costs that would be avoided.

The cost of transport for out of region shipments was not able to be calculated. The shipments would have to have been sent from a different distribution center, and it is difficult to calculate the extra cost associated with the alternative distribution center, though it is not expected that the costs would vary significantly.

The cost of transport for return shipments is estimated at $5,000 to $11,000. The difference between the low and the high cost is constituted by the rate used as mentioned above. If there are additional returns not captured in this data, such as the daily UPS returns described earlier, costs could be higher. Again, these figures are intended to be estimates for purposes of evaluation.

6.3.4.2 Operational Impact

It would be extremely difficult to eliminate inventory disposition, out-of-region shipments, and product returns, because it is a natural result of operating a product company. However, if Aveda did commit to reduce this inefficiency it would require more accurate customer demand forecasting. However, there would also be reduced labor required for restocking inventory.

Additionally, there may be unique situations that arise when Aveda will need to change its manufacturing schedule. For example, if a product is out of stock in a distribution center, it may be better for Aveda to move up the production of a new batch so that inventory is replenished throughout the distribution network. Currently products may be shipped out of region, or between distribution centers in order to meet the demand. Again, this may require better demand forecasting.

6.3.4.3 Customer Impact

Aveda's customers demand and are guaranteed exceptional service, which results in Aveda's liberal policy on customer returns and shipments from out-of-region. It is not recommended that Aveda eliminate this policy because it is integral to being a premium brand. However, because most of Aveda's customers believe in its environmental mission, the company could better educate its customers about the impact due to returns and out of region shipping (see Table 6G for a summary of Recommendation 3).

Table 6G Summary of Environmental, Financial, Operational, and Customer Impact for three transport inefficiencies

	Inventory Disposition	Out of Region Shipments	Product Returns
Environmental Impact	• 1,054,000 MJ • 86,120 kg CO_2	• 106,990 MJ • 8,750 kg CO_2	• 6,780 MJ • 560 kg CO_2
Financial Impact	• $109k - $198k	• N/A	• $5k - $11k
Operational Impact	• Improve forecasting • Reduce no. SKUs held at PADC and LADC • Reduce Labor needed for restocking		
Customer Impact	• Educate customers of return impacts • May require longer delivery times on low running SKUs		

6.4 RECOMMENDATION 4 – REDUCE VOLUME OF PRODUCT SHIPPED BY LOOSE-PICK

6.4.1 PROBLEM DEFINITION

Holding all variables equal, loose-pick packaging and parcel shipping requires two to three times more energy and emits close to three times the amount of metric tons of CO_2 equivalents of GHGs as compared to packing and shipping via full pallets (see Appendix D). Given that 6% of the total pound-miles is shipped via parcel,[82] Aveda has an opportunity to make a small incremental improvement to reducing its environmental impact.

6.4.2 PROPOSED SOLUTION

The proposed solution depends on the future of Aveda's shipping and handling (S&H) policy, namely whether the current shipping and handling fee will remain as is or whether Aveda will provide free S&H to customers (see Figure 6Y). The following list of solutions aims to provide financial incentives for customers to ship via pallets.

6.4.2.1 CUSTOMER SERVICE ALGORITHM

Currently, customer service representatives determine the shipping options based on the total cost of the order. Any order that is greater than $2,500 will be shipped via LTL carrier and any order costing less than $2,500 is shipped via UPS. This logic is based on the premise that, on average, $100 of Aveda product roughly weighs about one pound and that it is most economical to ship any order greater than 250 pounds via LTL and any order fewer than 250 pounds via loose-pick (e.g., UPS). There are a few caveats to this logic:

- For orders that fall in the $2,000 to $3,000 range, the customer service representatives have been trained to quickly look over the order to determine if the composition is made up of mostly high-weight products, like shampoo and crèmes, or low-weight products like makeup and accessories. In the case of the former, the sales representative may ship via LTL even though it does not meet the $2,500 threshold.

- The Roseville DC also performs a "reality check" on orders that hover around the $2,500 mark. If they recommend changing the carrier, they contact customer service to determine whether the change in carrier is permissible based on stated customer needs (e.g., due dates, ability to receive pallets, etc.).

- Lastly, there are some customers that cannot receive pallets due to obstacles (e.g., narrow doors, stairs, no elevators, etc.).

While this system has worked well for Aveda, there are some opportunities for improvement. We recommend that Aveda update the current software used by customer representatives to include a module that calculates the total weight of the order as it is being received. This will allow Aveda to determine more accurately the shipping costs at the time of the order, as well as

provide more information to the representative who is often faced with the challenge of upselling. Additionally, it is imperative that Aveda develop a system of rewarding customers who choose to receive pallet-loads, such as a carbon credit reward (further discussed below).

6.4.2.2 Sliding Scale

If Aveda cannot build a software module as described in section 6.4.2.1, Aveda can use a sliding scale to charge more for loose-pick orders. For example, Aveda can charge a flat fee per loose-pick box and full/mixed pallet. A pricing mechanism where the loose-pick flat fee is significantly greater than a pallet fee, will motivate customers to order in pallet quantities. There are numerous pricing options; see Table 6H for a description of two.

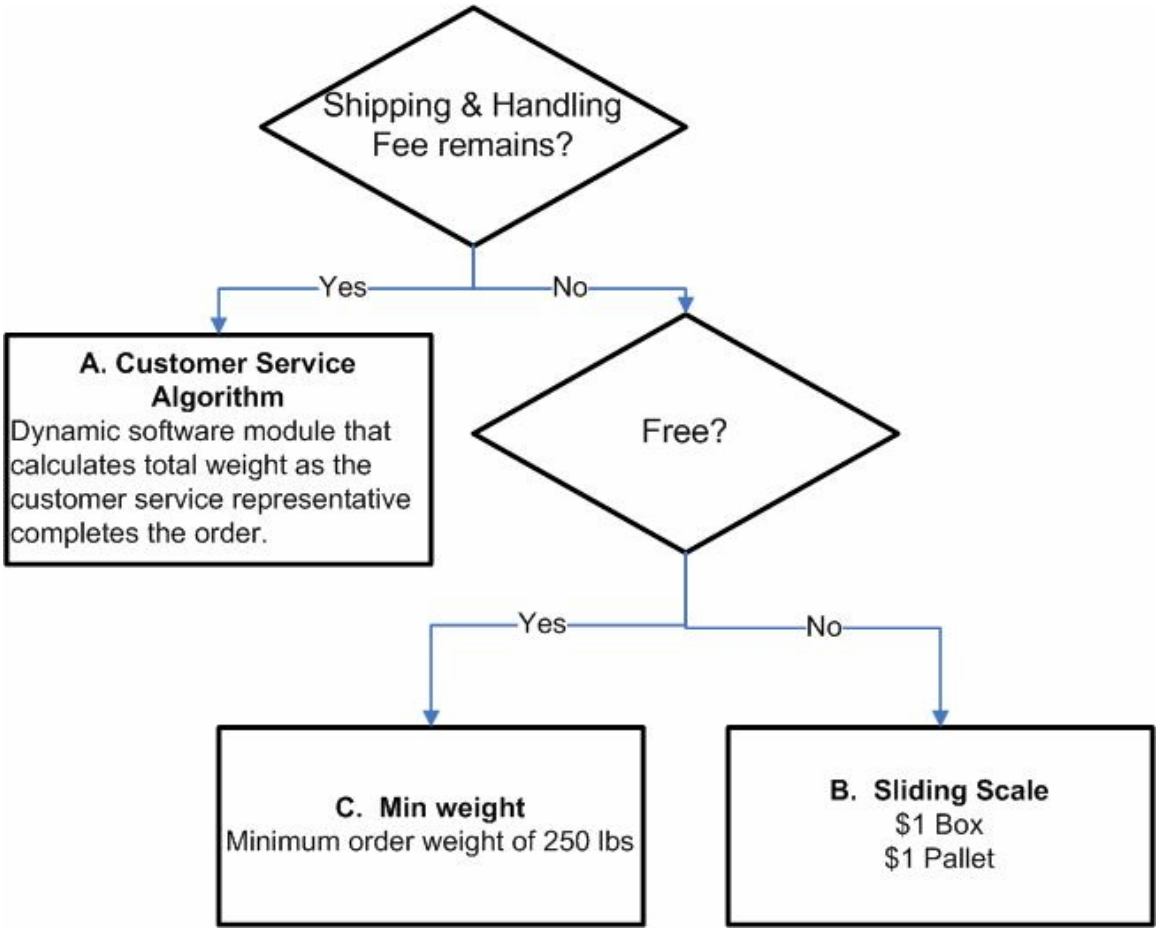
Table 6H S&H sliding scale to motivate

Total Order Cost	Number of Loose-pick Boxes	Number of Pallets	S&H Cost $1 LP, $1 Pallet	S&H Cost $10 LP, $1 Pallet
$1 - $100	1	0	$1	$10
$101 -$200	2	0	$2	$20
$201 - $300	3	0	$3	$30
$2,401 - $2,500	24	0	$24	$240
$2,501 - $2,600	0	1	$1	$1
$2,601 - $2,700	1	1	$2	$11
$2701+	. . .	. . .	. . .	. . .

6.4.2.3 Minimum weight requirements

If Aveda decides to provide free S&H, the company should impose a minimum order weight of 250 lbs, which is the threshold for shipping via LTL. This approach may not be suitable for low-volume salons.

Figure 6X Diagram of Proposed Recommendations based on Aveda's S&H Policy



6.4.3 Environmental Impact

Any one of these recommendations will provide a reduction of orders shipped out via loose-pick. The model used in our analysis reveals that salon orders contribute 3.76 MM MJ energy and 308 metric ton of CO_2 equivalents to the PDS (note: air shipments to Hawaii were removed from these figures). Given that, if just 1% of shipments were changed from parcel to LTL, Aveda would save an estimated 0.029 MM MJ and 2.3 metric tons CO_2 equivalents (0.1% of PDS) at a comparable cost to current operations. This amounts to taking 1.4 autos off the road each year. If Aveda were to convert 10% of their orders from parcel to LTL, these efforts would amount to taking 14 autos off the road per year.

6.4.4 Business Impact of Proposed Solution

If any part of this recommendation is implemented, it may increase sales and decrease shipping costs.

6.5 RECOMMENDATION 5 - CARBON OFFSETS

6.5.1 PROBLEM DEFINITION

Aveda's PDS, especially transportation, accounts for a large portion of GWP and energy use. According to our assessment the PDS' GWP is 2,811 metric tons CO_2. While we have offered several recommendations to minimize this impact, carbon offsets offer a means to negate the impact by avoiding or sequestering an equal amount of emissions at another location.

Carbon offsets are increasingly being used throughout the world. Carbon offsets fund projects that slow, counter or prevent the release of CO_2 into the atmosphere. From 1996 to 2000 North America was the only region of the world participating. However, starting in 2001 many European countries launched their own carbon offset programs.[83] Further, the ratification of the Kyoto Protocol is likely to increase demand for offsets.

Over the past several years, Aveda has entertained the idea of using carbon offsets to partially or fully offset the GHG impact of its operations. In 2004 Aveda purchased carbon offsets for their Air Control line of hairspray. However, in their 2002 CERES report, Aveda recognized the potential flaws of permanence and effectiveness with carbon offsets. Given this ambiguity, we have further researched carbon offsets and evaluated the associated financial and environmental impacts.

6.5.2 PROPOSED SOLUTION

We have identified three different options through which Aveda could offset the GWP from its PDS: Climate Care, CCX®, and Native Energy. Organizations such as Climate Care (www.co2.org) enable both groups and individuals to fund international projects that prevent the emission of carbon dioxide and other GHGs. However, it should be noted that the impact of such projects can be difficult to quantify, and most of the internationally recognized mechanisms that allow for companies to count specific offsets are still under development.

6.5.2.1 CLIMATE CARE

Climate Care is located in Oxford, England and was formed in 1998 to help individuals and organizations reduce their own impact on global warming. When a company or individual works with Climate Care, their carbon dioxide emissions are calculated (measured in tons of CO_2), and then offsets are sold to the company or individual. The money gained from the sale of the offsets is used to help protect the climate from further damage by investing in renewable energy projects, investing in energy efficiency projects, and financing projects which remove CO_2.[84]

Climate Care's projects are scrutinized by its Environmental Steering Committee. The Committee members include organizations such as the WWF (Worldwide Fund for Nature) and Forum for the Future. Climate Care is implementing projects in several developing countries including South Africa and Bangladesh. In South Africa, 95% of electricity is generated from coal in power stations. This means that the CO_2 emissions per unit of electricity are some of the highest in the world. Climate Care is installing 25,000 low energy lamps, lightening the load on electricity demand, people's electricity bills and the climate. In addition, Climate Care is working with a number of municipalities and housing developers in Cape Town and Johannesburg to install energy efficient lighting into residential homes.

Climate Care has teamed up with a local NGO in Bangledesh, the Intermediate Technology Development Group (ITDG), which has been working in the area for over 30 years, to reduce GHG emissions. ITDG will run a series of training courses over a year to show villagers how to build energy efficient stoves using local materials. A portion of the program will be to show people how to set up a micro enterprise to make stoves for others in the community.

6.5.2.2 CCX®

Aveda might also consider purchasing carbon credits on the Chicago Climate Exchange (CCX®).[85] CCX® serves as a marketplace for trading and reducing GHGs. As of late 2004, carbon was trading on the exchange at a rate of $1.43 per metric ton. CCX® is a GHG emission reduction and trading pilot program for emission sources and offset projects in the United States, Canada, Mexico and Brazil. CCX® is a self-regulatory, rules based exchange designed and governed by CCX® Members. These members have made a voluntary, legally binding commitment to reduce their emissions of GHGs by 4% below the average of their 1998-2001 baseline by 2006, the last year of the pilot program. Emission offsets include landfill and agricultural methane and sequestration in soils.

The development of the CCX® was initiated through a feasibility study that was funded in May 2000 by a grant from Chicago-based Joyce Foundation. The program specialized in developing and trading new environmental, financial and commodity markets. It also designed risk management and hybrid financial instruments that enhance the interrelationships between the capital, commodity and environmental markets. The study concluded that a North America private sector pilot GHG trading market is feasible. To participate with CCX®, Aveda would contact Rafael Marques at info@chicagoclimateexchange.com or (312) 554-3350. Additional information can also be found at www.chicagoclimateexchange.com.

6.5.2.3 NATIVE ENERGY

Native Energy is a renewable energy company that specifically works to support the Rosebud Sioux Tribe in its efforts to build a wind energy farm.[86] By purchasing carbon credits, companies and individuals can fund turbine construction that offsets CO_2 emissions with clean energy. Aveda is already a part of Native Energy's WindBuilders[sm] Business Partner Program and used Native Energy to achieve a climate neutral status for their Air Control hairspray. Other companies and organizations that contribute to Native Energy include: Ben and Jerry's, Green Mountain Coffee Company, Clif Bar, Stoneyfield Farm, Seventh Generation, Timberland, and the Dave Mathews Band. To participate further in this program, Aveda would call 800.924.6826 or email business@nativeenergy.com.

Native Energy is also certified by the Climate Neutral Network, an alliance of companies and other organizations committed to developing products and enterprises that eliminate their impacts on the earth's climate.[87] The Network is an independent 501(c)(3) non-profit organization that has a certification program called Climate Cool™. The Climate Cool™ brand is a trademark of the Climate Neutral Network that can be licensed only by Climate Cool™ certified companies for use in the marketing and promotion of their Climate Cool™ products, services, and enterprises.[88] Products and enterprises backed by the Climate Cool brand have been certified by an Environmental Review Panel, which includes leading environmental groups such as the World Wildlife Fund, the Nature Conservancy and the Rocky Mountain Institute. It should be noted that NativeEnergy is certified as a Climate Cool™ program.

6.5.3 ENVIRONMENTAL IMPACT

Depending on which organization is used for offsets, the environmental impact varies. In the case of Climate Care, international environmental programs are funded. On the other hand, CCX® helps support the market for trading carbon, which aims to incentivize companies to reduce their emissions. And in yet another approach, Native Energy supports Native Americans and increases wind power through building turbines.

While each of these options looks good on paper, several concerns should be considered. One is that purchasing carbon offsets shifts the responsibility of reducing carbon in the air to developing countries instead of focusing on domestic possibilities.[89] Companies are thus not incentivized to reduce their carbon footprint, but rather to continue to pollute and fund international projects, thereby widening the gap between developed and developing countries with regard to GHG emissions. Another concern is that each carbon offset represents a release that is occurring and

does not provide a permanent avoidance of carbon release into the atmosphere. In addition, companies may not be as likely to invest in new technologies to decrease their CO_2 emissions if they are participating in a carbon offset program.

6.5.4 Business Impact of Proposed Solution

Based on our analysis, if Aveda were to become a "carbon neutral" organization with respect to its PDS, the total cost to the company would be $11,250, $4,020 or $8,433 per year, under the Climate Care, CCX®, and NativeEnergy frameworks, respectively.[90] The large disparity among the three results from the difference in how each calculates the value per ton of carbon.

Table 61 Total Cost to offset the PDS through three different options

	Climate Care ($13.34/ton)	CCX® ($1.43/metric ton)	NativeEnergy ($10/ton)
Offset Packaging	$2,857	$1,021	$2,142
Offset Transportation	$8,392	$2,999	$6,291
Offset PDS	$11,250	$4,020	$8,433

6.5.4.1 Operational Impact

There is no operational impact from implementing this recommendation.

6.5.4.2 Customer Impact

Customers will not be impacted by carbon offsets. However, implementing a carbon offset program is in-line with Aveda's commitment to environmental excellence and may result in favorable media coverage.

6.5.4.3 Recommendation

Each of the above alternatives to reducing or eliminating Aveda's carbon footprint has pros and cons. These are laid out in the below table (Table 6Q).

Table 6J Comparison of CCX®, Native Energy, and Climate Care

	Climate Care	CCX®	Native Energy
Cost to offset	Packaging: $2,857 Transportation: $8,392 Total PDS: $11,250	Packaging: $1,001 Transportation: $5,673 Total PDS: $6,674	Packaging: $2,142 Transportation: $6,291 Total PDS: $8,433
Pros	Supports international energy-saving initiatives	Lowest cost; supports carbon reduction through trading credits/retiring; incentivizes companies to reduce emissions;	Supports local, new renewable energy facilities; relationship already established;
Cons	Focuses on international rather than decreasing domestic impact; no incentives to reduce domestic emissions;	Still some skepticism about positive effects; fairly young program, developed in 2000	

Given the environmental and business impact of each of the options, we recommend that Aveda continue to participate with Native Energy because of its credible clients, domestic focus, support for Native Americans, and longer-term focus of supporting renewable energy. This is the one option that establishes US renewable energy capabilities. As an alternative to help save on costs, Aveda could do a hybrid mix of purchasing carbon credits from CCX® and also Native Energy.

