Diesel Fuel Emissions and Truck Idling:

The Oregon Interstate 5 Idle-Free Corridor Project
A Bounded Rationality Perspective

A Masters of Public Policy essay by Cliff Ham

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Abstract:

Long-haul diesel trucks carry the lion's share of all shipped goods in the United States. The drivers of these trucks often live in these trucks for days, sometimes weeks, at a time as they deliver these goods. When stopped overnight, many of these drivers leave their engines idling to heat or air-condition their cabs and produce power for the amenities they need to carry on their lives while on the road. To address the problem of environmental degradation due to idling trucks, the EPA and other interested parties are funding the Interstate 5 Idle-Free Corridor project, which is researching ways to reduce truck idling.

This paper details the Oregon portion of the Interstate 5 Idle-Free Corridor project and the problems related to truck idling along Interstate 5 in Oregon. Interviews with truck owner-operators and fleets uncovered reasons why truckers idle and what they are doing to reduce idling, as well as their views on several idle-reduction technologies. It became clear that many truckers are hesitant to buy in to the place-based technologies that the I-5 project is supporting because of initial costs and their skepticism that it will be available when and where they need it. The project revealed that most of our respondents preferred on-board technologies that were available at all times, wherever the truck was stopped.

Analysis and interpretation of the data gathered suggests that policy created to address the idling issue should be flexible enough to allow truckers to use a variety of solutions to reach their goals for idle reduction.

Diesel Fuel Emissions and Truck Idling: The Oregon Interstate 5 Idle-Free Corridor Project

Introduction

The central focus of this paper is the Oregon Interstate 5 Idle-Free Corridor Project. It is a joint project, with the major participants being the U.S. Environmental Protection Agency, Oregon State University, the Oregon Climate Trust, and ShurePower LLC., (a producer of a truck stop electrification product). This is a part of the larger Interstate 5 Idle-Free Corridor Project which also includes the Washington and California portions of the Interstate 5 corridor. The purpose of the project is to test the usefulness of place-based technologies that reduce overnight truck idling.

The first part of this report explores the reasons that trucks sometimes idle overnight, and some of the reasons it would be beneficial for them to cease doing so. In these sections the size and scope of the trucking industry is examined in terms of miles traveled, amounts of fuel used, and pollutants introduced into the environment. The types of pollutants produced and their effects on public health and the environment are also considered.

The next sections describe work done to examine the attitudes and capacities of truck fleets and independent drivers in Oregon regarding idling and idling reduction technologies. Telephone interviews were conducted with trucking fleet decision-makers as well as field interviews with independent truck owner-operators to determine their attitudes on truck idling and their depth of knowledge regarding idling reduction solutions. I discuss the methods used and examine the results of the interviews. Finally I interpret the results of the interviews in terms of the relative usefulness of different idle

reduction technologies according to those that would use them or purchase them for use by trucking fleets.

I will also look at some questions that are raised by the project and the larger issue of trucking and the use of diesel fuel. I will look at some ambiguities in the solutions considered in the project. Next I will consider what the future may hold in terms of this issue; a few possible solutions to either reduce magnitude of the problem or to change the nature of the problem and reduce its negative impacts; solutions that were not considered in the Oregon Interstate 5 Idle-Free Corridor Project.

In the final section I look at the project through a public policy perspective in order to get an idea why things may have been done the way they were. I apply the "bounded rationality theory" to the Oregon Interstate 5 Idle-Free Corridor Project, and to the bigger "Smart Way" project that it is a part of. This bigger view may make it clearer why some things were done in the way they were.

What's the problem?

If you have had occasion to travel on the interstate freeways and other major routes, particularly at night, you may have noticed all the trucks that are parked at the rest stops, the truck stops, and any other reasonably convenient, safe place that is available. Chances are that each of these trucks has a driver inside the cab, resting between stints of driving. Since these trucks cover many miles, sometimes thousands with each delivery, it makes sense that the driver would need to stop and rest rather than drive straight through to the destination. Reasons for this include comfort and safety, as well as legality.

There are statutes, both state and federal, mandating the amount of time a driver can legally operate a truck continuously, and how long the rest period in between must

be. Generally, a truck driver can operate a truck no longer than eleven to fourteen hours continuously, with a mandated eight hour rest period before getting back behind the wheel (U.S. DOT Rule §395.3, ORS §825.252). Of course this mandated rest period creates a unique set of problems for the truck driver. How can the driver get comfortable enough to get any useful rest in the cab of a truck, particularly if the nights are cold? For truck drivers to stay in a motel each night would seriously increase the costs associated with trucking. And what if there is no truck stop or rest area nearby when the time comes to pull over?

You can begin to see that some long-haul truck drivers often live in their trucks for days or even weeks at a time. This expands the list of problems for the driver. How can the driver stay in contact with family and friends (especially when the cell phone battery runs down)? How can he / she prepare meals? And what about entertainment? In the wired, computerized world we live in, many people would be lost without an internet connection. All these issues and others must be addressed by the long-haul truck driver.

It comes down to this: long-haul trucks can benefit from some sort of reliable power supply, to heat or cool the cab during rest periods as well as to supply power for the other amenities the driver needs to conduct day-to-day business. There is a simple solution to this; leave the truck's engine idling during the rest period. It can produce heat for the cab as well as air conditioning when necessary. It also operates the truck's alternator which can produce electricity to power all sorts of electrical devices.

Beyond the creature comfort issues, keeping the diesel fuel in the truck's fuel tank warm can be important in cold climates. Diesel fuel can become semi-solid at low temperatures, rendering it unusable as a motor fuel. When the engine is running, the fuel pump re-circulates the fuel from the tank and heats it before returning it to the tank. Also, large diesel engines can become very difficult to start in cold temperatures, even without the problem of gelling fuel. These are serious considerations during the winter months in cold climates.

