CENTER FOR
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INVESTIGATING THE COST, LIABILITY AND RELIABILITY OF ANTI-IDLING EQUIPMENT FOR TRUCKS

FINAL REPORT

TO

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TRANSPORTATION

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INVESTIGATING THE COST, LIABILITY AND RELIABILITY OF ANTI-IDLING EQUIPMENT FOR TRUCKS

Final Report

to

Delaware Department of Transportation

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Executive Summary

Truck-idling[1] contributes to air pollution due to increased fuel consumption. Each year truckers spend between 1,600 and 1,800 hours idling their engines. The idling burns approximately 1 gallon of fuel per hour, and it is estimated that over 1.2 billion gallons of diesel fuel are consumed by idling trucks each year (Stodolsky et al., 2000). Fuel consumption from truck idling releases 11 million tons of carbon dioxide, 136,000 tons of carbon monoxide, 180,000 tons of nitrogen oxide, and 5,000 tons of particulate matter (NYSERDA, 2004).

Idling also causes economic costs for drivers and for trucking companies. Idling engines operate at 3-11% efficiency, compared to 40% engine efficiency while driving, wasting both engine oil and fuel and causing engines to experience greater wear and tear. The U.S. Department of Energy estimates that $1 billion is spent each year on idling related engine repairs (U.S. DOE, 2006).

The State of Delaware has a disproportionately large volume of commercial truck traffic relative to its size and population. The U.S. Census Bureau (2004) estimates, there were 16,200 trucks registered in Delaware in 2002 that traveled a combined total of over 300 million miles. Idling trucks are a concern in all areas of Delaware but especially along Interstate 95 where population density is high and the volume of trucks is likewise high. The poultry industry in the southern part of the state and the cargo traffic to the Port of Wilmington are also major sources of truck idling.

All three of Delaware's counties are currently classified as ozone non-attainment areas under the EPA's National Ambient Air Quality Standards (NAAQS) (Schuster et al., 2004). In addition to the ozone problem, New Castle County is in non-compliance for particulate matter (PM). Because truck idling emissions are a significant contributor to ground-level ozone and PM, Delaware could integrate efforts to curb truck idling into its state implementation plan (SIP) for EPA air quality standards attainment.

Project Objectives and Methods

Supported by the Delaware Department of Transportation and the Delaware Center for Transportation at the University of Delaware, the Center for Energy and Environmental Policy (CEEP) conducted research to explore strategies that might reduce the negative environmental and economic impacts of truck engine idling in Delaware. The research had three principal objectives:

- Investigate the cost, liability, and reliability of anti-idling equipment for trucks;
- Evaluate environmental, energy, and economic impacts of idled trucks and anti-idling equipment solutions; and
- Develop a set of policy recommendations to both curb idling and facilitate the entry of anti-idling equipment into the marketplace in Delaware.

[1] The main reasons for truck idling are 1.) climate control (heat and A/C); 2.) powering accessories (coolers, TVs, etc); and 3.) protecting the engine during cold weather (Metropolitan Washington Council of Governments, 2004).

A comprehensive literature review on idle reduction technologies and associated policies and programs has been conducted for this research. CEEP's researchers made on-site visits to truck stops, rest stops, and commercial truck fleets to observe the idle reduction equipment being used, the behavior of drivers, and the physical location and condition of the facilities. In addition to on-site research, telephone interviews were conducted with a wide range of equipment manufacturers, industry organizations, truck companies, and non-profit groups promoting improved air quality.

Anti-Idling Technologies

Idle reduction technologies can be generally divided into two categories: mobile technologies and stationary sources. Mobile systems include automatic engine shutdown devices, battery powered alternatives, diesel fueled heaters, and auxiliary power units (APUs) or generators. Mobile solutions often provide limited functionality; they may provide heating and cooling, but no electric power; or they may heat the truck cab and sleeper compartments and not the engine. Table 1 below provides comparative assessments of different mobile technologies.

Table E.1 Assessing the Pros and Cons of Mobile Idle-Reduction Technologies

		Cost	Pros	Cons
Mobile Technology Type	Engine Control Module	$0	No extra cost. Available from engine manufacturer.	Does not address cab comfort or provide power so not really a solution.
	Automatic Shutdown/Turn-On System	<$1,000	Low cost. Available from engine manufacturer.	Does not address cab comfort or provide power so not really a solution.
	Direct-Fired Heaters	$800–$1,200	Low cost. Lightweight. Available from engine manufacturer.	Provides heat only – useful only six months per year in Delaware.
	Auxiliary Power Units/Generator Sets	$5,000–$8,000	Provides all power needs.	Expensive, heavy, noisy, maintenance intensive. Requires after-market retrofit. Emits pollutants.
	Auxiliary Battery Powered Heating/AC with Inverter	$7,000–$12,000	Provides all power needs. Zero emissions from truck.	Moderately heavy. Draws down engine battery quickly. Expensive.

Source: CEEP research, Turner-Fairbank Highway Research Center, Federal Highway Administration.

Stationary anti-idling technologies, also known as truck stop electrification (TSE) systems, are classified as either on-board or off-board systems. On-board systems require the installation of dedicated heating and cooling systems in the truck, while off-board systems provide heating, cooling, and electricity through an external connection.[2] Table 2 below summarizes the two stationary technologies on the market.

Table E.2 Assessing the Pros and Cons of Idle-Reduction Technologies

		Cost	Pros	Cons
Stationary Technology Type	**On-board Solution -** Electrified parking spaces. Provided by Shurepower LLC. ("shorepower" technology has been used for many years by RVs and boat marinas. AC electric outlets are provided to power equipment inside the truck, Internet and cable TV are part of the plan). $1.00 - $1.25 per hour for to use.	$8,000 per space, $10,000 for small installations	Lower cost. More flexible and adaptable	Requires modifications to truck (electric heat/AC, inverter/charger)
	Off-board Solution – External equipment attaches to cab window. Provided by IdleAire Technologies Corp. (Driver receives filtered, hot/cool air as well as on-demand movies, internet, and electric outlets). $1.50 - $2.00 per hour for to use. Another company called AirPower Corporation of Texas has offered a similar product but is not competitive in the market.	$18,000 per space with subsidies, $25,000 at market rate.	No truck modifications needed.	Very expensive. High speed wireless Internet and satellite could reduce future usage.

Source*:* CEEP Research; Turner-Fairbank Highway Research Center; and Federal Highway Administration.

In addition to the established anti-idling technologies discussed above, there is a wide range of systems currently under development: super insulated sleeper cabs, roof integrated photovoltaic cells, and hybrid diesel-electric engines.

E^3 Impact Evaluations

CEEP's research reviewed anti-idling technologies in terms of their impacts on environment, economy, and energy use (E^3) in Delaware. The E^3 impact evaluation focused on

[2] The US EPA refers to onboard technologies as "dual system" technologies because they require installations both inside and outside the truck, while off-board technologies are referred to as "single system" technologies because no additional technology installations are required within the truck.

two technology delivery approaches: 1) anti-idling technology installed in trucks; and 2) systems installed at truck stops and rest stops and available in truck parking spaces.

Savings by Anti-idling Technology

Annual fuel savings from idling reduction technologies are significant. Even anti-idling technologies such as diesel-burning heaters can reduce liquid fuel consumption by as much as 3,000 gallons per year since the rate of diesel usage is 0.1 to 0.3 gallons per hour (CARB, 2005) compared to 1.0 gallons for idling. If a conservative fuel price of $2.50 per gallon is used, economic savings from the anti-idling technology are in the range of $9,000 per year.[3]

The application of anti-idling technologies can sizably reduce pollutant emissions, even if the off-setting increase in emissions at power plants from TSE systems are included. Additional environmental benefits derive from reductions in greenhouse gas emissions. One stationary anti-idling unit avoids 0.38 tons of NO_x, 0.01 tons of PM, and 17.46 tons of CO_2 per year (see Table 4.1). Mobile technologies can vary significantly in emissions factors and therefore the effect of mobile technology strategies is not easily benchmarked. But it is noteworthy that diesel APUs and diesel burning heaters reduce NOx by 0.34 and 0.37 tons per year, respectively, on average. CO_2 emission reductions from diesel burning heaters are 12.22 tons per year (see Table 4.1).

Truck and Rest Stop Technology Provided at Parking Spaces

CEEP also examined the delivery of anti-idling technology at truck and rest stop parking spaces, rely on research by EPA for this purpose (see U.S. EPA, 2004). In the best scenario where trucks use anti-idling technologies at parking spaces instead of idling, the gross potential savings by category is shown in Table 3.

Table E.3 Annual Savings Potential in Delaware

Category	Saving Potential
Annual fuel savings (gallon/yr)	304,988
Annul fuel cost savings ($/yr)	$762,470
Annual NO_x emissions reductions (tons/yr)	64
Annual PM emissions reductions (tons/yr)	1.75
Annual CO_2 emissions reductions (tons/yr)	2,968

Source: U.S. EPA, 2004

Considering Delaware's emission budget in its SIP and the goal of realizing attainment status from the U.S. EPA for ozone and PM releases, the use of stationary or mobile anti-idling technologies can clearly have an important role to play at a relatively low initial financial cost.

[3] With recent market prices for diesel about $3.00 per gallon, the relative fuel savings are larger, and the cost-effectiveness of the idle reduction technologies more pronounced.

Current Anti-idling Policies of Federal and State Levels

Federal Anti-idling Initiatives

The U.S. Department of Energy is involved in anti-idling activities, primarily on the technology development side. Most notably, the DOE is sponsoring research, development, and demonstration projects with a number of corporate partners. The goal is to incorporate on-board idle reduction technology into truck design at the factory, or if possible, as a dealer installed option (Levinson 2004).

The EPA has taken the lead in federal anti-idling efforts through several initiatives focusing on technology, economic incentives, and outreach and education. First, the EPA has established an expedited verification program that manufacturers can use to get their products and systems approved for implementation in EPA-related programs (Environmental Technology Verification Program). Second, EPA announced in March 2005 that it intended to develop a model law for idling of heavy-duty trucks and buses in order to encourage interstate policy harmonization. Third, EPA has launched the SmartWay Transport Partnership program with the freight industry to hasten the commercialization of anti-idling technologies (U.S. EPA, 2005).[4]

State Idling Policy and Regulations

Both the EPA and the American Transportation Research Institute (2005) maintain lists of state anti-idling policies. According the lists, 19 states and the District of Columbia have some form of anti-idling regulation in place at either the state or municipal levels. Most of these policies specify a maximum idling time between two and fifteen minutes either statewide or in specific zones, and a monetary penalty of less than $1,000 for first time offenders. The majority of these policies also specify a set of exemptions for different circumstances (traffic congestion, maintenance at a repair facility, etc.) and vehicles (emergency vehicles, snow removal, etc.).

Delaware Anti-Idling Policy

Title 7, Chapter 60, Sections 6005 and 6013 constitute Delaware's Anti-Idling Law passed in early 2005. The law applies to vehicles of all types weighing 8,500 lbs gross vehicle weight rating (GVWR) or more. The Anti-Idling Law is administered by the Delaware Department of Natural Resources and Environmental Control (DNREC)'s Division of Air and Waste Management under "Regulation No 45: Excessive Idling of Heavy Duty Vehicles". Regulation 45 was incorporated into the SIP as regards attainment with the eight hour standard for ozone.

[4] Among the 30 plus members of the SmartWay Transport Partnership's EPA Region 3, none are Delaware entities. The list of partners can be viewed at www.epa.gov/smartway/region3.htm. Perdue Farms, one of the poultry businesses operating in Delaware but based in Salisbury, Maryland, is one of the members.

Potential Policy Options

The research conducted for this report, in conjunction with the established literature, leads to the following potential guidelines regarding the attributes of an ideal anti-idling technology to be considered for adoption in Delaware:

- It would not create a large fixed infrastructure that would not be adaptable to rapid technology changes;
- It would be available or accessible anywhere and at anytime;
- It would maximize existing off-the-shelf technologies;
- It would not involve third parties who are solely interested in profit margins at the expense of idling reductions;
- It would be focused on original truck equipment as much as possible, for liability and reliability reasons, but also to establish universal standards and improved driver training and satisfaction; and
- It would not increase weight and thus fuel consumption, nor would it burn diesel.

Anti-idling Technology Options

Inverters with Auxiliary Batteries: Diesel APUs are a good short-to-medium term mobile solution but not quite as desirable as inverter/auxiliary battery systems that have shorepower access. By equipping trucks with diesel APUs can produce significant emissions reductions that the state can apply toward its SIP.[5] However, in the longer term, because of their weight, short service life, and the fact that they still burn diesel fuel, APUs are not a good solution to the idling problem.

An ideal solution would not involve any diesel consumption or increased weight-load to the truck while still providing power to meet drivers' primary need for cabin climate control. Inverters coupled with auxiliary batteries and shorepower adapters fit this type of solution.

Suitability for TSE Adoption: There are two commercialized truck-stop electrification (TSE) systems currently available (i.e., the "off-board" system from IdleAire, Inc. and the "on-board" system from Shurepower, LLC.). After reviewing all the available data, conducting site visits, and interviewing industry company officials, we believe that the on-board product is more suitable for Delaware.[6]

The on-board TSE system is usually two-thirds less expensive to install, requires less physical space and maintenance, and is more flexible for future technology developments. The

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[5] The financial payback time for APUs is two years or less. As for implementation, domestically domiciled diesel trucks can be identified through state registrations.

[6] The off-board TSE system may not be an option since the company requires at least 50 units per installation. Delaware, however, has just three full-service truck stops (Delaware Truck Plaza in New Castle, Route 301 Travel Plaza in Middletown, and Oasis Travel Plaza in Laurel), all of which appear to have too few parking spots to meet its requirements.

on-board approach to TSE has fewer risks and potential liabilities because the business model behind it is more sustainable and less dependent on public subsidies due to significantly lower installation costs.

Other Policy Suggestions

Driver Cooperation: Long-haul truck drivers have a tight-knit community and unique culture due to their unusual lifestyle and occupational demands. Many drivers also have similar traits in that they enjoy the freedom of being alone on the road, distrust authority figures, and enjoy trucks and trucking as a personal hobby. Trucking is a way of life and not just an occupation for many drivers. The culture of this community means that peer-to-peer educational models are highly effective, as well as those conducted by drivers' associations and industry groups. Educational and training efforts provided by universities, governments, and other external actors may not be successful.

Regional Cooperation: Shifting parked trucks to other neighboring states may not significantly reduce the impact of truck idling on Delaware's air quality. As discussed by Schuster et al. (2004), a significant proportion of the state's air pollution is attributable to downwind states. Air pollution is a regional challenge that requires both local and multi-state policy strategies to mitigate. Idle reduction policy advances and technology innovations are largely determined beyond the borders of Delaware.

TSE in Some Locations: Delaware should recognize truck drivers' need for heating and cooling services, and explore building TSE systems to accommodate drivers and reduce idling in illegal areas, like highway entrance ramps. Most trucks in Delaware are from out of state so it is difficult to mandate or finance mobile idle reduction solutions for trucks registered in other jurisdictions. For this reason, providing designated areas for trucks to access shorepower electricity makes good sense. Delaware would benefit from the development of small-to-medium truck stop electrification (TSE) sites in several locations across the state where significant truck activity occurs. Further studies would be needed to quantify such activity, but potential areas that may represent cost-effective TSE investments include:

- Abandoned Merchants Square shopping center along I-495 in Wilmington (this site would likely be an economically viable truck stop for hundreds of trucks);
- State government complex in Dover;
- Route 13/40 area in New Castle;
- Port of Wilmington;
- Poultry industry in Sussex County;
- Outlet store and retail complexes in the Rehoboth Beach area;
- Chemical, cosmetic, and car manufacturing companies in Newark.

Participation in Regional and Federal Institutional Efforts: At present, Delaware (and Pennsylvania) is noticeably absent from membership in the Northeast States for Coordinated Air Use Management (NESCAUM) consortium. Without membership in NESCAUM, Delaware has no voice in the policies and technologies being implemented on trucks in other states that regularly pass through Delaware, particularly along Interstate 95. It is also missing out on a tremendous amount of accumulated knowledge and field experience that other state officials are developing together.

Delaware is also unable to share the resources of bigger states like New Jersey and New York who are NESCAUM members and already have active TSE systems among other initiatives and policies. Delaware's economy and truck traffic is more integrated with its northern neighbors than its southern ones overall, and consequently membership in NESCAUM would be advantageous.

As of early 2006, not a single company or organization from Delaware was a member of the U.S. EPA's SmartWay Transport Partnership. Without representation in this group, Delaware risks losing grant monies, research data, technical assistance, policy influence, and other critical resources and services.

Rebate: Delaware-domiciled trucks have a strong incentive to use idle-reduction technologies because the surrounding jurisdictions are among the strictest enforcers of anti-idling laws (Berg, 2005). Delaware could confirm that grants it issues for mobile devices are actually installed and working properly on the trucks they were issued to, and not resold or put aside for lack of installation. To prevent these scenarios, rebates could be used to reward performance verified by an approved mechanic, as one possible solution.

Loan and Lease: The Lane Regional Air Pollution Authority (LRAPA) in Eugene, Oregon has a program that provides low-interest loans to truckers who install APUs and is helping mechanics in the area become trained in installation and maintenance of the APUs (Thomas, 2005). In another incentive, LRAPA borrowed money from the Oregon Department of Energy to purchase APUs that was subsequently leased to drivers for five years (Auxiliary Power Dynamics, 2004).

Replacement Incentives: In addition to financial incentives for mobile solutions, the state considers an incentive program for replacement of outdated heavy-duty trucks,[7] if funding is available.[8] By reviewing truck registrations, the state can identify owner/operators with old trucks and then provide a grant or large tax credit to help them finance a new generation truck that has idle reduction equipment integrated into the truck.

Mobile Emission Reduction Credits (MERCs): The Texas Commission on Environmental Quality has a Clean Fleet Program that issued "Guidelines for Vehicle Emission Credits" in July 2004. Under Texas' program, idle reduction technology users can claim a bankable mobile emission reduction credit. Texas has a for-profit, open market credit-trading

[7] National figures show that 27% of regional haul and 12% of long haul trucks are over ten years old, with ten years being the expected life of a long haul truck (125,000 miles per year) but some continuing for 20 years (Tunnell and Dick, 2006).

[8] Funding can be secured from a variety of sources. The Port of Los Angeles awards grants from its Air Quality Mitigation Program to reduce engine idling by diesel vehicles of all types. The funds amount to roughly $20 million over five years and come from a legal settlement in which the Port was accused of breaching the protocols of an environmental impact assessment (Ang-Olson, 2005).

program for emissions reductions that include idling reductions (Texas Commission on Environmental Quality, 2004).

Voucher System: Delaware can theoretically increase highway safety, enhance driver comfort, reduce idling significantly, and promote local economic development by partnering with motel chains and truck drivers to create a voucher system whereby drivers can stay over night in motels. This option is particularly attractive when used in winter, and in urbanized areas where commercial truck stops and other appropriate overnight rest areas are not available. In practice, however, this approach to idle reduction is rather infeasible beyond a small scale since few motels have sufficient parking for trucks.

Section 1: Introduction

Trucking is one of the cornerstones of U.S. commerce, and an estimated 458,000 long-haul truckers travel more than 500 miles each per day, carrying 56% of the U.S. freight (Stodolsky et al., 2000). Long-haul trucks are defined as commercial freight trucks (frequently called "tractor trailers" or "18 wheelers") that typically make trips of more than 500 miles and do not return to a central depot or home base each day. Long-haul truck drivers typically spend 18-24 days of the month on the road, frequently using their truck cabs as living quarters. These trucks are also called "heavy duty" in the field of transportation.

1.1. Long-Haul Truck Idling Problem

Each year truckers spend 1,600-1,800 hours idling their engines while loading and unloading, awaiting dispatch, stalled in traffic, regulating cab climate, maintaining engine temperature, and powering electrical appliances (Stodolsky et al., 2000). Truck idling[9] poses a range of technical and environmental challenges. Idling places strain on truck engines, generates noise pollution above regulated thresholds, and contributes to air pollution.