6.5.5 Carbon Offsets For Project

In the spirit of Aveda's environmental sustainability-driven mission, the teachings at the School of Natural Resources & Environment, and the personal values of the authors, the carbon emissions associated with the completion of this project have been offset using carbon credits. The travel required for this project created approximately 4.6 metric tons of CO_2 emissions. As noted in our recommendations, Aveda already contracts with the firm Native Energy to provide carbon credits, and 5 short tons (4.5 metric tons) were purchased from the company to offset this project's impact at a total cost of $60. Calculations are provided in Table 6K. Future calculations for offsetting travel related emissions will be simplified with Native Energy's simple online calculator which will be on its website in 2005.

Table 6K Project carbon offset calculations[91, 92]

Description	Distance	Conversion	Total emissions
May 2004 data gathering and project kick-off trip to Minneapolis with all 5 team members			
Air travel from Detroit to Minneapolis and return for all 5 team members	527 x 2 x 5 = 5270 "medium haul" passenger land miles	0.2028 kg CO_2/ mile	1,069 kg CO_2
Auto use, including travel to airports.	Approximately 100 miles. Standard auto, assume "medium vehicle" at 23 mpg.	0.3920 kg CO_2/ mile	39 kg CO_2
November 2004 data gathering trip to Minneapolis with 3 team members			
Air travel from Flint to Minneapolis and return to Detroit for 1 person	490 + 527 = 1017 "medium haul" passenger land miles	0.2028 kg CO_2/ mile	206 kg CO_2
Air travel Connecting flight from Detroit to Flint.	54 "short haul" passenger land miles	0.2897 kg CO_2/ mile	16 kg CO_2
Air travel from Detroit to Minneapolis and return for 1 person	527 x 2 = 1054 "medium haul" passenger land miles	0.2028 kg CO_2/ mile	214 kg CO_2
Air travel from Flint to Minneapolis and return to Chicago for 1 person	490 + 349 = 839 "medium haul" passenger land miles	0.2028 kg CO_2/ mile	170 kg CO_2
Rail travel from Chicago to Ann Arbor for 1 person	250 U.S. Intercity Rail passenger miles	0.1909 kg CO_2/ mile	48 kg CO_2
Auto use, including travel to airports.	Approximately 200 miles. Standard auto, assume "medium vehicle" at 23 mpg.	0.3920 kg CO_2/ mile	78 kg CO_2
January 2005 data gathering trip to Minneapolis for 1 team member			
Air travel from Detroit to Minneapolis and return for 1 person	527 x 2 = 1054 "medium haul" passenger land miles	0.2028 kg CO_2/ mile	214 kg CO_2
Auto use, including travel to airports.	Approximately 50 miles. Standard auto, assume "medium vehicle" at 23 mpg.	0.3920 kg CO_2/ mile	20 kg CO_2
March 2005 presentation to School of Natural Resources by all 5 team members			
Air travel from Oakland, CA to Chicago and return for 1 person	1834 x 2 = 3668 "long haul" passenger land miles	0.1770 kg CO_2/ mile	649 kg CO_2
Air travel from xxx to Detroit and return for 1 person	234 x 2 = 468 "short haul" passenger land miles	0.2897 kg CO_2/ mile	136 kg CO_2
Rail travel from Chicago to Ann Arbor and return for 1 person	500 U.S. Intercity Rail passenger miles	0.1909 kg CO_2/ mile	95 kg CO_2
March 2005 presentation to Aveda by all 5 team members			
Air travel from Detroit to Minneapolis and return for 3 team members	527 x 2 x 3 = 3162 "medium haul" passenger land miles	0.2028 kg CO_2/ mile	641 kg CO_2
Air travel from Chicago to Minneapolis and return for 1 team member	335 x 2 = 670 "medium haul" passenger land miles	0.2028 kg CO_2/ mile	136 kg CO_2
Air travel from San Francisco to Salt Lake City for 1 team member	599 "medium haul" passenger land miles	0.2028 kg CO_2/ mile	121 kg CO_2
Air travel from SLC to Minneapolis for 1 team member	990 "long haul" passenger land miles	0.1770 kg CO_2/ mile	175 kg CO_2
Air travel from Minneapolis to Atlanta for 1 team member	908 "medium haul" passenger land miles	0.2028 kg CO_2/ mile	184 kg CO_2
Air travel from Atlanta to San Francisco for 1 team member	2,137 "long haul" passenger land miles	0.1770 kg CO_2/ mile	378 kg CO_2
Auto use, including travel to airports.	Approximately 100 miles. Standard auto, assume "medium vehicle" at 23 mpg.	0.3920 kg CO_2/ mile	39 kg CO_2
TOTAL			**4,628 kg CO_2**

6.6 RECOMMENDATION 6 - ENROLL IN EPA SMARTWAY PROGRAM

6.6.1 PROBLEM DEFINITION

As an environmental leader, Aveda should demand excellent environmental performance from its business partners throughout its supply chain. However, many of Aveda's current transport carriers are not being as proactive as other carriers with regard to improving their environmental and energy efficiency performance, to the extent that they are not participating in a voluntary U.S. EPA program called the SmartWay Transport Partnership (SmartWay).

SmartWay is a collaborative, voluntary program between EPA and the freight industry that aims to increase energy efficiency.[93] The development of SmartWay was largely informed by the Green Freight Working Group at Business for Social Responsibility (BSR). While Green Freight no longer exists as such, the group has evolved into the Sustainable Freight working group, which has two primary objectives: 1) to develop metrics to comparatively assess efficiency of different modes of transport, and 2) to develop corporate standards for shippers. There are several major differences between Sustainable Freight and SmartWay. First, SmartWay has an exclusively domestic focus and does not apply to transport of goods outside of the U.S., whereas Sustainable Freight is global in scope. Next, Sustainable Freight addresses all modes of transportation, whereas SmartWay addresses truck carriers only. Lastly, SmartWay currently has specific program requirements for all participants, whereas Sustainable Freight is in very early stages of development and has not yet developed any specific standards or program requirements. SmartWay currently offers more practical tools for shippers and carriers to reduce their transportation footprint. Sustainable Freight, though, is more comprehensive in scope than SmartWay and has the potential to have a far-reaching impact. Aveda should stay apprised of developments at Sustainable Freight program and consider participating if interested, especially as the company expands further into international markets.

SmartWay currently has over one hundred participating partner firms, including 85 carriers, 18 freight shippers, and six shipper-carriers. Participating carriers include major freight companies such as UPS, Fed-Ex, and DHL, and participating shippers include companies such as Interface Inc., IKEA USA, J & J Industries, Nike, The Home Depot, and Dell. One participating shipper, Quad/Graphics, indicated in a recent publication that "by using SmartWay's recommended techniques, we have significantly reduced GHG emissions and improved the fuel efficiency of our ground freight transportation."[94]

Of all Aveda's 31 carriers that were reviewed for the purposes of this study, only DHL (which shipped only ten pounds of products over the five-month period studied), Fed-Ex, and UPS are enrolled as SmartWay partners. Out of all of Aveda's shipments during the period studied, approximately 5.1% (in terms of ton-miles) were made by carriers that are currently enrolled in SmartWay; however, UPS shipments alone account for 5% of total shipments, while Fed-Ex and DHL account for the remaining 0.1%. As described by Table 6L, Aveda's top five carriers accounted for approximately 90% of all shipments on a ton-miles basis. (Appendix E includes a list of all Aveda carriers and their relative impacts).

Table 6L Top Five Inbound and Outbound Transport Carriers by Ton-Miles (Annualized using data from October 2003 through February 2004)

Carrier	Portion of Total Shipments
Carrier D	60%
Carrier E	15%
Carrier F	7%
Carrier G	5%
Carrier H	3%

6.6.2 PROPOSED SOLUTION

Aveda should join the SmartWay Transport Partnership as a shipper. The major value of Aveda's participation in SmartWay is the potential to assist its current carriers in becoming more fuel efficient. Participation in the SmartWay program entails Aveda's committing to:

- Determine the percentage of freight shipped by SmartWay Transport Partnership carriers. Currently, we estimate that approximately 5.1% of all outbound shipments are via such carriers (namely UPS and FedEx). Aveda may also need to quantify the amount of inbound freight carried by SmartWay partners, to the extent that Aveda has control over such carriers. Inbound carriers were considered to be outside the scope of the system under investigation for this study.

- Measure the GHG emissions of the shipping operations using EPA's FLEET Performance Model for Shippers.

- Increase the percentage of freight shipped by SmartWay Transport Partnership carriers to at least 50%, within three years. This percentage can be either by weight or by sales volume, as decided upon in discussion with EPA. Since "Carrier D" accounts for 60% of all shipments, it appears that Aveda would need to convince this carrier to enroll in SmartWay in order to meet the program requirements. As noted above, however, this could change if inbound carriers are considered.

- Identify specific goals to reduce GHG emissions from shipping operations. These goals are determined in partnership with EPA. Several of the recommendations in this report might help Aveda meet this requirement, such as increasing pallet shipments to salons, shipping direct from Roseville to select Western Region stores, and implementing biodiesel transport from Blaine to the new DC.

- Develop an action plan detailing how each of these goals will be achieved. This action plan is also developed in partnership with EPA.
- Report progress toward achieving each of these goals to EPA annually.

In return, EPA commits to:

- Increase public awareness of company participation in the SmartWay Transport Partnership through national and regional events, articles, and awards.
- Provide technical assistance to help quantify the emissions from your shipping operations.
- Assist in developing and achieving goals and work to address challenges.
- Provide shippers that demonstrate they ship over 50% of their goods with SmartWay Transport Carriers with EPA's SmartWay Transport logo to advertise their status.[95]

After joining SmartWay, Aveda can leverage its own purchasing power and EPA resources to encourage the carriers it already uses to become SmartWay partners (as a less desirable alternative, Aveda could switch to carriers who are existing SmartWay members). EPA will provide resources, such as literature, workshops, and other technical assistance, to help existing carriers meet SmartWay requirements. An additional benefit to Aveda of participating in the program is the ability to evaluate carriers based on fuel efficiency and other environmental metrics. In addition to helping reduce the GHG and energy impact of Aveda's PDS, joining SmartWay is in line with Aveda's commitment to environmental excellence, may provide a public relations benefit, and could act as a catalyst for additional, similar action across the Estée Lauder and possibly the larger personal care products industry.

To participate in SmartWay, carriers must commit to:

- Measure the environmental performance of their existing fleet
- Identify a goal to improve the environmental performance of their fleet
- Develop a plan detailing how the goal will be achieved
- Report their progress annually to EPA[96]

Benefits to carriers are similar to those that EPA provides to shippers.

Aveda should focus on working with its top carriers to join the SmartWay program and adopt the program's fuel efficiency measures. Typically, carriers achieve improved efficiencies through such measures as idle reduction, improved aerodynamics, automatic tire inflation systems, and driver training.[97] These investments have proven to have a short payback period while reducing operating costs, and it is possible that in the long run, SmartWay carriers will be able to provide

lower costs to their customers as a result of realizing these savings. Additionally, if Aveda can convince its carriers to participate in SmartWay, it will be able to evaluate each carrier in terms of energy efficiency and other metrics.

Clearly, challenges exist in convincing Aveda's existing carriers to participate in SmartWay. However, EPA offers significant assistance with such efforts, and the trucking industry strongly supports SmartWay and was instrumental in its development. In fact, SmartWay was launched at a press conference with the President of the American Trucking Association and former EPA Administrator Mike Leavitt. The team recommends that Aveda discuss any concerns about joining the partnership with the EPA SmartWay program manager.[98]

6.6.3 Environmental Impact of Solution

Since specific energy efficiency goals are developed to meet the needs of each participating company, at this point it is not possible to precisely quantify the energy and GHG impact of Aveda's participating in the program. Nonetheless, it is safe to assume that a net environmental benefit would result from participation. Although at this early stage in the SmartWay partnership insufficient carrier data has been collected to quantify improvements in fuel efficiency, preliminary data suggests that SmartWay partners have achieved fuel efficiency benefits not realized among firms not participating in SmartWay.[99] It is important to note that if Aveda were to succeed in persuading any of its carriers to join SmartWay, the environmental benefit associated with the carrier's overall improved fuel efficiency would be realized well beyond Aveda's PDS.

For the purposes of this report, the potential environmental benefits of Aveda's participation in SmartWay are therefore quantified using the assumption that SmartWay carriers are 5% more fuel efficient than non-SmartWay carriers. While each carrier company participating in SmartWay develops an individual goal with regard to improved fuel efficiency, it is generally expected that most will improve on the order of 5%. Some carriers, such as Triple S, have achieved improvements of 10%.[100] If "Carrier D," "Carrier E," "Carrier F," and "Carrier H" each gained a 5% fuel efficiency as a result of joining the SmartWay Partnership, the associated improvements in environmental impact could be described as follows in Table 6T:

Table 6M Reductions in Energy Use and GWP Resulting from Aveda's Top Four Carriers' Participation in SmartWay (Excluding UPS, Which Already Participates in SmartWay)

Carrier	Energy Use Before SmartWay (MJ)	Energy Use After SmartWay (MJ)	Reduction in Energy (MJ)	GWP before SmartWay (kg CO_2)	GWP After SmartWay (kg CO_2)	Reduction in GWP
Carrier D	5,270,000	5,022,000	248,000	434,000	413,000	21,000
Carrier E	1,385,000	1,327,000	31,000	112,000	108,000	4,000
Carrier F	611,000	582,000	29,000	50,200	47,900	2,300
Carrier H	248,000	237,000	11,000	20,400	19,500	900

Fuel economy improvements modeled are shown below.

Carrier	Vehicle Type	FE_1(mpg)	FE_2(mpg)
Carrier D	Standard Class 8 Truck	6.69	7.02
Carrier E	Class 8 Truck with Two 28' Trailers	6.00	6.30
Carrier F	Standard Class 8 Truck	6.69	7.02
Carrier H	Standard Class 8 Truck	6.69	7.02

No change was made to the fuel economy of the following vehicles:

- Carrier E Cargo Planes – Used for shipment to Hawaii
- Carrier E Ocean Freighters – Used for shipment to Puerto Rico

Such a 5% increase in fuel efficiency from these carriers would reduce the energy and GWP impact of these carriers by 3.2%, while resulting in a 0.9% reduction to energy use and GWP associated with Aveda's PDS.

6.6.4 Business Impact

6.6.4.1 Financial Impact

There is no fee to join the SmartWay program, although costs may be incurred relating to Aveda staff time to adhere to the program reporting requirements. While it is not possible to precisely estimate the level of effort required for such administration, it is estimated to be in the range of several hours per month during the initial program enrollment period, and less as the program becomes institutionalized. Costs savings will also occur as increased fuel efficiencies are accomplished and less fuel is used. However, this is difficult to estimate considering information constraints about carriers' cost structures.

6.6.4.2 Operational Impact

As described above, Aveda transportation staff will need to spend some time adhering to the program's reporting requirements. Additional time may also be required to explain the benefits of participation in the program to Aveda's carriers, though U.S. EPA has suggested that it can assist with this effort. However, an important benefit to Aveda in participating in SmartWay is

that the program will enable Aveda to maintain a consistent measure of the transportation impact of its PDS over time.

6.6.4.3 CUSTOMER IMPACT

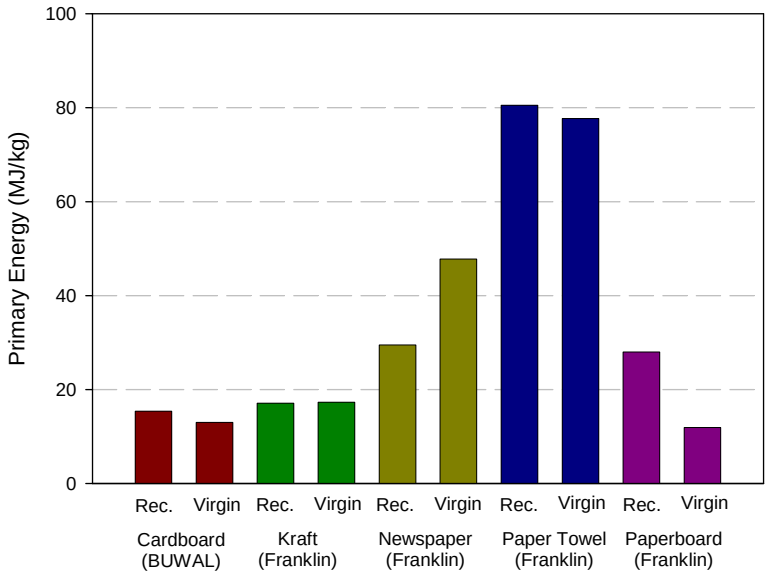
Implementing this recommendation will not impact Aveda's customers.

6.7 Recommendation 7 - Tertiary Packaging Content Requirement

6.7.1 Problem Definition

Post-consumer recycled (PCR) content is important because the production of virgin paper products requires more resources and can result in greater air and water pollution than the production of paper products with PCR content. However, while paper recycling and the use of recycled content material is generally viewed as a productive strategy for reducing the impacts of solid waste on society and the environment, this strategy does not always lead to reductions in energy and global warming emissions. A comparison of the impacts of paper manufactured with 100% post consumer content and that produced from 100% virgin content is presented in Figure 6Y.

Figure 6Y Primary Energy Requirements for the Production of Recycled and Virgin Paper Products[101]



Although in many cases energy impacts are similar, newsprint papers were the only category for which recycling appears to reduce the overall energy requirements of paper product production. Generally, the use of recycled content in packaging paper products is expected to require energy in excess of that required by identical virgin paper products.

However, as suggested above, there are other benefits associated with recycled paper that are beyond the scope of this report, and Aveda purchasers at the three DCs have been successful in procuring tertiary packaging materials with significant PCR content, as described in detail in

section 4.3.1. Because purchasers at the three DCs are currently procuring such materials, obtaining packaging materials with additional PCR content would result in marginal improvements to the company's PDS footprint at best; as described elsewhere in the report, a focus on reducing the impact of transportation holds significantly more potential for reducing the overall impact of the PDS.

Despite this success in procuring tertiary packaging with high PCR content, no official policy is in place at Aveda requiring specified levels of PCR content in tertiary packaging, and packaging suppliers are not required to provide documentation describing such content. In fact, several suppliers were unable to provide exact PCR content information to the Michigan team members during the data collection phase of this project.

6.7.2 PROPOSED SOLUTION

While the team does not believe that further increasing the PCR content of tertiary packaging will result in significant benefits, it is recommended that Aveda adopt recycled content guidelines for all tertiary packaging that the company purchases, and require suppliers to provide documentation that their products meet these standards. This will help ensure that Aveda knows the contents of the materials it purchases. A sample policy is included as Appendix F to this report.

6.7.3 ENVIRONMENTAL IMPACT OF SOLUTION

If Aveda were to institutionalize such a policy, the impact on its PDS would be negligible both in absolute terms as well as in comparison to the other recommendations offered in this report. However, the adoption of such a policy would both provide greater certainty to Aveda that the company is receiving "as advertised" the packaging products that it purchases, as well as help support the creation of markets for packaging products with PCR content by clearly communicating to suppliers that demand exists for tertiary packaging with high PCR content.

