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Developing a Sustainable Freight Transportation Framework with the Consideration of Improving Safety and Minimizing Carbon Emissions

Margaret "Rita" Neff
Research Assistant
Department of Civil, Environmental and Architectural Engineering

Yong Bai, Ph.D., P.E.
Steven D. Schrock, Ph.D., P.E.
Thomas E. Mulinazzi, Ph.D., P.E., L.S.

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Margaret "Rita" Neff
Research Assistant
Department of Civil, Environmental and Architectural Engineering
University of Kansas

Steven D. Schrock, Ph.D., P.E.
Assistant Professor
Department of Civil, Environmental and Architectural Engineering
University of Kansas

Yong Bai, Ph.D., P.E., F.ASCE
Associate Professor
Department of Civil, Environmental and Architectural Engineering
University of Kansas

Thomas E. Mulinazzi, Ph.D., P.E., L.S.
Professor
Department of Civil, Environmental and Architectural Engineering
University of Kansas

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16. Abstract

Despite the difficulties of the American economy in recent years the transportation sector continues to expand. Freight transportation alone has been projected to increase enormously even if the economy as a whole only manages a very moderate growth. Not only does freight transportation use a large percentage of resources but it contributes significantly to America's share of carbon emissions and affects the safety of the transportation system and all its users. These problems are only expected to increase as the volume of freight transportation is already reaching the limit of the American transportation infrastructure's capacity and demand continues to increase. The primary objective of this research was to compile a list of technologies and practices that should be included in the sustainable freight transportation frameworks of government agencies and commercial fleets to reduce their carbon footprint and increase their safety by providing recommendations on promising legislation, research, technologies, and practices. Data was gathered through a literature review of available materials and a survey of the state Departments of Transportation. The success of this research project provides the needed knowledge for the development of a sustainable freight transportation framework.

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Abstract

Despite the recent difficulties of the American economy, the transportation sector continues to expand. Freight transportation alone has been projected to increase enormously, even if the economy as a whole only manages a very moderate growth. Not only does freight transportation use a large percentage of resources, but it contributes significantly to America's share of carbon emissions and affects the safety of the transportation system and all of its users. These problems are only expected to increase as the volume of freight transportation is already approaching the limit of the American transportation infrastructure's capacity and demand continues to rise. The primary objective of this research was to compile a list of technologies and practices that should be implemented in the sustainable freight transportation frameworks of government agencies and commercial fleets to reduce their carbon footprint and increase their safety by providing recommendations on promising legislation, research, technology, and practices. Data was gathered through a literature review of available materials and a survey of all of the state Departments of Transportation. A successful outcome of this research project will provide vital knowledge necessary for the development of a sustainable freight transportation framework.

Chapter 1 Introduction

1.1 Background

Assuming an economic growth averaging 3% per year, domestic freight tonnage is expected to increase by 57% by 2020. This would add another 6,600 million tons of freight transported over highways, a 62% increase, and another 888 million tons of freight transported by rail, an increase of 44% (AASHTO 2011). However, America's transportation infrastructure is already close to capacity and it is not expected to be able to meet these increased demands. Table 1.1 presents a few basic statistics of freight shipped in the US, organized by shipment mode.

Table 1.1 US Freight in 2006 (BTS 2010)

Mode	Number of Carriers	Domestic Freight Tonnage (%)	Miles Traveled (%)	Domestic Freight Movement $ (%)	Miles of Infrastructure
Truck	679,744	78	60	88	4,048,523
Rail	559	16	28	6	94,313
Water	682	6	12	1	13,342
Air	98	<1	<1	5	1,686,333

1.2 Trucks

Trucks carry around 78% of domestic freight and account for 60% of ton-vehicle miles traveled (T-VMT) in the freight industry (AASHTO 2011). While they are not the most efficient mode of transportation, they are the preferred mode for many US goods because of their versatility and speed. When trucks are carrying freight over the US' extensive network of roadways, they can usually deliver freight from origin to destination without pausing to transfer goods. Approximately 29% (by volume) of the freight that is carried by trucks is moved by class 7 or 8 trucks. Long haul trucks make up 15% of US oil consumption and contribute 75% of our greenhouse gas emissions (Sahl et al 2009).

1.3 Rail

Rail carries 16% of the US' domestic freight by tonnage, which is approximately equivalent to 92 billion truck vehicle miles traveled (VMT) (AASHTO 2011). It is commonly recognized as the most efficient mode of transportation; however, its popularity is hindered by inflexibility. Whereas trucks can deliver almost anywhere in the United States by utilizing federally funded roadways, existing rail lines are much more limited in size and position. For this reason, trains are rarely the only method of transportation required to move goods from their point of origin to their final destination. The extra time required to move goods to and from train stations along with the associated loading and unloading times typically cause goods shipped by train to arrive later and with more hassle than those shipped by trucks. Beyond making rail a less attractive transportation method, it can also render it inappropriate for time-sensitive goods such as raw foods. Rail is also not always a cost effective shipment method for small quantities and light weight goods. Any shipment smaller than a standard cargo container increases the loading and unloading times of the trains involved and increase the risk of damage to the cargo (Lawyer 1986).

Rail’s main claim to fame is fuel efficiency. Today, one gallon of fuel can move one ton of freight by rail an average of 480 miles (AAR 2010), making rail a very attractive choice for non-perishable high density goods where savings per Ton-mile will be most obvious. Rail's high safety record also makes it the preferred carrier for hazardous materials (AASHTO 2011). In fact, unlike other modes of transportation, railroads are legally required to transport certain hazardous materials whether or not this is what the company prefers. Table 1.2 shows the approximate amounts of hazardous materials shipped by mode.

Table 1.2 Hazardous Materials: Percentages Shipped by Mode (BTS 2010)

Mode	Shipped by Dollar Value (%)	Shipped by Weight (%)	Shipped by Ton-miles (%)	Number of Transportation Incidents in 2008
Truck	66.0	57.0	34.0	14,752
Rail	7.0	6.0	34.0	745
Water	6.0	9.0	32.0	98
Air	2.0	negligible	negligible	2,174
Pipeline	19.0	28.0	negligible	unknown

With the development of the national highway system, railroads have had difficulties competing with the trucking industry and rail capacity has been substantially reduced. The number of rail carriers has been consolidated from the original twenty-two into only seven, of which four generate 95% of all the class I revenue. Rail track mileage has decreased from 380,000 miles in 1920 to 172,000 miles today, and the number of locomotives and freight cars has been reduced by 29.7% and 23%, respectively. Additionally, railroad employment has fallen by 55% (IFC et al, 2004). Since rail was deregulated by the Staggers Act in 1980, it has stabilized with returns on investments increasing 4.4% in the 1980s, 7.0% in the 1990s, and 8.0% from 2000 to 2009 (AAR 2011).

1.4 Air

Air is a fuel inefficient mode of transportation, with fuel costs constituting more than 30% of total airline operating expenses (BTS 2008). This, and other factors, contributes to air being the most expensive method of freight transportation; therefore, it is an unpopular choice for moving large quantities or heavy goods. However, air is seeing more and more demand from small, light, and expensive products that must be delivered within stringent time constraints. Air transports a negligible amount of freight by tonnage and ton-miles, but 5% of freight by value (AASHTO 2011). Due in part to its current small size, air is the second fastest growing mode of freight transportation after container rail. From 1990 to 2000, the annual growth rate of freight carried by air was 5.1% (IFC et al 2004).

1.5 Waterways

Air and water shipping are necessary for a lot of international trade; where air is faster and more expensive, and water is slower and cheaper. In 2000, boats transported 6% of freight by tonnage, 1% by value, and 15% of all freight ton-miles travelled in the US (AASHTO 2011). From 1970 to 1999, the international trade's share of the GDP increased from 10.7% to 26.9%, and the tonnage handled by US ports increased by 33%. Yet, port capacity has only expanded marginally during this time, and not nearly fast enough to keep up with demand. This slow expansion has caused many ports to suffer from congestion in both the land and water segments of these facilities. In 2000, 20 to 25% of the top US ports reported unacceptable flow conditions on the land side of their intermodal access. In many cases there is not sufficient land space to expand even for ports with sufficient funds (IFC et al 2004).

Due to a lack of appropriate updating, ports also suffer from aging. In 1997, the US Army Corps of Engineers reported that the median age of all lock chambers in US ports was 35 years

(BTS 2000). Lock specific delays have been increasing on US waterways and at that time caused an average delay of 6 hours, with some locks taking much longer. Nonetheless, many ports do not have the funds necessary to update their facilities.

1.6 Pipeline

Pipelines consist of a series of pipes, in which diameter varies by capacity required, that pump liquids, gasses, or capsules through the pipe with a vacuum or air pressure. Long distance pipelines require booster pumps to be spaced every few miles to ensure continued movement. Pipelines are typically made of plastic or steel. They can be built both below and above ground and fully automated such that only minimal oversight is required. They must be designed to withstand the expected pressures, internal and external, to prevent leakage. Petroleum is one of the most common goods transported by pipeline, and the detrimental effects caused by its release into the environment when leaks do occur are well known.

1.7 Intermodal

Intermodal transportation consists of freight shipped by two or more different modes. Goods are typically packed in large rectangular shipping containers with standard dimensions which can be easily transferred from one vehicle to another. For instance, a container can be loaded onto a truck at a manufacturing plant, which then drives to a railway loading station, next it is transferred to a train for the majority of its journey. It is unloaded at the train stop closest to its destination, and lastly it is placed on another truck for the final leg of its journey. Loading times for containers are more similar to loading times for trucks than transfer times for more loosely boxed goods to trains, and they reduce opportunities for goods to be damaged in transit. Domestic intermodal transportation is generally truck-rail, while international transportation is typically truck-rail-ocean, rail-ocean, or truck-ocean.