Idling burns approximately 1 gallon of fuel per hour, and it is estimated that over 1.2 billion gallons of diesel fuel are consumed by parked trucks each year (Stodolsky et al., 2000). This fuel consumption releases 11 million tons of carbon dioxide, 136,000 tons of carbon monoxide, 180,000 tons of nitrogen oxide, and 5,000 tons of particulate matter. These air emissions damage the environment and human health and pose a regulatory challenge to states attempting to comply with EPA air quality standards.[10]

In addition to the environmental costs, idling incurs economic costs for drivers and for trucking companies. Idling engines operate at 3%-11% efficiency, compared to 40% engine efficiency while driving. This inefficiency wastes both engine oil and fuel, and has become an important issue for the trucking industry following an increase in average fuel prices from $1.80 in 2004 to $3.05 in August 2006 (Kilcarr, 2004; EIA, 2006). Idling also causes engines to experience greater wear and tear, and the U.S. Department of Energy estimates that $1 billion is spent each year on idling-related engine repairs (U.S. DOE, 2006).[11]

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[9] Idling refers to the act of running a vehicle's engine while being parked for a period of time when the vehicle is not in operation. Technically speaking, engine idling occurs when vehicles are stopped at traffic lights. Those vehicles, however, are said to be in operation since they are in transit to a destination. This report uses the commonly used meaning of idling whereby drivers intentionally leave the engine running to power a non-transit function or for some measures of convenience.

[10] In addition to the environmental and health impacts associated with idling emissions, noise pollution generated by idling trucks parked overnight at truck stops can cause sleep loss and impact driver performance and safety (NYSERDA, 2004).

[11] According to the American Trucking Association (2003), the cost of engine wear due to unnecessary engine idling is $0.23 per hour, implying that engine wear costs for a driver idling 1,600-1,800 hours per year is about $370 to $410 annually.

In its position as a major stopping point along the north-south corridor of the eastern seaboard of the United States, the State of Delaware has a disproportionately large amount of commercial truck traffic relative to its size and population. Of particular concern to the State of Delaware are the effects of trucks that are parked (usually at public rest stops, commercial truck stops, and occasionally at warehouses and the shoulders of highways), yet continue to have their engines operating. Idling trucks are a concern in all areas of Delaware but especially along Interstate 95 where population density is high and traffic is increasing in tandem with economic growth.[12]

1.2. Non-Attainment Status

All three of Delaware's counties are currently classified as ozone non-attainment areas under the EPA's National Ambient Air Quality Standards (NAAQS) (Schuster et al., 2004).[13] Because truck emissions are a significant contributor to ground-level ozone, Delaware could integrate efforts to curb truck idling into its state implementation plan (SIP) for EPA air quality standards attainment. A potential consequence for continued non-attainment is the loss of roughly $250 million in federal transportation funds. A loss of funds of this magnitude would be disastrous for the state since it represents a large proportion of its overall transportation budget.

In addition to the ozone problem described above, New Castle County is in non-compliance for particulate matter (PM). PM, also called soot, is responsible for severe and chronic respiratory diseases, particularly in urban areas and among vulnerable populations such as children and the elderly. Kent County is at risk of being non-compliant for PM under the more stringent 8-hour average test method the EPA has recently implemented.

Table 1.1 below from American Lung Association data shows the air quality grades earned by Delaware's counties. Idling activity is a contributor to the diesel emissions and to these poor air quality grades.

Table 1.1 Air Quality Grades in Delaware's Counties

County	**State of the Air 2005 Pollution Type**	
	Ozone (from NOx, VOCs)	Particulates (24 hour test)
New Castle	F	F
Kent	F	D
Sussex	F	D

Source: American Lung Association, Delaware Chapter. *State of the Air 2005.*

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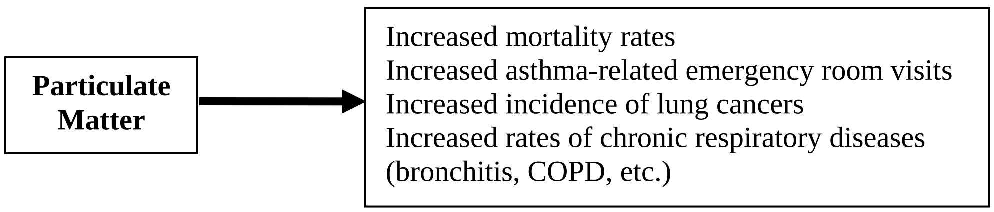
[12] The poultry industry in the southern part of the state, manufacturing, supermarkets, large retailers, outlet stores, electronic commerce and cargo traffic to the Port of Wilmington are also major sources of truck idling.

[13] The U.S. EPA's new standards measure averages over longer periods, such as 8 or 24 hours, instead of the 1-hour, or spot, tests used in the past. All three Delaware counties are in non-attainment for eight-hour average ozone concentrations (www.epa.gov/oar/oaqps/greenbk/gnca.html#6163).

The Delaware chapter of the American Lung Association (2005) says that 44,000 state residents suffer from asthma, with children accounting for 16,000 of those with the condition. The costs of treating those children with asthma run more than $10 million each year, and it is estimated that 50,000 lost school days result from asthma treatment. A substantial portion of these asthma events are related to ground level ozone formation that is largely attributable to NOx and VOC emissions.

Ozone-induced asthma attacks are such a serious problem in many urban areas that color-coded warning systems have been created to warn vulnerable residents to stay indoors on days of especially bad air quality.[14] Figure 1.1 below helps to frame the scope of the health consequences for particulate matter by illustrating the multiplier effect on health impacts of harmful diesel emissions. Tremendous social and economic costs result from this multiplier effect, and effective emissions reductions have corresponding benefits for public health (CDC, Health U.S., 2004).

Figure 1.1 Health Consequences of Particulate Matter



Source: CDC, Health U.S., 2004.

In recent years there have been efforts in the field of environmental regulation and management to establish environmental justice as a top criterion in the decision-making process and to increase the participation of stakeholders from the community in deliberations over proposed public policy changes (see, for reference, the US EPA's homepage for Environmental Justice at www.epa.gov/compliance/environmentaljustice/).

Citizens residing in high-density urban areas face greater exposure risks than do residents of suburban and rural areas, and these city dwellers are often members of low income or minority communities. People who live in a city along a main boulevard are exposed to the diesel emissions of dozens of buses and trucks on a daily basis that people outside the city are not exposed to.[15] People along the I-95/I-495 corridor in New Castle County, and particularly the residents of Wilmington, have much more exposure and associated health risks from the hazardous emissions of diesel engines. Areas in red (Figure 1.2) highlight the urbanized areas with high population density. The volume of trucks is especially large in these areas because of the number of out-of-state trucks passing through Delaware in transit to other destinations along I-95/I-495 and transport needs of poultry industry in southern Delaware.

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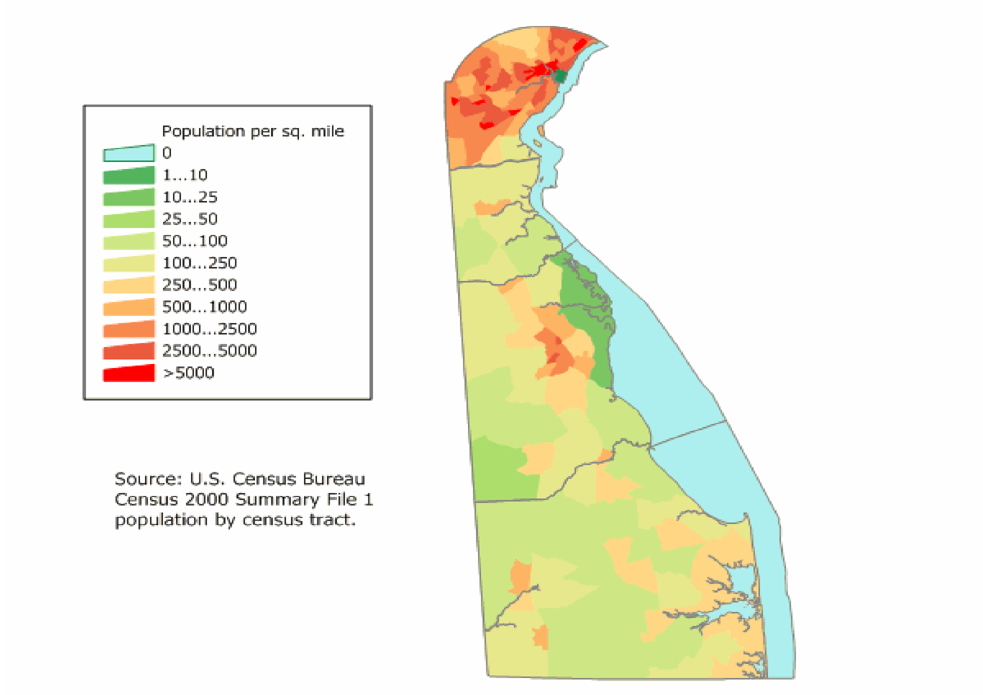
[14] The Clean Air Council (www.cleanair.org) and DNREC (www.dnrec.state.de.us/air/aqm_page/airmont/air.asp) have online color-coded air quality rating systems.
[15] The city dwellers' exposure is often aggravated by other health vulnerabilities and a lack of treatment options due to a lack of insurance.

Figure 1.2 Population Density in Delaware



1.3. Objectives and Methods

The Center for Energy and Environmental Policy (CEEP) is conducting research to explore strategies to reduce the negative environmental and economic impacts of truck engine idling in Delaware. This project has been supported by the Delaware Department of Transportation through the Delaware Center for Transportation, University of Delaware. Truck traffic, and truck idling, generates local and regional air pollution that poses public health and regulatory risks for Delaware.

1.3.1. Project Objectives

Because truck emissions are a significant contributor to ground-level ozone, Delaware should consider following the lead of other states and integrate truck anti-idling strategies into its EPA State Implementation Plan (SIP). Located in the corridor of the U.S. Interstate 95, Delaware has heavy long haul truck traffic and accommodates significant numbers of them in truck stops near I-95. Besides stationary idling of long haul trucks parked for extended periods, idling by delivery and short-haul trucks and by trucks idled in congestion while in operation are other issues within the State of Delaware. The focus of this report is, however, on idling issues of long haul trucks.

The main objectives of this study are to:

- Investigate the cost, liability, and reliability of anti-idling equipments for trucks;
- Evaluate environmental, energy, and economic impacts of idled trucks and anti-idling equipment solutions; and
- Develop a set of policy recommendations to both curb idling and facilitate the entry of anti-idling equipment into the marketplace in Delaware.

1.3.2. Methods

The researchers made on-site visits to truck stops, rest stops, and commercial truck fleets to observe the idle reduction equipment being used, the behavior of drivers, and the physical location and condition of the facilities. These onsite visits included trips to New Jersey and Pennsylvania as well as locations around Delaware. A truck stop with truck stop electrification was visited, and a large truck fleet using mobile idle reduction technologies was investigated. Some on-site visits included personal interviews with owners or managers, while some visits were strictly for observation. Interviews with approximately forty truck drivers were completed at four locations.[16] In addition to the on-site research described above, telephone interviews were conducted with a wide range of equipment manufacturers, industry organizations, truck companies, and non-profit groups promoting clean air.

There is a growing body of literature on idle reduction technologies and associated policies and programs. This report used a number of authoritative sources of published literature including the U.S. EPA, the U.S. DOE, the California Air Resources Board (CARB), the New York State Energy Research and Development Authority (NYSERDA), national laboratories like Argonne National Laboratory, industry groups such as the American Trucking Associations, non-profit groups such as the Clean Air Council, and trade publications such as *Fleet Owner* and *Transport Topics*. The scope and substance of this study are influenced by a number of parameters, including state laws, federal regulations, socio-commercial features unique to Delaware, trucking industry characteristics, and available technology options. This report reflects these parameters using case studies.

The final project report briefly describes the project team's findings. Each of the subsequent sections in this report corresponds to one of the following six project tasks identified in the project proposal:

- Identification of mobile and stationary anti-idling equipment;
- Survey of truck idling in Delaware;
- E^3 impact evaluations of the selected anti-idling technologies;
- Review of current anti-idling policy and initiatives;
- Case studies; and
- Policy suggestions

[16] It is noted, however, that although these interviews were highly valuable for the anecdotes shared and insights gained, but they are limited in scope and were not based on randomly sampled surveys.

Section 2: Mobile and Stationary Anti-Idling Equipment

This Section identifies current and emerging truck anti-idling technologies and evaluates their cost, liability, and reliability through literature reviews, Internet research, and initial interviews with stake holders in industry associations, the private sector, and local, state, and federal governments.

2.1. Types of Anti-Idling Technology

Idling technologies can be generally divided into two categories: mobile technologies and stationary sources. Mobile systems include automatic engine shutdown system, battery powered systems, diesel fuel fired heaters, and other auxiliary power units (APUs) or generator sets. Stationary systems include both off-board and on-board[17] truck stop electrification (TSE). An important distinction between mobile and stationary idle reduction products is that the mobile solutions often provide limited functionality.[18]

2.1.1. Mobile Technologies

2.1.1.1. Engine Management Systems

Engine management systems, also referred to as automatic shut-down/start-up systems, allow truckers to program their engines to turn off and on according to certain parameters. Engines can be programmed to shut down after a preset period of time, and most systems have modes in which the engines cycle off and on based on engine temperature, cabin temperature, and/or battery voltage (Fleet Owner, 2003).

One of the primary advantages of these systems is that they are easy to install, and do not require significant modifications to the trucks. The drawback of these systems is that, although they reduce the amount of time spent idling, they do not address the inherent inefficiencies associated with idled engines. Engine management systems also can be disruptive to drivers' rest when they cycle on and off (Stodolsky et al., 2000). A recent survey of truckers revealed that 55% of the respondents had some form of engine management system installed in their trucks (Tunnell and Dick, 2006).

The costs for these systems range from below $1000 to $2,500, depending on the manufacturer and the systems' complexity (SmartWay Transport Partnership, 2006a; Turchetta, 2005).

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[17] On-board TSE is also referred to as truck-board

[18] In other words, they may provide heating and cooling, but not electric power, for example, or they may heat the truck cab and sleeper compartments and not the engine. Thus many mobile devices are of limited value depending on the particular characteristics of the driver, the truck, the climate, and the operating conditions.

2.1.1.2. Direct Fuel-Fired Heaters

Direct-fired heaters were developed in the 1950s and are widely available. For decades, direct-fired heaters have been available from companies like Espar Heater Systems, based in Ontario, Canada, and Michigan-based Webasto Thermosystems, which is also working on a Thermo Cooler concept to provide both heating and cooling (Leavitt, 2001). Usually they are small, lightweight devices installed in the tool or luggage compartment. Direct-fired heaters can be used to heat both the sleeper cabin and the engine as necessary. They do not provide cooling nor power for accessories and appliances, however. Direct-fired heaters are used in about 90% of the trucks in Europe but only 35% in the United States (Leavitt, 2002; Tunnell and Dick, 2006).

According to Argonne National Laboratory, direct-fired heaters are many times more efficient (80%) than engine idling (11-15%), typically running 20-plus hours on a single gallon of diesel, as compared to idled engines burning 1 gallon of fuel per hour (Leavitt, 2001). This is because direct-fired heaters supply heat directly from a combustion flame to a small heat exchanger, while the diesel engine must first burn fuel to overcome engine friction, and only part of the waste heat from the engine is transferred to the heating system (Argonne National Laboratory, 2000). Mountaire Farms of Millsboro, which is one of the largest private truck fleet in Delaware, has installed more than half of its fleet with Webasto direct-fired heaters.

Direct-fired heaters cost about $800-1500 and use negligible battery power from the truck engine. They cost approximately $110 per year to operate, and come with 2-3 year warranties (SmartWay Transport Partnership, 2006a; Tunnell and Dick, 2006).

2.1.1.3. Generators and Auxiliary Power Units (APUs)

Generators are powered by 1- to 4-cycle diesel engines and produce AC electricity to power plug-in appliances like air-conditioners, heaters, and entertainment systems. Auxiliary power units (APUs), meanwhile, consist of a small engine, a compressor, and an alternator that are fully integrated into the truck's existing heating, ventilation, air conditioning, and battery-charging system. An inverter can be added to an APU so that it can serve as a source for AC power for appliances as well (Fleet Owner, 2003). Generators and APUs are versatile technologies that can provide a wide range of energy services to truckers, including emergency power.[19]

Pony Pack APUs fit within a 2-foot cube, at 21 by 22 by 22 inches and are one of the most common brands on the market. Cooling capacity is up to 30,000 Btu. The engine produces between 50,000 and 60,000 Btu of hot coolant to be circulated through the main engine and the cab's heating system. They weigh about 300 pounds installed. In contrast, the comparably sized

[19] One of the greatest benefits of APUs is their portability. Because the units are truck-mounted, they can be used virtually anywhere, including at loading docks. They may even be valuable as survival units in case of a truck breakdown in extreme weather conditions (U.S. DOE, EERE, 2005).

Willis-branded APU has an output of 54,500 Btu for air conditioning and 42,000 Btu for heating. The Willis APUs weigh 332 pounds and come with a 130-amp, 12-volt alternator standard.

An increasingly popular new model is Thermo King's TriPac Auxiliary Heating/Cooling Temperature Management System that features a microprocessor control to efficiently allocate energy between the engine for pre-heating, the battery, and heating/cooling in the cab. ThermoKing claims the payback for its product is faster than other APUs, and ThermoKing does have a large network of national dealers that can provide prompt maintenance and repair. The TriPac has added noise insulation and can power any on-board appliance with an inverter module. More recently, Espar and other companies have introduced electrically controlled heating and cooling systems to the market. These products are powered off the truck's battery, meaning that no diesel is consumed like standard APUs. They are comparatively light and can be mounted under the bunk or on the cab roof.

Dometic Corp. has created an integrated auxiliary HVAC and power-generation system called Idle Solutions that operates completely isolated from the main engine and other truck systems. The Idle Solutions system consists of a Dometic 14,000 BTU air-conditioning system and 2,500-watt heating system, and a Temco 1,800-rpm 7.8 kW power generator. The HVAC system consists of a condensing unit, which is mounted outside the truck, and a cooling/heating unit, which is installed inside the sleeper, usually under a bunk or seat. The two components are connected by flexible refrigerant tubes.

The principal drawbacks of APUs are their higher initial costs, their comparative complexity, and their weight, which can be up to 400 pounds.[20] While this added weight has a negligible impact on fuel economy, it reduces the load that weight-limited trucks can carry. There is also concern from the California Air Resources Board that, with more stringent standards for truck engines, unregulated diesel-fired APUs may eventually generate more emissions than the main engine (Fischer, 2006; Gaines, 2004). The market penetration for APUs among U.S. truckers is estimated to be 12% (Tunnell and Dick, 2006). Recent studies have also shown that fuel cells can have a competitive payback when used as APUs, and fuel cells are currently being developed for commercial use as anti-idling technologies (Brodrick et al., 2002b; North, 2005; Thomas, 2002).

For APUs with combined cab heat/air conditioning, electric power, and heat to the engine and fuel, the cost is estimated to be around \$7,000 - \$10,000 installed, while other researchers find equipment costs to be in the range of \$5,000 - \$9,000 (Proc et al., 2003; SmartWay Transport Partnership, 2006a). However, the operating cost of APUs is estimated to be twice as much as the operating cost of using a truck stop electrification (TSE) system at a truck stop (Berg, 2005).

[20] The National Energy Policy Act of 2005 created an exclusion, or exempt allowance, for onboard anti-idling devices of up to 400 pounds (Transport Topics, 2006). Many fleets and truckers, however, are unaware of this provision.

Figure 2.1 Examples of APUs

a) Example of a Generic APU

b) Truck Not Suitable for APU[21]

2.1.1.4. Thermal Energy Storage (TES)

Thermo energy storage (TES) systems are an emerging technology and do not yet enjoy large-scale market penetration. Webasto’s offering is called “BlueCool” and is designed to keep the cab or sleeper bunk of a heavy-duty truck cool on hot nights without requiring the idling of the truck's engine or the running of an auxiliary power unit. While direct-fired heaters are light weight and use very little diesel fuel, the addition of air conditioning adds significant weight and requires much more power. The BlueCool product uses a different approach to achieve an effective cooling solution. The core technology is an innovative cold storage cell that is charged during the daytime when the truck is being driven. At night, the truck engine can be switched off, the BlueCool system turned on, with the result that cool air is circulated throughout the truck’s interior.