Yet there are serious problems associated with long-term idling of large diesel engines. These problems include the relatively unproductive use of our dwindling supply of fossil fuel, economic factors associated with the cost of this fuel, environmental pollution from diesel exhaust, and public health concerns stemming from the release of these toxic pollutants. Many such efforts are underway to deal with the problems these truck drivers face other than long-term idling.

What we know already

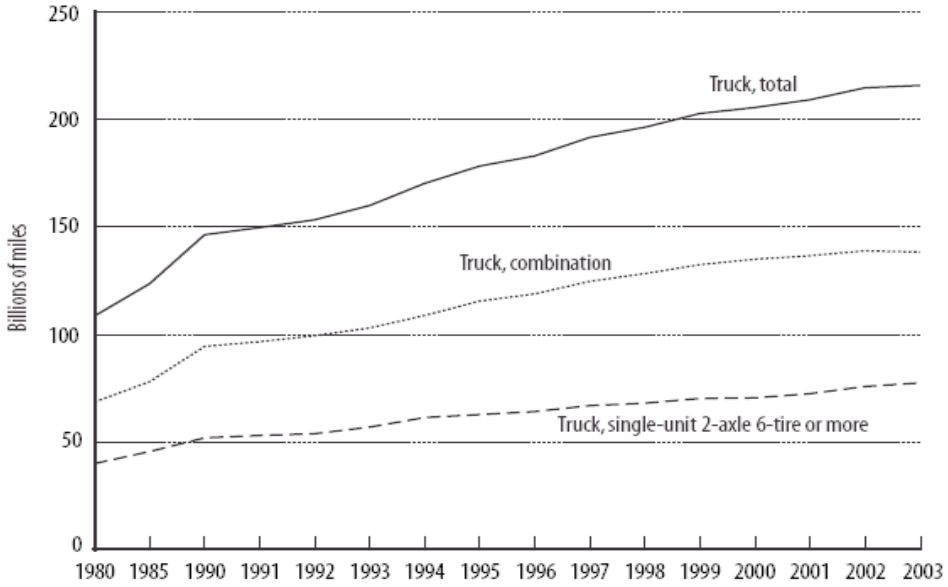
The trucking industry and its use of diesel

We know that trucks routinely idle for long periods of time. "Long-haul trucks typically idle 6 hours per day, or 1,830 hours per year, but actual practice varies, from idling 1-2 nights per week to hardly ever turning the engine off." (Gaines, 2004:01). When we start to consider the size of the trucking industry and the amount of ton-miles covered annually by long-haul trucks, we can begin to see the magnitude of the problem.

According to the U.S. Department of Transportation, in the U.S., diesel trucks cover well over 215,000,000,000 miles annually (US DOT, 2003). As suggested by the truckers I talked with nearly everything in our homes and places of business has been transported by diesel truck. The trucking industry is quickly supplanting freight trains for the delivery of all but the heaviest payloads. In Figure 1 and the surrounding text below, the U.S. Department of Transportation makes this clear:

> Trucks carried three-fourths of the value and two-thirds of the tonnage of everything shipped by manufacturers, wholesalers, and other industries in the United States in 1997. An additional twelve percent of the value of everything shipped by those establishments went by mail and courier services that used trucks for at least part of their trip. The Nation's highways handled over a trillion ton miles of commodities in 1997.

Figure 1:
Truck Vehicle-Miles Traveled on U.S. Highways: 1980-2003



NOTE: Total trucks exclude light trucks such as pickup trucks, sport utility vehicles, and minivans.

SOURCE: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, *National Transportation Statistics 2005*, available at http://www.bts.gov/publications/national_transportation_statistics/ as of August 2005.

This growth shows no signs of abating. Freight tonnage is forecast to increase by 70 percent between 1998 and 2020. Trucking is forecast to account for the majority of the projected increase (U.S. DOT, 2004: Ch.14).

Diesel fuel's negative effects on our environment

The environmental impacts of the combustion of diesel motor fuel are quite serious, and they are both localized and global in nature. According to the California Air Resources Board, "Diesel engines release a host of harmful substances including directly emitted organic and elemental carbon (soot), toxic metals, nitrogen oxides that form ozone and nitrate particulate matter, volatile organic compounds, carbon monoxide, carbon dioxide, and a variety of toxic metals and gases such as formaldehyde, acrolein, and polycyclic aromatic hydrocarbons" (CARB, 2000:20). This has many serious impacts for the environment beyond direct health concerns for humans. It affects the quality of our air, water and soil.

One of the effects that diesel soot has on air is that it is a major contributor to cloud cover and atmospheric warming, an issue that is now in the forefront of environmental concern. In a 2000 report, Hansen et. al. (2000) argue that particulates such as black carbon contained in soot may change the makeup and pervasiveness of our cloud cover, thereby being a major contributor to global warming even to a greater extent than CO_2 and other gases from fossil fuel combustion. Black carbon particles encourage droplet formation with the particle as the nucleus. These droplets are smaller than they would otherwise be, thus inhibiting rainfall and extending the duration of cloud cover. They also increase the brightness of the cloud cover, thus increasing reflectivity, contributing to the greenhouse effect.

The presence of black carbon particles, sulfur oxides and heavy metals in diesel exhaust also presents numerous issues of soil contamination. Black carbon precipitates in topsoil affects the ability of plants to extract nutrients from the soil, as well as affecting the soil's ability to absorb and hold water (Ghosh, 2007). This can have an impact on our ability to grow the crops we need for food, and thus perhaps for the production of alternative fuels. In addition, the other toxins found in diesel exhaust will precipitate out and be deposited in the soil. These toxins will be absorbed by plants, and may be ingested by animals ultimately destined for the slaughterhouse. Some of these toxins such as the heavy metals do not biodegrade and are not eliminated, and so will be concentrated as they travel up the food chain. The implications to our food supply should give us pause. Of course the same implications that exist for the precipitation of diesel exhaust into our water supply as do for the soil, and the results are similar.