The increased efficiency of intermodal transportation has made it the fastest growing form of freight transportation. From 1990 to 1999, trailer and intermodal container loadings throughout the U.S. increased from 6.2 to 9.18 million (Berwick et al 2002). An analysis conducted by researchers in North Dakota to estimate the profitability of a possible intermodal facility projected that sugar and dry pasta could be transported to Kobe, Japan at an 18 to 25% savings with intermodal transportation. However, the associated shipping time would increase by approximately a third (Berwick et al 2002).

Similar to rail, as the distance between the product's origin and the nearest intermodal facility increases the costs associated with container shipping also increase. This increase in cost forms the largest barrier preventing more companies from using intermodal transportation. Increased distance also means increased travel times, which can be inconvenient and potentially unfeasible for perishable goods. Intermodal transportation can be especially unattractive in rural areas for all of these reasons. Intermodal service in rural areas decreased from approximately 1,500 operations in 1970 to less than 370 in 1998 (Berwick et al 2002).

1.8 Bottleneck Points

Bottleneck points are physical locations along the transportation route where congestion or other issues cause delays in the delivery of all or some of the freight passing through. Bottleneck points are not a mode of freight transportation, but are included here due to their ever increasing effect on, and therefore importance to, freight transportation. Bottlenecks are typically ports which have exceeded their capacity but are unable to expand or update their facilities to handle demand. Some major US bottlenecks are briefly described below.

Los Angeles and Long Beach processes almost 11 million ton-equivalent units, and then sends them to the east and Midwest through Chicago by intermodal rail. Congestion occurs at the docks and rail terminals, which slows down the processes at both places and the speed of freight transfer suffers as a result.

Chicago transfers incoming goods from the coasts and outgoing goods from the Midwest. The bulk of Chicago's container traffic, truck and rail, must move through congested urban roads (BTS 2009).

The Mississippi River, along with its principal tributaries, the Illinois and Chicago Rivers, is a major highway for water transported bulk freight, particularly coal and grain. Its lock system is aging, with some locks causing delays of more than 6 hours during peak periods.

The international borders, Mexico in particular and Canada to a lesser degree, can also be slowed by the necessary customs inspections and paperwork. The Bureau of Customs and Border Protection have improved efficiency at the Mexican border by requiring all inbound and outbound truck and rail transportation to file paperwork electronically before reaching the border.

1.9 Growth

As mentioned in the introduction, demand for freight services is projected to increase in coming years, such as imports and exports increasing by nearly 100 %. Much of the freight transportation network in America is either close to or already above operating capacity. Infrastructure can be expensive to expand and in some places there is no space available for expansion. Lack of infrastructure causes congestion, slowing down the transportation of goods and reducing the effectiveness of the freight system. As the number of vehicles used in transportation grows, America’s total greenhouse gas emissions escalate and there is an increase in the odds that accidents, injuries and fatalities will occur throughout the transportation system.

Chapter 2 Objectives, Scope, and Methodology

2.1 Objectives

The primary objective of this research was to compile a list of technologies and practices that should be implemented in the sustainable freight transportation frameworks used by government agencies and commercial fleets to reduce their carbon footprint and increase their safety by providing recommendations on promising legislation, research, technology, and practices. Data was gathered through a literature review of available materials and a survey of the state Departments of Transportation (DOTs).

2.2 Scope

The scope of this research project was limited to improving the safety and reducing the carbon emissions of freight transportation. The survey used in this research for data collection purposes was only sent to state DOTs.

2.3 Research Methodology

A comprehensive literature review was conducted to gain an understanding of technologies currently in use to improve safety and reduce carbon emissions in the freight transportation industry. It also includes information on laws and corporate practices related to these areas and investigated some technologies currently being developed. This review contains information from journals, periodicals, government documents, conference proceedings, and other sources.

To garner a better understanding of freight transportation’s current legal environment, and to gain a more accurate picture of how that environment may be expected to change in the near future, a survey was sent out to the state DOTs. The survey response was very limited, with only two surveys returned, so this information was supplemented with information found on publicly available state documents.

Chapter 3 Transportation Safety

3.1 Transportation Safety Overview

Although VMT in the US have continued to increase across all transportation modes, a large number of safety improvements have managed to keep the number of fatal crashes relatively consistent in recent years. Table 3.1 shows transportation fatalities and VMT in 2008 by transportation mode.

Table 3.1 Fatalities and VMT by Mode in 2008 (BTS 2010)

Mode	Fatalities in 2008	VMT in 2008 (millions)
Highway	37,261	2,973,509
Railroad	800	582
Water	109	Unknown
Pipeline	8	Unknown

3.2 Truck Safety

One of every eight people who die on US roadways are killed in a crash involving a heavy truck, a truck with a gross vehicle weight rating (GVWR) of more than 10,000 pounds. In fact, almost half of all trucks involved in fatal crashes weighed more than 60,000 pounds at the time of the crash (NCHRP 2004). Although heavy trucks are less likely to be involved in crashes than civilian vehicles, when they are involved in an accident then their increased weight, size, and stiffness make fatalities much more likely. In fact, a crash involving a heavy truck is 2.6 times more likely to result in a fatality than a crash between passenger vehicles. The composition of the truck also has an impact on its safety performance. Trucks with multiple trailers are subject to “rearward amplification” or the “crack the whip” phenomenon, where each point of articulation increases the vehicle’s side-to-side sway by approximately 70% in all truck combinations involving one or more trailers (NCHRP 2004).

3.3 Driver Fatigue

As fatigue impairs judgment, truck drivers who are ill rested are more likely to make mistakes, causing accidents, fatalities, and injuries. Yet, many truck drivers report difficulty finding places to stop and rest for the night or for short periods during the day. In 1996, the Trucking Research Institute estimated that more than 28,000 additional truck parking spaces were needed nationwide. Table 3.2 shows fatal truck involvements in 2007 as they correlate with the number of hours the driver had been on duty at the time of the crash. These statistics do not include approximations of the average length of driver shifts, so it can be assumed that the reduced number in fatalities for drivers who had been driving 10 or more hours is affected by the decreased number of drivers working such long shifts. Therefore, these statistics may not reflect what percent of drivers who had been driving over 10 hours were involved in a fatal crash versus what percent of drivers who had been driving for shorter periods.

Table 3.2 Fatal Truck Involvements by Hours Driven and Truck Configuration in 2007 (Jarossi et al 2010)

Hours Driven	Straight Truck	Straight Truck with 1 Trailer	Bobtail	Tractor with 1 Trailer	Tractor with 2 Trailers	Other Combi-nations	Unknown	Total
1 hour	379	64	26	420	19	10	0	918
2 hours	167	35	4	349	24	3	0	582
3 hours	105	14	2	216	15	0	0	352
4-5 hours	145	17	7	375	23	3	0	570
6-7 hours	80	7	7	234	22	4	0	354
8-9 hours	40	2	6	124	18	1	0	191
10-11 hours	6	1	4	36	2	0	0	49
12-18 hours	2	1	0	20	0	0	0	23
>18 hours	1	0	0	1	0	0	0	2
Unknown, legal	125	19	14	595	11	2	0	766
Unknown, not legal	2	2	0	20	0	0	0	24
Unknown/ Not applicable	494	85	34	563	28	3	11	1,218
Total	1,546	247	104	2,953	162	26	11	5,049

Researchers in Tennessee analyzed crashes among trucks parked adjacent to the Interstate highway while the truck was either parked or moving from a parked location along the Interstate, an Interstate ramp, or a rest area ramp (AASHTO 2004). Researchers found that this type of crash was relatively rare, but when they did occur they were 5.3 times more likely to result in a fatality than average. These crashes were also found to have a slightly higher probability of injury, 1.27 times.

Truck drivers may also simply not know the locations of stops on their routes or waste time and fuel searching for a space in a full parking lot. The North Carolina Welcome Center installed a solar-assisted changeable message sign (CMS) about a quarter of a mile before the center itself, near the Virginia border (AASHTO 2004). The CMS turns on when the truck lot is full, showing that there are no more available spaces. The pilot study showed a substantial decrease in overcrowding and parking on ramps. In the two week period before the sign was installed, the center averaged 34 trucks parked at or around the welcome station, which had 19 spaces available. The following year after the sign was added, the number of trucks decreased to the lower twenties.

3.4 Other Truck Driver Factors

In 1986, Congress established the commercial driver's license (CDL) for drivers operating large vehicles, transporting hazardous materials, or carrying more than 15 passengers. The legislation set mandatory minimum federal standards for state licensing programs, which were strengthened in 1999. However, not all states comply with all of the standards. Surveys conducted in 2000 by the American Association of Motor Vehicle Administrators (AAMVA) found that five of the ten states visited reported instances of not disqualifying commercial drivers due to convictions through the Commercial Driver License Information System (CDLIS).

Even states following all of the regulations can fall prey to licensing fraud. The CDL is a license necessary to hold a job, which provides more than enough incentive for security breaches to occur. To reduce possibilities for fraudulent testing, a computerized testing system is being developed. The program will maintain a vast test bank of problems and provide a different set of questions for each driver taking the test. This should reduce not only opportunities for a hard copy of the test answers being taken from the testing facility, but also the value of such a cheat sheet. Fraud detection training and test auditing standards are also being tried as ways to decrease fraudulent licensure.

Alcohol use, whether by truck drivers or civilian drivers, is known to be a significant factor in vehicle safety. Research has shown that states with higher levels of alcohol consumption experience higher truck-crash fatality rates and that 0.08 BAC laws reduce such fatalities (Neeley and Richardson 2009).

3.5 Vehicle Factors

The make and model of the vehicle itself can also have a profound influence on its safety. Different vehicles may have differences in stiffness, side-to-side sway, and other factors, causing them to behave differently on the road. Single-unit large (straight) trucks, for instance, have relatively low crash involvement rates, when compared to those of tractor-trailers. The lower crash rate is most likely due to the fact that they are typically used for local trips rather than long-haul the way that tractor-trailer combinations are. Single-unit truck crashes tend to be more severe than those of light vehicles but less severe than those involving tractor-trailer combinations (NCHRP 2004). Overall, the number of crashes involving straight trucks is more similar to light vehicles than to combination-unit trucks. Table 3.3 shows fatalities from 2003 to 2007 by the type of truck involved.