6.7.4 BUSINESS IMPACT

6.7.4.1 FINANCIAL IMPACT

A slight increase in the cost of high PCR packaging may be incurred. This depends on the supplier and percentage PCR. No other financial impacts are expected from implementation of this recommendation.

6.7.4.2 Operational Impact

No operational impact is expected from implementation of this recommendation.

6.7.4.3 Customer Service Impact

Implementing this recommendation will not impact Aveda's customers.

6.8 RECOMMENDATION 8 - ALTERNATIVE TRANSPORT OPPORTUNITIES FROM BLAINE TO THE NEW BLAINE DC

6.8.1 PROBLEM DEFINITION

Aveda is building a new distribution center (Blaine DC), to be located 1/8th of a mile from the Blaine manufacturing facility (Blaine). This recommendation will assess the level of environmental impact resulting from moving the facility, and identify additional steps that Aveda can take to decrease or eliminate GWP from the transport of product between the two facilities.

6.8.2 PROPOSED SOLUTION

Two feasible options exist for transporting finished goods from the Blaine manufacturing facility to the new Blaine DC: using biodiesel fuel or a human powered bike system. Given the short distance between the two facilities, time to transport would not be an issue.

Hybrid class 8 vehicles were considered, but due to the unavailability and uncertain benefits, this option is not recommended. As background information, several companies have combined forces to create class 8 hybrid vehicles, but none exist on the commercial market just yet. For example, FedEx has contracted Eaton to create their hybrid delivery cars.[102]

6.8.2.1 BIODIESEL

There were more than 400 major fleets using biodiesel in May 2004 including all branches of the US military, Yellowstone National Park, NASA, several state departments of transportation, major public utility fleets and more than 50 schools including the University of Michigan.[103] Soybean oil and yellow grease usually derived from recycled cooking oil from restaurants are the most common sources for biodiesel production.[104] Two typical blends exist, B20 and B100; these represent 20% biodiesel and 100% biodiesel respectively.

Biodiesel blends operate in diesel engines, from light to heavy-duty, just like petroleum diesel. B20 works in any diesel engine with few or no modifications to the engine or the fuel system, and provides similar horsepower, torque, and mileage as diesel. However, vehicles running on biodiesel blends may exhibit more drivability problems at less severe winter temperatures than do vehicles running on petroleum diesel.[105] This is a potential concern during the winter in much of the United States, including Minnesota. The solvent property of biodiesel can cause other fuel-system problems. Biodiesel may be incompatible with the seals used in the fuel systems of older vehicles and machinery, necessitating the replacement of those parts if biodiesel blends are

used.[106] The initial use of B20 or B100 in any vehicle or machine requires care. Petroleum diesel forms deposits in vehicular fuel systems, and because biodiesel can loosen those deposits, they can migrate and clog fuel lines and filters.[107]

Another disadvantage of biodiesel is that it tends to reduce fuel economy. The energy content per gallon of biodiesel is approximately 11% lower than that of petroleum diesel.[108] Vehicles running on B20 are therefore expected to achieve 2.2% (20% x 11%) fewer miles per gallon of fuel."[109]

High quality biodiesel is available in all 50 states. All National Biodiesel Board (NBB) fuel supplier members only sell biodiesel that meets the national specification, ASTM D 6751.[110] There are several ways to purchase the fuel such as through marketing agencies or direct from suppliers.

6.8.2.2 Human Powered Transportation

Two human powered transportation companies have been identified that would be able to create vehicles capable of transporting pallets from Blaine to the Blaine DC. Human Powered Machines (HPM) was established in 1991. HPM's primary interest is in relieving urban congestion by building load-carrying work-bikes. HPM produces many types of vehicles including utility trailers, folding bikes, hand- powered vehicles and farm machines. The production of these vehicles integrates youth apprentices whenever possible.

The most promising option is Organic Engines in Tallahassee, Florida which has produced bicycles capable of towing sailboats. Conversations with Organic Engines, specifically Daniel Kavanagh, revealed that the weight being towed will not be an issue, but that speed will slow significantly. A custom bike can be built that can tow a pallet of Aveda's product from Blaine to the new Blaine DC. Mr. Kavanagh is confident that his bikes can be used year round and that bikes can be custom-developed to accommodate the operational needs of Aveda. The estimated travel time of actual transport of a pallet 1/8th of a mile is 2 minutes.[111] The total time will depend on how long it takes the forklifts to load and unload the pallets from the bikes and also extra time to cross the street. A traffic sign may be needed to alert cars of the bike crossing.

Figure 6Z Example of Bicycle capable of towing cargo[112]

6.8.3 ENVIRONMENTAL IMPACT OF SOLUTION

Key Data Assumptions:

- Aveda ships 100 pallets a day from Blaine to Roseville.[113]
- Vehicle loading and unloading each require one hour. Vehicles idle during this period.
- Trucks used in this analysis use 0.8 gal of diesel fuel equivalent for each hour of idle time.[114]
- Total delivery distance is 1/8 mile each way.
- Average fuel economy for a standard tractor-trailer over this short distance is 4 mpg.
- Empty return improves fuel economy by 12.5%.[115]
- All vehicles deliver 30,000 lbs/load.
- Diesel fuel equivalents for biodiesel fuels are 0.96 gal B20/gal diesel, and 1.10 gal B100/gal diesel.[116]
- Only fossil fuel sources are accounted for in energy and CO_2 values.
- B20 uses 86% of the energy and releases 84% of the CO_2 of conventional diesel. B100 uses 26% of the energy and 21% of the CO_2 of conventional diesel.[117]

6.8.3.1 CONVENTIONAL TRACTOR TRAILERS

Making these deliveries to the new Blaine distribution center with a conventional tractor-trailer would require 221,760 MJ. Current deliveries over 10 miles to Roseville require 374,400 MJ. This move results in a 41% decrease in MJ needed to complete deliveries.

6.8.3.2 Use of Biodiesel for Shipments from Blaine Manufacturing to Blaine Warehouse

Biodiesel works in any diesel engine with few or no modifications to the engine or the fuel system.[118] Two types of bio-diesel fuels are considered here. Blends of 20% biodiesel with 80% petroleum diesel (B20) can generally be used in unmodified diesel engines. Check your manufacturer's warranty to be sure it won't affect coverage. Biodiesel can also be used in its pure form (B100), but it may require minor engine modifications to avoid maintenance and performance problems.

6.8.3.3 Biodiesel, 20% Blend

Using B20 in place of conventional diesel further decreases energy use to approximately 182,160 MJ. This provides an 18% reduction in both energy use and GWP.

6.8.3.4 100% Biodiesel

Using B100 would further reduce primary energy requirements to 62,160 MJ. This represents a 72% decrease from conventional diesel energy use. However, this value assumes that no engine modifications would be required to operate on 100% biodiesel. This is likely not the case. Engine modifications may be expected to slightly decrease the benefits of using 100% biodiesel. Additionally, challenges with cold weather performance may make B100 an unfeasible option for year-round use in Minnesota.

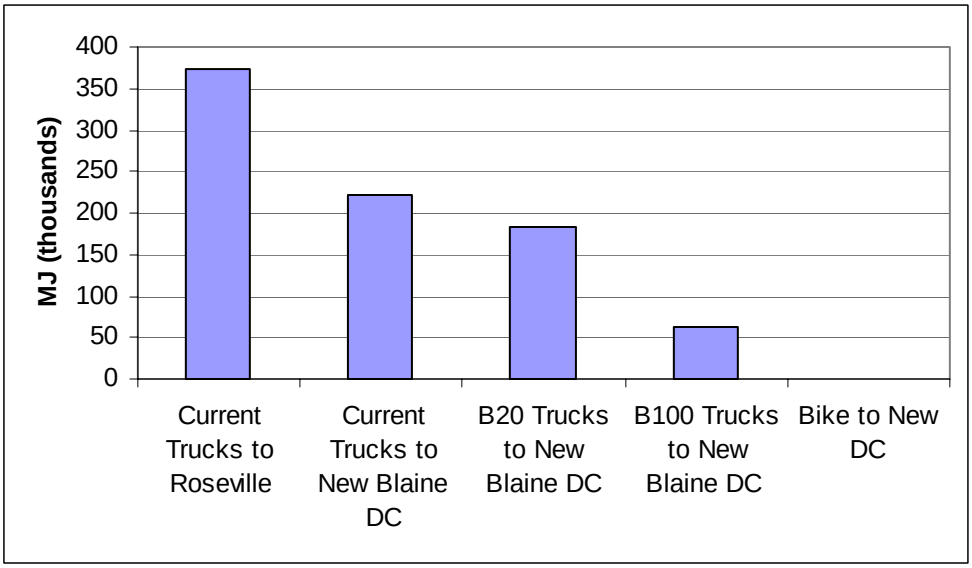
6.8.3.5 Use of Bicycle

There are relatively little impacts from using bicycles to transport pallets from Blaine to the new Blaine DC. Specifically, no GHG or GWP impact would result from the use of the bicycles. However, negligible impacts might result from their fabrication.

6.8.3.6 Summary of Alternatives

Figure 6AA shows that by re-locating the Roseville DC to across the street from Blaine without changing the vehicle decreases energy use and GWP by 41%. The 221,760 MJ required for conventional tractor-trailer delivery to the new location would be about 1% of the total distribution system energy use. By switching to B20 trucks, this would further decrease energy use and GWP by 18%. Using B100 trucks would decrease MJ by 72% of the conventional truck value. The ultimate reduction would be through the use of human powered bikes to transport pallets from Blaine to the Blaine DC resulting in zero environmental impact.

Figure 6AA Environmental Impact of transportation of pallets from Blaine to Roseville and the new Blaine DC



6.8.4 BUSINESS IMPACT OF SOLUTION

The costs associated with the biodiesel option and the bicycle option are described below. Organic Engines would be able to create a customized bike for $5,000 and each additional bike for $2,500. The bikes can be designed to accommodate transportation of the pallets from a forklift onto the bike as well as for specific weight loads. The weight load considered for this scenario is up to 2,500 pounds per trip (approximately one pallet per trip). Given that there are roughly 100 pallets transferred per day from Blaine to Roseville and assuming that it would take five minutes to load, five minutes to unload, three minutes for transport, and two minutes to return to Blaine, the total time for round trip delivery of a pallet is fifteen minutes. This equates to four pallets per hour and 32 pallets in an eight hour shift. We estimate that it will take three bikes transporting pallets for eight hours per day to accommodate Aveda's PDS. The cost for three bikes would be about $10,000 not including labor.

There are two options for how biodiesel is supplied to Aveda. One is to use a fueling company that arrives on site and fills tanks at night. There are 3 main companies in the twin city area: Farmer's Union Coop Oil, Cannon Valley, and Lube Tech. The second option is to have a bulk tank on site. A permit is needed for the tank and can be obtained from the county. There would be an additional capital cost to either rent a tank or purchase one.

Performance and maintenance of the trucks do not change. However, biodiesel is an excellent lubricant; if using old trucks, the fuel will flush dirt from the tank through the filter and will clog.

Old trucks that switch over to biodiesel will need to change their filter every few days. Eventually, the fuel tank will be cleaned and filters will not need to be changed. It is not advised to use greater than B20 in the winter because the fuel will crystallize and clog the filter.

A great resource is the biodiesel help line at the University of Minnesota. Contact Kelly Strrebig at 615.457.1404. Given the other advantages of biodiesel, though, an emission management system with biodiesel is a least-cost alternative. A study by Booz-Allen & Hamilton, Inc., found fleets using a 20% biodiesel blend would experience lower total annual costs than other alternative fuels.[119] The cost of biodiesel depends on the market price for vegetable oil. In general, biodiesel blended at a 20% level with petroleum diesel costs approximately 20 cents per gallon more than diesel alone. As a rule of thumb there is a 1¢ increase per 1% increase in biodiesel (B20 ~ 20¢ increase per gallon). There are no additional increases in costs. Similarly, results reported by the University of Georgia indicate biodiesel-powered buses are competitive with other alternatively fueled buses with biodiesel prices as high as $3 per gallon.[120]

SECTION 7 – FUTURE INVESTIGATIONS

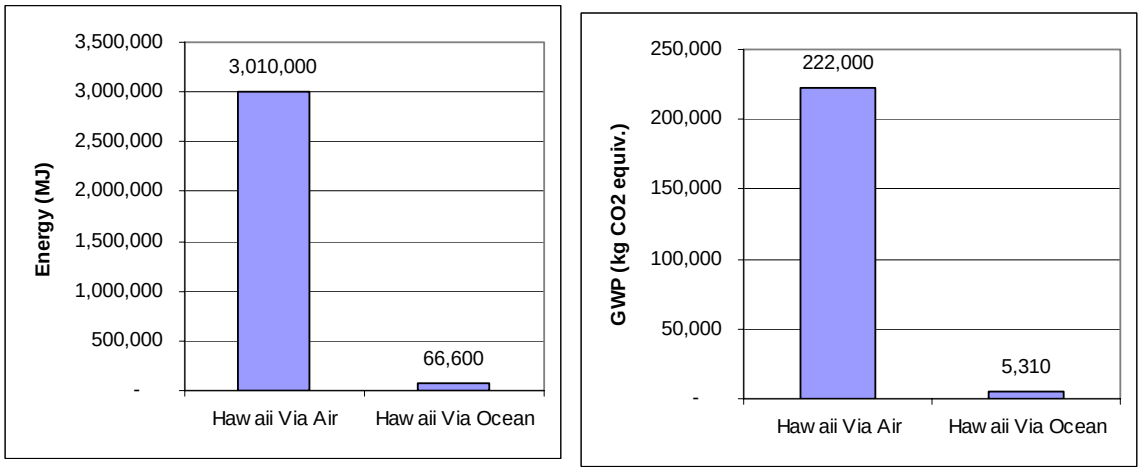
Aveda's business is constantly changing to meet the demands of customers, react to competition and reduce costs. The recommendations in this report are provided in the context of the state of the business in early 2004 and are limited to the PDS as defined above. However, since this project commenced, several business issues have arisen that may affect our analysis and recommendations or that are outside the scope of this project. These issues should be considered for future study:

7.1 HAWAII

For the period studied in this report, shipments to Hawaii traveled via air. However, since the report was started, Aveda has begun shipping to its Hawaiian stores via ocean in order to reduce costs to serve this customer base by approximately 75% or almost $200,000. It should be noted, that the customers were not paying for the high shipping fees, instead Aveda was spending significant money just to ship product to the region. In addition to the cost savings, there is a large environmental benefit, which actually was not considered when making the change.

Had Aveda not already initiated this switch, the primary recommendation of this report would have been to switch Hawaiian shipments to ocean. However, Aveda has not been able to completely eliminate air shipments to Hawaii, primarily because there has been criticism and pushback from customers due to the increased shipping times (13 days vs. 2 days). The environmental benefit of the switch is provided below, and Aveda should complete the implementation of ocean shipping and continue to look for environmental savings to highlight areas that could also provide cost savings. Furthermore, in light of the criticism Aveda has received from some of its customers in Hawaii, this analysis is intended to provide a better story to tell Aveda salons and institutes to encourage their cooperation.

Figure 7A Energy and GWP impact of Switching Hawaiian shipments via air to ocean



As illustrated in the graph below, shipments from LADC to Hawaii constituted 3,010,000 MJ and 222,000 kg of CO_2. By switching from air cargo to ocean freight, the impact is reduced by almost 98% to 66,600 MJ and 5,310 kg CO_2. 2,943,400 MJ is equivalent to approximately 22,300 gallons of automobile fuel, enough to fuel approximately 43 vehicles in the U.S. for one year. Additionally, the reduction in emissions of 216,690 kg CO_2 is equivalent to the emissions from approximately 50 automobiles.

The following charts (Figures 7B through 7F) show how the corresponding charts in section 5 would change if all Hawaiian orders were shipped via ocean.

Figure 7B Total Annualized Transportation Energy and GWP For Products Leaving Aveda-Owned DCs

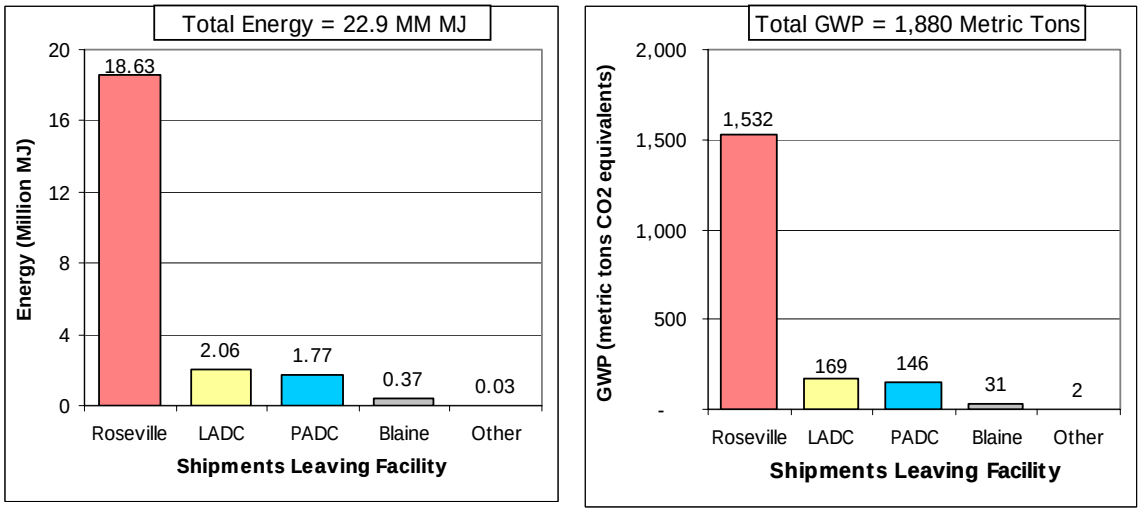


Figure 7C Total Annualized Transportation Energy and GWP To Retail and Salon For Distribution Centers