A further problem relating directly to the idling of the diesel engine is the nature of the pollutants produced as compared to the same engine propelling a truck down the highway. The idling engine, due to its lower operating temperature, tends not to burn the fuel as completely as it would under heavy load and demand conditions, creating particularly harmful particulate pollutants:

> Preliminary chemical analysis showed that emitted particles contain more chemical components at lower speeds and loads because, at the low temperatures involved, several of the chemical constituents of diesel fuel don't evaporate or react completely. The particles were found to contain more potential cancer-causing pollutants; specifically, more polycyclic aromatic hydrocarbons (PAHs). At high engine operating conditions, the particles were found to consist mostly of carbon in the form of graphite. This means that when diesel trucks or buses are driven on the highway, they most likely produce graphitic particles, but in the downtown areas of major cities, they tend to produce particles that contain both

> graphitic and hydrocarbon components, including possibly harmful PAHs (Lee, 2002:01).

Diesel fuel's negative effects on public health

Public health is also negatively affected by the combustion of diesel fuel and the resulting toxins that are released into the environment. There are many health concerns related to the use of diesel fuel as an energy source, and they are often distributed unequally among the population. The U.S. Environmental Protection Agency recognizes diesel exhaust as one of the greatest risks to public health of all airborne pollutants. In New Jersey alone, it is estimated that nearly 900 premature deaths, 17,926 asthma attacks and 107,364 lost work days could be prevented by reducing diesel soot emissions by only 20% (Schneider, 2000; Schneider & Hill, 2005).

Diesel combustion emits both gases and fine particulates into the air. The particulates released are commonly called soot. These particles are less than 2.5 micrometers in size, representing added health dangers due to their small size. Diesel soot is recognized under the Clean Air Act as a regulated air quality contaminant. There are numerous toxins contained in diesel soot, and the small particle size enables them to be drawn into the deepest part of the lungs where they can be taken into the blood and spread throughout the body. These particulates can also accumulate in the lungs, decreasing the efficiency of the respiratory system by obstructing oxygen uptake, and causing many other health problems such as asthma, bronchitis and cancer. A safe level of diesel soot, below which no negative health effects would be found, has not been scientifically determined. According to Pope, "Each 10 microgram/cubic meter increase in PM leads to 8 percent increased risk of lung cancer deaths, a 6 percent increased risk

of cardiopulmonary mortality/heart attacks, and a 4 percent increased risk of death from general causes" (Pope et al, 2002:03).

Children, elderly people and urban dwellers are the most vulnerable members of our society to the negative health effects of diesel combustion emissions. Children are still developing their respiratory and immune systems, and they breathe a larger volume of air by body weight than do adults; as much as 50% more (Dietert et al, 2000). They are more likely to suffer from asthma due to the aspiration of diesel soot. This is the leading chronic disease among children, as well as the greatest cause of school absenteeism (ALA, 2003).

Older people and people in poor general health will also be disproportionately harmed by diesel engine emissions. Poor cardiopulmonary health and a weakened immune system make them more susceptible to the negative effects of aspirating diesel soot. Of course those involved in the trucking industry and those living near major highways, interstate freeways, truck stops, truck terminals or anywhere that diesel truck use is concentrated will be more affected than those in other, more isolated areas. According to the U.S. EPA, "Eighty three percent of the U.S. population lives in cities with concentrated diesel emission sources such as highways, bus and truck depots, heavy industry and construction sites." (EPA, 1999:01). The impact of living in these areas of high levels of diesel emissions on human health is well documented. "The risk of premature death is 26 percent greater in areas with high soot levels than in areas with less fine-particle pollution" (Dockery et al, 1993). However, diesel soot can be found in the air in lesser concentrations further away from its source, and as discussed earlier there is no "safe" airborne concentration of diesel soot, either in rural or suburban areas.

Because this paper is considering the specific issue of idling diesel trucks, it is worth mentioning again that the nature of exhaust emissions from an idling truck is more toxic than a truck in which the engine is fully loaded, propelling the truck down the highway. Therefore the public health consequences of idling trucks are predictably greater per gallon of diesel consumed than the fuel actually used to propel the truck. This provides us with additional cause for addressing the problem of long-term idling of trucks.

The Interstate 5 Idle-Free Corridor Project

There are many people and organizations that have recognized many of both the positive and the negative contributions of the trucking industry and its dependence on fossil fuels. Some of them are coming together in collaborative efforts to find effective ways to reduce the severity of the negatives. One such effort is the Interstate 5 Idle Free Corridor Project. It is a project that includes the entire Interstate 5 corridor, the major north-south land trade route on the west coast of the United States. The Oregon portion of this project is a collaborative effort between the U.S. Environmental Protection Agency, the Oregon Climate Trust, Oregon State University, several truck stops along the Oregon Interstate 5 corridor, and ShurePower LLC. ShurePower LLC is a producer of an idle-replacement technology which provides a ground-based power supply for trucks.

The project is an effort to address the problem of extended idling of diesel trucks parked at truck stops during rest periods. As mentioned earlier, many truck drivers essentially live in their trucks, often for weeks at a time, and therefore need a reasonably comfortable area inside their truck cabs in which to rest, eat, maintain contact with family

and friends, and conduct the business of everyday life. Among the amenities these truck drivers seek is a comfortable temperature within their cab, power for entertainment and communication, and facilities for preparing meals. This can be provided by idling the truck's engine, which powers the heater and the air conditioner compressor for the cab, and the alternator for powering appliances such as a microwave oven or a computer. Yet operating a 500-horsepower turbodiesel power plant which is designed to propel a loaded truck weighing many tons at freeway speeds is an extremely inefficient use of diesel fuel to produce the relatively miniscule amounts of power for creature comforts.