Table 3.3 Fatalities by Year and Truck Configuration (Jarossi et al 2010)

Year	Straight Truck	Straight Truck with 1 Trailer	Bobtail	Tractor with 1 Trailer	Tractor with 2 Trailers	Other Combinations	Unknown
2003	1,499	218	87	3,005	157	38	100
2004	1,622	221	111	3,160	156	33	10
2005	1,647	215	93	3,159	185	32	12
2006	1,600	252	102	3,054	158	36	50
2007	1,546	247	104	2,953	162	26	11
Total	7,914	1,153	497	15,331	818	165	183

3.6 Infrastructure

Roadway design guidelines governing speed limits, as well as physical features such as upgrades, downgrades, and interchange ramps, have a great impact on trucks. Lane width and horizontal curve lengths may hamper and slow large vehicles; their lack of maneuverability greatly reduces margins for driver error compared to that of smaller vehicles. Some roadway segments contain a higher concentration of heavy truck crashes, due in varying degrees to the volume of heavy truck traffic on these roadways and relative truck safety factors. When improvements are made to road safety conditions, these high crash zones should be the first to be considered for possible improvements. In circumstances where improvements at high-crash locations are not feasible, for economic or other reasons, it may be possible to provide truck drivers with in-cab warning systems. These systems could alert the drivers when they are nearing these roadway segments and then they would know to drive with more caution.

3.6.1 Lane Restriction

Lane restriction, designating certain highway lanes for use by one type or a limited number of types of vehicle, is also a possible infrastructure decision. Lane restriction requires a large capital investment and extended periods for design, construction, and installation. It is typically only possible in roadway sections of three lanes or greater in each direction, allowing trucks to be restricted to the right-most two lanes and leaving the left-most lane truck free. Contrary to expectations, a number of studies on lane restrictions show an increase in overall accidents after the restrictions have been introduced. On the other hand, studies have also shown a decrease in the number of truck accidents and fatalities. Some of the findings are listed below; however, it is clear that more research is needed before any definite conclusions can be drawn.

The South Carolina DOT conducted a pilot study on the combined effect of lane restriction, along with its associated enforcement, while it was considering introducing lane restrictions to a major north-south route with a high concentration of heavy trucks (AASHTO 2004). The study demonstrated a 78% reduction in truck related crashes. Since SCDOT's actual implementation of lane restriction in 2001, however, truck crash frequency on interstates has increased slightly but fatalities involving heavy trucks have decreased.

The Texas Transportation Institute (TTI) conducted traffic studies both before and after lane restrictions were implemented on the I-10E in Houston, for a total of 36 weeks of observation (AASHTO 2004). The TTI study estimated that of the factors affecting crash rates, lane restrictions had likely helped to reduce vehicle crashes by 68%.

The North Carolina DOT has implemented lane restrictions along 123 miles of a three-lane interstate highway and has identified the following safety benefits: prevents trailers on two sides of a passenger vehicle, moves largest vehicles out of the highest speed zones, reduces evasive truck maneuvers to the truck's right or into the truck's blind side, provides additional spacing from median barriers, provides additional truck clearance from opposing direction traffic, improves visibility and clearance for disabled vehicles in or along median shoulders (AASHTO 2004). NCDOT excluded lane restrictions from highway sections with left-side exits and merging areas, and between closely spaced interchanges for safety concerns.

3.6.2 Speed Limits

Excessive speeds are another safety threat. Because large trucks require greater distances for stopping and turning than smaller vehicles, some attention has been given to separate speed limits for highways, with lower speeds allowed for trucks than for lighter vehicles. This raises the concern, however, that the speed-variance would result in more car-truck crashes. So far, studies have not shown a reduction in crashes on highway segments employing different speed limits for trucks. One analysis of state crash data from 1991 through 2005 indicated higher speed limits for both cars and trucks increased fatalities, but separate speed limits by vehicle type did not have a significant impact. One significant exception occurred: in cases of large speed differences there was a substantial increase in fatalities (Neeley and Richardson 2009).

Large trucks have high centers of gravity, making them more vulnerable to rollover on curves than smaller vehicles. Vehicle height and the effects of articulation between the tractor and trailer can make it easy for a driver to underestimate their speed. Interactive highway signs have been used to warn drivers approaching high risk ramps and curves. The simplest signs measure the vehicle's speed with attached radar and signal the driver if they are going too fast. More sophisticated systems can also measure vehicle dimensions and weight for a more accurate calculation of rollover risk. Signs can be programmed with one warning or a variety of messages to provide more specific warnings for varying situations. When properly installed, these can significantly decrease the number of crashes. Furthermore, truck drivers may overestimate safe speeds on downhill slopes under some conditions and could benefit from interactive signs on steep slopes. Vehicle-based warning systems also exist, but their cost per vehicle is prohibitive.

3.7 Civilian Vehicles

Trucks are designed for the amount of weight they will eventually carry, with the result that drivers may be protected with a reinforced frame. Smaller vehicles constructed for other purposes do not offer the same protection. This means that occupants of other vehicles account for the majority of fatalities in crashes involving heavy trucks, as shown in table 3.4.

Table 3.4 Fatalities in Crashes Involving Large Trucks in 2001 (NHTSA 2011)

Victim Type	Number	Total (%)
Occupants of Large Trucks - Single Vehicle	471	9
Occupants of Large Trucks - Multiple Vehicle	233	4.5
Occupants of Other Vehicles (non-trucks)	3,940	77.5
Non-occupants（pedestrians, cyclists, etc）	438	9
Total	5,082	100

Civilian vehicles are one of the greatest challenges to truck safety as civilian drivers are statistically no more careful driving around trucks than they are around smaller vehicles. One analysis of crashes involving a heavy truck and a passenger vehicle found that 35% of crashes involved the passenger vehicle moving into the truck's No-Zone area, or blind spot (NCHRP 2004). Another analysis of factors involved in fatal truck crashes found that approximately two-third of fatal crashes were caused by an action on the part of the driver of another vehicle (Jarossi et al 2010). A study of light-vehicle-heavy-vehicle interaction, analyzing 142 driver errors (some of which resulted in near crashes), observed that 117 (82%) of these errors were initiated by the surrounding light-vehicle drivers, while only 25 (18%) were initiated by the heavy vehicle. A little over 20% of these errors involved encroachment into the truck's lane by another vehicle while a little less than 15% involved encroachment by the truck into the light vehicle's lane (NCHRP 2004). Tables 3.5 and 3.6 show some factors leading to truck crashes resulting in fatalities.

Table 3.5 Analysis of Two-Vehicle Crashes Involving a Large Truck and a Passenger Vehicle in 1996 (AASHTO 2004)

Type of Crash	Estimated Total of No-Zone Related Crashes	All Crashes (%)
Truck Encroaching - Non-Intersection (right and left No-Zones)	21,500	8
Truck Encroaching - Intersection	10,500	4
Front No-Zone	32,500	13
Rear No-Zone	25,000	10
Total Potential No-Zone	89,500	35
Total of All Types of Two-Vehicle, Large Truck/Passenger Vehicle Crashes	258,000	100

Table 3.6 Driver Characteristics in Two-Vehicle Crashes Involving a Heavy Truck and a Passenger Vehicle in 1998 (AASHTO 2004)

Driver Characteristic	Heavy Truck Driver (%)	Passenger Vehicle Driver (%)
Driver < 26 Years Old	7.2	24.4
Driver >65 Years Old	2.4	20.1
Invalid or No License	1.9	10.2
Driver Restraint Use (any)	76.4	48.8
Driver Alcohol Use (any)	1.7	18.8
Driver Alcohol > 0.10%	0.6	13.5
Failure to Yield	5.3	20.3
Ran Off Road/ Out of Lane	4.8	27.8
Driving too Fast	3.8	14.9
Failure to Obey Traffic Devices	3.0	12.1
Inattentive	2.7	9.8
Driver factor recorded	26.4	81.5

3.7.1 Public Outreach

Increasing public understanding and knowledge of safe driving practices in the vicinity of large trucks may decrease overall fatalities, as public awareness programs for seat belt effectiveness and the hazards of drinking and driving have done. The public must be aware of “No Zone” blind spots, reduced maneuverability, and the hazards of a truck’s increased weight.

Public outreach programs are unfortunately difficult to implement. It is generally unfeasible to require testing over truck-specific safety information for licensure and drivers must be reached through other channels. Information is typically distributed through pamphlets and mailings, which may be ignored, and at car rental facilities. It is sometimes, though not required to be, included in driver safety schools that are operated in conjunction with courts for offenders required to attend courses on driver improvement. While these specific courses can be more effective than other outreach methods, they can only reach a certain percentage of the populace. Effective public outreach programs typically utilize the media to make service announcements. Driving safety information can be printed in newspaper columns and displayed as public service announcements on television, billboards, and other advertising mediums.

It is difficult to find studies which can demonstrate the relative benefits of any of these outreach programs because of the incremental rate of change and a wide variety of other factors. Furthermore, public awareness programs must be composed of short sound bites or they risk losing the attention of their audience. One such program in Weld County, northeastern Colorado, used the slogan "Size Matters for Safe Driving in Weld County." The slogan was backed by a detailed crash analysis of the county, which had been chosen for its high crash rate, and disseminated with brochures, information sheets, wallet-sized plastic cards, and posters in both English and Spanish. The program also enlisted the help of press and media to spread information (AASHTO 2004). The Weld County program was a template for a larger program planned for the state.