A BlueCool system runs independent of the vehicle's air-conditioner, utilizing only small amounts of electricity to circulate super-chilled coolant (between the cold storage unit and a heat exchanger in the truck sleeper cabin) and to run four small, quiet air distribution fans. Controls are simple: one rotary temperature knob and a variable fan speed control with an integrated on/off switch. Air vents are manually adjustable to provide optimal airflow throughout the cabin. The cold storage unit puts out an impressive 17,000 BTUs. Other companies are rolling out similar thermo-storage devices that employ heat exchangers. Authotherm’s Energy Recovery System, for example, uses a battery charged by the engine to circulate the heat in the engine and radiator into the cab via a heat exchanger.

The costs of these systems vary widely depending on the technologies employed. Webasto’s system costs around $2,300.

[21] An increasing number of truck brands include aerodynamic side panels (“railings”) that improve fuel efficiency. Made of lightweight fiberglass, they are unable to support APUs that frequently weigh more than 300 lbs.

2.1.1.5. Inverter/Chargers with Auxiliary Batteries

In one survey, 24% of drivers indicated that they had used a battery-powered system that encompasses an inverter/charger setup (Tunnell and Dick, 2006). The auxiliary batteries are generally charged by the truck's engine during operation and then discharged from the battery when the truck ceases operations. Batteries can also be charged by shorepower systems (see below).[22] The resulting energy can be used for heating and cooling as well as powering appliances and accessories.

Inverters are typically part of any APU-type package, and Xantrex Technology is the market leader for inverters. Xantrex's RM1012 model inverter, for example, weighs 40 pounds with 35 pounds of harnesses, brackets, and cables. It converts battery or diesel motor power into 120 volt AC power for any appliance or accessory. Xantrex inverters come in a wide range of wattage, with 1,000 – 3,000 watts common, and they are increasingly sophisticated with displays and controls that regulate directional flows, amperage and voltage, safety shutoffs, etc.

The Xantrex Heavy Duty Inverter/Charger/Shorepower unit or the FleetPower 2500 have an automatic sensor that detects when an external shorepower electrical connection is present. That connection overrides any power withdrawal from the batteries and charges them. Consequently, this product is appealing since it can be used in any environment and provides power from two sources, the battery or external electrical outlet.

Electricity generated at a power plant – and then used by trucks through battery storage and inversion from AC to DC power - is much more efficient than the diesel burned in an APU (31% versus 17%, respectively, Argonne National Laboratory). Other advantages of inverter/auxiliary battery hybrid solutions include:

- Virtually maintenance free
- Requires no fuel storage
- Inverters provide exactly the amount of electricity needed
- Batteries can be charged in many ways or locations
- They run silently compared to fuel burning equipment

Inverters/batteries typically cost \$3,000 - \$7,000 with \$200 in estimated annual maintenance, while on-board HVAC equipment used in conjunction with these systems costs \$500 - \$1,600 (SmartWay Transport Partnership, 2006a; Tunnel and Dick, 2006).

Table 2.1 below provides some comparative evaluations between different mobile technologies.

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[22] Shorepower refers to a type of stationary technology for truck stop electrification in which trucks pull up as a boat would into a marina dock and plug-into an electrical outlet. This is in contrast to the other common type of truck stop electrification in which cables and power lines hang from infrastructure above the truck cab.

Table 2.1 Assessing the Pros and Cons of Mobile Idle-Reduction Technologies

		Cost	Pros	Cons
Mobile Technology Type	Engine Control Module	$0	No extra cost. Available from engine manufacturer.	Does not address cab comfort or provide power so not really a solution.
	Automatic Shutdown/Turn-On System	$1,000–$2,500	Low cost. Available from engine manufacturer.	Does not address cab comfort or provide power so not really a solution.
	Direct-Fired Heaters	$800–$1,500	Low cost. Lightweight. Available from engine manufacturer.	Provides heat only –useful only six months per year in Delaware.
	Auxiliary Power Units/Generator Sets	$5,000–$9,000	Provides all power needs.	Expensive, heavy, noisy, maintenance intensive. Requires after-market retrofit. Emits pollutants.
	Auxiliary Battery Powered Heating/AC with Inverter	$3,000–$7,000	Provides all power needs. Zero emissions from truck.	Moderately heavy. Draws down engine battery quickly. Expensive.

Source: CEEP research, Turner-Fairbank Highway Research Center, Federal Highway Administration

2.1.2. Stationary Technologies

While mobile anti-idling technologies travel with the truck, stationary anti-idling technologies are fixed locations where trucks can purchase energy services (i.e. heat, cooling, or electricity). Stationary anti-idling technologies, also known as truck stop electrification (TSE) systems, are classified as either on-board systems, or off-board systems. Onboard systems require that dedicated heating and cooling systems be installed within the truck, while off-board systems provide heating, cooling, and electricity through an external connection.[23] Table 4.6 below summarizes the two stationary technologies on the market, while a detailed description of each type and its manufacturer is included afterwards.

[23] The U.S. EPA refers to onboard technologies as "dual system" technologies because they require installations both inside and outside the truck, while off-board technologies are referred to as "single system" technologies because no additional technology installations are required within the truck.

Table 2.2 Assessing the Pros and Cons of Idle-Reduction Technologies

		Cost	Pros	Cons
Stationary Technology Type	**On-board Solution -** Electrified parking spaces. Provided by Shurepower LLC. ("shorepower" technology has been used for many years by RVs and boat marinas. AC electric outlets are provided to power equipment inside the truck, Internet and cable TV are part of the plan). $1.00 - $1.25 per hour for to use.	$8,000 per space, $10,000 for small installations	Lower cost. More flexible and adaptable.	Requires modifications to truck (electric heat/AC, inverter/charger)
	Off-board Solution – External equipment attaches to cab window. Provided by IdleAire Technologies Corp. (Driver receives filtered, hot/cool air as well as on-demand movies, internet, and electric outlets). $1.50 - $2.00 per hour for to use. Another company called AirPower Corporation of Texas has offered a similar product but is not competitive in the market.	$16,000 per space with subsidies, $22,000 at market rate.	No truck modifications needed.	Very expensive. High speed wireless Internet and satellite could reduce future usage.

Source*:* CEEP Research; Turner-Fairbank Highway Research Center; and Federal Highway Administration

2.1.2.1. On-Board Truck Stop Electrification

Campgrounds in the United States have provided electrical outlets for camper cars, or RVs, to pull up to and plug in for many years. These systems are frequently called "shorepower" systems, and the term comes from boats that pull up to electrical outlets in marinas. The company name Shurepower is, consequently, a linguistic play on the existing "shorepower" terminology. According to a recent survey, 88% of truck fleets support the development of shorepower (Cullen, 2003).

Shurepower's TSE product takes the same campground and marina "pull-in and plug-in" concept and transfers it to the truck stop environment. It simply provides reliable electrical power in the voltage and alternating current (AC) that household appliances and accessories normally use. Once a driver plugs in, the electricity can be used to power a wide range of on-board devices, engine components, or auxiliary equipment. This includes additional batteries or main engine batteries. A shorepower system includes 120-volt wiring in the sleeper, a 12-to-120-volt inverter and an extension cord.

In operational terms, Shurepower concludes a site agreement with the host truck stop that includes local contractors – for installation and maintenance – and the local utility. Installation of Shurepower's pull-up service pedestals involves digging up the truck stop's pavement, which can be a disincentive to truck stop operators. To make the relationship more attractive for the truck stop, Shurepower provides a commission of 5-10% of all sales to the truck stop. Thus, the truck stop owner has a financial incentive, as a vested partner, to market the system. The kiosk itself is small and does not reduce the area available for trucks to park. Shurepower supports its TSE product with a 24/7 call center, and claims that the only significant disruption it has experienced involved a power surge from lightning.

Figure 2.2 Shurepower Kiosk and Shurepower Truck Connection

Shorepower system (external plug-in)

A kiosk of the type offered by Shurepower

For a driver with existing heating/cooling units, extra batteries, and other items, the installation of an external outlet adapter (duplex receptacle) and some wiring is the only equipment required at a cost of $200; this "Level 1 Komfort Kit" includes a distribution box with breakers that goes in the truck, a small portable heater, weatherproofing, and extension cord, and interior wiring with a face-plate type of dual plug receptacle.

Drivers or fleet owners can buy a range of higher level Komfort Kits. A Level 2 kit offers heating and cooling plus an additional outlet, with optional remote digital thermostat. The highest-level kit includes the items above plus a Xantrex inverter, additional dual outlet adapter, and power switch to change to battery power when an external plug-in is not available. Auxiliary batteries run separate from the engine battery are recommended for this option.

A customized package is available and can include extra batteries, a bigger inverter, and/or an APU (PonyPack or similar). Regardless of what options Shurepower offers, the company is betting that truck makers will start offering shorepower wiring and external adapters as standard equipment. The company believes about 10% of all trucks now have shorepower wiring, and that percentage is probably higher in California due to stringent regulations in that state (Thomas, 2005). At this time Shurepower has its product operational only at one or two truck stops in upstate New York but has an agreement to install it in seven locations in Oregon and Washington.[24]

Electric plug-ins are available in other places besides truck stops, although some effort may be required to find those locations. At many loading docks when trucks are stopped for an hour or two, many companies will allow drivers to plug-in at the docking area. Port facilities and other locations also have electricity available, or will be adding that capability in coming years. Using an extension cord, an owner/operator can also plug-in at home or where ever grid electricity is available. This is where Shurepower's TSE product has a potentially big advantage over rival IdleAire's product; it can be used anywhere electricity is available, even if that place does not have a Shurepower kiosk.

For drivers it costs $1.00 to $1.50 per hour to plug-in to Shurepower's service pedestal, and that is accomplished by swiping an account card through a kiosk. That makes the cost for an eight-hour sleep in the $8.00 -$12.00 range, compared to $20.00 when idling for a similar period if diesel is $2.50 per gallon. Furthermore, there are a number of intangible or hidden benefits provided by the Shurepower TSE, including a quiet night's sleep for the driver and drastically lower maintenance costs. It also eliminates the possibility of a police ticket and provides the community with cleaner air.

Shurepower has received technical and financial support from NYSERDA and is working on new technologies including ones for refrigerated trucks and regenerative breaking systems. Shurepower can also provide Internet, cable TV, WiFi, and telephone connections to clients who want them. Shurepower has also received financing from the U.S. EPA, the U.S. DOE, the state of Texas, and The Climate Trust (Oregon/Washington state partnership).

2.1.2.2. Off-Board Truckstop Electrification

Founded in 2000, IdleAire's TSE system offers not only electrical hookups like Shurepower's product but also air conditioning/heating, Internet access, telephone and television services. All this is done via a service unit that attaches to the passenger-side window (see below image), using a $10 adapter that takes less than five minutes to install. There is a per-hour charge for use, ranging from roughly $1.50 to $2.15. The company also calls its TSE a "shorepower" system, but technically speaking it is not a shorepower-type of hookup. With over 4 million hours of service provided at more than 30 locations across the country, the product has shown a high level of reliability and market penetration. In some places availability is a problem as demand exceeds supply considerably, particularly during winter in colder climates.

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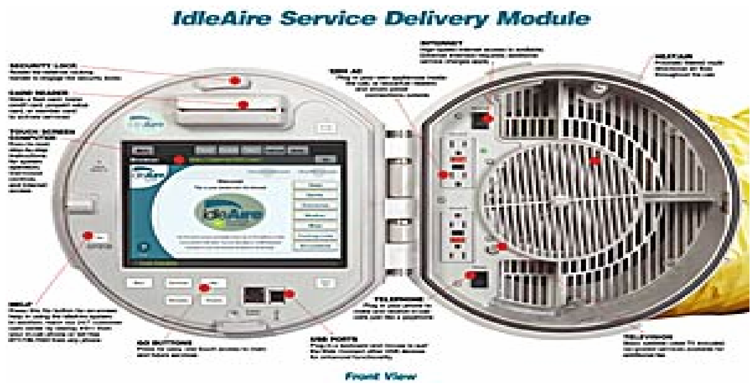
[24] A project at the Walt Whitman Truck Stop in Philadelphia was cancelled when the truck stop property was closed for redevelopment into other uses. Shurepower has been blocked from many potential truck stops by its competitor, IdleAire, which was first to market and signed exclusive "no-compete" contracts with at least three of the largest truck stop chains.

Figure 2.3 IdleAire's Service Unit that Connects to the Driver's Door



Source: Image courtesy of IdleAire.

Newt Gingrich has served as the company's lobbyist and spokesperson (Thomas, 2005) and it is rumored that a United States senator is a major shareholder in the privately held firm. A nearby neighbor of IdleAire's in Tennessee, Siemens Electronics Manufacturing, produces some of the critical components for IdleAire's product, and the company has trademarked the term "Advanced Truckstop Electrification (ATE)" to brand itself as a superior type of TSE system.

IdleAire has created a non-profit organization called the "Driver Education & Idling Reduction Foundation" to conduct driver education and training on idling issues, and that education will be delivered by the company's service module to drivers at IdleAire locations (IdleAire, 2005). The foundation also creates opportunities to receive private grants and conduct low cost driver research that benefits the for-profit corporate side of the business.

Figure 2.4 Infrastructure of IdleAire's TSE System and Service Module Hookup

As for operations, a major difference with Shurepower is that IdleAire has a company employee on-site at every truck stop it operates. This site coordinator is responsible for all operations including driver education, maintenance, account management, and security. IdleAire, as a company policy, will only operate at large truck stops where it can install at least fifty units, or parking spaces, with its product.[25] Payment for services is made by swiping a member card through an account reader.

IdleAire requires a large site to generate enough revenues to cover the labor cost of the on-site coordinators who generally work in three shifts around the clock. The business model also depends on the truck stop providing its parking lot for free, in exchange for a small cut of the revenues. At just $1.70 per hour as the customer charge, IdleAire's TSE would seem to require a very high volume and utilization rate to make a profit when one considers that its overhead infrastructure (see image below) costs roughly $16,000 - 22,000 per parking spot (IdleAire, 2006).

To provide a sense for how expensive IdleAire's TSE system costs, a January 2006 press release from the company announced that it had issued $320 million in debt in order to finance its expansion. The company stated that the $320 million would be used to construct about 13,200 spaces, but that figure does not include about $42 million in public subsidies that the same press release acknowledged (IdleAire, 2006).[26] At most locations IdleAire has on-site managers 24 hours per day, 7 days per week including holidays, meaning that they have three full time employees on the payroll for each truck stop where it operates. That appears to be a significant expense when one considers the relatively meager revenue stream.

There is a danger, cited by Iowa State University's Center for Transportation Research and Education (Boeckenstedt, 2005), that IdleAire's technology or product will become obsolete before its expected a 15-year life cycle is completed. This conclusion was also reached by a NYSERDA-commissioned report (Antares Group, 2005). IdleAire's revenue stream could take a big hit in future years as truckers substitute IdleAire's e-mail, movie-on-demand, and other services with WiMax and satellite-based services provided by their companies or associations. Chris Driscoll of the Technology & Maintenance Council of the American Trucking Associations is quoted as saying "When the wireless industry unveils WiMax, you will see a revolution in the way data is transferred" (Reddy, 2006).

As further evidence of the potential danger to IdleAire's revenues, TravelCenters of America, according to an article in Computerworld, has opted out of IdleAire's internet service in favor of its own WiFi service so that it doesn't have to share income with IdleAire (Brewin, 2003). Driver demand for IdleAire's music, movies, and games could quickly shrink, and threaten IdleAire's profitability, as more and more drivers obtain their own DVD players, TVs, stereos/satellite radios, and computers. The most recent data (see Table 4.7 below) shows drivers with the following convenience and entertainment-related items on-board – with the implication that in the future many drivers will not use IdleAire's services beyond its heating and cooling functions.

[25] This effectively eliminates the potential for the IdleAire TSE in Delaware.

[26] That equates to about $27,424 per space, or $5 per day for 15 years of operation, not including the labor expense of the on-site coordinators, maintenance, and a considerable amount of interest.

Table 2.3 Use of On-board Appliances

Appliance/Accessory Type Requiring Electric Power	% of Drivers With Appliance On-board
CB radios	90%
Mobile phones	84%
Televisions	61%
Stereos/satellite radios	58%
DVD players	42%
Computers	39%
Refrigerators	58%
Microwaves	29%
Coffee makers	23%
Lamps, blankets, razors, etc.	5-45%

Source: ATRI, 2006.

IdleAire has concluded contracts with three of the four largest national truck chains and more than 1,300 truck fleets have signed up as members to use IdleAire's off-board services (Kelly, 2005). These contracts are exclusive in that they prevent those truck stop chains from using a TSE system from any other manufacturer. IdleAire has a dominant market position that will make it difficult for Shurepower to be competitive in the short term, yet IdleAire's business model and technology may not be viable in the long term. However, for air quality officials focused on immediate emissions reductions, IdleAire's TSE product, like that of its smaller competitor, eliminates idling while saving fuel, reducing maintenance costs, and complying with anti-idling laws. At the same time, the cost effectiveness of the off-board approach remains dubious.

2.1.3. Emerging Technologies

In addition to the established anti-idling technologies discussed above, there is a wide range of systems currently under development.

2.1.3.1. Hydrogen Fuel Cells

Germany-based Webasto has strong ties to fuel cell makers and is performing experimental work to make APUs powered by solid oxide fuel cell (SOFC) technology (Wunderlich and Boltze, 2005). At a presentation at an EPA conference (Air Innovations 2005, Chicago), the company promoted the fact that it has been in business since 1901 and does not accept any government subsidies for its R&D. Its fuel cell APU will provide power for every function a truck could need without idling, and should be semi-commercialized in five years or so.

Freightliner's subsidiary is developing a hydrogen fuel cell that could be ready for testing in five years and it would likely receive support from the U.S. Department of Energy due the Bush Administration's large investments in fuel cell R&D, according to an article entitled "Can You Kick The Idling Habit? Why you should, and how you can" (Thomas, 2005).

Noteworthy is also a major report done by Argonne National Laboratory and the Department of Energy that pushed for funding to develop hydrogen fuel cells specifically to help alleviate idling by long haul trucks ("The Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks", 2000).

2.1.3.2. Hybrid Diesel-Electric Engines

Eaton and other companies have hybrid engine technologies in semi-commercial stage, and these trucks will likely have new generation APUs (Boeckenstedt, 2005), possible with regenerative braking technologies. Japanese firms like Mitsubishi Fuso Truck and Bus Corporation (a subsidiary of DaimlerChrysler), Nissan Diesel Motor Company, and Hino Motors (a Toyota subsidiary) appear to be leaders in this field (Nikkei and Asia Pulse Pte Ltd, 2006; Mitsubishi Fuso Truck and Bus, 2005). UPS is also a big player in hybrid trucks, although its fleet is generally short or medium haul over generally fixed routes, and not long-haul .

In March 2006, Volvo's truck and bus division announced it had created a diesel-electric heavy-duty engine that would go into production in 2009.[27] Volvo cited big breakthroughs in battery technology as the key to its new product and disclosed that the U.S. Air Force had purchased five for field testing (Agence France Presse, 2006).

2.1.3.3. Super Insulated Sleeper Cabs

Truck drivers report that 56-72% of the time they spend idling is specifically for the purpose of heating or cooling the interior of their trucks (Tunnell and Dick, 2006). Two inches of insulation and thermal window covers could maintain a 60-70º F cab temperature when outside temperatures are 40-50º. This is probably the most overlooked and under-appreciated strategy toward anti-idling compliance, but one of the most cost effective methods since it provides a comfortable cab/sleeper climate for many hours (e-RoadStar.com, 2005). If drivers do not demand it from truck manufacturers at the time of purchase, super insulation is not likely to become commonplace despite its favorable financial payback.

2.1.3.4. Roof Integrated Photovoltaic Cells

A roof-integrated PV product has been demonstrated on a Sainsbury supermarket refrigerated truck in the United Kingdom for heating and cooling purposes (ATA Technology and Maintenance Council, 2003; Tubb, 2001). This technology, especially when paired with battery storage, has good potential as a mobile idle reduction solution. While solar electric power can be intermittent, roof integrated PV only needs to generate enough power to provide heating or cooling for a portion of the day (or, more often, night) and a few appliances that are used relatively briefly.

[27] Ozark Trucking is testing eight trucks with LNG engines in the eastern United States (Thomas, 2005).