The Interstate 5 Idle-Free Corridor Project seeks to mitigate the necessity of long-term idling by studying the feasibility of providing alternate sources of power for these amenities to the truck drivers. This may be accomplished with the use of a ground-based stanchion, such as that provided by ShurePower, LLC., that the truck can be attached to that provides "on-the-grid" power for an on-board heating / air conditioning unit, electrical power for lighting and appliances, and communications hookups for telephone, cable/satellite television and broadband internet services. If widely used, technologies such as these could substantially reduce the quantity of diesel fuel required to keep the truck fleet delivering goods by eliminating the necessity of idling the engine for long periods of time.

The Oregon Interstate 5 Idle-Free Corridor Project is only one of many ways to address the problems associated with the widespread use of diesel fuel for commercial purposes. Truck stop electrification appears to promise a reasonable, technology-based method to make a measurable improvement in the fuel efficiency of our trucking fleet on this major thoroughfare. If economically feasible this method may be applied on other

routes, at other truck stops and other places where trucks stop for rest periods. The research that was completed as a part of this study also examined several other popular methods of addressing the problems associated with diesel fuel use by the trucking fleet. We will delineate some of the most popular of these technologies, as well as some of the alternate solutions that were created by the truck drivers themselves, some of which are ingenious, enlightened, effective and well-thought-out.

Bounded Rationality Perspective

We can begin to see that there are numerous ways of addressing the problem of truck idling, and as we continue to examine the issue we will find that the problem keeps changing in nature and each of the solutions carry their own, ever-changing set of problems. Clearly, since the driving force behind the Oregon Interstate 5 Idle-Free Corridor Project is the U.S. EPA, the major issue to be addressed is environmental protection. Yet there are many other concerns that must be taken into account to reach the most equitable and effective solution possible.

As the administrative body that will be responsible for creating and enforcing a set of federal policies to address this issue, and for facilitating the creation of state policies, that are seen as coherent and equitable, the EPA is faced with a daunting task, and to their credit they are attempting to gather as much information as possible from as many interested sources as possible. They recognize that the issue is a moving target and priorities and variables are constantly changing, more information is becoming available, and technologies are changing and improving, even as the size of the problem increases. It is not possible to fully understand all facets of the issue, and incomplete understanding is compounded by the ever-changing landscape. No person or agency can be expected to

be omniscient, so decisions must be made based on the best information available at the time. This is the framework within which policies must be decided upon and put into place.

Herbert Simon in *Models of Man* called this principle *bounded rationality* and described it in this way:

> The capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world – or even for a reasonable approximation to such objective rationality (Simon, 1957; p.198).

This principle was set within the context of a discussion of rational man, making rational decisions in the face of ignorance about the future and an incomplete picture of the present. These decisions are based on a simplified model of the real situation; a model on which he can apply objective rationality in decision-making. As the model is fleshed out more completely as more information is added, the decisions based on the model become more and more appropriate to the actual situation that the model is based on.

As we continue our examination of the truck idling issue it will become increasingly clear that *bounded rationality* is the framework within which idling policy must be created, and that the ability of the EPA to acknowledge this and to function within this framework enhances the likelihood that good and equitable policy will be the result.

What We Did

The study was designed to identify long-haul trucks that travel through Oregon on Interstate 5 and stop within the state, and may have reason to idle their engines for extended periods of time. Interviews were conducted with a sample of long-haul fleet

operators and independent long-haul truck drivers who stop at Oregon Interstate 5 truck stops. We focused on those fleets that carry truckloads along the Interstate 5 corridor and idle in Oregon. Therefore our subject population included; (1) individuals responsible for specifications and purchases at truck fleets; and (2) owner-operators of trucks who idle in Oregon. In interviewing the subjects, we hoped to determine the depth of their awareness of the problem of truck idling, the steps they have taken to mitigate it (if any), and their knowledge of the ShurePower technology and any other available technologies. We conducted telephone interviews with decision-makers employed by several of the long-haul trucking fleet operators, as well as in-person interviews with independent long-haul truck drivers at the truck stops that are involved in the project.

The research team, which consisted of two sociologists, Dr. Stephanie Sanford and Dr. Denise Lach, and myself as a graduate research assistant created a questionnaire for both the in-person and the telephone interviews. The questionnaires are very similar in nature, but customized for the different situations. Five fleet interviews were conducted by telephone, each of which was approximately 30 minutes in length. These interviews were semi-structured and in-depth, with the individuals that we had determined met our criteria as decision-makers for the fleet, which is that they were in a position to install, or order, idle-reduction technologies on the trucks in the fleet.. This was a "purposive" sample, in that we talked with the fleets that we knew idle their trucks on the Interstate 5 corridor. So, rather than using these interviews to generalize statistically, we used the information to gain an understanding of the issues of concern to these fleets.

We also conducted 15 in-person interviews of independent owner-operators at the truck stops. Some effort was made to provide a diverse sampling, although the sample size was small. These interviews ranged from around 45 minutes to well over an hour, and were sometimes wide-ranging in terms of subject matter, though efforts were made to stay close to the scripted questionnaire. The purpose of these interviews was also to gain an understanding of the issues faced by this particular group rather than to conduct statistical analysis with, or to generalize results to a larger population. We recruited these interviewees by posting a sign offering a $10 truck stop gift certificate. Essentially, we bought them dinner. We also invited truck drivers who were seated at the restaurant to participate in the survey, offering them a gift certificate as well.

This was clearly a sample of convenience, since we simply interviewed drivers who happened to be there when we were interviewing. The drivers we interviewed were all males, aged from 25 to 60 years of age. Eleven were White, two were Hispanic, one was Black, and one was East Indian. Their truck driving experience ranged from under one year to over 40. The routes they covered included the entire U.S. including Alaska and Hawaii, the lower 48 states, the Midwest and the west, the southeast and southwest, and various routes along the Pacific Coast Interstate 5 corridor.

Handwritten notes were taken during the interviews, and later transcribed for purposes of grouping and analysis. Beyond basic demographic and informational questions, we asked respondents their opinions about and experience with different types of idling technologies. The interview protocol is included as Appendix A.