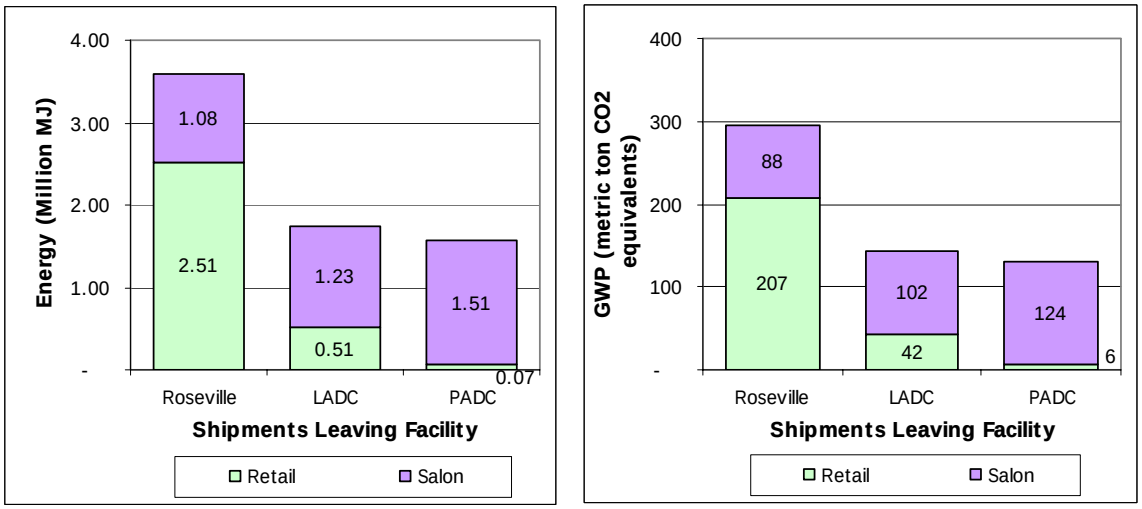


Figure 7D Weight-Based Transportation Energy and GWP for each DC

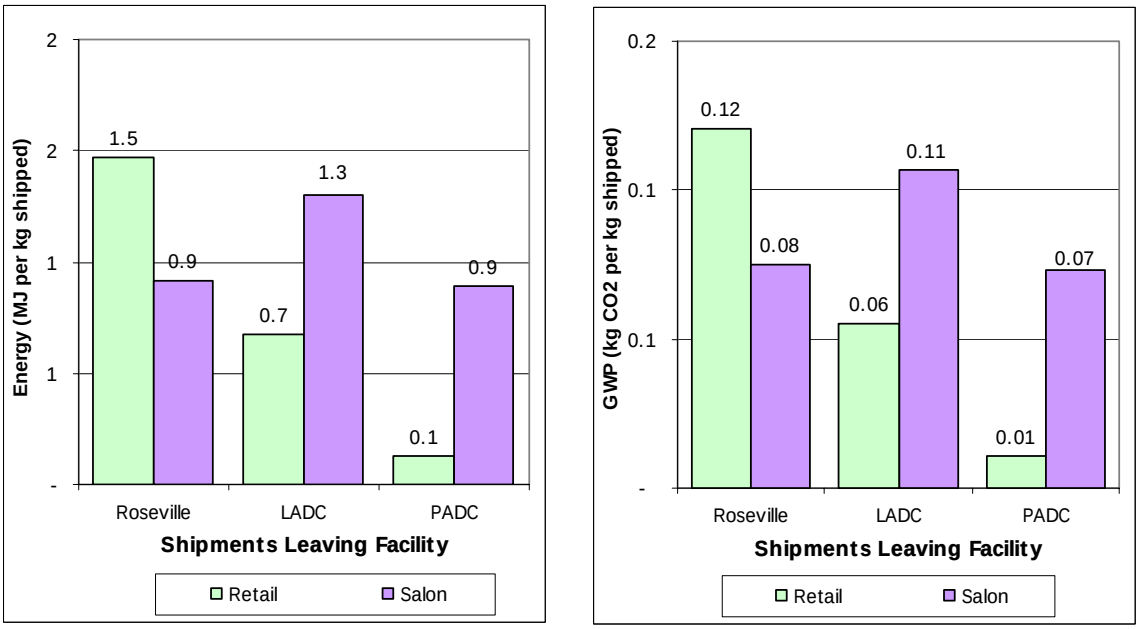


Figure 7E Weight-Distance-Based Transportation Energy and GWP per DC

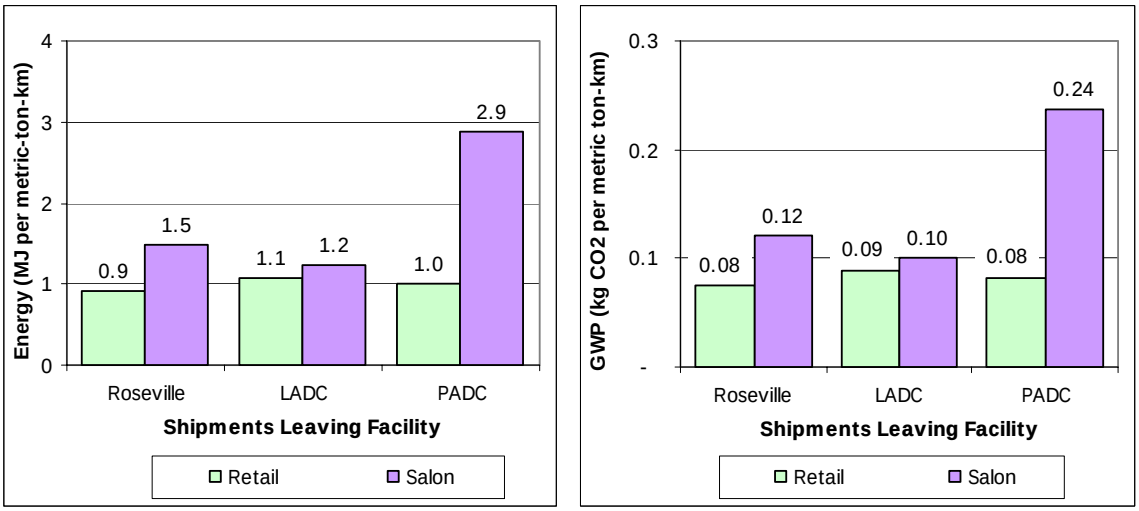
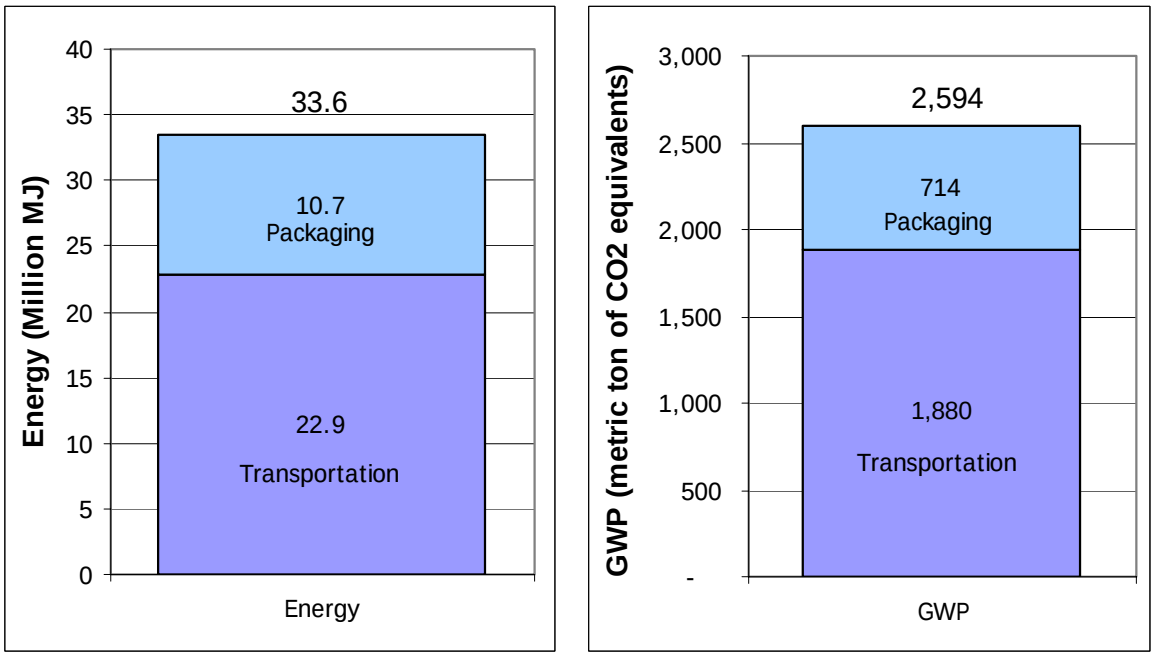


Figure 7F Total PDS Energy and GWP Impact



7.2 PRODUCT RETURNS

During our research phase, we discovered that the Roseville DC receives between one and three cartons a day of returned product. Each carton contains between eight and twelve items. Several reasons for returned product are:

- The product is damaged in transit and customer returns are sent to the distribution center. In some cases, the damage is superficial and the contents can be used on the backbar.

- End-use customer returns due to an adverse reaction with the Aveda product. These products are shipped directly to customer service.
- End-use customer does not like the product or exchanges it for something else, the unused portion of the product cannot be reused and must be disposed. In the past, the salon or retail client would locally dispose of the contents of the product and recycle the packaging. However, starting in Oct 2004, Estée Lauder requires that all its retail outlets dispose the contents of its product in specialized buckets containing anhydrous material.
- Customer returns due to salon refusal (e.g., cannot pay the COD).

We did not model the environmental impact of these returns, but believe that its impact is significant given that the product is packed as a loose-pick, shipped via UPS, and travels over twice the distance that a product would normally. The weight of these returns will increase significantly, as Estée Lauder rolls-out the product-disposal bucket, which will add significantly to the total weight of shipping returns.

7.3 THE NEW LADC

Our interviews with Aveda managers revealed that there is a proposal to move the current LADC to another location. Moving the LADC to another location in the Los Angeles region will not impact our model significantly, but should Aveda plan to move it outside that area, the life-cycle analysis model would need to be updated.

As alluded to in Section 6.1, the new LADC location should reflect the future growth of the company. Currently, the LADC serves retail stores and salons in AZ, CA, NV, OR, WA. The new location should reflect the company's strategy in future growth and be situated in location that most efficiently serves all these locations. Considering current store and salon locations, a facility in Reno, NV or Denver, CO would be better situated than the current location.

7.4 ONE SKU PER PALLET

There is a common practice in the shipment of goods where customers demand that only one SKU be put on a pallet, rather than having a mixed pallet. Having one SKU per pallet facilitates the transfer of the goods from the truck to a specific shelf location. In other words, the receivers are relieved of the need to sort the product as it comes in. This practice may increase worker's safety on the floor by reducing the amount of lifting and twisting to move the boxes, but it increases shipping costs and environmental impact due to increased packaging and lower truck utilization.

Since we modeled transportation and packaging at an aggregate level, we did not measure the environmental impact that these shipping policies have on Aveda's TPS. However, as the background research for Section 6.5 reveals, shipping full or mixed pallets is the most efficient shipping option available to Aveda. Aveda should further investigate the number of customers with this shipping policy and collaborate with them to find alternative solutions.

7.5 THE BLAINE MAILROOM

Our project scope did not include the shipping from the Aveda mailrooms. However, interviews with Aveda mailroom staff revealed that violations of the company's no-air policy stem from the Blaine mailroom. While payroll checks must be shipped by air to all the retail stores to ensure timely delivery, there are approximately 20 additional overnight shipments sent out of the Blaine mailroom per day. There are three major sources for this:

- Aveda staff can ship 1-, 2- or 3-day packages from the front mailroom, however, they must walk over to loading dock in order to ship UPS ground. Aveda staff cannot ship out via ground from the front mailroom because Merrill Corporation, the contractors who run the front-mailroom, only manage 1-, 2-, or 3- day packages. This system does not sufficiently encourage Aveda staff to use UPS ground, because of the additional time and inconvenience to utilize the "back mailroom" located near the loading docks.

- Given the nature of Aveda's business, there are many salon or retail events throughout the country on the weekends but due to the tight deadlines, most of the promotional materials are shipped out on Thursday or Friday. As a result, heavy promotional materials are shipped by air.

- Currently there is a system to consolidate shipping between the Blaine and New York City offices. The so-called "pouch" leaves Blaine every Tuesday and Thursday. Interviews with management suggest that this pouch could be more fully utilized.

Clearly, a company the size of Aveda cannot fully wean itself of air shipping but small changes to the Blaine mailroom will greatly ameliorate the abuse of the no-air policy that is currently in place.

- We recommend that Aveda change the contract with the mailroom staff and allow for packages shipped by ground to be dropped off in the front mailroom.

- Additionally, marketing and promotions should be encourage to have their promotional materials ready by Tuesday or Wednesday is order to take advantage of UPS ground. Aveda should investigate the possibility of tying financial incentives to department accounts to encourage this behavior.

- The pouch system is a great idea, but it is not well understood at the company. A non-scientific survey of staff revealed few people knew that it existed, much less how it works and when the pouch reaches its destination. Aveda should publicize this mail consolidation option through an educational campaign (e.g., posters in the mailroom). Additionally, the mailroom plans to shift the pouch schedule to pickups on Monday and

Wednesday with the hopes of reducing the reliance on air-shipping. This should be tracked carefully to ensure the desired behavior is achieved.

7.6 MOVING PRODUCT FROM MANUFACTURING TO THE WAREHOUSE

We end this research paper on an issue that inspired Aveda to fund this student project. Currently, the manufacturing facility packages all their products in master cartons, palletizes them, and then ships about 100 pallets to Roseville. Approximately 30% of the master cartons are taken off the pallets and moved to the loose-pick area, where the contents are picked one at time. When the box is emptied, it is reused approximately 10% of the time, but otherwise, it is recycled. In terms of packaging, this system is very wasteful, because a sizeable portion of all master cartons are discarded and sent to a recycling facility or discarded after a single use.

Aveda should explore the option of using reusable totes (e.g., similar to the blue bins used to deliver product to Minneapolis salons and retail stores) to move finished product between the manufacturing facility and warehouse. Given that Aveda has data for each SKU that describes the percentage of product shipped via pallet or loose-pick, one could allocate the percentage of product per SKU that gets packaged in totes versus master cartons. In other words, at the end of the fill line, the packer can allocate a portion of the run to master cartons and the remainder to totes.

The feasibility of this option needs to be fully explored particularly as it raises many pragmatic issues, such as:

- Many of the high-speed fill-line have automated packers. Unless these can be retooled, this tote system is restricted to those lines with manual packing.
- Each SKU may require more storage space in the warehouse.
- The new totes would have to fit the dimensions of the loose-pick tracks.
- Increased logistical challenges in managing FIFO.

In terms of cost, Wal-Mart and Target have stated that they are able to recoup the investment after six to eight turns of the re-usable trays that they use in their retail operations.[121] We can expect that the same would be true for Aveda.

SECTION 8 – GLOSSARY

ASI – Aveda Services Inc. is the legal entity that manages retail stores and the independent salons serviced out of the west coast and east coast distribution centers.

Backbar – Personal care products (typically shampoo) used by salons to wash customers' hair. Usually sold in larger containers and not available for retail sale.

Class 8 Truck - A classification by the Department of Transportation to describe the tractors normally used to haul trailers commonly seen traveling US roadways. They area also referred to as Tractor Trailers.

Contracted Carrier – A term used to describe companies that provide LTL and TL transportation.

DOT - Department of Transportation which publishes energy values for fuel as well as truck classifications.

Dunnage – loose materials used to support and protect products packed in loose-pick boxes (e.g., padding).

FSC – Forest Stewardship Council is a third-party organization that provides best practices in sustainable forestry, and certifies the wood products made from those timber stands.

Full pallet – A pallet holding multiple master cartons of one SKU, often stacked no more than four feet high.

Greenhouse Gas - Greenhouse gases occur both naturally and as a result of human activities. Natural occurring GHGs include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Often, GHGs such as carbon dioxide, methane, and nitrous oxide are often elevated due to human activities.

GWP – Global Warming Potential. Describes the total greenhouse gas emissions equated in units kg carbon equivalents. GWP weights each gas by its GWP value which reflects each gas' cumulative radiative force. CO_2 is the reference gas so each unit is counted once, while methane (CH_4) is 23-times more powerful, so each unit of methane is multiplied 23 times.

Kraft paper - Paper used to fill empty space in package shipments and to cushion products to protect them from damage.

LADC—Acronym for Los Angeles Distribution Center, located in Compton, CA. This DC is owned by Aveda and exclusively distributes its products to salons, retail stores and all other customers in Washington, Oregon, Canada, Nevada, and Arizona. LADC receives approximately 95% of its incoming product from the Roseville distribution center.

Loose-pick order – A customer order for a specific quantity of product that is fewer in number than contained in the master carton.

Loose-pick boxes – Multiple SKUs are taken out of their original master cartons and re-packed in one or more corrugated boxes that have reinforced walls. There are three types of loose-pick order boxes available. Additionally, these boxes are not designed for any specific product type and consequently require a significant amount of dunnage to protect the product.

LTL – Less than truckload. Describes typical shipments of pallets in North America. Trucks pick up pallets from customers in multiple locations, and then often pass through a hub to optimize truck cargo before continuing on a longer transportation leg.

Master carton – The corrugated box in which one SKU of product is packed. For example, a typical master carton may hold 24 125 ml shampoo bottles.

Mega-joule – a unit of work or energy equal to the work done by a force of one Newton acting through a distance of one meter.

Mixed pallet – A pallet containing multiple SKUs.

PADC—Acronym for Pennsylvania Distribution Center, located in Bristol, PA. This DC is owned by Estée Lauder, and the central distribution center for all Estée Lauder's fifteen brands. The PADC distribution area includes New England, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia and North Carolina.

Parcel shipping – distribution of wrapped bundles or packages from manufacturer to consumer. In this report, the parcels are either full master cartons or loose-pick boxes and are shipped via FedEx or UPS.

PCR content – Post-Consumer Recycled content. Describes the portion of the product made with materials that have completed there intended use by consumers and would otherwise have been disposed as solid waste. These materials are those commonly recycled by municipalities and include newspaper, office paper, cardboard and aluminum cans.

PDS – Product Delivery System. This includes tertiary packaging and transportation required to deliver Aveda's products to its customers.

Primary packaging - Contains the product as received by the consumer (e.g., a shampoo bottle or perfume bottle).

Retail store – Stores that are owned and operated by Aveda

Salon – Salons that use and sell Aveda products are independently owned and operated.

Secondary packaging - Organizes multiples of products (e.g., trays for tins of baked beans, carriers for beer bottles, and display packs) or serves as an outer wrapping that stores, transports, informs, displays and/or protects the product (e.g., decorated carton, gift box).

SKU – Stock Keeping Unit is a unique alpha-numeric code used to identify a product type.

Tertiary packaging - The transport-packaging unit (e.g., corrugated cardboard cartons, wooden pallets, and plastic shrink wrap).

TL – Truck load. Describes a method of truck transportation in which an entire truck is contracted for a direct route. These shipments usually have the highest utilization rates.

Tractor trailers - See Class 8 Truck.

U.S. Maritime Administration – A U.S. federal agency that publishes fuel consumption rates and payload for ocean freight.

SECTION 9 - APPENDICES

APPENDIX A - PACKAGING MODELING ASSUMPTIONS AND METHODOLOGY

A1 PACKAGING MODELING ASSUMPTIONS

The use of wood in this model is treated as the use of a material resource (not as a fuel, thereby excluding wood from the energy analysis) and wood is considered carbon neutral – carbon emissions associated with wood combustion are excluded from the global warming gas assessment.

Throughout these notes and in the associated model, the term “recycled content” is taken to refer to post-consumer recycled content unless otherwise specified. Content not specified as recycled is assumed to come from a standard mix of post-industrial (24%) and virgin sources (76%).

No information on pallets is currently incorporated into the model. Where possible, information on package quantities, sizes, weights, and material composition were taken from Aveda records and supplier data. When incomplete data were available alternative reference sources and assumptions were utilized to fill data gaps. Specific examples are noted in the points that follow.