Roof and wall integrated PV is a proven, albeit expensive, product on some green buildings (Strong, n/d) and consequently the technological leap from building roofs to truck roofs is not likely to be difficult. In fact, PV could easily be used as a power source in TSE systems designed so that the PV panels are mounted above the trucks to maximize solar collection and also provide shade that reduces the thermal heat penetration into trucks (Lepley and Nath, 1997). Already PV charging stations have been successfully deployed at several locations around the country (Fitzpatrick and McGuffey, 2002; PowerLight, 2004; Wirsching, 1999).

2.2. Reliability and Liability Issues

Liability issues are somewhat related to reliability issues concerning the performance of anti-idling equipment and technologies, and consequently it makes sense to begin discussion of reliability first.

2.2.1. Reliability Issues

Reliability issues fall into several types as follows:

- Self-declarations of performance and specifications;
- Discrepancies between laboratory or controlled testing and real life performance;
- Variable installation, operation, and maintenance conditions; and
- Warranties and warranty service.

2.2.1.1. Self-declarations of Performance and Specifications

Generally speaking product manufacturers create technical specifications for their products and list performance characteristics based on internal evaluations. Subsequently, they advertise and promote their products based on those same self-determined specs and evaluations. This situation creates opportunities for manufacturers to engage in partial disclosure or marketing embellishment. The downside is that truck operators may interpret those manufacturers' claims as warranties of performance under all conditions and consequently commit themselves to industry or government regulatory requirements that have legal or financial penalties for non-compliance in the case that the equipment does not fully perform as advertised.

2.2.1.2. Discrepancies with Real Life Performance

In other circumstances, third parties might use evaluation methods or set standards that are inappropriate for the product's design or the testing parameters. A prominent example of this scenario is the US EPA's measurement system for the fuel efficiency of new passenger vehicles. Typically, the advertised fuel efficiency on the sticker of a new vehicle is 10-20% above the vehicle's actual road performance (Maynard, 2006). This discrepancy is due to the fact that the U.S. EPA continues to use formulas and test methods created many decades ago when driving conditions, vehicle characteristics, and driver behaviors were dramatically different than they are today. In this type of scenario, a technology or product's performance might be considered unreliable when compared to its stated or advertised specifications or performance standards.

2.2.1.3. Installation, Operation, and Maintenance Conditions

An important caveat used by almost any manufacturer is the term "when used as directed". In fact, most manufacturers' warranties are voided if a customer misapplies a product or otherwise uses the product in a way that contradicts the manufacturer's instructions and specifications for safe and efficient operation or consumption. Customers (in this case truck owners and drivers) must install, operate, and maintain equipment and systems according to the intended procedure and purpose.

Regarding mobile solutions for anti-idling truck equipment in particular, reliability of performance is a matter of concern if truck operators fail to understand or comply with the installation, operation, and maintenance requirements of their anti-idling equipment. This concern increases in the case of owner/operators that do not have access to the specialized installation and diagnostic equipment that could be required for effective use of mobile anti-idling equipment solutions. Maintenance and replacement costs could be prohibitive for some owner operators as well.

2.2.1.4. Warranties

There are dozens of companies making various types of aftermarket idle reduction products, and it is possible that many of them may not be around in five or ten years due to market consolidation and business failures. Conversely, the major engine and truck manufacturers are likely to remain strong market players. For these reasons, warranties for anti-idling equipment are more durable when offered by an OEM than an aftermarket supplier (Office of Energy Efficiency and Renewable Energy, 2004). Truck and engine makers generally have better technical skills and more experienced customer service.

At present idle reduction equipment generally comes with a 1-3 year/2,000 mile warranty (Office of Energy Efficiency and Renewable Energy, 2004). Market acceptance of anti-idling equipment would improve if warranties were longer since the average truck is 6-10 years old and runs roughly 125,000 miles per year (Tunnell and Dick, 2006).

2.2.2. Liability Issues

Liability issues also fall into several categories, including:

- Insufficient performance;
- US EPA Verified Technology List; and
- Potential liability to the state and its taxpayers.

2.2.2.1. Insufficient Performance

As discussed above, an owner of a fleet of trucks (and less likely a self-employed operator) could theoretically be held responsible for failure to meet regulatory requirements for emissions performance if, despite their best faith effort to purchase and install mobile anti-idling equipment, they were unable to curtail their emissions enough to meet regulatory requirements. There are reasonable scenarios in which anti-idling equipment could perform well enough to meet emissions mandates in ideal laboratory conditions, but in practice fail to attain the desired level of performance due to climatic conditions, variability in operation, etc.

As regards stationary solutions based on truck stop electrification technology, a search of the literature revealed no known liability concerns. TSE involves a simple electrical plug-in very similar to the electrical outlets used daily in offices and homes. Naturally, the same question from above still applies: can stationary systems perform as they are advertised in a way that meets the targeted emissions reduction goal?

2.2.2.2. U.S. EPA Verified Technology List

The US EPA is addressing some of these concerns for a number of retrofit technologies. To maintain a retrofit product's status on the EPA's Verified Technology List (after going through the EPA's Environmental Technology Verification (ETV) Program), manufacturers of retrofit equipment must conduct in-use testing on a sample of units that have been through significant road testing to be sure that they still meet the EPA's performance criteria and the manufacturer's performance specifications. Further details can be referenced at www.epa.gov/otaq/retrofit/retrotesting.htm.

2.2.2.3. Potential Liability to the State and Its Taxpayers

A potential liability for state and its taxpayers is the risk of IdleAire's business model proving infeasible since it is based on extremely expensive and large fixed equipment in centralized locations that depend on revenues from drivers purchasing entertainment and communication services that are easily substitutable. There is also a risk that IdleAire's technology could become obsolete before it has delivered a sufficient payback to state in terms of financial investment by the state. One researcher calculated that a full service TSE such as IdleAire's has a payback of 10.4 years, as opposed to 3.4 years and 2.3 years, respectively, for a simple shorepower connection and the average conventional APU (Boeckenstedt, 2005). Consequently, to mitigate the risk of technology obsolescence associated with off-board solutions, investments and incentives for both near-term and longer-term solutions could be pursued.

2.2.3. Limitations of Current Technology Options

The technologies reviewed in this section represent the range of currently available anti-idling technologies. An updated website of anti-idling technologies by manufacturer, including cost, weight, and function, is maintained by the US EPA's SmartWay Transport Partnership (2006a). Many of these technologies do not supply the full range of services sought by truckers. Direct-fired heaters, for example, may not heat both the engine and the cabin, and they do not supply cooling or electricity. Those technologies (and blends of technologies) that can supply a full range of services, on the other hand, may not be affordable for the average trucker. Under Section 4, CEEP will analyze the cost and environmental trade-offs inherent in several of these technologies and attempt to determine what the optimal technology or optimal mix of technologies would be.

It should be noted, however, that all of the technologies currently under consideration are only appropriate for stopped trucks that are idling for extended periods of time. A significant percentage of trucks' idling time occurs for short periods during transit, however, and there are currently no commercially-available technological solutions that address this short-term idling (Canadian Centre for Pollution Prevention, 2005).

Section 3: Truck Idling in Delaware

Section 3 characterizes the extent of truck idling in Delaware, focusing on long-haul truck traffic at truck stops near the U.S. Interstate 95. Onsite surveys are conducted to better characterize trucker idling in Delaware. The surveys seek to find out the number of trucks parked at the stops and their average duration of engine idling. Even though it is not the main focus of the project, this task also reviews the fleets of local trucks in Delaware, in collaboration with DelDOT.

3.1. Truck Traffic in Delaware

3.1.1. Trucking Activity

According to the U.S. Census Bureau (2004) estimates, there were 16,200 trucks[28] registered in Delaware in 2002 that traveled a combined total of over 300 million miles. Compared to 1997 census figures, the number of registered trucks decreased by 1.1%, and the number of vehicle miles traveled declined by 11%. The majority of the trucks registered in Delaware were heavy trucks (57%) that listed Delaware as their primary jurisdiction (75%)[29] and that had a typical operating range of less than 100 miles from their home base (US Census Bureau, 2004: Table 3a).

These state-registered trucks serve a range of key Delaware industries, including agriculture and poultry, construction, and chemical processing (Delaware Department of Transportation, 2005). According to the U.S. Freight Analysis Framework, truck traffic in the First State is expected to grow significantly over the next 20 years, with most of the growth occurring along the I-95 corridor, State Route 1 around Dover, and a few areas of high residential growth like Middletown and southeast Sussex County (Federal Highway Administration, 2002).

Records obtained from the Delaware EZ Pass office show that 2,976,546 trips and 50,545 trips were made by Class 5 and Class 6 vehicles[30] on Interstate 95 and on State Route 1 in fiscal year 2005, respectively. Despite the fact that this data are for I-95 and Route 1 only for all trucks and, therefore, is not an accurate count of long-haul truck activity in Delaware, it does convey a sense of the scale of the truck traffic and the quantity of potential emissions from idled diesel engine trucks. As of 2002, only 2% of truck traffic was in-state, compared to 6% that was moving to or from Delaware and 24% that was passing through Delaware (Federal Highway Administration, 2002).

[28] Excluding pickups, minivans, other light vans, and sport utility vehicles.
[29] During research interviews, a state official commented that there could be as many as 5-10% more trucks domiciled in Delaware that are improperly registered in New Jersey, and therefore not accounted for in Delaware's statistics.
[30] Class 5 and class 6 represent large trucks of at least 26,000 pounds grow volume weight and five or six axles. In this statistics, a same-day return trip by one vehicle is counted as two vehicle trips.

3.1.2. Truck Stops and Rest Stops

Regarding truck idling at rest stops and truck stops, several different sources have reported different figures for the number of truck parking spaces located within Delaware:

- America's Independent Truckers' Association (2004) lists 10 truck stops in Delaware;
- Fleger et al. (2002) report 70 spaces at one public rest area and 128 - 324 spaces at eight travel plazas;
- Bubbosh (2004b) reports 394 spaces; and
- CEEP identified between 140 - 215 parking spots at one public rest stop and three private truck stops during site visits.

The ranges of these figures are attributable to different definitions of what is considered truck stop, a rest stop, and a truck parking space.

In contrast, the demand for truck parking in Delaware was estimated to be 900 parking spaces at peak hours in 2000, and demand is expected to grow by 2.4% annually to 1,140 by 2010 (Fleger et al., 2002). Fleger et al. note that the current surplus demand for parking space can be absorbed by rest facilities in neighboring states. Shifting parked trucks to other states may not significantly reduce the impact of truck idling on Delaware's air quality, however. As discussed by Schuster et al. (2004), a significant proportion of the state's air pollution is attributable to downwind states.

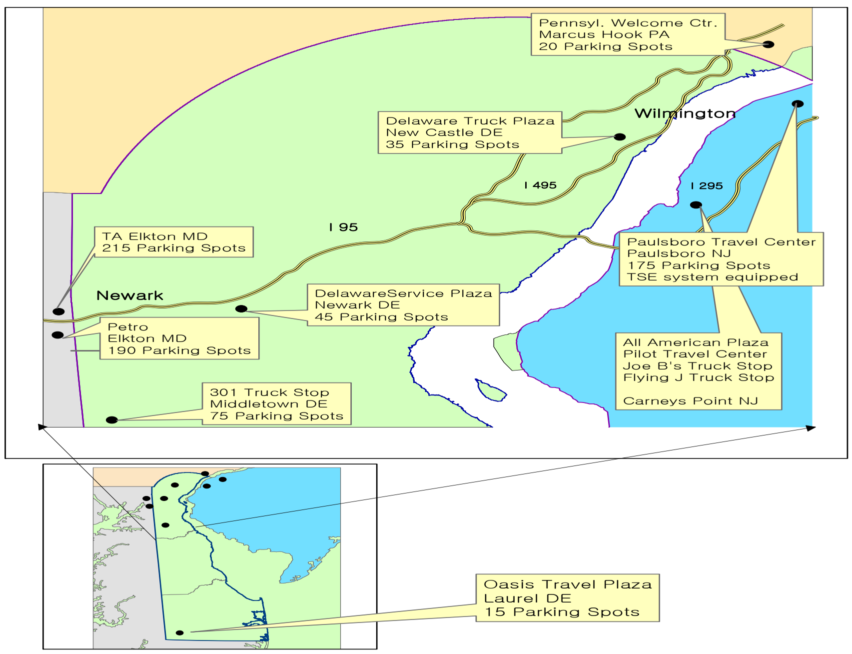
There are a few locations with a minimal amount of truck parking that do not offer the services required to be considered a proper truck stop. For example, the Christiana Truck Stop (New Castle) is not open 24 hours, and does not offer truck repair services or showers for drivers. A number of places can accommodate a few trucks but are simply fueling stations, with the BP-branded Uncle Willie's in Felton being a good example. The Oasis Travel Plaza (see Figure 3.1 below) is visited by dozens of trucks on a daily basis during the harvest months of June to October, but is utilized rather infrequently outside of that seasonal time period.

Figure 3.1 Oasis Travel Plaza, Laurel DE

Source: Photo by CEEP. Parking for 15-25 trucks

According to field survey conducted for this report by CEEP researchers, Delaware has one public rest stop with a capacity of 65 spaces and three private truck stops of note, with the private sites providing 75 – 150 parking spots.[31] The Figure 3.2 below graphically illustrates the relative locations of the truck stops and rest stops in the area based on information from the America's Independent Truckers' Association. Field survey conducted by CEEP researchers at truck stops and rest stops for this study indicated that the number of idling trucks at any day averaged 60 – 80%. These results were observed in October and November in 2005 when temperatures are relatively moderate, so idling rates are presumably higher in the peak periods of summer and/or winter. For the analysis, 80% of the numbers of idling trucks were used.

Figure 3.2 Truck Stops and Rest Stops in and Around Delaware



Note: Map is not drawn to scale.
Source: CEEP research.

3.2. Behaviors and Motivations of Drivers

Personal interviews with drivers at area truck stops and rest stops revealed some common themes that are important for Delaware to consider when implementing any new idle-reduction policies. The anecdotes and insights provided by the drivers in informal interviews were highly informative of the issues around, and reasons for, idling.

3.2.1. Interviews with Truck Drivers

Important lessons from interviews with truck drivers in Delaware regarding idling can be summarized as follows:

[31] Private truck stop operators tend to overestimate the number of spots that drivers can practically use while maintaining sufficiently comfortable and safe gaps between trucks and turning lanes.

- As expected, owner/operators have more of an incentive to conserve fuel since they pay for it out of their pocket, and thus they are more motivated to turn off engines than are individual drivers employed by a company. Company fleets are often installing electronic onboard computers that measure idling time, and these devices act as a disincentive for fleet drivers to idle;[32]
- Large national freight carriers that are part of a publicly traded company are much more likely to have professional cost control and management accounting systems than privately owned or regional carriers that are sometimes family owned. Such national carriers are also under more public scrutiny for environmental performance and thus are motivated to use anti-idling technologies or have strong policies in place;
- Owner/operators generally do not have the free cash flow necessary to invest in a $2000 - $5000 anti-idling product for their truck, even if there is an advantageous return on investment and even for the better-paid drivers in the long-haul industry. Smaller trucking firms similarly do not have sufficient operating margins or capital to invest in anti-idling equipment;
- A driver for J.B. Hunt, a large national carrier, said that many of the biggest trucking firms have incentive programs in place for drivers who do not idle. After a trip, drivers can receive a bonus based on a formula that analyzes the amount of fuel consumed to the number of miles traveled;[33]
- Most drivers are aware of the noise and air pollution associated with heavy-duty diesel engines but have grown desensitized to it. They feel that they are under appreciated despite the fact that they deliver people their daily necessities. Thus, truckers tend to rationalize that the pollution is not their problem since they did not create the demand for it;
- Some cargoes, i.e. perishables and hazardous materials, require continuous power to run. Thus engine idling is sometimes useful as a secondary power source for backup purposes in case the trailer's generating unit goes out;
- Many drivers insist that it takes 15 minutes for the engine to warm up in colder weather and, therefore, a five-minute maximum limit on idling is not reasonable. Start-up in cold weather is particularly damaging to the engine or its related components like turbochargers, according to drivers.[34]
- In order to reduce loneliness, many drivers (especially owner/operators) keep pets in their truck cabs. Occasionally, fleet owners will encourage pets as a means of improving driver retention. Some pets may be more sensitive than humans to temperature and humidity conditions and may be harmed without adequate climate control.[35]

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[32] Mountaire Farms of Sussex County is planning to install onboard recorders for its entire fleet of approximately 70 trucks.

[33] In moderate temperatures drivers are often able to hit the target, but in winter and summer they do not bother trying to get the bonus, since comfort and convenience are more important than the amount of bonus offered. A recent survey indicates that 32% of fleet operators offer incentive pay or bonuses for drivers who idle as little as possible (Tunnell and Dick, 2006).

[34] Some trucks have 12 gallons of anti-freeze alone, and it takes more than five minutes for that amount to be heated.

[35] In addition to the potential loss of their pets, drivers do not want to be accused of animal abuse.

3.2.2. Reasons for Idling

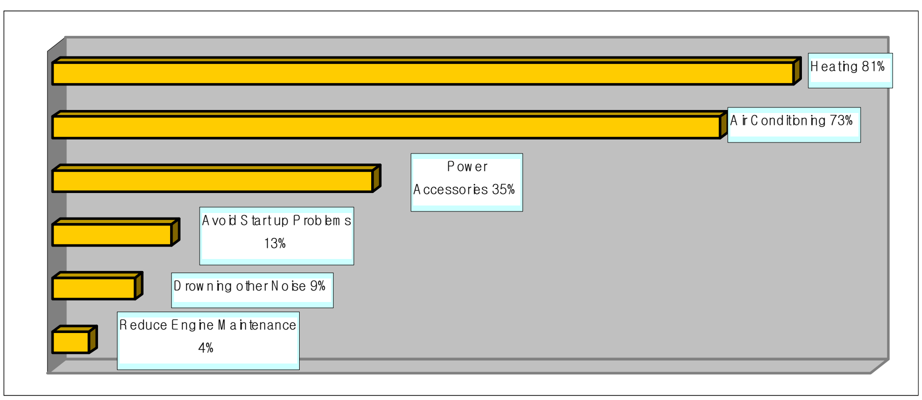
According to research from the Metropolitan Washington Council of Governments, "Transportation Idle Free Corridors" program in 2004, the top three reasons truck drivers idle their engines are:

- Climate control (heat and A/C);
- Powering accessories (cooler, TV, etc);
- Protecting the engine during cold weather.

The same results are shown by an extensive nationwide survey conducted by the University of California at Davis (Figure 3.3). Our interviews with drivers at rest stops and truck stops yielded largely the same results as the survey results shown above. Additionally, the American Trucking Associations suggests that there are some security concerns, manufacturer's operating recommendations, and cargo requirements that contribute to idling. The only surprising result is from the UC Davis survey in which 9% of drivers said that idling their engine was useful for drowning out other noises so that they could sleep better.[36]

Most importantly, however, it must be emphasized that climate control via the trucks HVAC system is not simply a matter of comfort, but a matter of health and safety. At the extreme end of health concerns, one driver who was interviewed claimed to have known a driver who died in his cab from dehydration and heat exposure while sleeping in Arizona because he was trying to save fuel costs instead of idling for air conditioning. As for safety concerns, research consistently cites driver fatigue as a leading cause of crashes, while government regulations universally acknowledge 10 hours of sleep as the requirement for truck operators to drive in an alert condition (Kilcarr, 2004). However, without thermal comfort, the reality is that drivers receive only a few hours of proper (i.e. quality) sleep and, consequently, pose an increased risk of dangerous driving.

Figure 3.3 Why do Drivers Idle Their Engines?



Source: Lutsey et. al (2004)

[36] This indicates that "noise pollution" is an additional externality that is not commonly perceived by truckers as a problem associated with idling.

Next, our interviews revealed that there are a number of drivers who use the mini-refrigerators or coolers in their cabs to store diabetes medicine or similar items directly tied to their health and well being. While this group of drivers represents a very small fraction of the total, the serious needs of drivers – such as essential medicines – cannot be dismissed easily. As the average age of the driver population increases, the number of drivers needing continuous HVAC services to mitigate respiratory problems will continue to increase as well.