Chapter 4 Carbon Emissions

4.1 Carbon Emissions Overview

Global warming is caused by large amounts of carbon dioxide buildup in the atmosphere. These gasses increase our atmosphere's natural greenhouse effect, trapping the sun's heat and causing a permanent worldwide temperature change. This causes changes in global weather patterns, increasing the frequency and magnitude of tornadoes and other extreme weather. Many efforts have been made to reduce the amount of greenhouse gasses released into the environment, thereby limiting their final effects on the earth's environment.

In 2008, approximately 26.8% of the U.S's greenhouse gas emissions were produced by the transportation industry (AAR, 2010). A general comparison of greenhouse gas emissions by freight transportation modes follows in table 4.1. These percentages are not weighted by VMT they are just the overall amounts.

Table 4.1 Greenhouse Gas Emissions Produced from Transportation in 2005 (EPA 2007)

Mode	Terragrams CO2 Equivalents	% of All Transportation Emissions
Trucking	385.8	19.4
Freight Railroads	44.1	2.2
Waterborne Freight	49.9	2.5
Pipelines	31.1	1.6
Aircraft (freight and passenger)	170.3	8.6

Around 93% of all emissions are carbon emissions. Other emissions produced by the combustion of petroleum include Nitrogen oxides (NO, NO_2), Sulfur dioxide (SO_2), particulate matter (PM), and air toxics.

4.2 Emissions Regulations

At least as far as freight transportation is concerned, the majority of US environmental policy stems from the Environmental Protection Agency (EPA). Most states implement the federal EPA regulations and do not add any new policies of their own. The few states which do put their own policies in place have anti-idling laws and not much, if anything, else. The notable exception to this is California, which prides itself on being the US's testing ground for environmental policy. The idea seems to be that California will try a policy and if it proves effective the EPA will attempt to pass it into federal regulations. The Clean Air Act of 1970, and its subsequent amendments, has promoted cleaner fuels, cleaner vehicles, inspection and maintenance programs, and policies favoring carpooling and alternative transit.

In 2003, the EPA implemented an emissions improvement plan in stages, called tiers. The idea of the tiered system was to allow companies some time to upgrade their fleets to comply with the changes, as opposed to expecting them to alter their fleets overnight. Emissions limits are set years in advance of the date they will be effective, giving companies time to upgrade their fleets to the required levels on their own schedules. The EPA standards for Line-Haul Locomotives appear below in table 4.2.

Table 4.2 EPA: Line-Haul Locomotive Emission Standards (g/bhp – hr)

Tier	Year of Original Manufacture	PM	NOx	HC	CO
0	1973-1992	0.22	9.5	1.00	5.0
1	1993-2004	0.22	7.4	0.55	2.2
2	2005-2011	0.10	5.5	0.30	1.5
3	2012-2014	0.10	5.5	0.30	1.5
4	2015 and later	0.03	1.3	0.14	1.5

(Note: PM – Particulate Matter, NOx – Nitrogen Oxides, HC – Hydrocarbons, CO – Carbon Oxides)

The tiered standards set emissions restrictions based on the model year of the vehicle and those restrictions increase at regular intervals over a period of years. The EPA estimates the changes across all transportation modes will reduce PM by 90%, NOx by 80%, and greatly reduce CO, CH, and other air toxics (EPA 2008).

The International Civil Aviation Organization (ICAO) sets emission standards for jet engines. These have been based on the EPA regulations and follow the same process of setting restrictions which increase in stringency every few years.

4.2.1 Speed Limits

Engine efficiency goes rapidly downhill after passing 60 mph so reduction of speed limits has been promoted as a means to reduce fuel use. A truck traveling at 75 mph for instance, consumes 27% more fuel than one traveling at 65 mph (ATA 2011), and the resulting fuel conservation reduces both emissions and expense. One study predicted that limiting trucks to 68 mph in Canada would result in fuel savings of $8,000 per year for the typical tractor trailer. On the other side of this issue, fleets argue that reduced speeds would make trucking slower, not only delaying delivery, but also potentially inflating the driver shortage as many drivers are paid by miles logged. Proponents of reduced speed argue that the lower speed limits would not make a large difference (Carey 2006). The ATA has predicted that reducing speed limits for trucks to 65 mph would save 2.8 billion gallons of diesel fuel in 10 years and reduce CO_2 emissions by 31.5 million tons.

4.3 Alternative Fuels

Over the years a number of alternative fuels, alternative to petroleum, have been developed to limit the environmental impact of the vehicles using them. They have varying benefits at reducing emissions and effectiveness as fuel sources, with some providing far less power than diesel. Table 4.3 provides a brief comparison of the more prominent alternative fuels. Even the less efficient fuels see some use for the political advantages of reducing the United States' dependence on foreign oil.

Table 4.3 Alternate Fuels in Brief

Fuel Type	Description	Application	Emissions Reductions	Downsides
Emulsified Diesel	A mixture of petroleum diesel, water, and additives.	Any diesel engine without modification	NOx	Does not reduce CO_2 emissions Reduces engine power and fuel efficiency
Biodiesel	A blend of petroleum diesel and biodiesel manufactured from new and used fats and oils. The most common variety is BD20 consisting of 80% petroleum and 20% biodiesel. The biodiesel component is renewable, biodegradable, and can be produced in the U.S.	Some concentrations can be used in any diesel engine, others require modification	CO_2, PM, OH , and air toxics	
Natural Gas	Natural gas is used in a compressed or liquefied form. It reduces foreign oil consumption, but does not have an environmental benefit.	Modified diesel engines	None	Does not reduce CO_2 emissions Reduces fuel efficiency of the engine
Propane	Used in a liquefied form.	Modified diesel engines	NOx and PM	Does not reduce CO_2
Ethanol	Ethanol is typically a 90% petroleum diesel, 10% ethanol blend. Most famous for its ability to be produced from local crops, ethanol can be made in the U.S.	Modified diesel engines	None	Does not reduce CO_2 Only produces approximately 1.3 units of energy for every unit consumed in production (as opposed to nearly 5 units produced by petroleum)

4.4 Hydrogen Power

Recently, there has been a lot of interest in the possible use of hydrogen fuel cells. These fuel cells capture the electricity created by the chemical reaction of gaseous hydrogen and water. The primary exhaust of the fuel cell is water, resulting in greatly reduced carbon, and other emissions. The necessary use of other fuels to produce and transport gaseous hydrogen prevents fuel cells from being a completely emission-free technology. However, fuel processing facilities can be expected to maintain stricter control of emissions than fleets of vehicles, so hydrogen fuel cells could greatly reduce the amounts of emissions of all kinds where they are used.

Introduction of hydrogen fuel into the market faces several difficulties. For a start, hydrogen fuel cells require engines built specifically for them so any vehicle running on hydrogen power would have to be either new or retrofitted with a new engine. As with other engine retrofits, this substantially increases both initial cost and overall risk to the fleet.

Furthermore, although gas stations are readily available throughout the US, hydrogen stations are not. A hydrogen engine would not be able to simply switch over and run on diesel if no hydrogen stations were available. A vast reworking of the infrastructure would be required before hydrogen could be widely available, which would be necessary to make it a viable option for long-haul trucking. Trains, water, and rail, on the other hand, already have centralized fueling stations which would limit the number of adaptations necessary. Therefore, these modes may be better positioned for an introduction of hydrogen fuel cells. Hydrogen trains are already being built and tested for viability.

Another problem is that to travel the same distance, a hydrogen engine needs to burn more fuel than a petroleum engine. Some companies are researching ultra-light materials for use in commuter vehicles with the hope that by reducing the weight of the vehicle itself, less fuel will be necessary to propel it.

<u>4.5 Electric Vehicles</u>

Emissions benefits from electric vehicles stem from the fact that electricity is produced in centralized facilities, which makes emissions produced easier to control than those from a large number of the wide variety of engines types used throughout America's fleets. It is expected to create fewer emissions than using traditional fuels for these vehicles.

There are a number of problems, however, with its widespread use. Electric vehicles require electric engines. These cannot run on petroleum when electric fuel stations are not available, making them unattractive for long-haul trucking. They also have all of the associated costs of new vehicles or retrofitting. Electric vehicles can be more expensive to purchase and maintain and refueling them can take much longer than a traditional diesel engine.

Although these flaws make electric vehicles unsuitable for long-haul and some short-haul uses, electric vehicles should be examined for their possible benefits as support vehicles at ports. In Europe, electric vehicles have mostly been used for similar short-range services such as milk and post office delivery (De Neufville et al. 1996).

There is also some possibility for hybrid technology. This would enable trucks to maintain the versatility that petroleum engines allow them, but still grant energy savings. So far, hybrid trucks are uncommon and prohibitively expensive. Washington based Paccar Inc., for instance, has been manufacturing and selling hybrid trucks since at least 2008. These vehicles can be expected to cost approximately $40,000 more than traditional diesel trucks (Katz 2008). Paccar custom makes these hybrids to customer specification so it is unknown what the cost difference would be for one model of hybrid trucks produced on a simple assembly line. It can at least be assumed to be somewhere between the cost of a traditional diesel truck and that of a hybrid truck made to custom specifications. However, as it would not require any reworking of the current infrastructure, hybrid vehicles are worth considering.

4.6 Logistics and Congestion

Logistics, the efficiency of the route and transportation mode chosen to ship goods also has a direct impact on fuel used per trip and carbon emissions released. The fewer miles a vehicle has to cover, the less fuel it requires. Freight is not always shipped by the most efficient mode and this should be investigated to see where switching modes might be beneficial, usually transporting freight by rail as opposed to truck. A study by the Federal Railroad Administration found that railroads average four times the efficiency of trucks, reducing greenhouse gas emissions by 75% (ARR 2010). One of the greatest concerns for logistics into the future is the growing congestion throughout America's transportation infrastructure. Once a road surpasses its optimum traffic capacity all additional vehicles slow down the overall speed creating stop-and-go traffic. Waiting for lights or traffic jams to clear extends the time required to cover the same amount of distance; it keeps the engines on longer and burns more fuel. Stop-and-go traffic also increases idling, which leaves the engine is running, even though the vehicle is not moving. Currently, some fleets use anti-idling upgrades in their engines, switching engines off automatically after some predetermined amount of time. The ATA estimates that if congestion were completely eliminated in all 437 main urban congestion areas it would reduce truck CO_2 emissions by 45.2 million tons over 10 years.