Data analysis began by each team member individually examining the transcriptions of the interviews, noting patterns and looking for consistency in the

responses. We looked for notable differences between the drivers and the fleet owners, between the individual drivers, and for consistency between them. Following this exercise we compared our notes and negotiated any differences in our understanding of the interview data. The results of this research have been presented to the U.S. EPA, the Oregon Climate Trust and ShurePower to facilitate their decision-making with regard to the feasibility of the truck stop electrification project, including the likely population of truck drivers and fleets that will use their facilities. What follows is the discussion of the data.

What we found out: Results of the interviews

Nearly all of the respondents had concerns about idling, with widely varying reasons. Independent owner-operators and fleet representatives were both concerned about the cost of fuel as it relates to idling, and they shared concerns about the comfort issue of idling in hot or cold weather as it relates to highway and driver safety. Some of the respondents expressed concerns about pollution, though not all did. One long-haul driver we interviewed summed up his view of the issues related to idling as follows:

> [I] think the Clean Air Act should make idle reduction mandatory and that manufacturers should install the technology on all new trucks. . . . there is a safety issue with regard to drivers being uncomfortable and not getting enough rest. This is partly due to the noise of truck idling. [I] believe in an unwritten trucker's code that you should park away from other truckers if you must leave your truck idling. The fact that fuel costs have nearly doubled in the last two years has helped to reduce truck idling.

It is the fleet representatives, however, who are more likely than owner-operators to believe that considerable idling takes place along the Interstate 5 corridor. Most owner-operators state that they only idle infrequently, and then only when it is very cold or hot.

In interview question four we asked respondents about five specific idle reduction technologies. These were additional batteries, auxiliary power units, ShurePower, Idle Aire, and fuel cells.

The owner-operator results

For the owner-operators, the most widely used of these technologies (at 87%) were batteries and *inverters*, which convert battery current so it can be used by 110-volt household current equipment and appliances. These were used mainly to operate amenities other than heaters and air conditioners, which both have substantial energy requirements. The list of amenities included microwave ovens, televisions, video cassette recorders and DVD players, facsimile machines, computers, printers, small, apartment-size refrigerators, electric blankets, cellular phone chargers, food coolers, electrical power tools, lighting, global positioning systems, small space heaters, copy machines, and an automatic cat litter box (!).

A full quarter (25%) of owner-operators had outfitted their trucks with auxiliary power units (APUs). These units can be used to heat and cool the truck cab during rest periods as well as preventing the gelling of fuel in the tank in cold weather. They also produce electrical power for the appliances mentioned above. Being on board the truck, the power from an APU is available anywhere the truck driver may stop to rest. One driver stated, "Cost recovery is a factor, but APUs are [my] first choice. I don't usually drive a fixed route, so finding Idle Aire units is a problem. With increasing idling regulations, [I am] looking for a flexible alternative, which an APU can provide."

Other idling alternatives used by owner-operators include portable gasoline generators and diesel-fired heaters, "good sleeping bags" and electric blankets. There

were also several unconventional solutions that owner-operators had utilized. One respondent had converted a generator and air conditioner removed from a motor home for use in his truck. One trucker who drives from Ontario, Canada to Los Angeles describes the technologies he has tried:

> [I] use shore power, sometimes an RV generator, and an Espar (diesel) heater. I previously used a "Park and View" – also called a "turtleback – which was available at truck and travel stops. . . . they offered phone and TV hookups, somewhat like the old drive-in movie speakers. They have since gone out of business.

Most of the owner-operators we interviewed were aware of the Idle Aire ground-based solution, and 40% of them had used the technology at some time or another. However, none of our interviewees had ever used ShurePower, though many had heard about it. Four owner-operators had never heard of ShurePower.

The fleet results

One of the fleets we interviewed has installed auxiliary power units (APUs) in all of their trucks after testing them to insure their practicality and economic feasibility. Another fleet has tested APUS and found that they are *not* cost-effective compared to using an automatic engine start-stop system on the main engine to provide power to heat and cool the cab. This company is also researching battery-operated air conditioners and hydrogen fuel cells. This company also expressed concerns about the lack of insulation in truck cabs. Their comment was that "the cabs of most trucks have an R-value of less than 2." One of the fleets has decided not to take any action to reduce idling at this point, but rather to simply absorb the added cost. They expressed concerns of possible litigation by their drivers due to unsatisfactory working and safety conditions if they were not allowed to idle their trucks. Yet another of the fleets has some of their trucks already

equipped to use the ShurePower technology, but they believe that ShurePower "does not provide air conditioning," so they are considering the use of APUs in conjunction with ShurePower.

Why Truck Drivers Do / Don't use Idle Reduction Technologies

One of the intended outcomes of our study was to gain an understanding of what would cause a truck driver or a fleet to use or to not use ShurePower or other idling replacement solutions. What follows are concerns raised by our interviewees about each of the idle reduction technologies.

ShurePower

Only one of the five fleets we interviewed has any trucks that are equipped with the proper retrofits to enable use of the ShurePower technology. This particular fleet views ShurePower as the least expensive idle reduction alternative for them, but they are considering the use of APUs in conjunction with ShurePower, in order to provide air conditioning. None of the other fleets are considering ShurePower. The main reason stated is the lack of availability of truck stops and other parking facilities that offer the technology. One decision maker said that, "until there is more availability of shore power units like Idle Aire or ShurePower, this is not a viable alternative." All of the fleets were concerned with the high costs associated with idling, yet they were aware of the high costs associated with many of the idle reduction technologies as well, or to quote one fleet decision maker, "Even as fuel prices rise, the cost of the technology is very high."

None of the owner-operators we interviewed were equipped to use the ShurePower technology. Most of our owner-operator interviewees had heard of

ShurePower, but none had used it; indeed, few had ever seen it. They expressed several observations and concerns about this technology.