Industry average recycled content for paperboard (including roll cores, etc) was taken as 28%, while recycled content for fluting medium in corrugated containers was taken as 59% (Oregon DEQ packaging study). Industry average values were used when specific data were not available.

Cellulose tissue was treated as “unbleached cellulose sulfate paper” and modeled using data for Swiss processes. The data used reflect 29% recycled content. Other recycled content levels were not modeled.

Corrugated cardboard boxes were assumed to have a composition of 65% linerboard, 32.5% fluting medium, and 2.5% adhesive based on the midpoint of the range of values provided by Uline (45-85% linerboard, 15-50% medium, 1-3% adhesive) and the industry average statistics provided in the Oregon DEQ study (68% linerboard, 32% medium).

Cohesive products were assumed to be composed of a kraft liner (50% by weight) and a kraft fluting (50% by weight) with 100% post-consumer recycled content in liner and 30% post

consumer content in the fluting. Fill Pak material is assumed to be 100% kraft based on information from the RanPak Company.

The overall recycled content range for Ernest Paper boxes (50% - 60% as provided by the manufacturer) was assumed to come from 100% recycled fluting and 28% (industry average) recycled content liner. Providing and overall package recycled content of 51%.

Ernest Paper chipboard weight calculated assuming each piece is a flat sheet with dimensions of 10 1/8" x 8 3/16" (per N. Arbitman telephone conversation with supplier). This provides a total area of 82.9 sq. in. for each piece (0.576 sq. ft). Using an average density (from Encyclopedia of Packaging Technology) of 0.1 lb/sq ft, the total piece weight would be 0.0576 lbs.

Bubble wrap bundles treated as 50% LDPE and 50% LLDPE per Oregon DEQ Study. Bubble wrap weight calculated based on Oregon DEQ data as 0.03 lbs/sqft.

Marlee Corroseal wrap modeled as 48% kraft fluting and 52% kraft liner based on manufacturer data. Fluting = 50 lb/3000 sq ft, liner = 18 lb/1000 sqft
When specific package type was not available or was considered obsolete for Blaine, data were excluded. This resulted in the elimination of 14 packages from Green Bay Packaging (5.8% of all Green Bay SKUs, 4.6% of total Green Bay package quantity), and 14 packages from Smurfit Stone (21.5% of all Smurfit SKUs, 16.3% of total Smurfit package quantity). Packages eliminated from the analysis represent 5.9% of the total annual average packaging use at Blaine.

Due to the large number of packaging products purchased by the Blaine facility on an annual basis, package data were summarized at the package type level (i.e. packages of various sizes were averaged together according to the quantity purchased). This reduced the total number of packaging line items for Blaine from 281 to 20.

Smurfit corrugated containers listed with 90% post-consumer recycled content material specification were modeled with a 92% recycled content liner (96% post-consumer) and 100% post-consumer recycled content fluting. Smurfit chip partitions for which dimensions but no weight were provided are modeled assuming each partition consists of four sheets providing a total of nine cells using a chipboard basis weight of 0.1 lb/sqft (from Encyclopedia of Packaging Technology). For example, the 8 13/16" x 8 13/16" x 7 5/16" partition was analyzed as four sheets of 8 13/16" x 7 5/16" chipboard giving a total area of 1.79 sq ft. This results in a total package weight of 0.179 lb.

Die-cut products supplied by Green Bay are assumed to be 100% post-consumer kraft linerboard. Green Bay chipboard partitions are assumed to contain 100% post-consumer material. Green Bay pad products are included in the model as industry average corrugated cardboard.

Supplier/Delivery Locations. The following supplier/delivery locations were assumed based on limited on-line information for Aveda facilities and package distributors.

For delivery to Roseville DC:

- 18 miles from "Supplier F"
- 13 miles from "Supplier E"

For delivery to LADC:

- 15 miles from "Supplier K"

For delivery to PADC:

- 74 miles from "Supplier J"
- 166 miles from "Supplier I"
- 441 miles from "Supplier G"
- 518 miles from "Supplier H"

For delivery to Blaine:

- 22 miles from "Supplier E"
- 11 miles from "Supplier A"
- 10 miles from "Supplier C"

A2 IMPACT ASSESSMENT FACTORS

(Note: the following discussion does not include impacts associated with wood energy content or wood combustion emissions, per the comment above)

Two impact categories are included in the Aveda assessment; these are global warming potential (expressed in CO_2 equivalents) and primary energy use (expressed in MJ) over a 100 year time period.

Global warming potential values for carbon dioxide (CO_2) and methane (CH_4) are taken as reported by the Intergovernmental Panel on Climate Change (IPCC) in the Third Assessment

Report (2001). The equivalency factors for CO_2 and CH_4 are 1.0 and 23 respectively. Based on a preliminary analysis of available data, the inclusion of a factor for an additional emission (N_2O) would increase the life cycle global warming potential of the system by less than 1%[1].

Primary energy use factors for non-renewable fuels are taken as published from the SimaPro database. Primary energy equivalents are expressed in lower heating value which is an estimate of the energy content of the fuel assuming a combustion reaction results in gaseous water as a product. Factors of greatest interest are those relevant to North American data sets (as published by Franklin Associates Ltd.) as these provide a majority of the data for the study. These factors are shown in the table below.

Table A1 Primary Energy Equivalents for Fuel Sources

Fuel Material	Primary Energy Equivalent (Low Heating Value)
Coal	26.4 MJ/kg
Crude Oil	42 MJ/kg
Natural Gas	46.8 MJ/kg
Uranium (refined fuel)	2291 MJ/g

A3 Model Implementation

A model of the annual impacts for production and delivery of packaging material to Aveda manufacturing and distribution centers has been developed using SimaPro (v. 5.1).

A4 Results

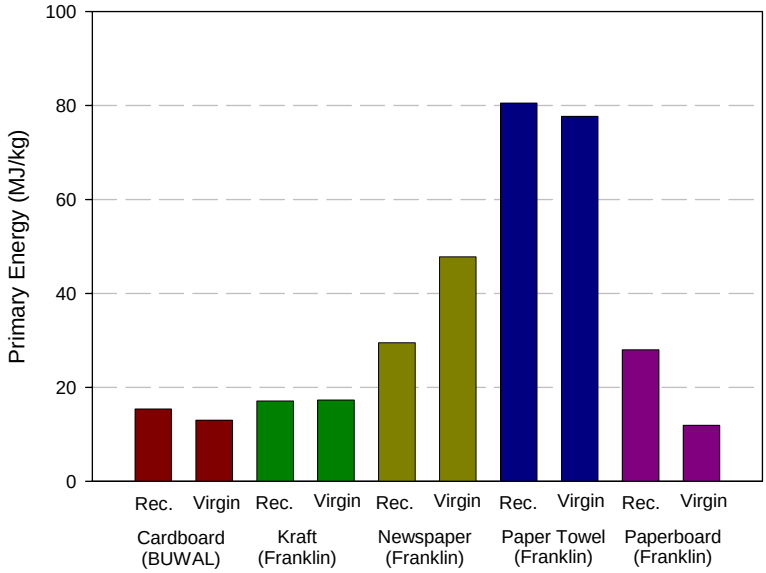
Figure A2 provides a flow diagram for the system showing major sources of energy use and indicating relative importance of each process graphically.

A5 Energy Use and Paper Recycling

While paper recycling and the use of recycled content material is generally viewed as a productive strategy for reducing the impacts of solid waste on society and the environment, this strategy does not always lead to reductions in energy and global warming emissions. As part of the initial modeling effort, sources comparing paper manufactured with 100% post consumer content to that produced from 100% virgin content were analyzed. The results are shown in the graph below.

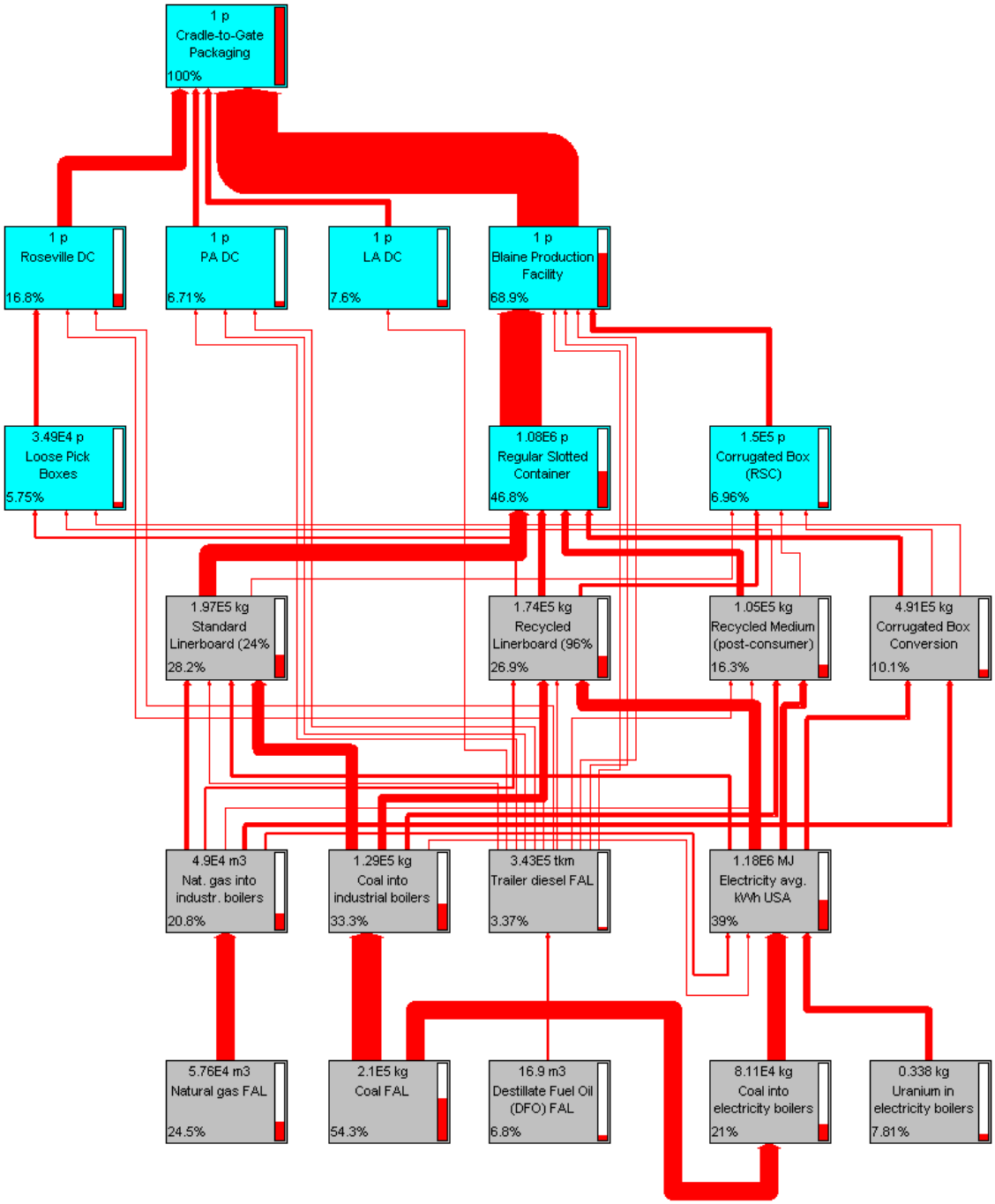
[1] Preliminary analysis of the cradle-to-gate life cycle inventory of the annual packaging material required for the Roseville DC.

Figure A1 Primary Energy Requirements for the Production of Recycled and Virgin Paper Products (source: SimaPro data libraries)



Although in many cases energy impacts are similar, newsprint papers were the only category for which recycling appears to reduce the overall energy requirements of paper product production. Generally, the use of recycled content in packaging paper products is expected to require energy in excess of that required by identical virgin paper products.

Figure A2 Process Contributions to Cradle-to-Gate Life Cycle Primary Energy Use



A6 ANNOTATED REFERENCES

Brody, A. L. and Marsh, K. S. (Eds.) (1997) *The Wiley Encyclopedia of Packaging Technology*, Wiley, New York Provided reference data for package material densities and typical applications.

Franklin Associates (2004) Life Cycle Inventory of Packaging Options for Shipment of Retail Mail-Order Soft Goods, Oregon Department of Environmental Quality, Salem, OR. Provided package production inventory data, national average package composition data, and recycled content for typical packages.

Houghton, J. T., Ding, Y., Griggs, D. J., Noguer, M., Linden, P. J. v. d., Dai, X., Maskell, K. and Johnson, C. A. (Eds.) (2001) Contributions of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, New York. Provided impact assessment values for global warming potential evaluation.

SAEFL (1998) Life Cycle Inventories for Packagings, Swiss Agency for the Environment, Forests, and Landscape (BUWAL), Berne, Switzerland. Provided data on cellulose based paper materials.

APPENDIX B - TRANSPORTATION MODELING ASSUMPTIONS AND METHODOLOGY

B1 INITIAL DATA

Aveda provided the team with 5-months of LTL shipment data from October 2003 to March 2004. Each row of data included:

- Carrier Name – Any of 39 carriers listed in the data file
- Weight – The actual weight of the shipment
- Ship From Information – Included Company Name, Address, City, State and Zip
- Ship To Information – Included Company Name, Address, City, State and Zip

In order to analyze the data, the origin and destination of each shipment was coded. The codes were as follows:

FROM

- Retail – If coming from one of the 131 listed retail stores provided by Aveda
- Salon – If coming from a salon. Salons were identified by a list of Aveda Services Inc. serviced salons and through the online salon directory at Aveda.com.
- Third-party USDC – If coming from one of the Third-party U.S. distributors
- Third-party CADC - If coming from one of the Third-party Canadian distributors
- LADC
- PADC
- Roseville
- Blaine

TO

- LADC
- PADC
- Roseville
- Blaine
- Retail – If going to one of the 131 listed retail stores provided by Aveda
- Salon – If going to a salon. Salons were identified by a list of Aveda Services Inc. serviced salons and through the online salon directory at Aveda.com.

- Third-party USDC – If going to one of the Third-party U.S. distributors
- Third-party CADC - If going to one of the Third-party Canadian distributors

B2 OTHER CARRIERS

There are a few carriers that do not provide detailed shipment data to Aveda. Instead they provide a monthly total for each DC. Therefore, this data needed to be distributed among the stores each carrier ships to. The assumptions were unique to each carrier.

Carrier B – This carrier provides a "dedicated run" to 18 stores in the NYC region. These shipments depart out of PADC and contain products for both Aveda and Origins stores. These stores are both owned by Estee Lauder and are co-located, which makes combined shipments optimal for these stores. The total shipments were assumed equally distributed to each store, except for stores that receive shipments every week, instead of every other week.

Carrier A – This carrier ships to 12 retail stores in southern California out of LADC. From LADC they go once a day by straight truck (24 ft with lift gate) to the carrier's hub nearby. From the hub, salons orders are shipped by cargo van (varying size and model) to all of Southern CA (LA to border).

The total shipments were assumed equally distributed to each store, except for one store that receives shipments every week, instead of every other week.

B3 MODELING ASSUMPTIONS

- All vehicles are weight-limited. Therefore, the impacts from transportation can be allocated to Aveda based on the mass of product shipped.
- Road vehicles and locomotives are powered with diesel fuel. Ocean freighters are powered by fuel oil turbines (number 5 fuel oil). Cargo planes are fueled with jet fuel (kerosene).
- Unless specific data were available from carriers, vehicles modeled in the study had the following characteristics:

Table B1 Vehicle types, payload and fuel economy used in model

Vehicle Type	Payload (lbs)	Fuel Economy (miles per gal fuel)	Data Source
Class 2 Truck/Van	7,200	14.11	(Davis and Diegel 2003)
Class 7 Truck	26,500	7.07	(Davis and Diegel 2003)
Class 8 Truck	35,000	6.69	(Davis and Diegel 2003)
Locomotive	6,000,000	0.135	(Davis and Diegel 2003)
Ocean Freighter	44,000,000	0.024	(Maritime Administration 2002)
UPS Cargo Plane	58,000	0.340	(Air Transport Association 2002)

- UPS delivery vehicles (frequently referred to as UPS "Brown" Trucks) were modeled using information provided by UPS representatives. Information provided included an average delivery load of 2,500 lbs, an average fuel economy of 8 mpg, and an average delivery distance of 50 miles.

- Franklin Associates estimates for the combustion of fuel have been used for consistency with inventory model calculations. Fuel combustion impacts, including CO_2 and CH_4 emissions resulting from fuel combustion (including upstream), net crude oil input requirements, total primary energy, and total global warming potential are shown below.

Table B2 Greenhouse gas emissions and energy associated with different fuel types

Fuel	Vehicle	CO_2 (kg/gal)	CH_4 (g/gal)	Crude Oil (kg/gal)	Energy (MJ/gal)	GWP (kg CO_2 eqv./gal)
Diesel	Truck	12.6	14.7	3.52	158	13.0
Jet Fuel	Cargo Plane	11.0	14.1	3.41	153	11.3
Fuel Oil	Freighter	13.8	16.8	3.93	177	14.1
Diesel	Locomotive			3.52	158	13.0

- When additional data were unavailable, all transportation and product delivery operations were modeled assuming class 8 trucks were used for the full delivery distance. Generally these vehicles are used for the vast majority of transportation distances for the carriers studied.

- Assumptions on truck type were made based on interviews with specific carriers.

    - *Carrier C:* Full transport distance is covered using Class 7 Trucks

    - *Carrier A:* For shipments from LADC, all shipments travel 44 miles to a local hub via strait truck (assumed to be a Class 7 Truck as described above). From here deliveries are made to the greater LA area via delivery truck/cargo van (assumed to be a Class 2 Truck).

    - *Carrier E:* Full transport distance provided in 28 foot trailers. Two trailers are attached to a single tractor (truck) during transportation. This articulated vehicle provides an overall payload of 40,000 lbs at a fuel economy of 6 mpg.

    - *Carrier I:* For shipments from PADC, all shipments travel 16 miles to a local hub via a 28-foot single unit truck (Class 7 Truck). Transportation to final destination is provided by a Class 8 tractor-trailer. For shipments from Blaine, MN, all shipments go directly to customer on Class 8 trucks.

- Federal Express (FedEx) ground shipments are considered identical to UPS shipments. The following FedEx shipments include airborne transportation: 2nd Day shipments over 1000 miles, Standard Overnight shipments over 200 miles, and Priority Overnight shipments over 200 miles. Airborne shipments include transport via class 8 truck to the closest commercial airport, use the data provided above for UPS cargo planes, and include 50 miles of delivery truck driving to final customer location.

- Delivery distances for deliveries to Puerto Rico were estimated using two stages. The first stage consisted of road transport from Roseville to Miami, FL (1791 miles). From there, ocean freighter transport to San Juan, PR was estimated using the projected distance from Miami (1032 miles).