Moving freight using modes other than trucks would also reduce highway congestion. Since trucks take up more space and require larger separation distances between vehicles than cars, a reduction in the number of trucks on the roads could have a greater percentage impact than changes to the numbers of cars (Bryan et al 2006). On the other hand, not all goods currently shipped by trucks would create a net emissions or cost benefit by the switch whether due to extended distances from the point of origin to the closest rail hub, inappropriateness of the cargo, or other factors.

4.7 Vehicle Weight Limits

Another way to reduce carbon emissions is to increase the efficiency of the vehicle itself. Improvements can include those made to the vehicle body, such as the reduction of aerodynamic drag or by increasing the efficiency of auxiliary loads such as air conditioning.

The trucking industry typically makes profit margins of 1 – 2%, which makes companies weary of infrastructure investments with even a minimal risk of not proving beneficial (Sahl et al, 2009). In addition to the initial investments required, upgrades can cause increased difficulties in locating qualified mechanics to perform repair and upkeep, longer wait for replacement parts, higher upkeep costs, and uncertainties in the regulatory climate. Businesses do not want to place a large investment on something that will be overruled by new policies in a few years, and this makes the transportation sector cautious. Despite all of these issues, regulations and hopes for decreased expenditures are encouraging many businesses to adopt policies which decrease their carbon footprint.

One idea pushed by trucking advocacy groups is to increase the overall vehicle weight limits above the current limits (see table 4.4). This would allow larger loads; therefore requiring fewer trucks to carry the same amount of freight. This would decrease the number of vehicles on the roads, reducing congestion on the highway system as a whole, and allowing more freight to be transported as demands increase. As mentioned in section 3.2, fatalities increase when there is a truck involved, and so there is also the possibility that fewer trucks would mean fewer fatal accidents.

Table 4.4 Current Vehicle Maximum Weight Limits (USDOT 2011)

Limit	**Weight (lbs)**
Per. Single Axle	20,000
Per. Tandem Axle	34,000
Gross Weight of Vehicle	80,000

Safety concerns are the main opposition to increased weight limits. As discussed in Chapter 3, although trucks are not known to get into more accidents than non-commercial vehicles, their increased weight makes fatalities far more likely to occur. Whether or not this would lead to an increased number of fatalities if those limits were raised is unknown. Another concern is the expected increased costs of road repair. Because roads would carry more weight over time they would wear out faster and need to be replaced and repaired more frequently. This has been partially addressed by increasing the number of axles required in trucks so that the pound per axle limit would remain the same. This would keep the weight distributed and limit costs, but there would still be an increase in wear.

The effect that this would have on bridges is another concern. Bridges have been designed to withstand the current weight limits and some would not be able to support heavier loads. In order to support the new loads, many bridges could require upgrades. However, state DOTs may not have the available funding to make the necessary improvements. This would force carriers to either use trucks subscribing to the older weight limits or plot alternate routes to avoid certain bridges. On the other hand, many of the bridges which would need improvement are older and already in need of updates.

In 2009, Wisconsin published a comparative cost-benefit study of six types of heavy trucks: the six-axle 90,000 lb tractor-semitrailer, seven-axle 97,000 lb tractor-semitrailer, seven-axle 80,000 lb single unit truck, eight-axle 108,000 lb double, six-axle 98,000 lb tractor-semitrailer, and the six-axle 98,000 lb straight truck trailer.

Researchers found that five of these six configurations generated net benefits to the state when bridge costs were not included in the calculations. However, when bridge costs were included in the calculations then only three of these configurations resulted in net benefits. With all costs included, the most beneficial configuration was the six-axle 98,000 lb semitrailer, which does not meet the current Federal Bridge Formula. The second most beneficial truck was the seven-axle 97,000 lb semitrailer, and this was followed by the marginally successful six-axle 90,000 lb semitrailer (Cambridge Systematics et al. 2009).

A before and after study of the effects of increased weight limits was conducted in Britain when maximum truck weight was raised from 41 metric tons to 44, approximately 90,400 lbs to 97,000 lbs (McKinnon 2005). It should be noted that neither analysis, before nor after, considered costs or emissions associated with strengthening bridges to support the increased weight. The European Union had increased limits some years earlier and Britain had already updated its bridges. Nor did either study consider the safety impacts of the change, these were assumed to remain constant. The before study predicted, as its mid-range estimate, a yearly reduction of truck traffic of 100 million vehicle kilometers (more than 62 million miles), which is an annual cost savings of about £60–80 million (in 2000 prices), and an annual reduction in CO_2 emissions of 80–100 thousand metric tons (88-110 thousand short tons). It was also predicted that the change might divert some shipments from rail to trucks. The actual savings measured by the after study appear below in table 4.5.

Table 4.5 Estimated Actual Savings from Britain's Maximum Truck Weight Increase (McKinnon 2005)

Analysis Items	**Year**		
	2001	2002	2003
Reduction in Annual Truck km (approximate miles)	53 km (32 miles)	104 km (64 miles)	134 km (83 miles)
Saving in vehicle operating costs in £million, 2004 prices	44	85	110
Fuel Savings in million L (in gal) (average 0.377 L/km or 7.5 mpg)	20.1 L (5.3 gal)	39.1 L (10.3 gal)	50.6 L (13.3 gal)
Carbon Dioxide	53,800 (59304)	104,800 (115522)	135,700 (149583)
Nitrogen Oxide	351 (386.9)	684 (753.9)	884 (974)
Particulates (PM10)	12.5 (13.7)	24.4 (26.9)	31.5 (34.7)

The ATA believes that easing restrictions to truck size limits could cause a reduction of 294.7 million tons of CO_2. Horvath and Facanha's life-cycle emissions study (2007) estimated that both increasing truck capacity and requiring an additional axle or more could cut pollutants of all kinds by 4 to 16%. This decrease includes emissions generated from the increased maintenance, assuming that wear and tear on the road was proportional to weight per axle.

4.7.1 Lightweight Materials

Lightweight materials research attempts to replace mild steel with lightweight, high-strength materials: aluminum, magnesium, titanium, advanced high-strength steels, fiber reinforced composites, and metal matrix composites. Composites reduce the overall weight of the vehicle, which improves fuel economy and reduces emissions. So far, the greatest barrier has been the increased cost of many lightweight materials, and the research focuses not only on the materials themselves but on processes for producing them more efficiently (USDoE 2010).As was previously mentioned in Chapter 3, there are concerns that lightweight materials may not be strong enough to provide the same amount of safety to the driver in the event of a crash. So far these concerns have not been addressed by research.

4.8 Popular Practices

4.8.1 Trucks

In 1999, a study of forty-two fleets in the Canadian trucking industry found that all of the companies studied used some form of engine improvement technology, such as switching from mechanical engines to first-generation electric engines, and had regular vehicle maintenance. Forty percent of these fleets reported making year to year improvements in fuel efficiency between 1997 and 1999. Their overall average fuel efficiency was 7.15 miles per gallon, excluding fleets which operated B-trains. Fleets operating B-trains averaged an efficiency of 4.9 miles per gallon (NRC 2009).

While approximately 70% of the fleets studied maintained a driver education program on fuel efficiency, only four of these had full incentive programs with rewards. The other six fleets only posted the best results for fuel economy over a period of time. Fifty percent had installed fuel performance displays for the drivers. Their results were mixed, however, and it was difficult to tell which, if any, drivers had been making use of the displays.

Fifty percent of fleets had programmed their engines to shut off after 2 – 15 minutes of idling and a few had even programmed engines not to exceed a certain speed. Many reported using advanced aerodynamics and some fleets had maximum speed policies. The ATA believes that with the anti-idling technologies currently available, CO_2 emissions can be reduced an estimated 61.6 million tons over the next 10 years.

Ensuring that a vehicle reacts as its driver expects does a lot to reduce the number of accidents that it is involved in. A study of 42 Canadian fleets found that all 42 fleets had regular vehicle maintenance and nearly 95 % checked tire pressure regularly, although the definitions of "regular" varied widely (Sahl et al 2009). Over 75% regularly downloaded information from vehicle engines, usually at the same time the vehicle was being checked for preventive maintenance.

4.8.2 Rail

Railroads have been working to increase their fuel efficiency, with an overall fuel efficiency improvement of approximately 104%, 235 ton-miles per gallon in 1980 to 480 ton-miles per gallon today (AAR 2010). Trains can make use of "stop-start" idling-reduction technology to allow main engineers to shut the engines off when appropriate. Genset engines, which consist of two or three independent engines, monitor how much power is needed for the task at hand and then switch engines on or off to meet these requirements. The genset engines' smaller size and the use of anti-freeze allows them to shut down even in cold weather. Some railroads use auxiliary power units to warm engines that do not use antifreeze (AAR 2010). Another effective tactic for increased fuel efficiency is to lubricate the railway tracks to reduce friction and wear (AAR 2010). Finally, hybrid and hydrogen powered locomotives are also receiving a lot of attention, particularly since rail's limited fueling locations make hydrogen simpler to introduce than to the widespread trucking industry.

4.9 Infrastructure

Some arguments are made against rail based on the theory that rail infrastructure demands a higher initial investment than road, although it needs less maintenance. While this may be true financially, an analysis of life-cycle emissions by Horvath and Facanha (2007) concluded that emissions, on a ton-mile basis, associated with the construction of rail infrastructure are lower than those associated with road construction. However, rail infrastructure maintenance was not found to have a lower emissions count than other modes. In fact, rail maintenance was found to have higher NO_x, PM_{10}, and SO2 emissions than road maintenance.