The data in Table 3.1 below indicate drivers' preferences for choice of parking depending on objective or activity. Compared to rest areas, truck stops are preferred sites for meeting the need for most truck drivers: extended rest; travel information; public phone; minor maintenance; and meal.

Table 3.1 Drivers' Parking Facility Preferences by Purpose of Stop

Reason for Parking	Rest Area	No Preference	Truck Stop
Take a quick nap (≤ 2 hours)	45%	36%	19%
Take an extended rest (> 2 hours)	6%	16%	79%
Use vending machines	28%	58%	14%
Get travel information	9%	51%	40%
Use public phones	14%	49%	37%
Perform minor maintenance on truck	2%	19%	79%
Use the restroom	25%	45%	30%
Eat a meal	1%	8%	91%

Source: FHA. 2002. Study of Adequacy of Commercial Truck Parking Facilities Technical Report (FHWA-RD-01-158).

Section 4: E^3 Impact Evaluations

Section 4 reviews the anti-idling technologies (identified in Section 2) in terms of their impacts on the environment, the economy, and energy use (E^3) in Delaware. Considerable research has been published on the cost-effectiveness and reliability of stationary and mobile anti-idling technologies (Bubbosh, 2004; California Air Resources Board, 2005; Fleger et al., 2002; Goldstein, 2003; Lim, 2002; Perrot et al., 2004). Based on these studies and the specific geographic situation in the State of Delaware, CEEP researchers developed an analytical framework (see Appendix A for a set of analytical criteria) and evaluated the E3 impacts of anti-idling technologies which may address Delaware's SIP compliance needs with the U.S. EPA air quality standards.

4.1. Evaluation Methodology: E^3 Impacts

CEEP used the U.S. EPA's *Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity* (2004) as a reference to estimate the potential benefits of anti-idling technology application on long-haul trucks in the state of Delaware.

According to the EPA, to quantify the emissions impacts of stationary idling reduction technologies, the historic idling activity for each location needs to be determined. The data collected should include sufficient information through such means as survey or direct observation methods to determine the following:

- Percentage of truck parking spaces used at the location throughout the year (for example, annual occupancy rate);
- Of the percentage in (a) above, the percentage of those trucks which idle for a long duration (defined as 15 consecutive minutes or more at idle); and
- Of the trucks in (b) above, the historic number of hours the trucks idled per day for an average day for the past year (if pursuing NOx emission reductions in an ozone non-attainment/maintenance area).

In the case of mobile idling reduction technologies, the historic idling activity for each truck needs to be determined. This information ideally should be documented with data from engine control modules, GPS, and other recording devices and would include the average number of hours the trucks idled per day. Annual figures are necessary in order to account for seasonal variation. Additional information required for calculating the emission factors specific to mobile idle reduction technologies includes:[37]

- The manufacturer and manufacture date of the idle reduction technology;
- Its engine model; and
- Average daily horsepower load for the time period for which emission reductions will be generating.

[37] This information has been found directly from literature, not from our survey.

4.1.1. Energy Impacts

The use of electricity at stationary truckstop electrification points would help reduce diesel fuel consumption in Delaware. Virtually, all of Delaware's diesel has to be imported from other states and thus represents an economic burden. Increased electricity production in Delaware may be preferable, especially if that electricity is renewably generated. Following the EPA's guidance, this study will:

- Estimate the number of hours per day the idle reduction technology is used; and
- Estimate the energy savings due to the application of anti-idling technology.

When other energy sources are substituted for diesel in the use of an anti-idling technology, there is an increase in alternative fuel use. Consequently the difference between avoided fuel use and alternative energy use is the net energy savings from anti-idling technology applications.[38]

4.1.2. Environmental Impacts

The difference between avoided emissions from engine idling and emissions from anti-idling technology is the net emission reductions from anti-idling technology applications. The net emission reductions can be used to quantify the benefits of anti-idling technology for public health and the environment. Anti-idling technology can also reduce noise, but it is hard to quantify the data on noise reductions.

Truck idling generates NOx, Particulate Matter (PM), VOC, and CO_2 emissions. Since all three counties of the State of Delaware are categorized as EPA non-attainment areas or near non-attainment for NOx and PM, the analysis completed for this study considered emission reductions of PM and NOx only. For this analysis, CEEP:

- Identified emission factors for the criteria air pollutant or precursor. For this analysis, the NOx emission factor is 135 grams per hour, and the PM emission factor is 3.68 grams per hour (US EPA, 2004); In case of mobile anti-idling technology application, the PM emission factor is 3.68 grams per hour if truck model year is 2006 and earlier, or 0.33 grams per hour if truck model year is 2007 and after (US EPA, 2004);
- Calculated the emission reductions from anti-idling technologies.

Quantifying the exact emissions impact of different anti-idling technologies can be challenging because truck emission levels vary according to engine speed, engine age, and accessory loading (Brodrick et al., 2002a). Emission reductions from idle reduction technologies are calculated by using U.S. EPA emission factors that are specified for use in compiling SIPs.[39]

[38] Calculation of the amount of electricity generated and emissions released by using the regional electricity mix where TSE is used is not explicitly considered in the EPA's guidance.
[39] Alternatively, the Argonne National Laboratory's estimates of the gross emissions reductions are used as a reference (Lim, 2002; Stodolsky et al., 2000).

4.1.3. Economic Impacts

The capital and operating costs of most current and emerging anti-idling technologies is available in the literature (Brodrick et al., 2001; Proc et al., 2003; SmartWay Transport Partnership, 2006a; Turchetta, 2005), and several simple payback analyses have also been published (Boeckenstedt, 2005; Stodolsky et al., 2000). Applying the most current information regarding equipment cost and fuel prices, CEEP analyzed the economics of idle reduction techniques based on the fuel savings of each technology.

(a) For Truckers: CEEP Estimated avoided energy cost savings by multiplying net energy savings and energy price; estimated hourly charges accruing to truckers using stationary anti-idling technology; and calculated the initial, operating, and maintenance costs for mobile anti-idling technologies.

(b) For Investors: Investors are responsible for purchasing, installing, operating and maintaining stationary anti-idling technology. To secure a return on their investment, investors charge truckers for a certain service fee as revenue. Simple financial analysis is applied to estimate a return on investment, or payback period;[40]

(c) For the Public: By decreasing pollution, anti-idling technology also reduces respiratory illness and the corresponding medical costs. The public health benefit of anti-idling technologies be estimated based on the respiratory health costs that the technologies prevent. Small and Kazimi (1995) estimate that the public health costs of NOx, SOx, and PM emissions from motor vehicles are $12,700 per ton, $130,500 per ton, and $121,100, respectively. Boardman, Greenberg, et al. (2005) suggest that NOx emissions have an impact of about $20,000 per ton, while PM emissions negatively effect health in the range of $12,000 to $165,000, varying significantly depending on regional characteristics.[41]

4.2. Analytical Results

4.2.1. General Assumptions

Directed by the EPA's guidance, CEEP made the following general assumptions for E^3 impact evaluation based on CEEP's field surveys, interview with stakeholders, and literature review:

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[40] A few mobile technology providers are well-capitalized large companies, but a larger number of them are smaller firms that need private investment to stay in business independently. However, investors generally do not invest directly into mobile solutions.

[41] In this report, CEEP used the Small and Kazimi data to make the estimation conservative.

- Average annual occupancy/utilization rate of a parking space at a truck stop or rest stop is 80%;[42]
- Percentage of those occupied parking spaces where idling occurs for long durations (defined as 15+ consecutive minutes of idling) is 80% as observed by CEEP researchers;
- Of the 64% (80% * 80%) of parking spaces above that are occupied by idling trucks, the number of hours per day the parking space has an idling truck are 12 hours;
- Idling fuel consumption is 1 gallon per hour;
- Fuel price: $2.50 per gallon;
- 170 parking spaces at truck stops and rest stops within the State (see Figure 3.2 for the count);

4.2.1.1. Comparison of Four Technologies

On-board TSE, off-board TSE, direct-fired heaters, and APUs are by far the most widely used idle reduction solutions in the marketplace (U.S. DOE, 2006). In this study, CEEP chose these four technologies for the E^3 analysis. Based on CEEP's field survey, interview with stakeholders, and literature review, specific assumptions are made for these four technologies as following:

- The operational lifetime for both on-board and off-board TSE is 15 years; the lifetime for direct-fired heaters and APUs is 5 years.
- Initial cost for an on-board TSE-equipped parking space is $6,000, and truckers need to invest $4,000 for on-board facilities as well. Annual operation and maintenance cost for on-board TSE is $1,500. For using the on-board TSE system, truckers will pay a service fee as of $1 per hour.
- Initial cost for an off-board TSE-equipped parking space is $16,000 for investors, but truckers do not need to invest anything. Annual operation and maintenance cost for the system is $2,500. For using the off-board TSE system, truckers will pay a service as of $1.75 per hour.
- Initial cost for a direct-fired heater is $2,000, annual operation and maintenance cost is $500.
- Initial cost for an APU is $8,000; annual operation and maintenance cost is $500.
- NO_x emission factor is 135 grams per hour and the PM emission factor is 3.68 grams per hour from idling trucks (USEPA, 2004).
- CO_2 emission factor is 6,228 grams per hour (CARB, 2005b).
- For direct-fired heaters, energy consumption is 0.3 gallon per hour, NO_x emission factor is 1.35 grams per hour, CO_2 emission factor is 1868.4 grams per hour (CARB, 2005b).
- For APUs, energy consumption is 0.2 gallon per hour, NOx emission factor is 13.5 grams per hour (CARB, 2005b).

[42] As a reference, Doraiswamy, Davis, et al (2005) used a 60-80% utilization rate.

- The public health costs of NOx, SOx, and PM emissions from motor vehicles are $12,700 per ton, $130,500 per ton, and $121,100, respectively (Small and Kazimi, 1995).

Based on the assumptions described above, and on the technical and economic parameters of each technology, a spreadsheet-based E^3 analysis was conducted. The results of the analysis are summarized in Table 4.1.

Table 4.1 E^3 Evaluation on Unit Savings per Parking Space

	Stationary Technologies		**Mobile Technologies**	
	On-Board TSE	Off-Board TSE	Direct-Fired Heaters	APUs
Economics				
Capital cost for investors ($)	$6,000	$16,000	-	-
Capital cost for truckers ($)	$4,000	$0	$2,000	$8,000
Lifetime (years)	15	15	5	5
Annual O&M cost ($)	$1,500	$2,500	$500	$500
For Truckers				
Annual energy cost savings ($)	$7,008	$7,008	$4,906	$5,606
Simple payback for truckers (yr.)	0.95	-	0.52	1.83
For Investors				
Simple payback for investors (yr.)	4.60	6.65	-	-
For the Public				
Health cost savings ($/yr)	$4,930.91	$4,930.91	$4,758.03	$4,325.48
Cost-effectiveness ($ per ton of NOx reduction)	$5.02	$9.42	$5.07	$9.10
Energy				
Annual fuel savings (gallon)	2803.2	2102.40	1962.24	2242.56
Environmental Benefits				
NOx emission reductions (tons/year)	0.38	0.38	0.37	0.34
PM emission reductions (tons/year)	0.01	0.01	N/A	N/A
CO_2 emission reductions (tons/year)	17.46	17.46	12.22	N/A

Note: N/A means credible data were not available.

As can be seen from the table above, stationary technologies require large initial capital investments from investors (which include state government agencies in the form of grants or other financing mechanisms), but off-board TSE does not necessitate any upfront financial outlay by drivers or fleet owners. Over a 15 year period, the simple payback time is 4.6 years for an on-board TSE system and 6.65 years for the off-board TSE.

When comparing the cost-effectiveness in terms of dollars spent per ton of NOx emissions reduced, on-board TSE is better than off-board TSE. Prices of mobile technologies vary widely, but the annual energy cost savings are significant. With only a half year simple payback period, direct-fired heaters are more economically attractive than APUs, whose simple payback time is 1.83 years. The cost per ton of NOx emission reductions is $5.07 for direct-fired heaters and $9.10 for APUs. It may not be appropriate to compare the two mobile solutions equally, however, because the heaters do not provide cooling whereas APUs offer cooling in the cab.

For each unit of anti-idling technology, the impact on public health cost is significant, ranging from $4,325 to $4,931 per year. Although the savings from mobile technologies are lower than those from stationary technologies, it should be noted that the EPA methodology does not take the increase in power plant pollution caused by electricity-consuming TSE technology into account. Also, there is a lack of data on PM emissions from mobile technologies available, and so the technologies' impact on PM are not included in the analysis. Finally, since CO_2 emissions are not the focus of the EPA's guidance, the economic values of CO_2 emissions are not included in this analysis. NOTE: CEEP might not be conservative – some NOx and SOx technologies increase PM. If we don't have PM data, let's not conclude whether we're conservative or not…

According to Thomas's estimation (2005), emissions reductions of NOx and CO_2 from anti-idling technologies are 425 pounds and 11 tons per year per truck. As shown in Table 4.1, CEEP estimations are little lower (340 – 380 pounds) in case of NOx reductions, while being little higher in case of CO_2 reductions (12 – 17 tons).

For a reference, a payback study done by Boeckenstedt (2005) is shown in Table 4.2. Boeckenstedt's calculation of typical APU payback is close to CEEP's, while the simple payback estimations for on-board TSE (Shurepower) and off-board TSE (IdleAire) are significantly different due to the methods used. First, Boeckenstedt included both costs on parking space equipment and truck mounted equipment as a total investment, whereas CEEP estimated separate simple paybacks for investors and for truckers. Second, Boeckenstedt used the difference of fuel savings and operational costs as net savings, while CEEP considered the fee charged for using TSEs. This charge was regarded as revenue for investors and cost for truckers, therefore shortening the simple payback for investors.

Table 4.2 Simple Payback of Three Idle Reduction Technologies

	Full Service TSE (IdleAire's model)	Shorepower TSE (Shurepower's model)	Typical APU
System Investment			
Parking space equipment	$18,000		zero
Truck mounted equipment	$10	$3,000	$7,840
Total investment	$18,010	$9,000	$7,840
Operational Savings			
Fuel	$4,140	$4,140	$4,140
Minus: operational costs	$(2,400)	$(1,500)	$(745)
Net annual savings	$ 1,740	$2,640	$ 3,395
Simple payback, in years	**10.4**	**3.4**	**2.3**

Note: Assuming 2000 hours annual service and excluding qualitative issues.
Source: Boeckenstedt, 2005

4.2.2. Gross Potential Savings in Delaware

Using the same calculation process, it can be assumed that all truck idling is eliminated from the above-identified 170 parking spaces (please refer to Figure 3.2 for the count). The maximum potential savings of anti-idling technologies under this assumption are shown in Table 4.3. Considering Delaware's emission budgets in its SIP and the imperative for attainment status from the U.S. EPA, the use of stationary or mobile anti-idling technologies can clearly have an important role to play at a relatively low initial financial cost.

Table 4.3 Annual Savings Potential in Delaware

Savings Categories	Savings Potential
Annual fuel savings (gallon/yr)	304,988
Annual fuel cost savings ($/yr)	$762,470
Annual NOx emissions reductions (tons/yr)	64
Annual PM emissions reductions (tons/yr)	1.75
Annual CO_2 emissions reductions (tons/yr)	2,968

4.3. Other Considerations

A number of qualitative factors impact the analysis of idle reduction technologies. Some of the technologies supply a full range of services to truck drivers, while others only supply heating or cooling. The goal, then, is to optimize the mix of technologies so that they provide the greatest range of services for the lowest price and least environmental impact.

Assumptions about the trucks' purpose will have important bearing on the technologies' impacts. As can be seen in Table 4.4, drivers of long-haul vehicles (i.e. sleeper cabs) reported spending the majority of their idling time in truck stops and rest stops, while day cabs spent the majority of their idling time in traffic or in loading docks. Given these idling profiles, it is highly likely that idle-reduction technologies will have greater benefits for sleeper cabs than for day cabs because sleeper cabs will have more opportunities to take advantage of the technology solutions. Short-haul trucks, which are also called regional trucks, are much more likely to be domiciled in Delaware, and it follows that they will spend considerable time at warehouses and delivery sites where mobile solutions are much more effective than stationary ones.[43]

Table 4.4 Percentage Idling by Location

Location	ATRI Survey	
	Day Cabs	Sleeper Cabs
Truck stops	3%	33%
Rest stops	5%	21%
Loading/Unloading	57%	20%
In traffic	19%	10%
Along the roadside	2%	2%
Other	14%	13%

Source: (Tunnell and Dick, 2006)

[43] If the warehouses have plugs where they could plug into, then stationary solutions again become an option.

Stationary idle reduction technologies need to be evaluated for their applicability to Delaware. The U.S. EPA's Idle Free Corridors project, for example, has published a TSE siting tool that takes the following into account: density of truck stops in the area, rate of usage of the rest/truck stop compared to capacity, expected percentage growth in truck stop use, capacity of the stop, number of spaces, attainment status for NOx and PM, population density of surrounding area (especially 0.5 mile radius), and drivers' compliance with idling laws and regulations. When using these criteria, Middletown, Dover, New Castle, and Wilmington seem to meet the criteria for potential sites with newly built, electrified truck stops fairly well.

Based on literature reviews, site visits, and initial research, it is concluded that an ideal anti-idling technology would:

- not create a large fixed infrastructure that would not be adaptable to rapid technology changes;
- provide cost-saving incentives and comfort for the drivers;
- be available anywhere and at anytime;
- maximize existing off-the-shelf technologies;
- not involve third parties who are solely interested in profit margins at the expense of idling reductions;
- be focused on original truck equipment as much as possible, for liability and reliability reasons, but also to establish universal standards and improved driver training and satisfaction;
- not increase weight and thus fuel consumption, nor would it burn diesel.

Until now there have been few appealing technology solutions due to cost, weight, and availability (U.S. DOE, 2006). While many perceive that auxiliary power units that use diesel fuel and electrification systems at truck stops are the only available options, there are other options on the market. The most attractive mobile technology in the short term could be an inverter and a charger coupled with shore power capability that could draw power from auxiliary batteries when electrification is not available. This solution provides non-diesel power anywhere, at any time. Why do we conclude that inverter and charger w/shorepower is the best if it is not in our analysis above? How is the analysis related to our conclusion?

With regard to the two TSE systems available on the market, onboard systems seem more attractive for Delaware. It is more adaptable to future technology changes, much less capital intensive, and scalable to the smaller truck stops that are generally appropriate for Delaware. Truck manufacturers are including shore power adapters as standard equipment on all models by 2009, and some idle reduction companies are beginning to include after-market auxiliary power units with shore power.

Section 5: Current Anti-idling Policies and Initiatives

The U.S. EPA's National Ambient Air Quality Standards (NAAQS) regulations are a motivating factor in states' anti-idling programs. Recent revisions (US EPA, January 2004) now allow states to integrate idling reduction efforts into their State Implementation Plans (SIP). The transportation sector plays a critical role in the states' compliance efforts and implementation activities within their respective SIPs. In fact, new transportation projects cannot go forward if the resulting increase in emissions is not offset with reductions in other areas. Within that context, reductions from idling trucks are an appealing source of emission reductions for many states.

At the same time, the new federal regulation on truck hours of service (HOS) requires drivers to increase the minimum hours of rest they get each day from eight to ten hours (Federal Motor Carrier Safety Administration, 2005). This extended rest period increases the pressure on drivers to park and idle despite the fact that they have been given few alternatives to comply with the law. Aside from these regulations, there is no comprehensive national regulation for idling in the United States. Instead, anti-idling policy has been established by individual states and municipalities around the country, with support coming from a variety of federal and industry sources.

This section provides a general overview of federal, state and local policies and programs. This section also reviews regional efforts to improve the Mid-Atlantic air quality, and industry initiatives to reduce engine idling.