- Deliveries to Hawaii were modeled using two transportation stages. First product is transported via Class 8 Truck to a port in the Los Angeles area (18 miles from LADC). From here product is transported via air transport (using the UPS aircraft profile shown above) to Hawaii (2552 miles). Air transport was utilized at the time of the data collection for this model; however, the effects of the recent switch to ocean freighter transport are modeled in a separate scenario.

B4 Shipments from Blaine to Roseville

Total weight of shipments from Blaine to Roseville was calculated assuming no net accumulation of mass in Roseville during the period of analysis. That is, the total weight of shipments leaving Roseville must equal the total weight of shipments entering Roseville. Shipments from Blaine are believed to account for the majority of the mass of product entering Roseville. These shipments are transported via Class 8 Trucks with an average load of 30,000 lbs each.

Trailers return to Blaine empty and the fuel use for the return trip is also allocated to the delivery. According to the US DOE 21st Century Truck Program, a reduction in load weight of 30,000 lbs would reduce fuel consumption by 12.5%.[122] This means that the return trip uses only 87.5% of the energy used in the delivery trip (this is reflected in the model through the use of a total route delivery factor of 1.875).

B5 Calculating Expected Driving Distance

When possible, data from the Mapquest driving distance database (mapquest.com) were used as the distance between the origin and destination zip codes. However, this data is time consuming to collect and impractical for a large number of deliveries. Therefore an alternative methodology was used for some distance data.

This method consists of two steps. First the “as the crow flies” distance between two zip codes was calculated based on the latitude and longitude for the center of the zip code area. Then these values were then adjusted by a distance-based factor in order to account for expected

differences between linear distance and driving distance. These calculations are explained in detail below.

The distance between two zip codes was calculated based on coordinate data provided for the center of the zip code area in the Census bureau Zip Code Tabulation Area data files. Distance between any two points (with coordinates in radians) can be calculated using the following formula:

$$D_{Zip} = 3958.75 \times \arctan\left(\frac{\sqrt{1-x^2}}{x}\right)$$

Where,

$$x = \left[\sin\left(lat_{frm}\right) \times \sin\left(lat_{to}\right)\right] + \left[\cos\left(lat_{frm}\right) \times \cos\left(lat_{to}\right) \times \cos\left(lon_{to} - lon_{frm}\right)\right]$$

lat_{frm} = latitude for from zip code

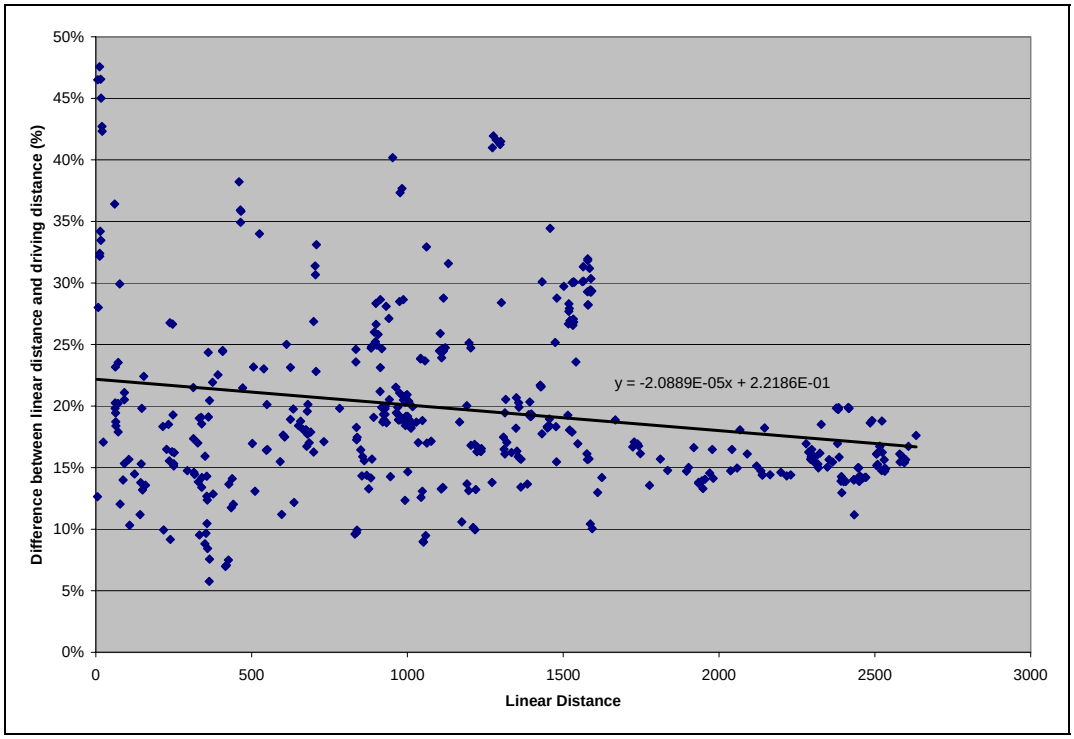
lat_{to} = latitude for to zip code

lon_{frm} = longitude for from zip code

lon_{to} = longitude for to zip code

However, distances calculated in this way differ significantly from the driving distances taken from the Mapquest database. In order to provide a distance values more consistent with published driving distances, the driving distance was compared to the liner distance for 450 data points. The result is shown in the figure below:

Figure B1 Calculation of expected driving distances



The following relationship for calculating the expected driving distance was derived from the figure:

$$D = D_{zip}\left(1.2219 - 2.089 \times 10^{-5} D_{zip}\right)$$

B6 IMPACT ASSESSMENT FACTORS

Two impact categories are included in the Aveda assessment; these are global warming potential (expressed in CO_2 equivalents) and primary energy use (expressed in MJ).

Global warming potential values for carbon dioxide (CO_2) and methane (CH4) are taken as reported by the Intergovernmental Panel on Climate Change (IPCC) in the *Third Assessment Report* (Houghton, Ding et al. 2001). The equivalency factors for CO_2 and CH_4 are 1.0 and 23 respectively. Based on a preliminary analysis of available data, the inclusion of a factor for an additional emission (N_2O) would increase the life cycle global warming potential of the system by less than 1%[2].

[2] Preliminary analysis of the cradle-to-gate life cycle inventory of the annual packaging material required for the Roseville DC.

Primary energy use factors for non-renewable fuels are taken as published for the SimaPro database. Primary energy equivalents are expressed in lower heating value which is an estimate of the energy content of the fuel assuming a combustion reaction results in gaseous water as a product. Factors of greatest interest are those relevant to North American data sets (as published by Franklin Associates Ltd.) as these provide a majority of the data for the study. These factors are shown in the table below.

Table B5 Primary Energy Equivalents for Fuel Sources

Fuel Material	Primary Energy Equivalent (LHV)
Coal	26.4 MJ/kg
Crude Oil	42 MJ/kg
Natural Gas	46.8 MJ/kg
Uranium (refined fuel)	2291 MJ/g

B7 Model Implementation

The Aveda distribution model was implemented in Microsoft Access to provide maximum flexibility in results calculation. This database model requires three input files:

- Distribution Data – information on shipments such as weight, from location and to location
- Carrier Data – information on the routing used by specific carriers for various service types such as transportation mode and hub distances
- Mode Data – information on energy and emissions associated with using various transportation options

The model calculates energy impacts of transportation as follows:

$$E = \sum E_{fuel,i} \left(\frac{W_i}{Load_i} \right) \left(\frac{D_i}{FE_i} \right)$$

Where,

i represents a specific transportation stage such as transport to a regional hub from a distribution center

E_{fuel} represents primary energy associated with fuel production, delivery and combustion (a function of the type of fuel being used for transportation)

W represents the weight of product being shipped (lbs.)

Load represents the total payload of the transportation vehicle (lbs.)

D represents the transportation distance (miles)

FE represents the fuel economy of the vehicle (mpg)

Global warming potential impacts are calculated using a similar equation with a factor representing global warming impacts of fuel production, delivery, and combustion replacing E_{fuel}.

B8 UPS "BROWN" TRUCK DATA VARIANCE

UPS delivery trucks ("brown" trucks) play an important role in the overall energy use and global warming emissions of the product delivery system. These vehicles account for 10% of the total energy use for product delivery while providing less than 1% of the total ton-miles of transportation. This relatively high energy use is related to the requirements of efficient delivery, e.g. packages must be easily identified within the storage space, and personnel must be able to stand upright while loading and unloading the cargo. These requirements lead to large vehicles that carry relatively low weights for delivery trips. Based on information provided by UPS, it was assumed that Aveda products were delivered an average of 50 miles in a brown truck, with an average total vehicle load of 2,500 lbs and an average fuel economy of 8 mpg. However, due to the importance of these values in the overall system analysis, a more through statistical investigation of these values is important.

If we assume the average values provided by UPS are mean values from a normal distribution and further assume these distributions have the characteristic properties shown in Table B6, then the variability in the overall results can be considered more thoroughly.

Table B6 Assumptions for the mean distance, fuel economy and payload for UPS "Brown" trucks per delivery

Variable	Mean Value	Standard Deviation
Delivery Distance	50 miles	± 25 miles
Fuel Economy	8 mpg	± 2 mpg
Delivery Payload	2,500 lbs	± 500 lbs

These values suggest the energy use to deliver one pound of Aveda product via UPS brown truck is 940 Btu/lb ± 700 Btu/lb (including the upstream fuel cycle energy). This range provides the expected standard deviation in the delivery energy (statistical values for GWP would be similar and are not repeated here for simplicity). This range provides the 68% confidence interval for the energy use value; the 95% confidence interval would be 900 ± 1340 Btu. The 68% confidence interval for total system energy use associated with brown truck deliveries is 2,300 MM Btu ± 1,700 MM Btu. This provides an overall variance in the total delivery system (for all product deliveries) energy use of 7.5%.

B9 UPS METHODOLOGY

B9.1 DATA COMPILATION

Two separate excel spreadsheets each with 2.5 months of shipments were used for UPS/FedEx modeling. "Aveda_UPS_New_Data_Part_A" included all invoice dates from October 18th, 2003 through December 14th 2003. "Aveda_UPS_New_Data_Part_B" included all invoice dates from December 20th through February 29th. Each shipment was coded for "From Code" based on the "Ship From Address," "To Code" based on the "Ship To Address," and "Designated Distributor" based on the specified distributor assigned to a particular ship to region. The designated distributor list was provided by Aveda.

Weights were calculated by sorting data by transportation node and summing weights for each node.

B9.2 DATA MODELING ASSUMPTIONS - TYPE OF SHIPPING

All UPS shipments were considered ground, based on the unique relationship Aveda has with UPS to guarantee ground shipping.

B9.3 DATA MODELING ASSUMPTIONS - TRUCK CAPACITY

Based on interviews with Brown Truck drivers and also an EPA staffer, the team used 2,500 lb as the average Brown truck capacity. It must be noted that there are a number of different types (and sizes) of brown trucks, but for the purpose of this report, we assumed all trucks were the small Brown Trucks.

B10 FEDEX METHODOLOGY

B10.1 DATA COMPILATION

Same as UPS Methodology

B10.2 DATA MODELING ASSUMPTIONS - TYPE OF SHIPPING

- "2nd Day": >1000 miles shipped by air, otherwise shipped by ground
- "Ground": All shipments are by ground
- "International Economy": All shipments are by ground
- "International Priority": All shipments are by ground
- "Standard Overnight": >200 miles goes by air otherwise by ground

- “Priority Overnight”: >200 miles goes by air otherwise by ground

B10. 3 DATA MODELING ASSUMPTIONS - TRUCK CAPACITY

FedEx Capacity was considered equal to UPS. The team treated the efficiency of the UPS and FedEx Networks as equal. We also assumed that the utilization of the network was 100% as per Aveda’s recommendation. Other GWP reporting tools use lower efficiency factors as they assume that trucks return empty.

APPENDIX C METHODOLOGY FOR EVALUATING STRATEGIC RECOMMENDATION 2

This appendix provides detailed routes, transportation mode, and mileage for each quote provided by different intermodal companies.

Table C1 Detailed steps for shipping with Clarke Intermodal Logistics. Costs do not include fuel surcharges. Quote dated 25 Oct 2004.

	Roseville to LADC	Roseville to USDC-B	Roseville to USDC-A	Roseville to PADC
1	Truck from Roseville to Canadian Pacific Ramp in St. Paul = 10 miles	Truck from Roseville to Canadian Pacific Ramp in St. Paul = 10 miles	Truck from Roseville to Canadian Pacific Ramp in St. Paul = 10 miles	Truck from Roseville to Canadian Pacific Ramp in St. Paul = 10 miles
2	Canadian Pacific railroad from St. Paul to Chicago = 400 miles	Canadian Pacific railroad from St. Paul to Chicago = 400 miles	Canadian Pacific railroad from St. Paul to Chicago = 400 miles	Canadian Pacific railroad from St. Paul to Chicago = 400 miles
3	Union Pacific railroad from Chicago to Los Angeles = 2100 miles	Union Pacific railroad from Chicago to Denver = 1000 miles	Trucked from Canadian Pacific ramp to Canadian National ramp = 1 mile	CSX railroad to Philadelphia = 760 miles
4	Truck from Los Angeles rail yard to Compton, CA = 20 miles	Truck from Denver rail yard to USDC-B = 10 miles	Canadian National Rail from Chicago to New Orleans = 920 miles	Truck from Philly rail yard to PADC = 25 miles
5			Truck from New Orleans to USDC-B = 55 miles	
Road Miles	30	20	66	35
Rail Miles	2,500	1,400	1,320	1,160
Total Days	7-9 days	4-5 days	3-4 days	4-5 days
Cost	$1,872	$1,853	$1,693	$1,637

Contact: Jack Powers
Director, Business Development
900 Ridge Road, Suite 3NW
Homewood IL 60430
800-925-0125
jpowers@clarkelogistics.com

Table C2 Mileage by mode with CH Robinson Intermodal Logistics and includes fuel surcharges. Quote dated 15 Dec 2004.

	Roseville to LADC	Roseville to USDC-B	Roseville to USDC-A	Roseville to PADC
1	Truck from Roseville to Canadian Pacific ramp in Minneapolis = 8 miles	Truck from Roseville to BNSF ramp = 21 miles	Truck from Roseville to BNSF ramp = 21 miles	Truck from Roseville to BNSF ramp = 21 miles
2	Rail - specific rail routes vary based on availability=1870 miles	Rail - specific rail routes vary based on availability=851 miles	Rail - specific rail routes vary based on availability=1316 miles	Rail - specific rail routes vary based on availability=1177 miles
3	Truck from Union Pacific ramp to Compton, CA = 13 miles	Truck from BNSF Ramp in Denver to USDC-B = 8 miles	Truck from Canadian National Ramp in New Orleans to USDC-A = 55 miles	Truck from Norfolk Southern ramp in Morrisville, PA to PADC = 8 miles
Road Miles	21	29	76	29
Rail Miles	1870	851	1316	1177
Total Days	7-8 days	3-4 days	6-7 days	6-7 days
Cost	$2,100	$1,975	$2,300	$2,300

Table C3 Mileage by mode with Triple Crown Logistics and includes fuel surcharges. Quote dated 20 Dec 2004.

	Roseville to PADC
1	Truck from Roseville to Triple Crown Ramp located at 525 Kasota Ave, Minneapolis, MN = 14 miles
2	Minneapolis ramp to Bethlehem, PA ramp = 1094 miles
3	Bethlehem, PA ramp to PADC = 53 miles
Road Miles	67
Rail Miles	1094
Total Days	3 days
Cost	$1718 + $127.71 (fuel charge) = $1845.71

Contact: Allen Johnson
Regional Marketing Manager
Triple Crown Services
651-340-8404
allen.johnson@triplecrownsvc.com

APPENDIX D RELATIVE IMPACT BETWEEN PARCEL VERSUS LTL SHIPPING

Please note that loose-pick boxes describe the packaging used to ship by parcel while palletized loads or full-pallets describe the packaging to shop by LTL.

The results presented in Section 5 reveal that shipping to salons has nearly four times the environmental impact of shipping to retail locations. One can intuitively hypothesize that shipping product in loose-pick boxes requires more packaging and less-efficient transportation than shipping via palletized loads. However, other variables may be contributing to this difference. In an effort to better understand this difference, two hypothetical scenarios for delivery of the same quantity of products were developed to highlight the energy and environmental tradeoffs of loose-pick verses palletized master cartons. The prototypical loose-pick box was based on the following information:

- The average loose-pick box weighs approximately 20 pounds and contains a variety of products.[123]
- The product mix includes seven of the top ten products by volume sold in the summer of 2004 by volume.

Table D1 shows delivery quantities for both scenarios.

Table D1 Products and number of units shipped in the loose-pick versus palletized load scenario.

Product Name	Number of Units Delivered
Product 1	17,280
Product 2	5,760
Product 3	2,880
Product 4	5,760
Product 5	5,760
Product 6	11,520
Product 7	5,760

In both cases a hypothetical delivery distance of 1000 miles were considered.

D1 SCENARIO ONE – LOOSE-PICK

In this scenario a total of 2,880 loose-pick boxes are delivered via UPS. Each box has identical contents and packaging. Tables D2 and D3 detail the contents of the hypothetical loose-pick box.

Table D2 Contents of a the hypothetical loose-pick box

Product Name	Number of Units per Loose-Pick Carton
Product 1	6
Product 2	2
Product 3	1
Product 4	2
Product 5	2
Product 6	4
Product 7	2

Table D3 Required packaging for the hypothetic loose-pick box

Packaging Material	Quantity	Supplier and SKU	Size
Loose-pick Boxes	1 box	Supplier E 4931, 35146, 40084	16" x 14" x 12"
Ran Pack	10 ft	Supplier E 18120	30" fill pak
#6 Kraft Grocery Paper Bags – 35 lb.	1 bag	Supplier F S-7083	6" x 3 5/8" x 11"
Kimpak Wadding, ¼" x 12" x 200"	2 ft	Supplier F S-2146	12"

Each loose-pick box weighs 21.91 lbs including contents and packaging. The standard assumptions for UPS ground deliveries were followed for this shipment. These assumptions are: UPS delivery vehicle ("Brown" truck) services the final 50 miles of the delivery. All prior transportation is provided by a standard class 8 truck. Standard class 8 trucks are assumed to carry a total payload of 35,000 lbs with a fuel economy of 6.69 mpg. UPS delivery vehicles are assumed to carry a total payload of 2,500 lbs with a fuel economy of 8 mpg.

D2 Scenario Two – Palletized Loads

In this scenario master cartons of the products listed above are loaded onto pallets to provide a total delivery quantity equivalent to that for the loose-pick shipments. The number of full pallets for each product are shown below (in some cases integer values were not possible so fractional pallets are used).

Table D4 Number and weight of the pallets used to compare between the hypothetical full pallet and loose-pick boxes

* includes packaging

Product Name	Number of Pallet Loads	Total Weight (lbs)*
Product 1	9.00	12,200
Product 2	2.00	956
Product 3	20.00	27,500
Product 4	1.90	1,830
Product 5	1.85	2,300
Product 6	2.67	3,570
Product 7	3.87	5,100

Master carton packaging for each product is shown below. Note, pallets and shrink wrap are used for pallet loads (40-180 cartons).