One of the greatest challenges in comparing emissions across different modes is accounting for all of the emissions created throughout the entire lifecycle process of the transportation. This includes the emissions from the transportation of the goods themselves, any associated vehicles loading and unloading at port locations, maintenance of infrastructure, and even emissions created by the refining process for the fuel used at these stages. Construction and maintenance of infrastructure also produces emissions and must therefore be considered to get a good picture of life-cycle emissions for transportation modes. Fuel refilling has been shown to be similar between modes (Hovarth and Facanha 2007).

Chapter 5 Survey

5.1 Design of Survey

The research team believed that the state DOTs would have both a better understanding of policies and provide valuable insights into emerging trends in the freight transportation sector. These insights might not be specific to any particular documents; therefore, they would not appear in the literature. A twelve question survey was sent to the fifty state DOTs in hopes of collecting some of this information. The survey included questions on both safety and carbon emissions policies. Particular emphasis was given to the effectiveness and difficulties of implementing policies, as it was expected that the state DOTs would have ample experience in these areas. The survey was initially sent out February 7th, 2011, and sent again with a reminder a few months later. Only two states, Florida and Iowa, responded to the survey so the information gathered cannot be considered complete. However, it does grant some insight into how freight transportation is viewed by the state DOTs.

5.2 Survey Responses

Although Florida and Iowa were the only states to respond to the survey, the information they provided is still useful in gaining a better understanding of the regulatory environment of freight transportation. Their responses have been included below, question by question.

1. Do you have policies, programs, or procedures in freight transportation? If yes, could you mail us a copy of these documents?

    Florida

    > The Department establishes safety goals and objectives in its transportation plans which integrate safety concerns for both passenger and freight movement:

- The 2060 Florida Transportation Plan, which serves as the state's long range transportation plan (pages 16-17):

  http://2060ftp.org/

- The Florida Strategic Intermodal System Strategic Plan (page 9):

  http://www.dot.state.fl.us/planning/sis/strategicplan/2010sisplan.pdf

- The Florida Seaport Systems Plan (pages ES-13, 2-3, 2-7):

  http://www.dot.state.fl.us/seaport/pdfs/_FDOT%20Seaport%20Plan_Report_complete.pdf

- The Policy Element of the Rail System Plan (pages 3-9 through 3-11):

  http://www.dot.state.fl.us/rail/PlanDevel/Documents/2009PolicyElementoftheRailSystemPlan-webfinal.pdf

The Department is also required by law to perform rail safety inspections under section 341.302(8), Florida Statutes. This program is implemented supplemental to and in cooperation with the Federal Rail Safety Inspection program. The FDOT program has 7 FRA-certified inspectors who look at track, operating practices, signal/train control systems, motive power/equipment, and hazardous materials. The focus of this program both at the state and federal levels is ensuring railroad compliance with federal safety regulations.

The Department's Rail Office also manages Highway-Railroad Grade Crossing Improvement program pursuant to section 335.141, Florida Statutes. The program is required to:

- Develop and maintain an inventory of all crossings;

- Accept applications for the opening and closing of public railroad-highway grade crossings;
- Prioritize the most hazardous crossings;
- Perform diagnostic field reviews;
- Make recommendations for signal upgrades; and
- Select safety improvement projects to receive federal funding.

In addition, the Department's Office of Motor Carrier Compliance (OMCC) is responsible for performing commercial vehicle safety and weight enforcement. To reduce the number of commercial motor vehicle (CMV) related crashes, OMCC also performs safety inspections on CMVs and traffic enforcement with an emphasis on violations by CMVs and passenger vehicles interacting with large trucks. For more information, please refer to: http://www.dot.state.fl.us/mcco/.

Iowa

The State of Iowa does have safety policies, programs, or procedures involving freight transportation. The majority of these safety policies, programs, or procedures involving commercial trucking are described in the document published by the Iowa Department of Transportation titled "Iowa Truck Information Guide." This document is located on the Web at the following site: http://www.iowadot.gov/mvd//omve/truckguide.pdf. Additional information on truck safety policies, programs, or procedures is shown in the Iowa Commercial Drivers License Manual located at the following Web site:

http://www.iowadot.gov/mvd//ods/cdl/cdlmanual.pdf. Additional information is available in our Comprehensive Highway Safety Plan which is located at http://www.iowadot.gov/traffic/chsp/index.htm.

2. What have you found to be the most difficult safety policy to implement in the freight transportation industry?

   Florida

   A key challenge is any policy which requires action on the part of the railroads without a federal compliance requirement. This is due to federal pre-emption under interstate commerce.

   Iowa

   All safety policies in the freight transportation industry are important. No particular policy in this area has been identified as the most difficult to implement.

3. What have you found to be the most effective safety policies in the freight transportation industry?

   Florida

   Policies that the state is willing to pay for and those related to compliance with federal regulations.

   Iowa

   The most effective policies in the freight transportation industry may involve the requirements of Iowa's Commercial Drivers License.

4. How do you measure the effectiveness of those policies?

   Florida

Effectiveness of our efforts is measured in two ways. First, we measure a variety of safety outcomes, e.g. derailments, crossing incidents. Second, we measure employee performance against the performance of other state inspectors. As examples, please refer to the following documents:

- The Strategic Intermodal System performance report (page 12-13): http://www.dot.state.fl.us/planning/performance/SIS-Performance.pdf
- The safety and security portion of the Department's Performance Report: http://www.dot.state.fl.us/planning/performance/Safety-Security.pdf

Iowa

The Iowa Department of Transportation, Iowa Department of Motor Vehicle, and the Iowa Department of Public Safety all monitor appropriate safety policies, programs, and procedures for effectiveness. We have developed some safety performance measures which can be found on the Results Iowa website at http://www.resultsiowa.org/transport.html and at http://www.dom.state.ia.us/planning_performance/files/reports/FY09/FY09TransportationPerformanceReport.pdf. While we have not identified measures specifically related to freight, a number of the measures relate to freight transportation.

5. What have you found to be the greatest threat to safety involving freight transportation?

Florida

The greatest threat is the openness of the railroad system, as it is too large and accessible to be completely protected. While facilities like rail yards and ports are fairly easily controlled, the rail corridors are relatively unprotected.

Iowa

The greatest threat to safety involving freight transportation may be the high volume of trucks on Iowa's Interstate roadways. High truck volumes pose increased safety impacts to passenger vehicles.

6. Do you have carbon emission policies in freight transportation?

Florida

The transportation plans referred to on page 1 (the beginning) of this survey also include policy objectives and strategies related to reducing energy consumption, improving air quality, and reducing greenhouse gas emissions.

The State of Florida has a truck idling standard, which is administered by the Florida Department of Environment of Protection. Pursuant to Rule 62-285.420, Florida Administrative Code, owners or operators of heavy-duty diesel engine powered motor vehicles are prohibited from idling for more than five consecutive minutes, unless otherwise exempted by rule.

http://www.dep.state.fl.us/air/rules/fac/62-285.pdf

Iowa

We do not have carbon emission policies. We did participate in a legislative greenhouse gas emissions study conducted by the Iowa Climate Change Advisory Council (ICCAC). ICCAC's immediate responsibilities included submitting a proposal to the Governor and General Assembly that addresses policies, cost-effective strategies, and multiple scenarios designed to reduce statewide greenhouse gas emissions. ICCAC divided itself into five subcommittees, one dealing with transportation and land use. A final proposal was submitted in December, 2008. More information is available on web site at http://www.iaclimatechange.us/.

7. What methods do you use to measure/determine carbon emissions by trucks?

    Florida

        Emissions by particular types of vehicles are not tracked routinely. As part of developing the state's Energy and Climate Change Action Plan, the state of Florida analyzed and projected emissions by various sectors (including on-road diesel) from 1990 to 2025 (refer to chapter 2 – Appendix):

        http://www.flclimatechange.us/documents.cfm

    Iowa

        Not applicable.

8. What have been the greatest difficulties you have faced in enforcing carbon reduction policies in the freight transportation industry?

    Florida

        There are currently no specific carbon reduction regulations to be enforced in either federal or state law.

    Iowa

        Not applicable.

9. What are the most effective methods you have found to implement and enforce carbon reduction policies in the freight transportation industries?

    Florida

        Not applicable.

Iowa

Not applicable.

10. Do you have sustainability policies and programs in freight transportation?

Florida

Presuming you mean sustainability means reducing air pollutant emissions from the freight sector, please refer to the response to question 6.

Iowa

Not applicable.

11. Are you conducting studies and research on safety, carbon emissions, and sustainability in freight transportation? If yes, could you send us documentation of these studies and research?

Florida

Not at this time.

Iowa

No.

12. Do you have additional comments?

Florida

The Department tends to approach policy implementation from an integrated approach, rather than segmenting strategies, such as looking at reducing energy consumption and air quality overall as opposed to strategies to reduce one particular emission verses another (e.g., ozone verses carbon). Also, when we make transportation investments, we seek to address multiple issues and provide multiple benefits. For example, the Department's Interstate 4/Crosstown Expressway Connector project will build a limited-access, elevated toll road to connect the Lee

Roy Selmon Crosstown Expressway to Interstate 4 in Tampa, Florida. When completed, the highway will be able to safely filter hazardous cargo away from Ybor City and into the Port of Tampa. This project will reduce congestion (thereby reducing emissions) and improve safety and livability in the historic Ybor City area of Tampa.

Iowa

When will the study be completed and can we get a copy?

5.3 Common State Regulations

Unfortunately, as only two surveys were returned, the information from them is incomplete. In an effort to increase our understanding of current policies we reviewed documents put forth by state agencies, most notably: long-term transportation plans, highway safety plans, commercial drivers manuals, and air quality conformity reports. Most of these documents did not contain specific policies but outlined general goals with a vast majority of safety plans stating that success of safety policies was measured by the numbers of fatalities, injuries, and crashes. Information on specific policies by state is displayed on table 5.1 and was gathered from ATRI 2010, FRA 2011, and GHA 2011.