5.1. Federal Anti-idling Initiatives

In May 2001, the President's National Energy Policy directed the U.S. EPA and the Department of Transportation to work with the trucking industry to establish a program to reduce the harmful emissions and fuel consumption from idling trucks. The federal government reiterated this charge in the National Energy Policy Act of 2005. On January 31, 2006, Congresswoman Kay Granger (R-Fort Worth) re-introduced legislation in the House Ways and Means Committee called the "Idling Reduction Tax Credit Act of 2006" (HR 4762) that would allow a 25 percent tax credit of up to $1,000 for the purchase of "idling reduction devices" (U.S. House of Representatives, 2006). The U.S. Department of Energy would be the authority to judge which devices would be eligible.[44]

5.1.1. U.S. Department of Energy

The U.S. Department of Energy is involved in anti-idling activities, primarily on the technology development side. Most notably, the DOE is sponsoring research, development, and

[44] This would be an advantageous and appropriate opportunity for DelDOT, DNREC, WILMPACO, MARAMA, and other stakeholders to support federal action. Representative Wynn of Maryland signed on as a co-sponsor of this legislation and Delaware's congressional delegation could be encouraged to follow.

demonstration projects with a number of corporate partners.[45] The goal is to incorporate on-board idle reduction technology into truck design at the factory, or if possible, as a dealer installed option (Levinson 2004). For example, the U.S. DOE FreedomCar Program's Advanced Vehicle Testing Activity Office has issued grants (Sleznak, 2004) for:

- Road testing of a Webasto direct fired heater and a thermal storage device in Freightliner sleeper cabs used by Schneider, one of the largest fleet operators in the country;
- An Espar direct fired heater matched with a roof-mounted electric air conditioning unit made by DC Airco and tested on Wal-Mart trucks.

5.1.2. U.S. Environmental Protection Agency

The EPA has taken the lead in federal anti-idling efforts through several initiatives focusing on technology, economic incentives, and outreach and education. First, the EPA has established an expedited verification program that manufacturers can use to get their products and systems approved for implementation in EPA-related programs (Environmental Technology Verification Program). Second, EPA announced in March 2006 its model law for idling of heavy-duty trucks and buses in order to encourage interstate policy harmonization.[46] Third, EPA has launched the SmartWay Transport Partnership program with the freight industry to hasten the commercialization of anti-idling technologies (U.S. EPA 2005).[47]

Additionally, EPA's sulfur emissions reduction efforts will have some bearing on anti-idling equipment and technologies. Under the 2007 Heavy-Duty Highway Final Rule, trucks from 2007 onward must reduce sulfur emissions from 500 to 15 ppm, or roughly 97%. This cut in sulfur emissions is a pre-condition for the effective use of other emissions reduction technologies such as diesel particulates filters (DPF) and oxidation catalysts (Transport Topics, publication of the ATA, Feb. 2000). Improvements in engine technologies, clean fuels, and other components could reduce the need for new anti-idling equipment and technologies among new heavy-duty diesel vehicles (HDDV).[48]

5.2. State Idling Policy and Regulations

Both the EPA and the American Transportation Research Institute (2005) maintain lists of state anti-idling policies. As can be seen in Figure 5.1, nineteen states and the District of

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[45] The DOE's Office of Energy Efficiency and Renewable Energy (2004) published an anti-idling technology introduction plan detailing research priorities for a consortium of DOT, EPA, DOE, the national laboratories, and private industry.

[46] US EPA recognizes the disadvantages of having widely divergent standards across the country and had received requests for guidance from jurisdictions that have not yet established regulations. The model law was released in May 2006 and can be found at www.epa.gov/otaq/smartway/documents/420s06001.pdf.

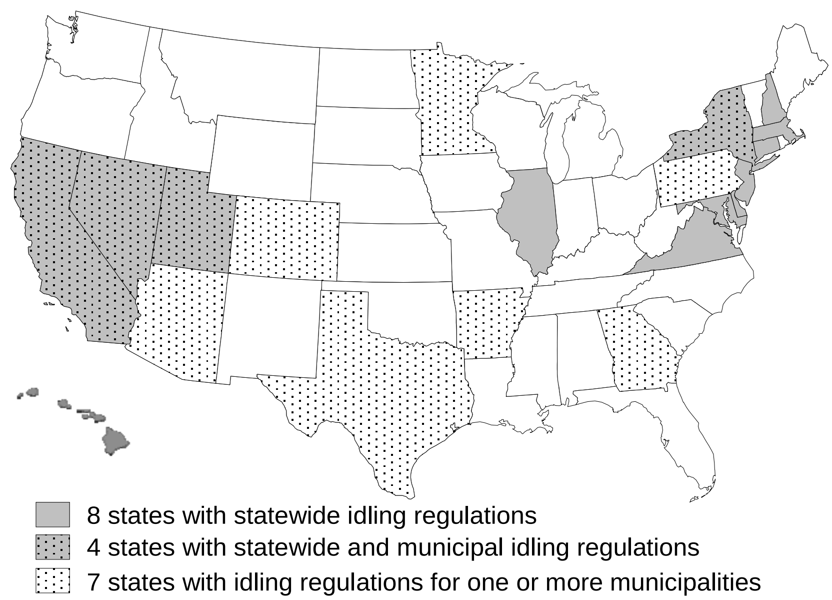
[47] Among the 30 plus members of the SmartWay Transport Partnership's EPA Region 3, none are Delaware entities. The list of partners can be viewed at www.epa.gov/smartway/region3.htm. Perdue Farms, one of the poultry businesses operating in Delaware but based in Salisbury, Maryland, is one of the members.

[48] The EPA's Office of Transportation and Air Quality has also a robust Voluntary Diesel Retrofit Program. This program is designed to immediately improve air quality from the existing fleet of diesel vehicles while new generations of vehicles and fuels (ultra low sulfur diesel and biodiesel) with better emissions performance are phased in gradually.

Columbia have some form of anti-idling regulation in place at either the state or municipal levels. Most of these policies specify a maximum idling time between two and fifteen minutes either statewide or in specific zones, and a monetary penalty of less than $1,000 for first time offenders. The majority of these policies also specify a set of exemptions for different circumstances (traffic congestion, maintenance at a repair facility, etc.) and vehicles (emergency vehicles, snow removal, etc.).

Of the states that have passed anti-idling legislation, California has been one of the most aggressive in developing statewide idling regulations (see more information on California case in the Section 6). Although the laws in California and other states establish idling as a ticketable offense, the laws are generally difficult to enforce. Furthermore, many truckers resent these anti-idling policies because few acceptable alternatives to idling have penetrated the mainstream trucking industry.

Figure 5.1 State and municipal anti-idling policies



As an alternative to idling restrictions and punitive measures, a number of states, municipalities, and local jurisdictions have instituted anti-idling incentive programs. In addition to the grants provided by the federal government through the EPA and the DOE, subnational organizations have successfully implemented a range of low-interest loan funds and grant programs for anti-idling technologies (ICF Consulting, 2005; Thomas, 2005), matching funds and rebates (Fleet Owner, 2003), and aging truck replacement programs (Orr, 2005b).

5.3. Delaware Anti-Idling Policy

Title 7, Chapter 60, Sections 6005 and 6013 constitute Delaware's Anti-Idling Law passed in early 2005. The law applies to vehicles of all types weighing 8,500 lbs gross vehicle weight rating (GVWR) or more. The Anti-Idling Law is administered by the Delaware

Department of Natural Resources and Environmental Control (DNREC)'s Division of Air and Waste Management under "Regulation No 45: Excessive Idling of Heavy Duty Vehicles". Regulation 45 was incorporated into the SIP as regards attainment with the eight hour standard for ozone.

The law and its associated regulations state that idling is not permitted beyond 3 minutes under normal temperatures. The time limit is 15 minutes if the outside air temperature is 32º to -10º F, and no idling time limit for air temperatures under -10º F. Penalties for violations can be from $50 to $500. A large number of exemptions exist to the regulations, however. There is no idling limit under the following circumstances:

- Due to traffic conditions, mechanical difficulties, and repairs;
- Emergency vehicles;
- Conform to manufacturer specifications or comply with safety inspections;
- For certain auxiliary equipment needs or engine warm up; and
- For heating/cooling during sleeping in a location beyond 25 miles with a truck stop that has electrification equipment.

In practice, these exemptions have several noteworthy implications. First, there are no truck stop electrification systems in operation in Delaware. That means that trucks can use the last exemption listed above to legally idle for extended periods. The current exception would be Wilmington, since it is just under 25 miles from the IdleAire TSE system at TravelCenters of America in Paulsboro, New Jersey. In the next few years IdleAire is expected to install its TSE product at one, and possibly two, truck stops in Elkton, Maryland. The existence of TSE-equipped truck stops in Elkton would make a large portion of New Castle County – including Newark, Wilmington, and Odessa – within the 25-mile zone specified by the law. Any trucks idling along Delaware's I-95 corridor could not claim the exemption if a TSE system existed in Elkton.

Second, the exemption for conformity to manufacturer's specifications represents a potential loophole that could be abused. The reason is that most original equipment manufacturers (OEMs) of heavy-duty diesel trucks specify that engines be warmed up to an ideal operating temperature before departing. The warm up periods are often five to fifteen minutes (particularly in cold weather), which conflicts with the three-minute limit mandated by Delaware's anti-idling law. As a consequence, a truck driver could, in theory, have good legal standing to challenge a citation and fine in court.[49]

Third, there is no provision, as in some other jurisdictions, for health and safety emergencies. California, for instance, waives its five-minute idling limit if it will "prevent safety or health emergencies". The U.S. EPA's model anti-idling law (EPA420-S-06-001), released in April 2006, specifies that the prevention of safety and health emergencies applies to conditions where a vehicle is broken down in severe weather and thus heating or cooling is

[49] In a few other jurisdictions (e.g. Connecticut, Maryland), the same type of exemption for manufacturer's specifications exists but the literature does not contain any examples of abuse or controversy on the matter.

essential for passengers' well-being. In this context, drivers clearly cannot claim that idling was "necessary" for their health under normal operating conditions (U.S. EPA, 2006).

The enforcement division of DNREC is responsible for enforcement of Delaware's anti-idling law. Through late 2006, drivers and fleet owners are being given warnings along with education about the law, and citations for violations are expected to disburse from about January 2007. As Delaware considers programs and policies related to anti-idling technologies, it can build upon the relationships it created during the process of establishing its anti-idling law. Specifically, it can extend the stakeholder group it established for drafting legislation to any technology or program committee that the state decides to initiate.[50]

5.4. Regional Anti-idling Efforts

The Mid-Atlantic Regional Air Management Association (MARAMA) is a voluntary, non-profit association of state and local air pollution control agencies. MARAMA's mission is to strengthen the skills and capabilities of member agencies and to help them work together to prevent and reduce air pollution in the Mid-Atlantic Region. MARAMA pools its collective resources to develop and analyze data, share ideas, and train staff to implement common requirements. The result are collaborative solutions developed by a body of experts that might not otherwise have structured opportunities to communicate. The members of MARAMA are Delaware, the District of Columbia, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, West Virginia plus Philadelphia and Allegheny Counties.

Intra-regional initiatives for implementing mobile solutions are the most logical strategy for Delaware to pursue, considering that a large majority of its long-haul diesel truck traffic is from surrounding states. Delaware is not a member of the Northeast States for Coordinated Air Use Management (NESCAUM) consortium. This collection of New York, New Jersey, and the New England states conducts joint research, development, standards setting, data collection, and policymaking activities.

Section 184 of the federal Clean Air Act designates the Northeast and Mid-Atlantic states down to Virginia and Washington DC as part of the Ozone Transport Region. The same law also authorizes the Ozone Transport Commission which gives states in the region broad authority to act cooperatively in the implementation of enforceable actions and programs that reduce at least some forms and sources of pollution, including the idled engines of trucks not in service. An official with the Pennsylvania Department of Environmental Protection said that idling is on the Commission's issues of concern and could move up to its priority list in the next few years.

The Delaware Department of Natural Resources and Environmental Control has a Division of Air and Waste Management that has regulations on emissions migration and related issues. For example, Regulation No. 16 *Sources Having An Interstate Air Pollution Potential*, sections 3.1 and 3.2, state that all new and existing air pollution emitters in Delaware are

[50] This idea stems from an interview in which the manager of a large truck fleet expressed appreciation for being allowed to participate in the stakeholder meetings that were conducted on the anti-idling legislation.

required to control their emissions to the extent that they do not “substantially effect” the ambient air quality of neighboring receptor states.[51] This type of regulation could also be used in to encourage buyers of new heavy-duty diesel trucks to buy the latest idle reduction equipment, or best-available engines, so as not to contribute to particulate and ozone-forming pollutants in other states.

5.5. Industry and Manufacturer Initiatives

5.5.1. Industry Activities

The Delaware Motor Transport Association, (DMTA), with headquarters in Dover, is a member of the national trade group, American Trucking Associations (ATA). The DMTA is run by a single industry professional with clerical support and serves largely as an information clearinghouse for state trucking interests. The DMTA has no official anti-idling policy of its own, and instead defers policy matters to the ATA and generally supports the recent model state/municipal idling law released by the U.S. EPA.

As for the national ATA, its Technology and Maintenance Council issues a Recommended Practices Manual. In the 2004-2005 version, there are two provisions related to idling:

- RP1105A - Idling Limiting Systems; and
- RP1108 - Analysis of Costs from Idling and Parasitic Devices.

The ATA’s American Transportation Research Institute, or ATRI, has done a number of studies and testing regimes on engine idling.

The Idle Elimination Manufacturers Association (IEMA) is a fairly new trade association that lobbies for technology standards, legal standards, and subsidies to catalyze industry growth. It pushed hard, for example, for federal legislation that would exclude the weight of idling equipment from the 80,000 pound combined weight limit for truck and cargo weight.

The National Association of Truck Stop Operators, or NASTO, has a policy that states that its primary strategy is to always serve their customers and respond to market demands. In line with this thinking NATSO does not believe that it (nor the government) should dictate what technologies are used for idle reduction, and that the best solutions will be the ones that arise from intensive and cooperative stakeholder efforts (NATSO, n/d). Particularly noteworthy is NATSO’s statement that “OEMs are introducing on-board technologies…including APUs, and electrical components that can enable powering of driver comfort…many of these options will be configured to utilize shorepower as a supplement to on-board components.” The reference to electrical components concerns inverter/charger setups with auxiliary batteries.

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[51] Theoretically speaking, under this regulation, a neighboring state with significantly more stringent air quality standards could force pollutant emitters in Delaware to reduce their emissions.

5.5.2. Truck Manufacturer Activities

Trucks will likely witness dramatic technology advances over the next ten years. The changes will include aerodynamic railings, new engine systems, new exhaust mitigators, new power trains, single-wide tires, new fuels, etc., according to the SmartWay Transport Partnership of the US EPA at www.epa.gov/otaq/smartway/smartway_fleets_strategies.htm. Some of the changes will be pushed by regulations from CARB , and some will come from evolving market demand and industry priorities. Some of these changes will relate directly to idle reduction efforts. Several idle reduction technologies will be implemented by truck and engine makers at or before the time of engine combustion, for example. Other approaches will reduce post-combustion impacts, such as Exhaust Gas Recirculation (EGR) technology in which exhausted gas is returned to the engine manifold where previously uncombusted NOx and PM molecules are then fully combusted for cleaner emissions.

Installation of idle reduction technologies by truck and engine makers has a number of important advantages over after-market solutions (US DOE, Office of Energy Efficiency and Renewable Energy, 2004). They include:

- Lower installation costs
- Better warranty service
- Improved financing opportunities
- Increased resale book value
- Faster market acceptance
- Reduced sales taxes due to avoidance of aftermarket excise tax of 12%

Several OEMs now offer factory-installed auxiliary power units, but APUs remain an expensive way to handle idling bans, so most sales are to owner-operators in the aftermarket (Berg, 2005). Owner-operators tend to spend more nights sleeping in their trucks, and keep more personal appliances than fleet drivers do, so they have a greater incentive to invest in an APU for personal comfort and convenience. Table 5.1 indicates which truck makers are offering shorepower adapter kits as standard equipment as of late 2005.

Table 5.1 OEM Makers and Shorepower Adapters

OEM Truck Maker Name	Offers Shorepower Adapter Kits
Kenworth	No
Peterbilt	No
Mack	Yes, usually as aftermarket service, often with inverter.
Freightliner	Yes, as an option.
International	Yes, as an option, but standard on some 2007 models.
Volvo	Yes, standard equipment on limited models is an option on most models.

Source: RoadStar, CEEP research as of March 2006.

International Truck and Engine Corporation, after support and grants from the U.S. Department of Energy, is planning to roll out anti-idling equipment in 2006 as original truck equipment. It will offer an APU as its first technology, and secondly it will offer a package that includes a fuel-fired heater with an electric air conditioner that can be powered by the battery or an AC plug-in adapter for use at shorepower electrification systems. It also includes added insulation in the cab (Transport Topics, 2005).

With the U.S. EPA funding and support, Eaton Corporation introduced a hydraulic hybrid truck for UPS that eliminates the truck's transmission and replaces it with a hydraulic system in combination with a highly efficient diesel engine that yields more than 50% savings in fuel. Part of the efficiency increase is achieved by regenerative breaking that powers the fluid and air pumps (Associated Press, 2006).

Cummins, a major engine manufacturer, has released a new product line, called ComfortGuard, of versatile, integrated heating/cooling systems and is testing them in International trucks. Connected with a truck's regular heating and cooling system, ComfortGuard is a two cylinder diesel motor combined with an electrical generator that allows for fuel savings of up to 5% and a drastic reduction in emissions compared to idling (Thomas, 2005).

Detroit Diesel Corporation (a Daimler-Chrysler subsidiary) appears to be focused on engines offering exhaust gas recirculation (EGR) technologies for emissions reductions while trucks are in operation at high speeds, as opposed to idled periods. Detroit Diesel's only anti-idling product is an electronic control module (ECM) called Optimized Idler that measures temperatures and battery charge in such a way that it could turn an engine off when specified parameters are exceeded. While providing useful information, ECM products do not change driver behavior or provide alternative power sources.

Another maker engine maker, Caterpillar, is field testing its Cat MorElectric system. This 7.3 kW water-cooled generator with advanced electronic engine controls replaces the alternator and provides three times as much electric power. A heating/cooling module fits under the driver's seat, and the condenser, fan, and compressor are all eliminated from the engine compartment so that the truck is lighter and it uses fewer hoses that could leak.

In addition to this new generation of HVAC technology, Caterpillar has a complimentary APU that provides electric power to both the truck's electrical system and HVAC. The 0.5-liter, two-cylinder engine of this APU consumes only 0.2 gallons of fuel per hour at 407-pounds. It was designed by Caterpillar with two speeds in order to deliver the required amount of power when needed. Unlike fixed-speed generator sets, the Cat Electronics' APU will run at 1,800 rpms the majority of the time, like when the driver is sleeping, and at 2,800 rpms during temperature extremes, to automatically provide all of a driver's comforts and conveniences at an appropriate level of energy consumption.[52] Caterpillar is also offering trucks with built-in adapters capable of connecting with off-board shorepower TSE systems. In fact they have a demonstration project in partnership with the Sacramento Municipal Utilities District (Thomas, 2005).

[52] That means all the heating, cooling and electric power, including battery charging, can be done without idling the main engine.

Of truck makers that offer shorepower capability, orders represent 15% of all sales at Volvo to 3% at a few others despite the fact that one poll showed that 90% of drivers and fleet managers would like to see it as standard equipment (Thomas, 2005). As for fleet owners, there is alarm at the rapidly increasing price of new trucks due to a steady flow of new rules and regulations. Low emissions engines that will be required from model year 2007 trucks will have an estimated $18,000 in additional costs according to a leading industry official (Longton, 2005). Some industry experts say the high cost of the 2007 model year trucks led to a run up in 2005 and 2006 model year trucks (Bearth, 2006) as annual sales of Class 8 trucks hit much higher in 2005.[53]

Furthermore, new NOx reduction techniques will increase particulate matter, which consequently necessitates DPFs that increase fuel consumption and maintenance burdens (Longton, 2005). Environmental costs that were previously considered "externalities" are increasingly being internalized into the trucks as products, and sales prices will rise to reflect those newly internalized costs.

5.5.3. Electric Utility Industry Activity

The electric power generation and distribution sector has a stake in the anti-idling practices because of the electric power consumption associated with TSE. In the *National Electric Transportation Infrastructure Working Council: 2004 Annual Report* (Electric Power Research Institute, 2005), it is reported that a stakeholders group has been working to research the potential power demand created via large scale TSE implementation, what connectors and other equipment are used, how well existing electricity infrastructure meets the needs of TSE growth, and similar concerns. Many aspects of TSE systems need to be reflected in the National Electric Code as well as other standards-setting bodies such as the National Institute for Standards and Technology (NISTI) and Underwriters Laboratories Inc. (UL).