There is a total lack of availability of ShurePower spaces in truck stops, and this is not likely to change anytime soon. A few experimental spaces at a few truck stops along the Interstate 5 corridor will be "a drop in the bucket." All regular parking is occupied at night at all the Interstate 5 truck stops. The likelihood of finding an available parking spot that has ShurePower availability is seen as a serious drawback. In the words of one owner-operator, "Idle Aire parking spots in the truck stops fill up quickly, often with trucks that don't use the hook-up. This is because they are the parking spots closest to the terminal. This means that truckers who want to use the hook-up, can't."

Owner-operators usually operate at a small profit margin and the cost of retrofitting their truck for ShurePower use is seen as a major drawback; the retrofit can cost several thousand dollars. They have similar misgivings about other idle reduction solutions. They need solutions that will have a short payback period, and that will be useful to them when they need it.

Place based solutions are viewed as most useful to drivers who drive a dedicated route on a main trade route, such as the interstate highway system. In order to take advantage of a specific place based technology, the driver must know where it is located.

Some drivers do not want to have to get out of their trucks, plug wires and hoses into receptacles or tug on the starting rope of a generator. They are tired and they just want to rest.

Still, even though the drivers had no actual experience with ShurePower, they understood that there were positives associated with this specific solution. ShurePower is

seen as easy to use. One driver who regularly travels Interstate 5 stated "[I] like the idea of having all the equipment on board and simply plugging in." It is understood that ShurePower is a multifaceted solution that provides many benefits, such as the ability to charge on-board batteries and power electrical accessories and appliances. Our interviewees see ShurePower as a low cost option for idle reduction after the initial retrofit costs have been met.

So, both the fleet representatives and the owner-operators agreed that the major drawback to ShurePower is its lack of availability. Still, they see it as a low cost alternative to idling (were it available to them). As an aside, all new Volvo trucks now are being manufactured, as standard equipment, to be ShurePower compatible. ShurePower compatibility is offered as an option on several other makes of heavy trucks as well.

Idle Aire

Idle Aire is currently the competitive place based idling solution to ShurePower. Idle Aire has the advantage of being "first out of the chute" with more widespread availability than ShurePower, and thus truck drivers and fleets are more familiar with it. It also has the advantage of having a low initial buy-in cost. All that is necessary to take advantage of the Idle Aire hook-up is a grommet that is rolled up in the window of the cab, somewhat like the drive-in movie speaker of days gone by. This grommet costs less than $50 at our last check. This makes Idle Aire a good possibility for occasional use, since initial investment costs are reasonable. Still, the technology has many of the same drawbacks as ShurePower, the other place based solution; mainly the lack of easy

availability. Idle Aire is more readily available than ShurePower, yet neither is yet available in Oregon on the Interstate 5 corridor.

There were other concerns that were expressed by those who were familiar with the Idle Aire units. Our respondents mentioned that often the Idle Aire hookups at the truck stops were already in use, and that hooking up to it is troublesome. One mentioned that the door grommet makes the passenger door unusable, and that the air conditioning unit would draw the exhaust fumes of nearby idling trucks into the cab of his truck. Another interviewee stated that the heating unit of the Idle Aire was inadequate, and he had to supplement it with a portable heater. Yet another mentioned that he and others saw Idle Aire as an expensive alternative to idling, and that they have observed the price continuing to rise.

Still, a few of our respondents had favorable opinions of Idle Aire. One respondent was impressed that he could use an Idle Aire hookup for $21.85 per night, compared with about $30 to idle overnight. Most of the positive comments about Idle Aire mentioned the range of amenities that it provided them, such as "cable TV, a computer internet hookup, heat and air conditioning, and phone hookup. There is even a push button to call for 'carhop' service."

As with ShurePower, the other proprietary place based solution, the major drawback to its use is its limited availability. Those who have personal experience using Idle Aire like the fact that it is a relatively complete solution, offering many amenities. However, there are other issues specific to Idle Aire, such as the perceived high per-use expense and the inadequacy of its heating and cooling units.

Auxiliary Power Units (APUs)

APUs are either in use, or are being considered and tested by several of the fleets that we interviewed, and one of these fleets has installed them on all its trucks. Highest among their positive attributes is their universal availability for use; "they can be used anywhere, even if the driver must stop between rest stops." One of the companies is testing the APU, and while they do not find much usefulness in anything except the APUs, it appears that the APU is "not saving them all that much." One major drawback of the APU is its initial buy-in cost, which is generally $8-9000 per unit. One of the fleet respondents commented, "…even with a projected eleven month return-on-investment time frame, it is difficult to justify an expense of $9,000 per truck to purchase APUs for nearly 200 trucks."

Of the owner-operators interviewed, several have purchased an APU or are planning to do so. Several of them have done considerable research into the APU market and have analyzed them based on buy-in cost, weight, maintenance cost, and cost recovery time frame. They also concurred with the fleets that their main advantage is that they are available for use anyplace and anytime. One of the owner-operators avoids truck stops because of the noise told us, "APUs as excellent alternatives for the owner-operator; it is flexible. Can be used anywhere and saves about $3000 a year on fuel and maintenance costs." Another stated, "cost-recovery is a factor, but APUs are my first choice. I don't usually drive a fixed route, so finding
Idle Aire units would be a problem. With increasing idling regulations, I am looking for a flexible alternative, which an APU provides." Yet he and other drivers thought the initial cost of a unit was too high, and they questioned the actual amount of fuel savings that are possible with an APU, considering the fact that they also are powered by fossil fuel,

usually diesel. An APU is quieter than a diesel truck engine, but one driver said that the "exhaust stays on the ground rather than being directed overhead like the truck's stacks do to the engine exhaust."

One advantage of many APU models is the feature that prevents the gelling of the diesel fuel in the tank. This is a very important feature for those operating in cold climates, though it may be less of a concern to those whose travel is confined to the Interstate 5 corridor. Most of the other idling solutions do not address this issue.