Table 5.1 Common Policies by State

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
Alabama	Primary seat belt law Rural interstates – 70 mph Urban interstates – 65 mph	Yes		
Alaska	Primary seat belt law Rural and urban interstates – 55 mph			
Arizona	Secondary seat belt law Rural interstates – 75 mph Urban interstates – 65 mph	Yes	Maricopa County – 5 min (60 min/60 min if >75ºF), fined	Uses California emissions standards
Arkansas	Primary seat belt law Separate speed limits for cars/trucks on rural interstates – 70/65 mph Urban interstates – 55 mph			

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
California	Primary seat belt law Separate speeds for cars/trucks on rural interstates – 70/55 mph Separate speeds on urban interstates – 65/55 mph	Yes	5 min, fined City of Sacramento and Placer County– 5 min (prohibits refrigeration unit operation within 100 ft of residential area or school unless loading/ unloading), fined	Uses California emissions standards
Colorado	Secondary seat belt law Rural interstates – 75 mph Urban interstates – 65 mph		City of Aspen – 5 min within any 1 hr, fined and/or imprisonment Colorado City & county of Denver – 10 min within any 1 hr, fined and/or imprisonment	
Connecticut	Primary seat belt law Rural interstates – 65 mph Urban interstates – 55 mph		3 min, fined	Uses California emissions standards

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
Delaware	Primary seat belt law Rural and urban interstates – 55 mph		3 min (15 min 32º to -10º F, no limit below -10ºF), fined	Uses California emissions standards
District of Columbia	Primary seatbelt law Urban interstates – 55 mph		3 min (5 min if below 32ºF), fined	
Florida	Primary seat belt law Rural interstates – 70 mph Urban interstates – 65 mph	Yes	5 min Fines: TBD	
Georgia	Primary seat belt law Rural interstates – 70 mph Urban interstates – 55 mph		City of Atlanta – 15 min (25 min if <32ºF), fined	
Hawaii	Primary seat belt law Rural and urban interstates – 60 mph		3 min for startup/cool down, fined	

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
Idaho	Secondary seat belt law Separate speeds for cars/trucks on rural interstates – 75/65 mph Urban interstates – 65 mph	Yes		
Illinois	Primary seat belt law Rural interstates – 65 mph Urban interstates – 55 mph	Yes	10 min within any 1 hr (no limit below 32ºF or above 80ºF), fined Chicago – 3 min in any 1 hr, fined	
Indiana	Primary seat belt law Separate speeds for cars/trucks on rural interstates – 70/65 mph Urban interstates – 55 mph			
Iowa	Primary seat belt law Rural interstates – 70 mph Urban interstates – 55 mph	Yes		

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
Kansas	Primary seat belt law Rural and urban interstates – 75 mph			
Kentucky	Primary seat belt law Rural and urban interstates – 65 mph (70 on some segments)			
Louisiana	Primary seat belt law Rural and urban interstates – 70 mph			
Maine	Primary seat belt law Rural and urban interstates – 65 mph	Yes	5 min in any 1 hr (15min/hr at 0-32ºF, no limit below 0ºF), fined	Uses California emissions standards
Maryland	Primary seat belt law Rural and urban interstates – 65 mph	Yes	5 min, fined	Uses California emissions standards
Massachusetts	Secondary seat belt law Rural and urban interstates – 65 mph		5 min, fined	Uses California emissions standards

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
Michigan	Primary seat belt law Rural and urban interstates for trucks – 60 mph (55 if speed limit for cars is over 70)		Detroit – 5 min in any 60 in, warned at first offense, fined for subsequent offenses	
Minnesota	Primary seat belt law Rural interstates – 70 mph Urban interstates – 55, 60, or 65 mph	Yes	Minneapolis – 0 min in residential areas between 10pm and 6 am, fined and/or imprisonment Owatonna – 15 min every 5 hr in residential areas, fined and/or imprisonment St. Cloud (portion of city) – 5 min, fined	
Mississippi	Primary seat belt law Rural and urban interstates – 70 mph	Yes		

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
Missouri	Secondary seat belt law Rural interstates – 70 mph Urban interstates – 60 mph	Yes	5 min in any hr Fines: TBD City of St. Louis – 5 min, fined St. Louis county – 3 consecutive minutes, max fined and/or imprisonment	
Montana	Secondary seat belt law Rural interstates cars/trucks – 75/65 mph Urban interstates – 65 mph	Yes		
Nebraska	Secondary seat belt law Rural interstates – 75 mph Urban interstates – 65 mph	Yes		
Nevada	Secondary seat belt law Rural interstates – 75 mph Urban interstates – 65 mph	Yes	15 min, fined Clark County – 15 min, fined Washoe County – 15 min, fined	

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
New Hampshire	No primary or secondary seatbelt law Rural and urban interstates – 65 mph	Yes	5 min if greater than 32ºF (15 min: 32º to -10ºF) Fines: TBD	
New Jersey	Primary seat belt law Rural interstates – 65 mph Urban interstates – 55 mph	Yes	3 min (15 min if <20ºF and stopped ≥ 3 hrs), fined Penalties for commercial vehicle and property owners New York City – 3 min (1 min if adjacent to a public school), fined and/or imprisonment New Rochelle – 5 min, fined and/or imprisonment Rockland County – 3 consecutive min, fined and/or imprisonment	Uses California emissions standards

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
New Mexico	Primary seat belt law Rural interstates – 75 mph Urban interstates – 65 mph	Yes		Uses California emissions standards
New York	Primary seat belt law Rural interstates – 65 mph Urban interstates – 55 mph	Yes		Uses California emissions standards
North Carolina	Primary seat belt law Rural and urban interstates – 70 mph	Yes	5 consecutive min in any 60 min period Fines: TBD	
North Dakota	Secondary seat belt law Rural and urban interstates – 75 mph			

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
Ohio	Secondary seat belt law Rural and urban interstates – 65 mph (cars may reach 70 on Turnpike)	Yes	Cleveland and Maple Heights – 5 min in any 60 min period (10 min/hr at loading docks/areas or if <30ºF or >85ºF), fined South Euclid – 0 min (20 min/hr at loading/unloading, no limit if <32ºF or >85ºF), fined	
Oklahoma	Primary seat belt law Rural interstates – 75 mph Urban interstates – 70 mph			
Oregon	Primary seat belt law Rural interstates cars/trucks – 65/55 mph Urban interstates – 55 mph	Yes		Uses California emissions standards

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
Pennsylvania	Secondary seat belt law Rural interstates – 65 mph Urban interstates – 55 mph	Yes	5 min in any 1 hr period (15 min/hr if sampling, weighing, loading, or unloading) Fined Alleghany County – 5 min (20 min/hr if <40ºF or >75ºF), fined City of Philadelphia – 2 min or 0 min for layovers (5 min if <32ºF/ 20 min if <20ºF), fined	Uses California emissions standards
Rhode Island	Primary seat belt law Rural interstates – 65 mph Urban interstates – 55 mph		5 min in any 1 hr period (no limit <0ºF, 15 min/hr between 0ºF and 32ºF), fined	Uses California emissions standards
South Carolina	Primary seat belt law Rural and urban interstates – 70 mph	Yes	10 min in any 1 hr, fined	

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
South Dakota	Secondary seat belt law Rural and urban interstates – 75 mph			
Tennessee	Primary seat belt law Rural and urban interstates – 70 mph	Yes		
Texas	Primary seat belt law Rural and urban interstates – 75 mph (up to 85 on some segments of rural)	Yes	5 min, fined	
Utah	Secondary seat belt law Rural interstates – 75 mph (up to 80 on segments) Urban interstates – 65 mph	Yes	Undefined time limit, fined Salt Lake City – 15 min, fined and/or imprisonment	
Vermont	Secondary seat belt law Rural interstates – 65 mph Urban interstates – 55 mph			Uses California emissions standards

State	Trucking Safety	Participant in FRA's State Rail Safety Program	Idling Restrictions	Emissions Standards
Virginia	Secondary seat belt law Rural and urban interstates – 70 mph	Yes	10 min for diesel vehicles (3 min for all others) in commercial or residential urban areas, fined	
Washington	Primary seat belt law Rural interstate car/truck – 70/60 mph Urban interstate – 60 mph	Yes		Uses California emissions standards
West Virginia	Secondary seat belt law Rural interstate – 70 mph Urban interstate – 60 or 65 mph	Yes	15 min in any 60 minute period, fined	
Wisconsin	Primary seat belt law Rural and urban interstate – 65 mph			
Wyoming	Secondary seat belt law Rural and urban interstate – 75 mph			

5.4 Information Summary

It should come as no real surprise that enforcement appears to be the critical element in policy effectiveness. All state plans and reports contain sections on funding and both the surveys we received listed the ability to enforce policies as important. To ensure success, legislation must include or be attached to some sort of action plan as to how it will be implemented and how its success will be measured.

5.4.1 Safety

Speed limits and seat belt laws are the primary devices used in safety regulations for transportation in the trucking industry. Interstate speed limits are within about 10 mph of each other. Seven states have separate speed limits for cars and trucks on rural interstates. Of these, four have differences of 10 mph, two have a difference of 5 mph, and one has a difference of more than 10 mph. Only one state has separate speed limits on urban interstates and this is a 10 mph difference. Twenty-five states have rural interstate speed limits over 65 mph and twelve states have urban interstate speed limits over 65 mph. Thirty-two states have primary seat belt laws, seventeen have secondary seat belt laws, and New Hampshire does not have a primary or secondary seat belt law.

The primary safety regulation in rail is the Rail Safety Act of 1970 (Public Law 91-458), which authorized states to work with the Federal Railroad Administration to enforce federal railroad safety regulations. These regulations enforce standards for track and freight car safety, locomotive and signal inspection, hours of service, hazardous material inspection, and grade crossing safety. So far twenty-nine states and the District of Columbia have chosen to adopt the rail safety participation program.