The Electric Power Industry Institute is working on an innovative program that recognizes that the needs of each fleet and each driver can be unique. Under a $200,000 grant from the U.S. EPA's SmartWay Transport Program, fleets can purchase a tailored, on-board idle-reduction technology package, and EPRI reimburses 50% of the cost. The package includes a Domestic or Taylor Made air conditioner/heater unit, Xantrex inverter/charger, Phillips & Temro basic cab wiring kit and from one to three Lifeline VRLA batteries. A shorepower adapter is also provided so the truck can power all its systems from a TSE unit when one is available, or it can obtain power from the robust batteries. With the money saved by these anti-idle systems, the companies must agree to reinvest the savings in new anti-idling packages and also to carefully measure the performance results (Thomas, 2005).

[53] There was a 6.6% increase in sales in December 2005, but some people argue that a strong economy could be just as responsible for that increase as a buy-up of cheaper pre-2007 trucks (Gilroy, 2006).

Section 6: Anti-idling Performances - Cases of Selected States

This section reviews a series of case studies of states that have implemented anti-idling programs, and identifies best practices for encouraging anti-idling strategies. Delaware-domiciled trucks have a strong incentive to use idle-reduction technologies because the surrounding jurisdictions are among the strictest enforcers of anti-idling laws. One study reported that New Jersey, Philadelphia, New York City, New York State, and Washington DC were the jurisdictions cited for issuing the most citations for idling violations (Avril, 2004). In this section, CEEP provides an overview of many states' experience with anti-idling technology, policy, and regulation including Pennsylvania, New York and California.

6.1. Anti-Idling Regulations in Pennsylvania

Because Pennsylvania is Delaware's immediate neighbor, it is useful to review its truck anti-idling efforts. Also, Pennsylvania has been pro-active in addressing anti-idling and its experience may offer lessons for Delaware. Pennsylvania's Governor Rendell reactivated the long-dormant Pennsylvania Energy Development Authority (PEDA) in recent years and that agency, combined with the Pennsylvania Department of Environmental Protection, has been active in encouraging idle reduction initiatives.

6.1.1. Pennsylvania's Small Business Advantage Grant Program

Pennsylvania has supported mobile solutions in addition to pursuing truck stop electrification systems. Usually states award small business grants to high tech companies for technology development, but in 2004-2005 Pennsylvania awarded small business economic development grants to truck owner/operators and small fleet operators for energy efficiency and environmental improvements. The program gave out more than $310,000 to support the installation of 88 auxiliary power units and direct fire heaters on Pennsylvania trucks (DEP, 2006).

6.1.2. Pennsylvania's Energy Harvest Grant Program

In November 2004, as part of its Energy Harvest Grants program, the Pennsylvania Department of Environmental Protection (PA DEP) awarded $360,000 to IdleAire Technologies Corporation for the installation of a stationary Advanced EPS installation at a Petro Truck Stop in Carlisle PA, a major truck center. IdleAire calculated that the project, over a 15-year period, will save 7.9 million gallons of fuel (PA DEP Daily Update, 05 November 2004). Pennsylvania has stated that it plans to offer truck stop electrification systems at 21 truck stops and rest stops as part of a major redevelopment program for those facilities (Thomas, 2005). A subsequent Energy Harvest Grant of $107,000 was provided to a coalition of stakeholders for the construction of a Shurepower TSE at the Walt Whitman Truck Stop, followed by a matching amount from Pennsylvania's Alternative Fuels Incentive Grant (AFIG) program in February 2006.[54]

6.1.3. Philadelphia's Anti-Idling Policy

Philadelphia's efforts to control mobile source emissions have a surprisingly long history. For instance, regulations on the idling of diesel engines were introduced in 1972 as "Air Management Regulation IX" by Philadelphia's Air Pollution Control Board (now called the Air Management Services office). Those early policies, however, were often based on the educated guesses of administrators rather than research data by professional scientists according to the Clean Air Council. At present, an extensive body of knowledge on the sources, characteristics, and health impacts of hazardous air emissions exists to make more informed decisions.

The Philadelphia Parking Authority is responsible for enforcing the city's idling regulations and the fine for a violation is $100 (Philadelphia, Pa Code and Charter §12-1127(2), 2003). According to Philadelphia's Anti-Idling Law, no person shall cause or permit the engine of a bus or truck to idle for longer than five (5) minutes while parking, stopping or standing at any terminal point along an established route, except that this prohibition shall not apply to:

- Any bus or truck when the ambient temperature is forty degrees Fahrenheit (40°F) or less;
- Bus or truck en route to a destination but stopped by traffic congestion; or
- Bus that pursuant to law must maintain a specific temperature for passenger comfort, provided that such a bus may idle in excess of five (5) minutes only to the minimum extent necessary to comply with such law.

It is interesting to note that the law recognizes the importance of comfort for bus passengers who typically ride the bus for 15-45 minutes, yet not for truck drivers who often spent most of the day in their vehicle.

6.1.4. Philadelphia Toxic Air Pollutants Risk Reduction Project

The U.S. EPA Region 3 Air Protection Division and Philadelphia Air Management Services (AMS) are conducting a joint project, called the "Philadelphia Toxic Air Pollutants Risk Reduction Project," to help reduce the health threat faced by Philadelphia residents from exposure to hazardous air pollutants. Air toxics are chemicals known to cause cancer or other serious disease; PM can fall into this category since the soot can be carcinogenic. The U.S. EPA and Philadelphia AMS are undertaking this project because the EPA's National Air Toxics Assessment (NATA) shows that residents of Philadelphia face higher than average health risks from exposure to air toxics.

As part of this project, Philadelphia has established a program called the "Philadelphia Diesel Difference" that is housed in the Clean Air Council, a non-profit group. This program is a coalition of diverse stakeholders whose primary purpose is to reduce the air pollutants associated with diesel-powered engines in the greater Philadelphia area. The coalition encourages the voluntary implementation of clean diesel technologies and the use of innovative strategies,

[54] The Walt Whitman Truck Stop later ceased operations when the property was sold.

including market-based approaches. The Philadelphia Diesel Difference website (www.cleanair.org/dieseldifference/about/index.html) lists the working group's goals as:

- To initiate the Philadelphia Diesel Difference Program as a way to support voluntary implementation of clean diesel technologies;
- To provide a forum for diverse stakeholders to exchange ideas, discuss, promote, and disseminate detailed information on the use of clean diesel technologies in the public and private sectors;

- To provide networking opportunities for organizations involved in education and outreach, and the manufacture, sales, or purchase of clean diesel technologies; and
- To promote the streamlining and standardizing of technology verification.

6.2. Anti-Idling Regulations in Other States

6.2.1. New Jersey

On September 7, 2005, New Jersey established a referendum for its November election in which voters decided whether or not the state could divert some revenue from an existing corporate business tax into a special fund for diesel retrofits, technical research, particulate traps, and other methods of reducing diesel engine emissions (Heck, 2005). The referendum was approved, meaning $160 million that was dedicated to a hazardous solid waste clean up fund could be transferred – due to an amendment of existing law – to a dedicated fund to reduce diesel emissions (Kidd, 2005). This fund will only apply to publicly funded buses, school buses, garbage trucks, and government fleet vehicles, but not to commercial trucks. On the enforcement side, the law authorizes local police in New Jersey to issue citations for drivers that break the state's 3-minute idling limit instead of limiting such enforcement to state police (Philadelphia Inquirer, 2005).

6.2.2. California

California, through the California EPA's Air Resources Board (CARB or ARB), is aggressively addressing heavy-duty diesel emissions on long haul trucks. CARB's activities are extensive, but for expediency a few of the most recent and important development are listed below:

- On October 07, 2005 California's Air Resources Board (CARB) ruled that heavy-duty diesel trucks with sleeper cabs are fully included in existing regulations banning idling for more than five minutes.[55] The same ruling mandated that all long haul trucks manufactured from 2008 onward have a non-programmable automatic engine shutdown system for trucks idled more than five minutes (Orr 2005); and

[55] In response, an official of the California Trucking Association asked CARB why it is illegal to leave a pet in a parked car with the heat off, but drivers are denied heat (Orr 2005).

- CARB had the legislature pass a new law effective February 2005,[56] that also prohibits the operation of external, diesel-fueled auxiliary power systems near restricted zones (CARB 2005). CARB will ban most diesel auxiliary generators from 2008 unless they are certified as emissions free because the rules for diesel engines will apply to auxiliary diesel generators equally.

6.2.3. New York

New York State and New York City laws limit the amount of time a truck or bus may idle. Under New York State Environmental Conservation Law, heavy-duty trucks and buses may not idle for more than five (5) consecutive minutes. Under New York City Environmental Protection Law, trucks and buses may not idle for more than 3 consecutive minutes.

New York State is a national leader in Truck Stop Electrification (TSE).[57] After investigation of several interstate roadways and consideration of factors such as truck traffic, truck stop/rest area locations, and environmental conditions, it was determined that Interstate 90 was the preferred roadway for a TSE demonstration project in 1999. In January 2001, Niagara Mohawk Power Corporation (NiMo), a Syracuse-based utility provider, partnered with the New York State Energy Research and Development Authority (NYSERDA) and other partners to begin installation of the first of several off-board TSE facilities. The design and installation of the first commercial shorepower facility was completed with credit card readers, cable television, and a communications interface from IdleAire Corporation.

The first, at the DeWitt Service Area on the eastbound side of I-90, was completed for commercial operation in June 2002. The second site was completed in April 2003 at the Chittenango Service Area on westbound I-90. Development time and modifications to the original design delayed installation of the facilities; however, both are now fully functional (Perrot, et al., 2004b). The TSE-equipped truck stops are apparently very popular among drivers who complain that supply is insufficient to meet demand.

In the fall of 2002, a parallel project, entitled Adirondack Northway Shorepower Demonstration, was initiated to design and deploy the on-board, marine-style shorepower systems. Co-funded by the NYSERDA, the N.Y. State Department of Transportation, and the U.S. Department of Energy, the project was undertaken by the Antares Group and is divided into two distinct phases. Phase I, completed in 2003, provided information on the potential for New York-based fleets to utilize shorepower in HVAC-equipped sleeper cab trucks, and on the cost of sleeper cab truck conversions plus the cost of the required stationary equipment. Starting in 2004, Phase II provides a real-world field test of the shorepower and truck-integrated HVAC systems at an existing travel plaza on the Adirondack Northway (I-87) in Wilton, Saratoga

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[56] California Code of Regulations, Chapter 10, Title 13, Section 2485, *Airborne Toxic Control Measure to Limit Diesel-Fueled Commercial Motor Vehicle Idling.*

[57] The Arkansas Department of Environmental Quality was awarded a $100,000 grant in September 2004 from the SmartWay Transport Partnership program of the US EPA for a feasibility study of truck stop electrification system implementation as part of the national strategy for TSE systems along national highway corridors (Levinson, 2004). About six other states, mostly in the South, have received similar SmartWay grants for feasibility studies over the past few years.

County. NYSERDA spent more than $1 million on this and subsequent ancillary demonstration projects and analytical studies.[58]

6.2.4. Oregon

One county agency, the Lane Regional Air Pollution Authority (LRAPA) in Eugene, Oregon, has a program that provides low-interest loans to truckers who install APUs, and LRAPA is helping mechanics in the area become trained in installation and maintenance of the APUs (Thomas, 2005). In another initiative, LRAPA borrowed money from the Oregon Department of Energy to purchase APUs that were subsequently leased to drivers for five years (Auxiliary Power Dynamics, 2004). With innovative financing and technical support schemes, LRAPA seems to be modeling itself on CARB, albeit on a smaller scale.

[58] As a general comment, NYSERDA differs from CARB in that it likes to catalyze market forces rather than regulate solutions.

Section 7: Policy Options

The research conducted for this report, in conjunction with the established literature, leads to the following policy implications regarding the attributes of an ideal anti-idling technology to be considered for adoption in Delaware:

- It would not create a large fixed infrastructure that would not be adaptable to rapid technology changes;
- It would provide cost-saving incentives and comfort for the drivers;
- It would be available or accessible anywhere and at anytime;
- It would maximize existing off-the-shelf technologies;
- It would not involve third parties who are solely interested in profit margins at the expense of idling reductions;
- It would be focused on original truck equipment as much as possible, for liability and reliability reasons, but also to establish universal standards and improved driver training and satisfaction; and
- It would not increase weight and thus fuel consumption, nor would it burn diesel.

Whereas Interstate 95 runs through Delaware for a very short distance through the northern part of the state along the larger east coast corridor, Delaware has little authority to regulate mobile truck technologies and driver behavior without violating inter-state commerce laws and other basic legal frameworks. In this case, the on-board TSE systems could be an option. Unlike I-95, the state highway, including State Route 1 through central Delaware, is completely within the state's jurisdiction, and consequently the state government should exert its authority there, especially because a much larger percentage of truck traffic has a Delaware origin or destination in comparison to the truck traffic on I-95. In this case, both the on-board mobile technologies and the on-board TSE systems could be considered.

7.1. Anti-idling Technology Options

Until now there have been few appealing technology solutions due to cost, weight, and availability. While many perceive that auxiliary power units that use diesel fuel and electrification systems at truck stops are the only available options, there are other options on the market. Based on the above implications, the anti-idling technology options can be considered for adoption in Delaware. The technology should have a favorable payback, technical reliability, and a significant impact on emissions reduction.[59]

[59] The widespread use of the on-board TSE systems may not constitute a significant improvement over the problem of idling engines because the emissions are simply transferred from mobile sources (trucks) to a fixed source (electricity-generating power plants). A more environmentally sustainable solution would be to create on-board TSE systems powered by renewable energy sources.

7.1.1. Inverters with Auxiliary Batteries

Diesel APUs are a good short-to-medium term mobile solution but not quite as desirable as inverter/auxiliary battery systems that have shorepower access. Equipping trucks with diesel APUs can produce significant emissions reductions that the state can apply toward its SIP.[60] However, in the longer term, because of their weight, short service life, and the fact that they still burn diesel fuel, APUs are not a good solution to the idling problem. An ideal solution would not involve any diesel consumption or increased weight-load to the truck while still providing power to meet drivers' primary need for cabin climate control. Inverters coupled with auxiliary batteries and shorepower adapters fit this type of solution.

7.1.2. Suitability for TSE Adoption

There are two commercialized truck-stop electrification (TSE) systems currently available (i.e., the "off-board" system from IdleAire, Inc. and the "on-board" system from Shurepower, LLC.). After reviewing all the available data, conducting site visits, and interviewing industry company officials, we believe that the on-board product is more suitable for Delaware. The off-board TSE system may not be an option since the company requires at least 50 units per installation; Delaware has just three full-service truck stops,[61] all of which appear to have too few parking spots to meet its requirements.

The on-board TSE system is usually two-thirds less expensive to install, requires less physical space and maintenance, and is more flexible for future technology developments. The on-board approach to TSE has fewer risks and potential liabilities because the business model behind it is more sustainable and less dependent on public subsidies due to significantly lower installation costs. The potential barrier of the on-board system is the requirement for minimal to moderate alterations of the truck cab for adapters and onboard HVAC equipment. This barrier can be overcome, however, by rebates and other measures. Anyway, new truck models are required to have the adapters and HVAC components as standard equipment from the factory.[62]

7.2. *Policy Considerations*

These policy suggestions are intended to tie closely to the numerical analysis we conducted, the published data, and the case studies. Some of these public policy suggestions are

[60] The financial payback time for APUs is two years or less. As for implementation, domestically domiciled diesel trucks can be identified through state registrations.

[61] CEEP completed field surveys of the three known commercial truck stops in Delaware (as we define them as full service truck stops): Delaware Truck Plaza in New Castle, Route 301 Travel Plaza in Middletown, and Oasis Travel Plaza in Laurel (See Appendix X for detailed information on these facilities and nearby states).

[62] Truck manufacturers are including shore power adapters as standard equipment on all models by 2009, and some idle reduction companies are beginning to include after-market auxiliary power units with shore power as well.

straightforward such as driver cooperation and regional partnership. Others have a record of success, such as rebates. Another, such as the creation of a market for tradable MERCs and voucher program is more speculative. The relative merits of each of these policy suggestions are explored.

7.2.1. Driver Cooperation

Long-haul truck drivers have a tight-knit community and unique culture due to their shared lifestyle and occupational demands. Many drivers also have similar traits in that they enjoy the freedom of being alone on the road, and enjoy trucks and trucking as a personal hobby. Trucking is a way of life and not just an occupation for many drivers. The culture of this community means that peer-to-peer educational models are highly effective, as well as those conducted by drivers' associations and industry groups.

Government attempts to regulate the trucking industry have been perceived by drivers as unfair and impractical. This history is reinforced by interviews with current drivers in the field, and resentment of government activity in truck operations is especially strong among some owner-operators. Thus it makes strategic sense for the State of Delaware to work cooperatively with trucking industry associations and specific industrial councils within the state to develop policies and technology solutions that are better received among drivers than state-imposed solutions. After all, driver cooperation is needed for compliance with the law and achievement of the state's air quality goals.

7.2.2. Regional Partnership

Shifting parked trucks to other neighboring states may not significantly reduce the impact of truck idling on Delaware's air quality. As discussed by Schuster et al. (2004), a significant proportion of the state's air pollution is attributable to downwind states. Air pollution is a regional challenge that requires both local and multi-state policy strategies to mitigate. Idle reduction policy advances and technology innovations are largely determined beyond the borders of Delaware.

Furthermore, investment and innovation in new anti-idling technologies depends on clear and consistent standards and laws across the United States because regulatory certainty (together with information transparency) allows manufacturers to take advantage of economies of scale. Truck traffic through Delaware is also a regional, rather than state, phenomenon. Due to all these related factors, Delaware can help reduce truck engine idling by advocating for:

- Coordinated regional anti-idling policies that replace the hodge-podge of dozens of municipal and state regulations already in place;
- Installation of mobile anti-idling devices like automatic shutoffs as original truck equipment;
- Cooperative development and testing of technologies with consortiums and authorities with expertise such as the New York State Energy Research and Development Authority (NYSERDA) and the Philadelphia Diesel Difference workgroup of the Clean Air Council; and

- New approaches to SIPs and attainment calculations that reward regional cooperation in a way that recognizes air pollutants migrate and represent a regional problem.

7.2.3. Small Scale TSE Applications

7.2.3.1. Some Locations

Delaware should recognize truck drivers' need for heating and cooling services, and explore building TSE systems to accommodate drivers and reduce idling in illegal areas, like highway entrance ramps. Most trucks in Delaware are from out of state so it is difficult to mandate or finance mobile idle reduction solutions for trucks registered in other jurisdictions. For this reason, providing designated areas for trucks to access shorepower electricity makes good sense.[63] Delaware would benefit from the development of small-to-medium TSE sites in several locations across the state where significant truck activity occurs. Further studies would be needed to quantify such activity, but potential areas that may represent cost-effective TSE investments include:

- Abandoned Merchants Square shopping center along I-495 in Wilmington (this site would likely be an economically viable truck stop for hundreds of trucks);
- State government complex in Dover;
- Route 13/40 area in New Castle;
- Port of Wilmington;
- Poultry industry in Sussex County;
- Outlet store and retail complexes in the Rehoboth Beach area;
- Chemical, cosmetic, and car manufacturing companies in Newark.

7.2.3.2. Granting Parcels

The state of Delaware could consider granting parcels of underutilized land to a TSE system operator willing to build appropriately scaled truck stops at the strategic locations suggested above. In exchange, the TSE truck stop owners would have to share revenues and pay taxes to the state to compensate for the land it was granted. The state would also benefit from cleaner air, less noise pollution, improved public health, and the creation of new jobs. Most importantly Delaware would make a big step toward attainment status with the U.S. EPA air quality standards.

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[63] In order to catalyze increased public transportation utilization and carpooling among consumer citizens, many states (and all of the states neighboring Delaware) have constructed park-and-ride locations at access points to major highways. In providing park-and-ride lots to car drivers, states have recognized that they must provide infrastructure and amenities if they want to change the behavior of car drivers for the benefit of the public good. In exactly the same way, the TSE system can be applied.