Table D5 Weight of individual products

Product Name	Master Carton Size	Weight (lbs)
Product 1	9”x13”x9	0.50
Product 2	8”x13”x9”	0.48
Product 3	13”x13”x13”	0.80
Product 4	7”x12”x9”	0.40
Product 5	8”x10”x7”	0.35
Product 6	4”x13”x10”	0.25
Product 7	10”x9”x7”	0.60
48” x 40” 4-Way Pallet	-	77.5
Shrink Wrap	120 ft.	0.5

D3 RESULTS

Results described in the Figures D1 through D4.

Figure D1 Energy requirements and global warming emissions associated with production and delivery of packaging materials used in loose-pick versus LTL

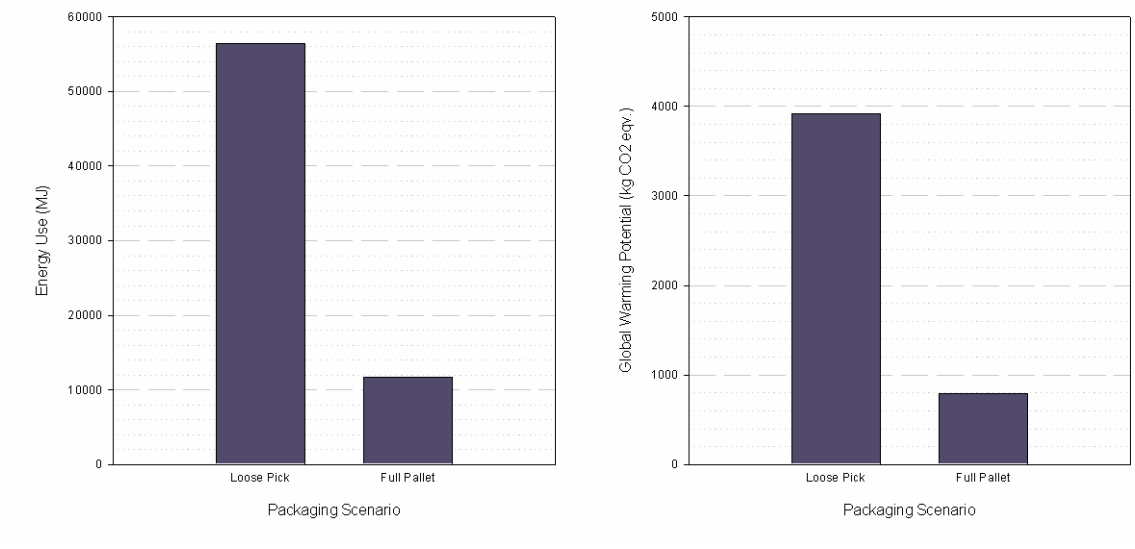


Figure D2 Energy requirements and global warming potential emissions associated with delivery of the shipments considered in each scenario

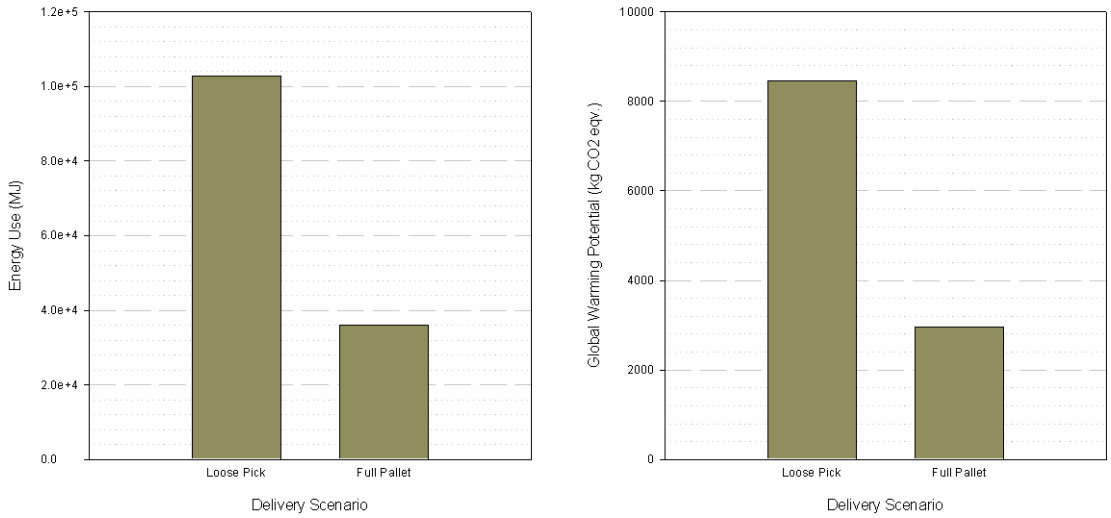


Figure D3 Total energy use and global warming emissions for the package production and delivery considered in each scenario

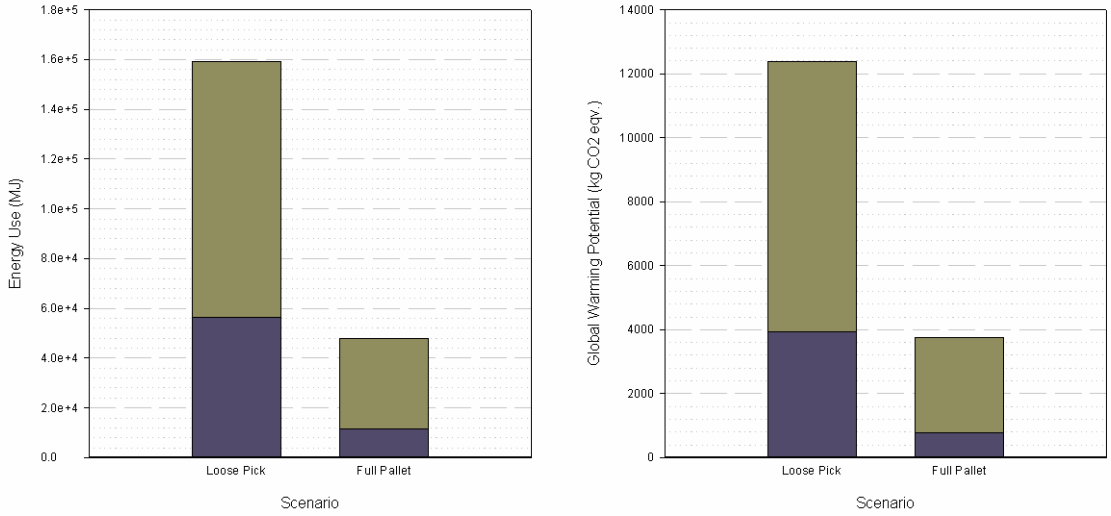
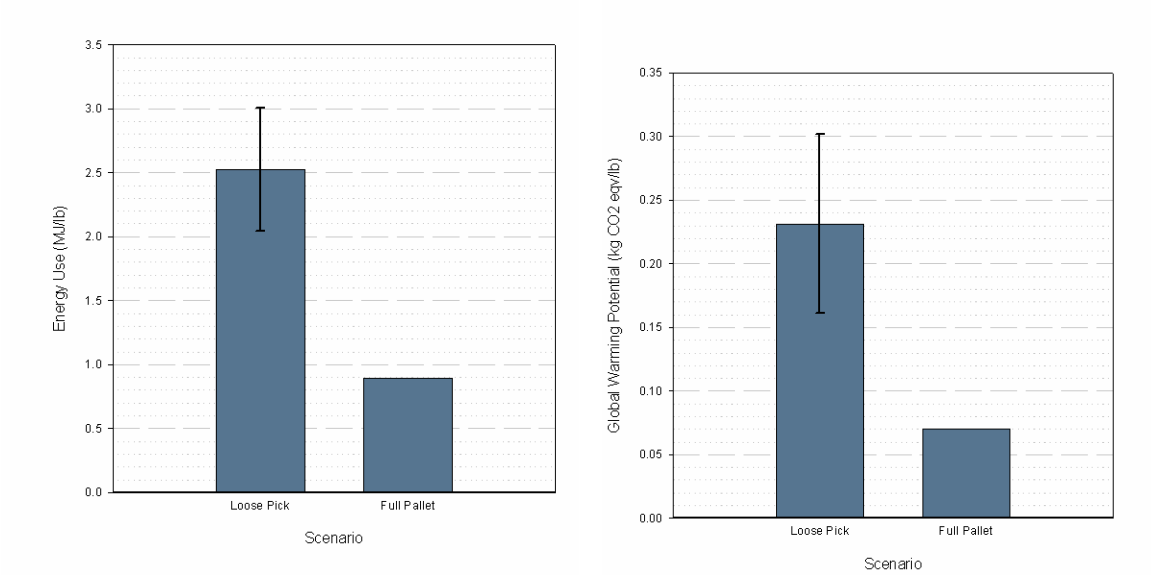


Figure D4 Differences in Energy and GWP on a per pound of product delivered



The range of values found (error bar on the loose-pick column) when the delivery distance for the UPS brown truck was varies between 25 miles and 75 miles. Holding all variables equal, the environmental impact associated with shipping loose-pick (parcel) is three to four times greater that fully palletized loads (LTL).

APPENDIX E SAMPLE LETTER TO CARRIER FOR EPA SMARTWAY TRANSPORT

Dear Freight Carrier:

The freight services you provide are a significant link in the supply chain that delivers our products to retailers and customers. Freight services like yours are amazingly efficient at quickly and affordably delivering products nationwide, safely and on-time. Yet, as you well know, that process carries an environmental cost as well. There are now more than six MM single-unit and two MM combination trucks on our nation's roadways and each year those trucks drive over 200 billion miles total. Those trucks consume more than 35 billion gallons of fuel each year, and emit about 294 MM tons of greenhouse gases, in addition to 3 MM tons of nitrogen oxides and 160,000 tons of particulate matter.

We believe that responsible corporate citizens will endeavor to find more sustainable business practices that reduce the environmental impact of producing and delivering consumer goods. We also believe that the goals of business and environmental protection are not mutually exclusive. We find that improved practices, with reduced environmental impacts, can actually improve the bottom line by reducing fuel use and improving operational efficiency. To that end, we are participating with dozens of other freight shippers and carriers in a voluntary effort called the SmartWay Transport Partnership. Industry leaders have agreed to work with the Environmental Protection Agency (EPA) to reduce greenhouse gas emissions from the freight sector. By 2012, SmartWay Transport aims to reduce carbon emissions by 9 to 18 MM metric tons.

The SmartWay Transport Partnership will achieve these reductions through advancing technologies and improving the management practices used in the freight industry. Technologies being used include new approaches to reducing or eliminating truck idling, like truck stop electrification and auxiliary power units. Other technological approaches to reduced emissions include improved aerodynamics, self-inflating and wide-base tires, synthetic lubricants, speed controls and others. Improved management practices include load matching and driver training. Companies which adopt these strategies are doing so because of their environmental stewardship, <u>and</u> because it is good for business. Doing business the "SmartWay" is setting the benchmark for excellence, and rewarding companies for using sustainable technologies and practices that will become the industry standard.

One of the more visible benefits for the highest performing participants in this voluntary program, will be the use of the SmartWay Transport brand for qualifying SmartWay Transport Partners. This logo can be used to acknowledge a company's environmental excellence and will symbolize to consumers, other business customers and competitors that delivery services are being provided more efficiently and with reduced environmental impact. EPA and SmartWay Transport Partners will be actively promoting the Partnership, so that over time customers will recognize the SmartWay Transport label as a preferred option.

We have joined (are joining) EPA in this voluntary effort as a Partner to promote our sustainable business practices and environmental commitment. As one of our preferred freight carriers, we would like you to join us as one of the leading carriers that are improving efficiencies. I believe that once you learn about this exciting new effort and the benefits that it offers your business, you will agree to come aboard. It would require a voluntary commitment on your behalf and some extra effort, but you will see both the near term and long term advantages of doing so. Consider the benefits:

Cost savings: save fuel with advanced technologies and strategies.

Business-to-business advantages: Carrier Partners are preferred by Shipper Partners who commit to ship more of their goods with SmartWay Transport Carrier Partners.

Management tools: the EPA Freight Logistics Environmental and Economic Tracking (FLEET) Performance model helps you to track and manage fuel use, evaluate fuel savings, and environmental benefits of various strategies, in addition to quantifying the benefits of future fleet enhancements.

Technical support: EPA can assist you with the FLEET Performance Model and finding the best approaches to meet your goals.

Recognition for existing fleet improvements: Your fleet's existing improvements and your continued improvements are credited in your efficiency ratings.

National Recognition and Promotional Opportunities: Public exposure, national and regional media events, articles and other special awards are provided to all Partners by EPA to recognize their participation and environmental performance. Exceptional performance will be recognized through the use of the SmartWay Transport Partner logo, a symbol of excellence that you may use in advertising and other marketing efforts.

The application process is simple; Sign a voluntary Partnership Agreement, calculate your efficiency and make a commitment for annual improvements that will ensure additional reductions over time. Our company has already agreed to work on this voluntary Partnership and we too have made commitments for efficiency improvements. We will also seek to ship more of our goods over time with higher scoring carriers that have committed to efficiency improvements. I hope that you will work with us to ensure the success of these important efforts. You can find more useful info at the Partnership website: http://www.epa.gov/smartway

I hope that you agree with us that doing business the "SmartWay" will help all of us to become more competitive in our industry, improve our public image and foster more sustainable business practices that will have a lasting impact.

If you have additional questions about the SmartWay Transport Partnership, please feel free to call the Partnership hotline at 734-214-4767, or e-mail smartway_transport@epa.gov. We will look forward to working with you.

Signed

APPENDIX F SAMPLE TERTIARY PACKAGING PURCHASING POLICY

The purpose of this policy is to establish recycled content procurement guidelines to increase the procurement of recycled content in tertiary packaging products used by Aveda distribution centers. This policy aims to encourage procurement of products with the greatest post-consumer recycled (PCR) content. PCR content is paper that has been recovered after use by individuals and organizations. It should be noted that some paper product manufacturers include in their definition of "recycled content" the material generated in the paper manufacturing processes, such as scrap and trimmings/cuttings. Since these are commonly generated from and reused within a manufacturing process, they are not considered "recycled" under these guidelines. This policy aims to increase the use of products with PCR content only.

Aveda's policy is to purchase and use tertiary packaging products containing significant PCR content when such products are:

- Of high quality and satisfy applicable specifications
- Available in the desired quantity within a reasonable period of time, and
- Available at a reasonable price.

Table F1 Minimum standards for PCR content in tertiary packaging

Paper type	Minimum Post-consumer Fiber (%)
Corrugated Cardboard Boxes	
Linerboard	30
Corrugated Medium	100
Kraft Paper / Wadding Paper	100
Kraft Grocery Bags	100
Corroseal Adhesive Wraps	
Exterior	100
Interior (Flute)	30
RanPak	80

Aveda staff purchasing tertiary packaging materials containing paper shall require suppliers to provide documentation stating that their products meet the above requirements.

APPENDIX G ENERGY AND GWP CONVERSION

Throughout this report, the resulting energy and GWP impacts from the various components of the PDS are provided in MJ of Energy and kg of CO_2 equivalents respectively. As a frame of reference, these figures are also presented in terms of equivalent gallons of gasoline and equivalent automobile use. The calculations for this conversion are as follows:

- 42 gallons = 1 barrel of automotive gasoline
- 5.253 MM BTU = 1 Barrel of automotive gasoline[124]
- 947.8170777 BTU = 1 MJ

(1 barrel/42 gallons)*(5,253,000 BTU/1 Barrel)*(1 MJ/947.8170777 BTU)

Therefore 132 MJ = 1 gallon [U.S.] of automotive gasoline

- Average light vehicle (cars, trucks and SUVs) in the US travels 12,039 miles per year[125]
- The average light vehicle on the road in the US achieves 24 mpg[126]
- 19.564 lbs of CO_2 emissions are generated per gallon of gasoline[127]
- 2.2046 lb/kg
- 1000 kg/metric ton

(12,039 miles per year per car)*(1 / 24 miles per gallon)

Therefore 502 gallons gas = 1 car for a year

(19.564 lbs CO_2 / gallon)*(1 kg / 2.2046 lb)

Therefore 8.874 kg CO_2 = 1 gallon [U.S.] of automotive gasoline

Example:

- 36.5MM MJ/132 = 276,515 gallons of gasoline
- 276,515 gallons/502 = Enough to fuel 551 cars for a year

- 2,811,000 kg CO_2 = 316,768 gallons gasoline
- 316,768 gallons/502 = Enough to fuel 574 cars for a year

SECTION 10 - REFERENCES / BIBLIOGRAPHY

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[1] From April 2004 through March 2005, the Michigan student team worked with Aveda employees, contractors, and vendors to collect and interpret data to provide a system-wide assessment of Aveda's PDS. A significant amount of data for this report was gathered over a three-day visit to Aveda's facilities in Blaine, MN and Roseville, MN from May 5 through May 7, 2004. At the Blaine site, the team toured the manufacturing facility and interviewed managers and directors of environmental affairs, packaging, distribution, and marketing. At the Roseville site, the team toured the distribution facility and interviewed the distribution personnel that manage facility operations, packing, transportation, and customer returns. The team paid subsequent visits to the Blaine and Roseville facilities in November 2004 and January 2005 to collect additional data and verify preliminary findings.

[2] "Other" includes customer returns; from stores, salons, and distributors. Shipments from distributors could be part of inventory management.

[3] PDS denominator is total weight shipped out of Roseville, numerator includes energy and emissions resulting from transporting goods to company owned distribution centers, retail stores, and salons

[4] Notably, the carbon emissions resulting from the completion of this project (due to air, train, and car transportation) will be offset through Native Energy.

[5] Hook, Paula and Heimleich, Joe E. "Ohio State University Fact Sheet: Purposes of packaging," Ohio State University, http://ohioline.osu.edu/cd-fact/0134.html (accessed October 25, 2004).

[6] "Waste, Product Stewardship, Products, Packaging Waste Fact Sheet," Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, http://www.epa.gov/epaoswer/non-hw/reduce/epr/products/packaging.html (accessed October 25, 2004).

[7] "Municipal solid waste in the United States: 2001 facts and figures," Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, http://www.epa.gov/epaoswer/non-hw/muncpl/pubs/msw2001.pdf (accessed Jan 14, 2005).

[8] Alastra, Anna. "Packing Light: Companies Cut Waste -- and Costs -- with Greener Packaging," GreenBiz, http://www.greenbiz.com/news/reviews_third.cfm?NewsID=25499&CFID=14192682&CFTOKEN=1834596 (accessed on October 26, 2004).

[9] "Aveda finds sustainability within," Green@Work, March/April 2004, GreenBiz.com http://www.greenbiz.com/news/reviews_third.cfm?NewsID=26806&CFID=14192682&CFTOKEN=1834596 (accessed on October 26, 2004).