Both the fleet representatives and the owner-operators view the APU as a worthwhile solution to the idling of the main truck powerplant, mainly because it gives the driver great flexibility. He / she is not dependent on finding a parking space in a truck stop that offers a place based technology. Most of our interviewees see the APU as cost effective although the initial buy-in cost is seen as problematic. The actual dollars saved by an APU will increase as the price of fuel continues to climb, as it is projected to.

Batteries and Inverters

Numerous owner-operators told us that generally the climate on the Interstate 5 corridor was mild enough that heating and cooling the cab during rest periods was not a major issue to them. Several of them addressed the problem with simple solutions such as a "good sleeping bag," or a 12-volt electric blanket. These and other types of solutions were much more common among the owner-operators than the fleets, however. For owner-operators, this seemed to open the door to simple and less expensive solutions to their issues associated with living in a truck for extended periods of time. Many of the other amenities that long haul truck drivers seek are not as energy intensive as an air conditioner or a space heater, neither of which can generally be operated for long with a

standard lead-acid automotive type battery. However, with additional batteries and an inverter to convert the battery power to household current, many amenities could be used. As mentioned earlier battery power is being used in trucks to power everything from televisions to electric drills; from DVD players to automatic cat litter boxes. The battery-inverter solution was used by all but one of the owner-operators we interviewed. The lone driver who did not use battery power other than to start the truck engine had had a bad experience with a run-down battery during cold weather, and it had made him wary of the possibility of being stranded with a dead battery.

While the owner-operators viewed the battery-inverter solution as a nearly universal positive, the fleet representatives were not as enthusiastic about it. Eighty percent of the fleet representatives interviewed did not install additional batteries or inverters in their trucks, and they did not encourage their drivers to use the battery as an idling solution. However, one of the fleets is using an unusual electric powered air conditioner in several of their trucks. This unit requires special batteries rather than the standard lead-acid type. It also requires a larger alternator to be installed on the truck's main engine in order to keep these special batteries charged. This is the company that is also using a cab temperature controlled automatic start-stop system for the main engine of the truck, as well as diesel fired cab heating systems.

Hydrogen Fuel Cells

Of the owner-operators we interviewed, though a few of them were aware of the hydrogen fuel cell, all were unaware of its application as an idle reduction technology. This is not surprising since this technology is not yet available for this use. However, one

of the fleets we interviewed is experimenting with fuel cells for this use, though the representative for this fleet stated that, "nothing has come of it yet."

Conclusions and Policy-Making Framework

Conclusions

Generally, all of the people we talked to about truck idling saw it as an important issue, often for varying reasons. As mentioned above, heating and cooling of the cab is not seen by many of the drivers interviewed as a critical concern on the Interstate 5 corridor because of the generally temperate climate. Most of them already were using some sort of idling reduction solution or a combination of several. The most common solution was the use of batteries; this was especially popular among the owner-operators we interviewed. The APU is seen as another useful solution. It offers flexibility and is always available.

Place based solutions such as ShurePower or Idle Aire are seen as problematic because of the lack of availability and flexibility. Perhaps they will gain more acceptance and widespread use when they become more readily available. There seems to be a convergence of opinion that these technologies will be most useful to truck drivers who travel a consistent route and can expect to reach a truck stop with the appropriate technology on a regular, recurrent basis. Those with widely varying routes see this technology as a problem because they may not be near a place where it is offered when they need to stop, or they may not know where it is offered on a route that they are not thoroughly familiar with.

The cost associated with most of these solutions is a concern to many of our interviewees. The initial purchase cost is high for both the APU and for the ShurePower

retrofit, being as high as $9000 and $3000 respectively. Initial costs for the Idle Aire retrofit is small at well under $100, and the battery-inverter solution initial cost may vary from around $100 to several hundred dollars.

The ongoing cost for the APU will include maintenance costs as well as fuel cost, which will increase with the rise in fuel prices. Yet as the price of fuel continues to increase, the overall cost saving of an APU will increase also. (This is true of all idle reduction solutions, of course). Though there is a federal 400 pound payload increase allowance for those trucks that are equipped with an APU, this allowance is not mandated to the states. Therefore the lack of uniformity in this provision makes it useless to interstate truck drivers who drive in states that do not recognize this allowance.

While the limited availability of ShurePower is a major drawback to its use, many of our respondents see it as the low cost solution after the buy-in costs are met. For fleets and owner-operators who buy new trucks the initial cost can be absorbed into the cost of a new truck, since ShurePower hardware is standard on some new trucks and is optional on many others.

Some of our interviewees were concerned about the ongoing cost of Idle Aire usage, expressing concerns that these prices would continue to rise as they have in the past. Yet it is recognized that it does offer cost savings over idling. It is apparent that there are many solutions to the problem of truck idling that are being applied and considered. The ultimate answer will probably be a combination of the solutions discussed above as well as others that we have not considered or are not yet widespread.

Other Considerations

To a business person dealing with this problem, the major consideration will probably be economic. Yet to the outside observer, this may not be the case. I suspect that the typical response of the layman to finding out about this problem would probably center on either political considerations or environmental pollution issues. This being the probable case, the solutions which seem to make sense to the owner-operators or fleet operators may not seem the best to others. For example, the APU solution which has a large and increasing popularity among industry insiders has some serious drawbacks to the lay observer. The APU still runs on fossil fuel, and though it uses less fuel than an idling 400-horsepower powerplant, there are other problems. The powerplant of an APU is considered a stationary engine, and therefore is not subject to many of the pollution control requirements of a vehicle powerplant. This means that their exhaust emissions are likely to be dirtier, more polluting, and unhealthier than that of the main truck engine. So as a solution to the environmental and public health concerns associated with truck idling, the APU may be found wanting. If we consider the place-based solutions such as ShurePower and Idle Air from the lay point of view, we must ask where the energy that these units supply to the truck come from. Of course, the answer is "the grid." So where does the power on the grid come from? A considerable amount of the electricity on the grid is generated either by the burning of fossil fuels or by the burning of coal, which has been transported by trains, which are powered by diesel. Figure 2 shows the breakdown of how the electricity on our national grid is produced. The burning of coal produces many of the same toxins and particulate pollutants as the burning of diesel, often in higher

concentrations. Perhaps a study should be done to determine if there are any real benefits to be found here beyond shifting the problem from one focal point to another.