7.2.4. Participation in Institutional Efforts

7.2.4.1. Regional Effort

At present, Delaware (and Pennsylvania) is noticeably absent from membership in the Northeast States for Coordinated Air Use Management (NESCAUM) consortium.[64] Without membership in NESCAUM, Delaware has no voice in the policies and technologies being implemented on trucks in other states that regularly pass through Delaware, particularly along Interstate 95. It is also missing out on a tremendous amount of accumulated knowledge and field experience that other state officials are developing together. Delaware is also unable to share the resources of bigger states like New Jersey and New York who are NESCAUM members and already have active TSE systems among other initiatives and policies. Delaware's economy and truck traffic is more integrated with its northern neighbors than its southern ones overall, and consequently membership in NESCAUM would be advantageous.

7.2.4.2. Federal Effort

As of early 2006, not a single company or organization from Delaware was a member of the U.S. EPA's SmartWay Transport Partnership. Without representation in this group, Delaware is less well positioned to take advantage of federal grant monies, research data, technical assistance, policy influence, and other critical resources and services. Peer entities in neighboring states, such as Perdue Farms in Maryland, are SmartWay members, and there seems to be no barrier or reason that would prevent fleets, companies, and agencies in Delaware from joining. Informal guidance or executive directives from the governor are just two of the methods the state might use to increase membership in the SmartWay program.

The Arkansas Department of Environmental Quality was awarded a $100,000 grant in September 2004 from the SmartWay Transport Partnership program of the U.S. EPA for a feasibility study of truck stop electrification system implementation as part of the national strategy for TSE systems along national highway corridors (Levinson, 2004). About six other states, mostly in the South, have received similar SmartWay grants for feasibility studies over the past few years, and there is no reason Delaware could not apply for one. In fact, a joint application with Cecil County, Maryland might make strategic sense.

7.2.5. Financial Incentives

7.2.5.1. Voucher System

In recent months, Travel Centers of America (TA) has offered an online promotion of $29 per night at select motels for truck driver members. The participating motels were chosen by TA because they have sufficient truck parking and because they welcome business from truck drivers. Delaware can theoretically increase highway safety, enhance driver comfort, reduce idling significantly, and promote local economic development by partnering with motel chains

[64] Although Delaware is a member of MARAMA, that membership alone is insufficient, and MARAMA's member states, beside Maryland, do not face as many commonalities with Delaware as do states with membership in NESCAUM.

and truck drivers to create a voucher system whereby drivers can stay over night in motels. This option is particularly attractive when used in winter, and in urbanized areas where commercial truck stops and other appropriate overnight rest areas are not available. In practice, however, this approach to idle reduction is rather infeasible beyond a small scale since few motels have sufficient parking for trucks. In addition, the voucher program could be administratively complex, and consistent availability of motel rooms is dubious, etc.

7.2.5.2. Rebates

Delaware-domiciled trucks have a strong incentive to use idle-reduction technologies because the surrounding jurisdictions are among the strictest enforcers of anti-idling laws (Berg, 2005). One study reported that New Jersey, Philadelphia, New York City, New York State, and Washington DC were the jurisdictions cited for issuing the most citations for idling violations (Tunnell and Dick, 2006, citing the Philadelphia Inquirer). Delaware could confirm that grants it issues for mobile devices are actually installed and working properly on the trucks they were issued to, and not resold or put aside for lack of installation. To prevent these scenarios, rebates could be used to reward performance verified by an approved mechanic, as one possible solution.

7.2.5.3. Loan and Lease

The Lane Regional Air Pollution Authority (LRAPA) in Eugene, Oregon has a program that provides low-interest loans to truckers who install APUs and is helping mechanics in the area become trained in installation and maintenance of the APUs (Thomas, 2005). In another incentive, LRAPA borrowed money from the Oregon Department of Energy to purchase APUs that were subsequently leased to drivers for five years (Auxiliary Power Dynamics, 2004). It is interesting to note that inverters were offered as an additional option, which supports the suggestion that solutions based on inverters are highly advantageous.

7.2.5.4. Conversion of Funds

New Jersey used a referendum in which voters decided whether or not the state could divert some revenue from an existing corporate business tax into a special fund for diesel retrofits, technical research, particulate traps, and other methods of reducing diesel engine emissions (Heck, 2005). The referendum was approved, meaning $160 million that was dedicated to a hazardous solid waste clean up fund could be transferred to a dedicated fund to reduce diesel emissions (Kidd, 2005) from publicly funded buses, school buses, garbage trucks, and government fleet vehicles.

7.2.5.5. Replacement Incentives

In addition to financial incentives for mobile solutions, the state considers an incentive program for replacement of outdated heavy-duty trucks,[65] if funding is available.[66] By reviewing

[65] National figures show that 27% of regional haul and 12% of long haul trucks are over ten years old, with ten years being the expected life of a long haul truck (125,000 miles per year) but some continuing for 20 years (Tunnell and Dick, 2006).

truck registrations, the state can identify owner/operators with old trucks and then provide a grant or large tax credit to help them finance a new generation truck that has idle reduction equipment integrated into the truck. The Caterpillar Cat MorElectric system reviewed in this report would be an example of the integrated engine/APU/HVAC system most beneficial for owner/operators as well as the state's clean air goals. The Port of Oakland (Orr, 2005b) has experience with a Replacement Truck Program as described earlier.

7.2.5.6. Mobile Emission Reduction Credits (MERCs)

The Texas Commission on Environmental Quality has a Clean Fleet Program that issued "Guidelines for Vehicle Emission Credits" in July 2004. Under Texas' program, idle reduction technology users can claim a bankable mobile emission reduction credit. Texas has a for-profit, open market credit-trading program for emissions reductions that include idling reductions (Texas Commission on Environmental Quality, 2004). At the prodding of commercial makers of mobile idling solutions, the Pennsylvania DEP is reportedly working on the rules and market platform for MERCs trading. Energy and Engine Technology Corporation of Plano, Texas, has licensed a technology that measures and tracks emissions with a high degree of accuracy and is pushing states, including Pennsylvania, to allow MERCs trading based on their APU product.[67]

Regulation 34 *Nitrogen Oxides Budget Trading Program* of DNREC's Division of Air and Waste Management states that participation in emissions banking and trading programs in the multi-state Mid-Atlantic region are explicitly in compliance with National Ambient Air Quality Standards of the EPA. The existence of this regulation establishes a precedent that allows Delaware to expand or replicate this program for long haul trucks and mobile source emissions. Additionally, Section 783, Title VII "Vehicles and Fuels Implementation Milestones" of the National Energy Policy Act of 2005 mandates that the EPA prepare a report on a mobile emissions trading in non-attainment areas (Edison Electric Institute, 2005). Delaware can study this market to determine what parts, if any, can be applied in Delaware.

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[66] Funding can be secured from a variety of sources. The Port of Los Angeles awards grants from its Air Quality Mitigation Program to reduce engine idling by diesel vehicles of all types. The funds amount to roughly $20 million over five years and come from a legal settlement in which the Port was accused of breaching the protocols of an environmental impact assessment (Ang-Olson, 2005).

[67] While there is no published material to refer to at this time, Pennsylvania is reportedly considering a regional approach in which MERCS can only be traded within set counties of its Philadelphia and Pittsburgh metropolitan areas.

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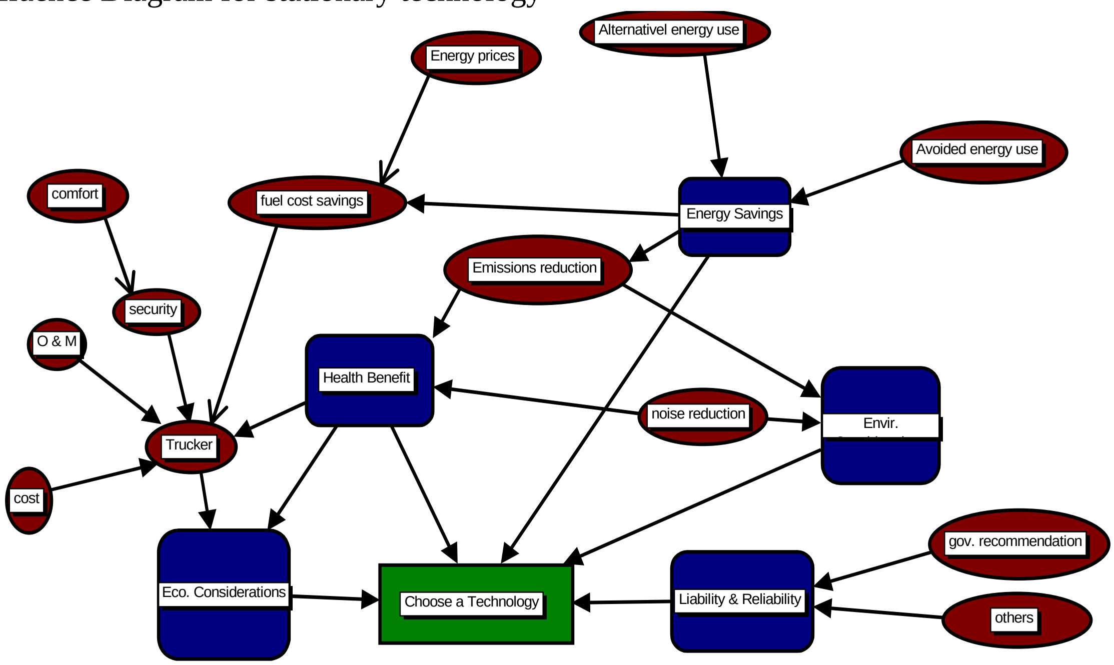
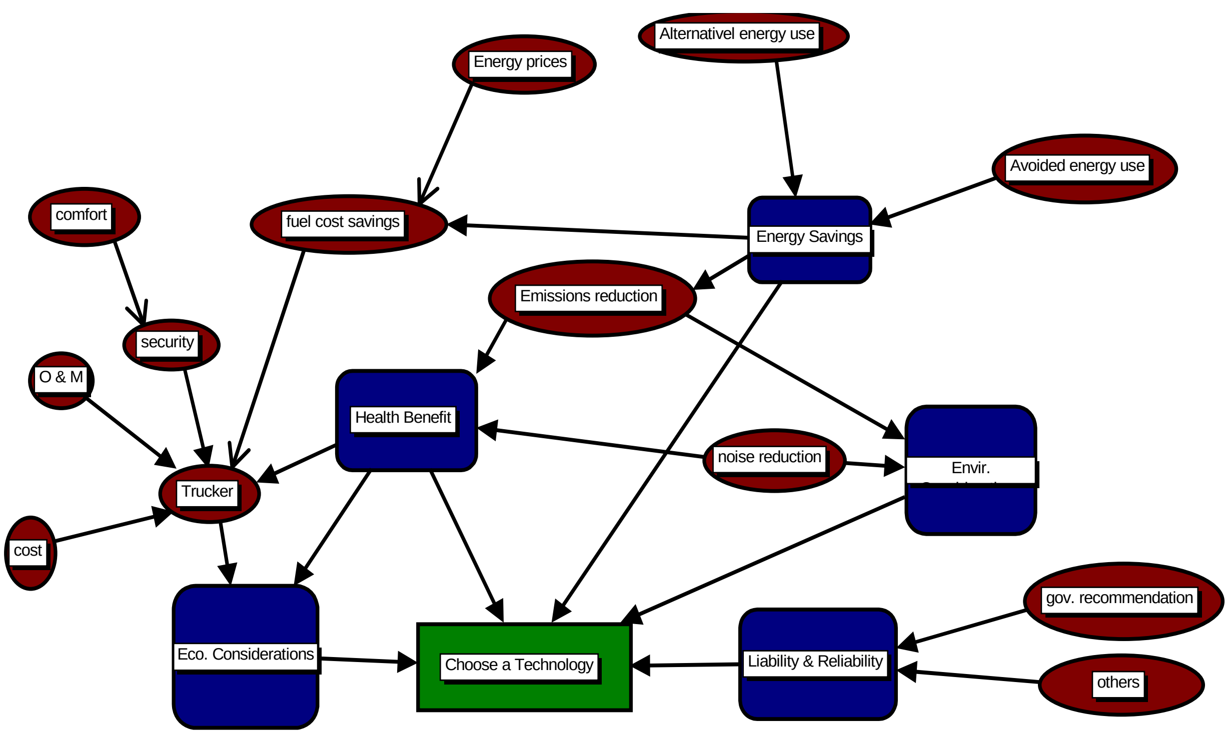
Appendix A
Analysis Criteria for E^3 Impacts

Influence Diagram for stationary technology



Influence Diagram for Mobile Technology



Appendix B
Presentation Handout

Investing the Cost, Liability and Reliability of Anti-idling Equipment for Trucks

Dr. Young-Doo Wang, P.I.
Dr. John Byrne, P.I.
Vincent O'Grady
Jun Tian
Wang Jin Seo
Jae Hyun Shim
Wilson Rickerson

May 1, 2006

Center for Energy and Environmental Policy

Main Issues

- **All three Delaware Counties: Non-Attainment Status of EPA Air Quality Levels**
- **Most Long Haul Trucks Passing Through; Few Are Domiciled or Destined for Delaware**
- **Significant Increases in Commercial Trucks in Delaware Resulting in More Roadside Idling**
- **3%-11% Efficiency for Idling Engine vs. 40% for Engine in Operation**
- **Need for Anti-idling Strategies as Part of State Implementation Plan (SIP)**

Center for Energy and Environmental Policy

Main Project Goal

- To Develop a Set of Policy Recommendations to both Curb Idling and Facilitate the Entry of Anti-idling Equipments in Delaware in Cost-Effective Ways to Comply with EPA's SIP Standards

Center for Energy and Environmental Policy

Project Tasks

- Evaluation of Costs, Benefits, Reliability, and Liability of Anti-idling Equipments
- Characterization of Truck Idling through Onsite Surveys and Other References
- Evaluation of E^3 Impacts of Anti-idling Equipments
- Review of Anti-idling Laws, Policies and Programs
- Case Studies: Pennsylvania and New York
- Policy Suggestions for Anti-idling in Delaware

Center for Energy and Environmental Policy

Reasons for Idling

Federal Regulation: Extensive Rest Hours to Promote Safety (Effective January 2004)

- **Climate Control in Cab (Heating/Cooling)**
- **Refrigerate Food & Medicine, Microwave**
- **Keep Engines Warm in Cold Weather**
- **To Power Accessories like Satellite Radio, TV, GPS, Phone, Electric Razor, Laptop**

Center for Energy and Environmental Policy

Anti-Idling Technologies

- **Direct-fired heaters** are an easy, immediate solution for cost effective, significant emission reductions (Heating is the most common reason for engine idling)
- **Diesel-based auxiliary power units** are an appropriate, market-proven solution with 5 years expected life that coincides with a new generation of very low emission trucks mandated by the US EPA from 2011.

Center for Energy and Environmental Policy

Anti-Idling Technologies

- **On-Board Truckstop Electrification System:** offers shore power electricity kiosks to trucks that power HVAC equipment in the cab

- **Off-Board Truckstop Electrification System:** provides climate control, electricity, television, telephone service, and internet access via a service unit that attaches to the passenger-side window

Center for Energy and Environmental Policy

Federal Anti-Idling Initiatives

- Establishment of Expedited Verification Program (EPA)
- SmartWay Transport Partnership Program (EPA)
- Technology Development Grants (DOE)
- Anti-Idling Technology Introduction Plan (DOE)

Center for Energy and Environmental Policy

State and Municipal Anti-idling Regulations

8 states with statewide idling regulations
4 states with statewide and municipal idling regulations
7 states with idling regulations for one or more municipalities

Center for Energy and Environmental Policy

Anti-Idling Regulation in CA

- California Air Resources Board (CARB) ruled that heavy duty trucks with sleeper cabs will be included in existing regulations banning idling for more than five minutes (Oct. 2005)
- CARB will also ban most diesel auxiliary generators from 2008 on unless they are certified as emission free.

Center for Energy and Environmental Policy

Delaware's Anti-Idling Policy

- Anti-Idling Law (Regulation No. 45): Idling is not permitted beyond three minutes under normal temperatures, 15minutes if the outside air temperature is 32° to 10° F, and no idling time limit for air temperature under 10° F (2005)
- Regulation 45 was incorporated into the SIP as regards attainment with the eight hour standard for ozone.

Center for Energy and Environmental Policy

Case Study: Anti-Idling Initiatives in Pennsylvania

- **Pennsylvania's Small Business Advantage Grant Program**: Small fleets and owner/operators given $600 - $7500 to subsidize the cost of APUS or direct-fired heaters.
- **Pennsylvania's Energy Harvest Grant Program:** Grants of $360,000 and $107,000 issued by the PA Dept. of Envir. Protection for TSE systems in two locations.*

* *One grant was rescinded because the truck stop was closed for unrelated reasons*

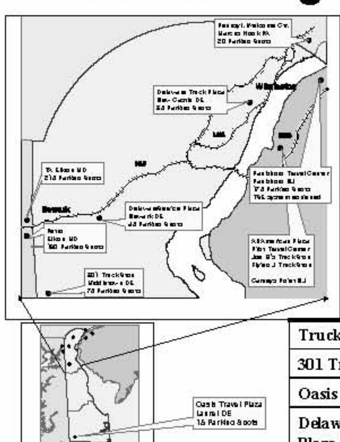
Center for Energy and Environmental Policy

Case Study: Anti-Idling Initiatives in Pennsylvania

- **Philadelphia Diesel Difference:** Facilitated by the Clean Air Council, 15 gov't and non-profit agencies cooperate on projects to reduce emissions including idled trucks
- **Philadelphia's Toxic Air Pollutants Risk Project:** US EPA Region 3 and the city's Air Management Services are working to reduce the health threat from toxic air emissions

Center for Energy and Environmental Policy

Truck Parking Space in DE



Truck Stops	Ownership	Space	Location
301 Truck Stop	Private	75	Middletown
Oasis Travel Plaza	Private	15	Laurel
Delaware Truck Plaza	Private	35	New Castle
Delaware Service Plaza	Public	45	Newark

Center for Energy and Environmental Policy

Potential Benefits from Reducing Long-haul Truck Idling in DE

Annual Fuel Savings	304,988 gal/year
Annual Fuel Cost Savings	$762,462/year
Annual NOx Reduction	64 tons/year
Annual PM Reduction	1.75 tons/year
Annual CO_2 Reduction	2,968 tons/year

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Field Survey Findings

- Reasons for idling vary from HVAC to telecom services to engine care
- Fleet owners are most concerned about fuel cost
- Truckers complain that anti-idling regulations don't provide them with alternative options to idling
- 80% avg. utilization rate for truck stops/rest stops, while idling rate is also about 80% at any given time

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E^3 Impact Evaluation

	Stationary Technologies		Mobile Technologies	
	On-Board TSE	Off-Board TSE	Direct-Fired Heaters	APUs
Economics				
Capital cost for investors ($)	$6,000	$16,000	-	-
Capital cost for truckers ($)	$4,000	$0	$2,000	$8,000
Lifetime (years)	15	15	5	5
Annual O & M Cost ($)	$1,500	$2,500	$500	$500
For Truckers				
Annual Energy Cost Savings ($)	$7,008	$7,008	$4,906	$5,606
Simple Payback for truckers (yr.)	0.95	-	0.52	1.83
For Investors				
Simple Payback for investors (yr.)	4.60	6.65	-	-
For the Public				
Health cost savings ($/yr)	4930.91	4930.91	4758.03	4325.48
Cost-Effectiveness ($ per ton of Nox reduction)	5.02	9.42	5.07	9.10
Energy				
Annual Fuel Savings (gallon)	2803.2	2102.40	1962.24	2242.56
Environmental Benefits				
Nox Emission Reductions (tons/year)	0.38	0.38	0.37	0.34
PM Emission Reductions (tons/year)	0.01	0.01	N/A	N/A
CO2 Emission Reductions (tons/year)	17.46	17.46	12.22	N/A

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Policy Considerations

- DE needs a truck stop with "shorepower" electrification. This type of **on-board** truck stop electrification system (TSE) is more flexible and less costly than the other type of **off-board** TSE. Private investors, with state incentives, will build and own the truck stop
- If each truck has an AC/DC inverter with auxiliary batteries, it can have electric power even when a shorepower plug-in is not possible
- DE needs to cooperate with surrounding states to formulate cooperative anti-idling activities

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Future Technologies

Regenerative brakes powering auxiliary batteries, super insulation in sleeper cab, fuel cell APUs, and built-in particulate filters are some new ways of eliminating idling and emissions

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