[10] "Environment, Policies, Waste, Packaging Fact Sheet," European Union Environmental Commission, http://europa.eu.int/comm/environment/waste/packaging_index.htm (accessed on November 9, 2004).

[11] "Group reports Europe's packaging waste cut by third," EDIE.net, http://www.greenbiz.com/news/news_third.cfm?NewsID=11517&CFID=14192682&CFTOKEN=1834596 (accessed November 9, 2004).

[12] "Eco-friendly packaging could spread holiday cheer," Greenbiz.com, http://greenbiz.com/news/news_third.cfm?NewsID=13760&CFID=14192682&CFTOKEN=1834596 (accessed November 9, 2004).

[13] "GreenBiz essentials: Buying recycled," Greenbiz.com, http://greenbiz.com/toolbox/essentials_third.cfm?LinkAdvID=4157&CFID=14192682&CFTOKEN=1834596 (accessed November 9, 2004).

[14] Alastra, Anna. "Packing Light: Companies Cut Waste - and Costs-- with Greener Packaging," GreenBiz, http://www.greenbiz.com/news/reviews_third.cfm?NewsID=25499&CFID=14192682&CFTOKEN=1834596 (accessed on October 26, 2004).

[15] Aveda's 2001-2002 Coalition for Environmentally Responsibility Economics (CERES) Report.

[16] "Minnesota pallet makers serve nice for certified wood resource," Forest Stewardship Council, http://www.fscus.org/news/?article=16 (accessed June 9, 2004).

[17] For a comparison in standards, go to http://www.certifiedwood.org.

[18] Hansen, Peter and Bob Eriksson. Interviewed by Ted Ekkers, Tony Baptista, Jon Forrester, Nathan Arbitman, and Heather Kirshman. Written notes. May 5th, 2004. Aveda: Blaine Manufacturing Facility.

[19] "What are greenhouse gases?" Global Warming Task Force, U.S. Environmental Protection Agency, http://yosemite.epa.gov/oar/globalwarming.nsf/content/Emissions.html (accessed January 3, 2004).

[20] Ibid.

[21] Energy Information Association, U.S. Department of Energy, "International Energy Outlook 2004," http://www.eia.doe.gov/oiaf/ieo/world.html (accessed October 26, 2004).

[22] Wood, John H., Gary R. Long and David F. Morehouse, "Long-term world oil supply scenarios: The future is neither as bleak or rosy as some assert," Energy Information Association, Department of Energy, http://www.eia.doe.gov/pub/oil_gas/petroleum/feature_articles/2004/worldoilsupply/pdf/itwos04.pdf (accessed November 1, 2004).

[23] Greene, David L., and Andreas Schafer. Reducing greenhouse gas emissions from U.S. transportation. Prepared for the Pew Center on Global Climate Change, 2003.

[24] U.S. Environmental Protection Agency. Inventory of U.S. greenhouse gas emissions and sinks: 1990 – 2002, EPA 430-R-04-003, 2003.

[25] Greene, David L., and Andreas Schafer. Reducing greenhouse gas emissions from U.S. transportation. Prepared for the Pew Center on Global Climate Change, 2003.

[26] Global Warming Task Force, U.S. Environmental Protection Agency. "Global Warming, Climate Webpage," http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html (accessed November 1, 2004).

[27] Energy Information Association, U.S. Department of Energy, "International Energy Outlook 2004," http://www.eia.doe.gov/oiaf/ieo/world.html (accessed November 1, 2004).

[28] U.S. Environmental Protection Agency. Inventory of U.S. greenhouse gas emissions and sinks: 1990 – 2002, EPA 430-R-04-003, 2003.

[29] Ibid.

[30] Ibid.

[31] Greene, David L., and Andreas Schafer. Reducing greenhouse gas emissions from U.S. transportation. Prepared for the Pew Center on Global Climate Change, 2003.

[32] Energy Information Administration, U.S. Department of Energy. 2003. Annual Energy Review 2003, Report #DOE/EIA-0384, 2003.

[33] Ibid.

[34] Office of Transportation and Air Quality, U.S. Environmental Protection Agency, "SmartWay Transport Partnership," http://www.epa.gov/smartway/swintro.htm (accessed November 15, 2004).

[35] Corbett et al. "Ship emissions assessment: Presentation at EPA – Region 9 meeting." 2001.

[36] Truck assumes diesel tractor trailers with fuel efficiency of 7 mpg. Ocean assumes "marine" rather than "inland" shipping. Rail assumes diesel locomotive. Air assumes long-haul flights greater than 994 miles. Calculation made using: "Mobile Combustion CO2 Emission Calculation Tool," GHG Protocol Initiative, http://www.ghgprotocol.org/standard/tools.htm (accessed November 18th, 2004).

[37] The North American Railroad industry, "Association of American Railroads: Railroad Industry Info," http://www.aar.org/AboutTheIndustry/AboutTheIndustry.asp (accessed December 1, 2004).

[38] Ibid.

[39] "Figure 5.1 Total primary transportation energy, Gross Domestic Purchases, and crude oil price indices, 1977 to 1993," Energy Consumption Division, Energy Information Administration, U.S. Department of Energy, http://www.eia.doe.gov/emeu/efficiency/eefig_ch5.htm#Figure 5.17 (accessed December 3, 2004).

[40] The range comes from two sources. The bottom end of the range (i.e., eight) come from: Truck assumes diesel tractor trailers with fuel efficiency of 7 mpg. Ocean assumes "marine" rather than "inland" shipping. Rail assumes diesel locomotive. Air assumes long-haul flights greater than 994 miles. The top end of the range (i.e., ten) comes from the data represented in Figure 5C of this report. Calculation made using: "Mobile Combustion CO2 Emission Calculation Tool," GHG Protocol Initiative, http://www.ghgprotocol.org/standard/tools.htm (accessed November 18, 2004).

[41] Greene, David L., and Andreas Schafer. Reducing greenhouse gas emissions from U.S. transportation. Prepared for the Pew Center on Global Climate Change, 2003.

[42] Three references were used for life cycle analysis:

Franklin Associates. Life Cycle Inventory of Packaging Options for Shipment of Retail Mail-Order Soft Goods. Department of Environmental Quality. Salem, OR: 2004.

Franklin Associates. USA LCI Database Documentation. Kansas: Prairie Village, 1998.

PRé Consultants. SimaPro, v5.1, Life Cycle Analysis Software. The Netherlands: Amersfoort, 2003.

[43] "About the Aveda founder, Horst M. Rechelbacher," Aveda Website, http://aveda.aveda.com/about/bio/default.asp (accessed October 17, 2004).

[44] "Mission of each of Estée Lauder Companies: Focus on Aveda," Estée Lauder Website, http://www.elcompanies.com/htm/frameset/frm_m2_aveda.htm (accessed October 18, 2004).

[45] "What we do," Aveda Website, http://aveda.com/protect/we/default.asp. (accessed October 25, 2004).

[46] "What we do: Environmental Sustainability Mission," Aveda Website, http://aveda.com/protect/we/default.asp. (accessed October 25, 2004).

[47] "Minnesota pallet makers serve nice for certified wood resource," Forest Stewardship Council, http://www.fscus.org/news/?article=16 (accessed June 9, 2004).

[48] "2001 – 2002 CERES Report Aveda," Aveda Website, http://aveda.aveda.com/protect/we/ceres2001_2002.pdf (accessed October 24, 2004).

[49] Brown, Mike. Interviewed by Jon Forrester. Phone. June 10, 2004.

[50] "What we do," Aveda Website, http://aveda.com/protect/we/default.asp. (accessed October 25, 2004).

[51] Franklin Associates. USA LCI Database Documentation. Kansas: Prairie Village, 1998

[52] Hansen, Peter and Bob Eriksson. Interviewed by Ted Ekkers, Tony Baptista, Jon Forrester, Nathan Arbitman, and Heather Kirshman. Written notes. May 5th, 2004. Aveda: Blaine Manufacturing Facility.

[53] Ibid.

[54] Note: The Roseville DC will move in 2005. The recommendations in this report will be issued within the context of this situation.

[55] Note: Aveda packaging suppliers provided purchasing data for 2002 and 2003. The data assessed in this report is an annual average of those two years.

[56] Rowe, Doug. Interviewed by Ted Ekkers. Phone. June 15, 2004.

[57] Erera, Alan. "Freight Rail Transportation." PowerPoint presentation for ISyE 6203: Transporation and Supply Chain Systems, School of Industrial and Systems Engineering at Georgia Tech, Atlanta, GA. (1996).

[58] Ibid.

[59] Kennedy, Mike and Tom Wellen. Interviewed by Tony Baptista. Phone. August 20, 2004.

[60] "Carbon Dioxide and Methane GHGs," Northeast Advanced Vehicle Consortium, http://www.navc.org/HDghg.htm (accessed March 14, 2004).

[61] Franklin Associates. Life Cycle Inventory of Packaging Options for Shipment of Retail Mail-Order Soft Goods. Department of Environmental Quality. Salem, OR: 2004.

[62] Rice, Tim, Dave Nordine, and Doug Rowe. Interviewed by Tony Baptista, Ted Ekkers, Nathan Arbitman, Jon Forrester, and Heather Kirshman. Written notes. May 6, 2004.

[63] Watson, R.T. and the Core Writing Team, eds. IPCC Third Assessment Report: Climate Change 2001. 2001.

[64] Franklin Associates. USA LCI Database Documentation. Kansas: Prairie Village, 1998.

[65] Davis, S.C., and S.W. Diegel. Transportation Energy Data Boook: Edition 23. Oak Ridge National Laboratory. Oak Ridge, TN: 2003.

[66] "U.S.-Flag Cargo Carrying Fleet by Area of Operation," Maritime Administration, U.S. Department of Transportation, http://www.marad.dot.gov (accessed January 5, 2005).

[67] "Other" includes customer returns; from stores, salons, and distributors. Shipments from distributors could be part of inventory management.

[68] Rowe, Doug. Interviewed by Ted Ekkers. Phone. June 15, 2004.

[69] Calculation assumes each automobile gets 20 mpg, travels 12,500 miles per year, and emits twenty pounds of CO_2 per gallon.

[70] These numbers differ slightly from Figure 5F because the previous energy and GWP values were determined based on shipments leaving the facility, rather than shipments arriving in the regional stores. There are occasional "out-of-region" shipments (i.e. LADC shipping to a PADC region store) as well as some shipments to OR and WA stores fulfilled out of Roseville.

[71] These numbers differ slightly from Figure 5F because the previous energy and GWP values were determined based on shipments leaving the facility, rather than shipments arriving in the regional stores. There are occasional "out-of-region" shipments (i.e. LADC shipping to a PADC region store) as well as some shipments to OR and WA stores fulfilled out of Roseville.

[72] Listgarten, Karen. Correspondence with Tony Baptista. E-mail. January 19, 2005.

[73] "A Glance at Clean Freight Strategies," Office of Transportation and Air Quality, U.S. Environmental Protection Agency, http://www.epa.gov/smartway/documents/intermodal%20shipping.pdf (accessed December 6, 2004).

[74] "Intermodal Industry Statistics 1999 – 2003," Intermodal Association of North America, http://www.intermodal.org/fact.html (accessed December 6, 2004).

[75] Ibid.

[76] "A Glance at Clean Freight Strategies," Office of Transportation and Air Quality, U.S. Environmental Protection Agency, http://www.epa.gov/smartway/documents/intermodal%20shipping.pdf (accessed December 6, 2004).

[77] Mongelluzzo, Bill. "Warnings on intermodal rail." *Journal of Commerce,* (2004): 47-48.

[78] "A Glance at Clean Freight Strategies," Office of Transportation and Air Quality, U.S. Environmental Protection Agency http://www.epa.gov/smartway/documents/intermodal%20shipping.pdf (accessed December 2004).

[79] Rice, Tim and Doug Rowe. Interview by Tony Baptista. Written notes. November 22, 2004. Aveda Roseville distribution center.

[80] Ibid.

[81] Rader, Steve. Interview by Tony Baptista. Phone. October 18, 2004. Aveda.

[82] The data presented in Section 5 of the report is dated from Oct 2003 to Feb 2004. Total LTL pound-miles = 12,289 M and total Parcel pound-miles = 689 M. 689/12,289 *100 = 5.58%.

[83] Haites, Eric. "The Global Carbon Market." Margaree Consultants, Inc. February 3, 2003.

[84] "What We Do," Climate Care, http://www.co2.org/ (accessed January 3, 2004).

[85] "About CCX®," Chicago Climate Exchange, http://www.chicagoclimatex.com/ (accessed December 18, 2004).

[86] "About *Native*Energy," NativeEnergy, www.nativeenergy.com (accessed December 18, 2004).

[87] "The Climate Cool Brand," Climate Neutral, http://www.climateneutral.com/pages/certifications.html (accessed March 20, 2005).

[88] Ibid

[89] "Backgrounder: Carbon Offsets," Climate Biz, http://www.climatebiz.com/sections/carbonoffsets.cfm. (accessed December 27, 2004).

[90] This is based on the average cost per ton of CO_2 times tons of CO_2 generated by Aveda's operations each year.

[91] Short haul flights are less than 281 land-miles. Medium haul flights are between 281 and 989 land-miles. Long-haul flights greater than 989 miles. Calculated using: "Mobile Combustion CO2 Emission Calculation Tool," GHG Protocol Initiative, http://www.ghgprotocol.org/standard/tools.htm (accessed November 18, 2004).

[92] Air Time Table, "airtimetable.com," www.airtimetable.com/Air_mile_calculator.htm (accessed February 16, 2005).

[93] "Smartway Transport Partnership," Smartway, U.S. Environmental Protection Agency, http://www.epa.gov/smartway/ (accessed November 5, 2004).

[94] "Views: Uncommon Solutions from QuadGraphics, Fall 2004," QuadGraphics, http://www.qg.com/whatsnew/views/articles/Views_Fall_2004_PUB.pdf (accessed October 23, 2004).

[95] "Shippers' Commitment," Smartway, U.S. Environmental Protection Agency, http://www.epa.gov/smartway/smartway_shippers_basics.htm (accessed November 5, 2004).

[96] "Freight Carrier Commitment," Smartway, U.S. Environmental Protection Agency, http://www.epa.gov/smartway/smartway_fleets_basics.htm (accessed November 5, 2004).

[97] "Freight Carrier Innovative Strategies," Smartway, U.S. Environmental Protection Agency, http://www.epa.gov/smartway/smartway_fleets_strategies.htm (accessed November 5, 2004).

[98] EPA SmartWay Partnership Program Manager, Buddy Polovick, can be reached at Polovick.Buddy@epa.gov or (734) 214-4928. See also www.epa.gov/smartway

[99] SmartWay Transport Partnership E-Update, Volume 1, Issue 3, October/November 2004.

[100] Ibid.

[101] SimaPro data libraries.

[102] "New FedEx Express Hybrid Electric Trucks Begin Service," Eaton, http://www1.eaton.com/hybrid_vehicle/ (accessed December 25, 2004).

[103] "Biodiesel Backgrounder," National Biodiesel Board, www.biodiesel.org (accessed December 13, 2004).

[104] "Biodiesel Performance, Cost and Use," Department of Energy, Energy Information Administration, http://www.eia.doe.gov/oiaf/analysispaper/biodiesel/ (accessed December 27, 2004).

[105] Graboski, M.S. and R.L. McCormick. "Combustion of Fat and Vegetable Oil Derived Fuels in Diesel Engines," *Progress in Energy and Combustion Science*, Vol. 24, No. 2 (1998):131-132.

[106] "Biodiesel—Clean, Green Diesel Fuel," National Renewable Energy Laboratory, Department of Energy, www.afdc.doe.gov/pdfs/Bio_CleanGreen.pdf (accessed January 5, 2004).

[107] "Biodiesel Usage Checklist," National Biodiesel Board, www.biodiesel.org/pdf_files/bdusage.PDF (accessed December 13, 2004).

[108] "Biodiesel—Clean, Green Diesel Fuel," National Renewable Energy Laboratory, Department of Energy, www.afdc.doe.gov/pdfs/Bio_CleanGreen.pdf (accessed January 5, 2004).

[109] "Biodiesel Performance, Cost and Use," Department of Energy, Energy Information Administration, http://www.eia.doe.gov/oiaf/analysispaper/biodiesel/ (accessed December 27, 2004).

[110] "Biodiesel – Guide to Buying Biodiesel," National Biodiesel Board, www.biodiesel.org (accessed December 27, 2004).

[111] Kavanagh, David. Correspondence with Heather Kirshman. Email. December 29, 2004. Organic Engines.

[112] Picture from Organic Engines website, http://www.organicengines.com/SUV/index.htm (accessed March 20, 2005).

[113] Eric Day. Correspondence with Heather Kirshman. Email. December 9th, 2004. Aveda.

[114] Office of Transport and Air Quality, U.S. Environmental Protection Agency. *A Glance at Clean Freight Strategies: Idle Reduction*. http://www.epa.gov/smartway/smartway_fleets_strategies.htm (accessed October 15, 2004).

[115] Department of Energy. *Technology Roadmap for the 21st Century Truck Program.* 2000. http://www.eere.energy.gov/vehiclesandfuels/pdfs/program/21ct_roadmap.pdf (accessed January 6, 2004).

[116] National Renewable Energy Laboratory. *Advanced Fuels Properties Database*. 2004, Advanced Vehicles and Fuels Research.

[117] Camobreco, V., J. Sheehan, J. Duffield, and M. Graboski. *Understanding the Life-Cycle Costs and Environmental Profile of Biodiesel and Petroleum Diesel*. in *Total Life Cycle Conference*. 2000. Detroit, Michigan: SAE International.

[118] "Biodiesel Commonly Asked Questions," National Biodiesel Board, www.biodiesel.org/pdf_files/bdusage.PDF (accessed December 13, 2004).

[119] "Safer, Cleaner Market for Government Fleets," National Biodiesel Board, www.Biodiesel.org. (accessed December 20, 2004).

[120] Ibid.

[121] Kupbens, Bob, Director. Interview by Tony Baptista. Phone. February 6, 2004. Target. Hassing, Ben. Interview by Tony Baptista. Phone. February 2, 2004. Wal-mart Inc.

[122] Department of Energy. *Technology Roadmap for the 21st Century Truck Program.* 2000. http://www.eere.energy.gov/vehiclesandfuels/pdfs/program/21ct_roadmap.pdf (accessed January 6, 2004).

[123] Nordine, Dave. Interview by Tony Baptista. Phone. October 18, 2004. Aveda.

[124] Energy Information Administration, Annual Energy Review 2003, DOE/EIA-0384, September 2004.

[125] US Department of Transportation, 2001 National Household Travel Survey. December 2004. Accessed via http://nhts.ornl.gov/2001/presentations/vehicleMiles/VehicleMiles.pdf

[126] EPA, Light-Duty Automotive Technology and Fuel Economy Trends 1975 Through 2004, EPA 420-R-04-001, April 2004.

[127] Department of Energy, Energy Information Agency. Greenhouse Gas Voluntary Reporting website, accessed March 15, 2005. http://www.eia.doe.gov/oiaf/1605/factors.html