5.4.2 Emissions

Thus far there seems to be a scarcity of environmental regulation concerning freight transportation. Vehicle inspections are the main method of ensuring that vehicles meet regulation emission standards. Most states use only the federally mandated EPA emissions regulations. It is believed, due to survey responses and state air quality reports, that many states work to have overall emissions policies, nonetheless they have yet to make specific policies in regards to transportation.

Emission standards and idling policies varied greatly for each state. At the time of this study, fifteen states had adopted the stricter California emissions standards. Twenty-one states and the District of Columbia currently have statewide anti-idling policies, and some of these states have idling policies for specific cities and counties within them. Six states without statewide idling policies have policies within specific locations. Twenty-three states do not have anti-idling policies. This data captures the emissions and idling policies in a quick glance.

Following this general overview, the idling policies can be examined in further detail. The majority of idling restrictions, twenty-two states and DC, are for periods of five minutes or less in any sixty minute period. Of this majority, eleven are for five minutes, and three of these vary depending on temperature. Further detailing this majority, five are for periods of less than five minutes, and again three these vary with temperature. Three state idling policies were for ten minute periods and two were for fifteen minutes. Utah did not specifically define a time limit. There were twenty-one different idling policies for specific cities or counties within states. These policies can be grouped together based on similarities: eight restrict idling to five minutes, with four of these dependent on temperature; seven restrict idling to periods of less than five minutes, with three of these dependent on temperature; one that restricts idling to ten minutes; and five that restrict idling to fifteen minutes. Clearly, there is not a nation-wide consensus on what is considered an appropriate idling time.

Emission standards compliance and fuel efficiency start at production, ensuring that all vehicles made within a year comply with the appropriate standards. State and federal offices conduct inspections on an annual to multi-annual basis to ensure standards continue to be met. As these inspections must be carried out in a wide variety of locations throughout the United States it can be difficult to ensure the standardization of inspection procedures and equipment.

Chapter 6 Conclusions and Recommendations

6.1 Summary

The transportation of freight throughout the US uses a large amount of resources, contributes significantly to America's share of carbon emissions, and affects the safety of everyone using the transportation system. The demand, and therefore supply, for freight has continued to grow in recent years despite the difficulties faced by the economy. Much of America's transportation infrastructure is already reaching its capacity and freight volume is only expected to continue growing. Research is needed to help the transportation sector grow in a practical, safe, and sustainable manner. A number of technologies and strategies examined within this report stood out as being more, or less, effective for use in the creation and planning of sustainable freight transportation frameworks of government agencies, and for use by commercial fleets attempting to reduce their carbon footprints and increase their safety. These have been included below as conclusions and recommendations.

6.2 Existing Strategies for Sustainable Freight Transportation

6.2.1 Logistics

Any fleet trying to reduce its carbon footprint should perform a logistics audit to determine whether transferring some or all of its freight to alternate modes of transportation would be beneficial. In some cases, alternate modes can provide both environmental and economic benefits. This is particularly true if the goods shipped are not time sensitive and there is a nearby station or port for the alternate mode being considered. In other instances, alternate modes can prove not only more expensive, but also produce a greater amount of emissions. Audits should examine both modes and routes, as well as take into account projected economic and emissions savings and the safety of all parties involved.

6.2.2 Idling Reduction

The most widely used fleet improvements increase fuel efficiency and have low initial costs. Anti-idling technologies stand at the forefront of the legislation regarding fuel efficiency, and the majority of US states have some form of anti-idling policy at this time. They are a good way to get more, or rather less, out of an engine without restricting the possible shipping routes due to fueling station availability. They save money by using less fuel, reduce the carbon footprint of the fleet by producing fewer emissions, and it seems likely that more and more states will adopt anti-idling policies in the near future.

6.2.3 Speed and Weight Limits

In addition to idling reduction policies, speed and weight limits could prove to be effective methods of increasing safety and reducing emissions in transportation of freight by truck. Speed limits of no higher than 65 mph have been shown to accrue significant safety and emissions reductions benefits. Additionally, increasing truck weight limits shows great potential in reducing congestion and increasing logistics efficiency. For these reasons, reduced speed limits and increased weight limits should be introduced nationwide, preferably in conjunction. Introducing them together should help to alleviate the fears of commercial fleets that reduced speed limits will cut into their profits. Moreover, reduced speeds could reassure groups opposed to increased weight limits due to safety concerns. Still, there is the concern that some bridges may not be able to safely support increased weight limits. Consequently, it may be prudent to adopt a tiered policy, similar to the EPA's approach to emission standards, to allow states the time needed to upgrade their bridges to support the higher weights.

While there are significant advantages to reducing speed limits and increasing weight limits, there are a few downsides to consider. One possible disadvantage to this plan is that it may divert freight from rail to trucks, a less fuel-efficient means of transportation. Even if this were the case, it is expected that the increasing demand for freight would render this a temporary problem. On the other hand, there is some possibility that the rail industry would suffer losses and have any possible expansion hindered during this time. A larger problem related to implementation is that for these policies to be truly effective they need to be adopted by the nation as a whole. If only individual states change their policies then the effects will be highly limited and potentially a source of confusion to fleet managers transporting goods through those states. This could make the policies more difficult to implement nationwide because it would be a challenge to accurately predict the benefits if only a few states were participating in a trial run. Nevertheless, if such a trial run was deemed necessary it would be most appropriate to choose states near an international border and preferably a group of states sharing borders between themselves with an international border as well.

6.2.4 Alternate Fuels

As explained previously, alternate fuels do not offer a simple, clear solution. Opportunities currently exist to utilize emissions reducing petroleum blend fuels, which would allow trucks to continue to use standard, or modified, engines that are capable of using petroleum fuels when alternates are not available. Because trucks using these fuels would still be able to travel in areas where they were unavailable, petroleum blend fuels would not require any immediate changes to the existent transportation system. The main difficulty in introducing the use of these fuels is their increased cost. Therefore, incentives and requirements should be implemented to encourage their use.

Petroleum blend fuels should be encouraged across the trucking industry, but electric vehicles should not be summarily dismissed. It is true that the length of fueling times and lack of infrastructure support for electric vehicles makes them unsuitable at present for use as long-haul vehicles. However, they should be considered for use as support vehicles in ports and for short range deliveries. A small fleet operating in a limited area could make effective use of electric vehicles. This is especially true if the fleet is parked in a centralized garage overnight, which could be retrofitted to recharge them during this period.

6.3 Strategies which Hinder Sustainable Freight Transportation

The previous discussion focused on strategies that should be implemented, but there are a few strategies that proved to be ineffectual and potentially harmful to sustainable freight transportation. They use resources which could be allocated elsewhere with much more effective results and may have other drawbacks. These strategies should be avoided and are explained in more detail below.

6.3.1 Speed Limits

At this time research suggests that roadway segments which have one speed limit for trucks and a different speed limit for cars do not decrease the likelihood of an accident. In fact, some research has indicated that it may actually increase traffic fatalities if the difference in the separate speed limits is 10 mph or more.

6.3.2 Alternate Fuels

Although the use of some alternate fuels can substantially reduce the greenhouse gasses emitted by the transportation industry, others are not so beneficial. The trucking industry depends upon widespread fueling stations throughout the US to be able to deliver goods virtually anywhere. Alternate fuels that use engines which cannot also run on diesel would require a massive, and expensive, overhaul to the existing infrastructure. It is unrealistic to expect that the necessary changes to infrastructure and equipment could be made in a timely manner and still be economically feasible. Again, one exception to this issue may be short-haul deliveries. It is possible for short-haul trucks to transport goods within an area containing enough alternate fueling stations that they would not be hindered (section 6.2.4).

6.4 Recommendations for Future Research

6.4.1 Vehicle Efficiency

It is absolutely imperative that research continue to explore possibilities for engine improvements for all transportation modes; both for low-cost alterations, which could have an immediate impact, and large-scale, long-term improvements. One such long-term improvement that should be highlighted is the use of ultra-light materials. Vehicles comprised of ultra-light materials have the potential to greatly increase energy efficiency as their reduced weight requires less fuel to propel. This would reduce the necessary fuel capacity of a vehicle, possibly encouraging the development of hydrogen vehicles. On the other hand, there are justifiable concerns that constructing freight transportation vehicles out of ultra-light materials may make them less able to withstand impacts, compromising their safety. More research is definitely required in this area.

Use of hybrid trucks also seems to be an excellent way to increase fuel efficiency; however, their high cost is a substantial impediment and may make them infeasible at this time. One solution that should be investigated is the possibility of a low cost producer utilizing the assembly line to produce one model of hybrid truck. Currently, commercially available hybrid trucks are custom made and limiting hybrid trucks to one model would seem to greatly reduce the cost. If such a venture proved successful then it could be expand as appropriate.

6.4.2 Fuel Sources

Hydrogen is a promising technology that is only just beginning to be explored. It may be a long time, if ever, before becoming widely available enough to meet the demands of the trucking industry. However, the railways' centralized fueling stations make hydrogen a much more viable option for trains. As hydrogen is researched further, attention should be given to the most economical methods of creating hydrogen fueling stations along rail lines.

6.4.3 Life-Cycle Emissions

Processes should be improved where possible for the production of bio-fuels and the alteration of existing vehicles to include anti-idling and other enhancements. The focus of this research should be to reduce the expense of adding these improvements; therefore, making them more attractive options for fleets and hopefully will be adopted more widely. Hybrid technology and other large-scale improvements could also benefit from this research focus.

Opportunities also exist to reduce emissions in vehicle production and infrastructure construction, thereby lowering life-cycle emissions of the transportation system. Research should consider ways in which this may be accomplished. Researchers should also continue to investigate emissions reductions strategies for fuel processing facilities. These might be easier to implement across a small number of stationary plants than a large number of mobile fleets.

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