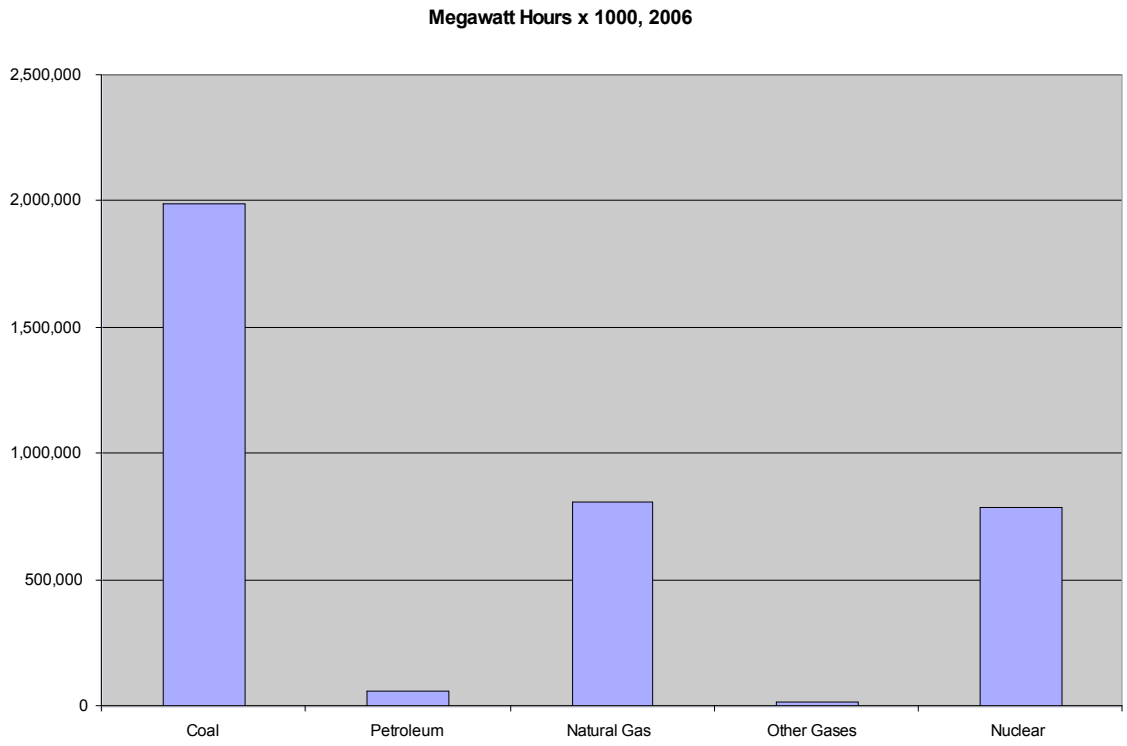


Figure 2: Sources of Electrical Power in the United States (data from U.S. Department of Energy) *http://www.eia.doe.gov/cneaf/electricity/epa/epat1p1.html*

If we consider the on-board battery-inverter, which is the most widespread solution we found in our study, we must also consider where the power in the battery comes from. Of course it comes from whatever mechanism is used to charge the battery, in this case the alternator which is turned by the truck's main engine. Charging a discharged or partially discharged battery places a load on an alternator, making it more difficult to turn. This in turn places an additional load on the truck's engine for the time it takes to recharge the battery. An additional load on the truck's engine will increase the engine's fuel consumption.

It seems that each of our answers has its own set of problems attached to it. Perhaps a cost-benefit analysis is in order; hopefully one which takes in to consideration, beyond economic considerations, the external costs such as environmental and public health consequences and political and international relations issues.

The Future

There are other possible answers to the idling problem if indeed the problem is greater than just an economic one. Throughout this paper it is made clear that the trucking industry is a huge part of our infrastructure, and supports our way of life. It could be said that our way of life has necessitated the size and scope of the trucking industry. If this is true, then perhaps a change in our lifestyle and our expectations is in order. If we were to buy more locally produced products, it would reduce the necessity of moving goods over long distances. We could ask ourselves if "more is better" is really a value we want to live with, or if the law of mutual ownership (you own it, it owns you) is robbing us of our freedom. If we did not "need" so many consumer goods, it would reduce the load on the trucking industry, thus reducing the problem of idling and its associated ills.

Another possible part of the solution may be cleaner fuels, for the truck's powerplant as well as the APU. Premium grades of diesel are now becoming available in the U.S. Until recently the only grade of diesel available here was "Number Two Diesel" which is a relatively low grade compared to the Number One grade which has been available in Europe for many years. Number One premium diesel burns cleaner than Number Two, and will yield better fuel economy in an engine that is designed to take advantage of it, due to its higher cetane rating. Also, the availability of another grade of

diesel, Ultra Low Sulfur Diesel (ULSD) is becoming widespread, and legislation is underway to mandate its use, much like unleaded gasoline. While these solutions may do little to address the economic issues surrounding truck idling, they are helpful in addressing the other issues that many consider to be of great importance. They can be expected to reduce the amount of toxic pollutants and particulates per ton-mile produced by long-haul trucks, both through better mileage and cleaner exhaust emissions. Demand is increasing for non-petroleum based fuels to at least partially replace petroleum-based fuels. These fuels generally have less toxic emissions of combustion than petro-fuels.

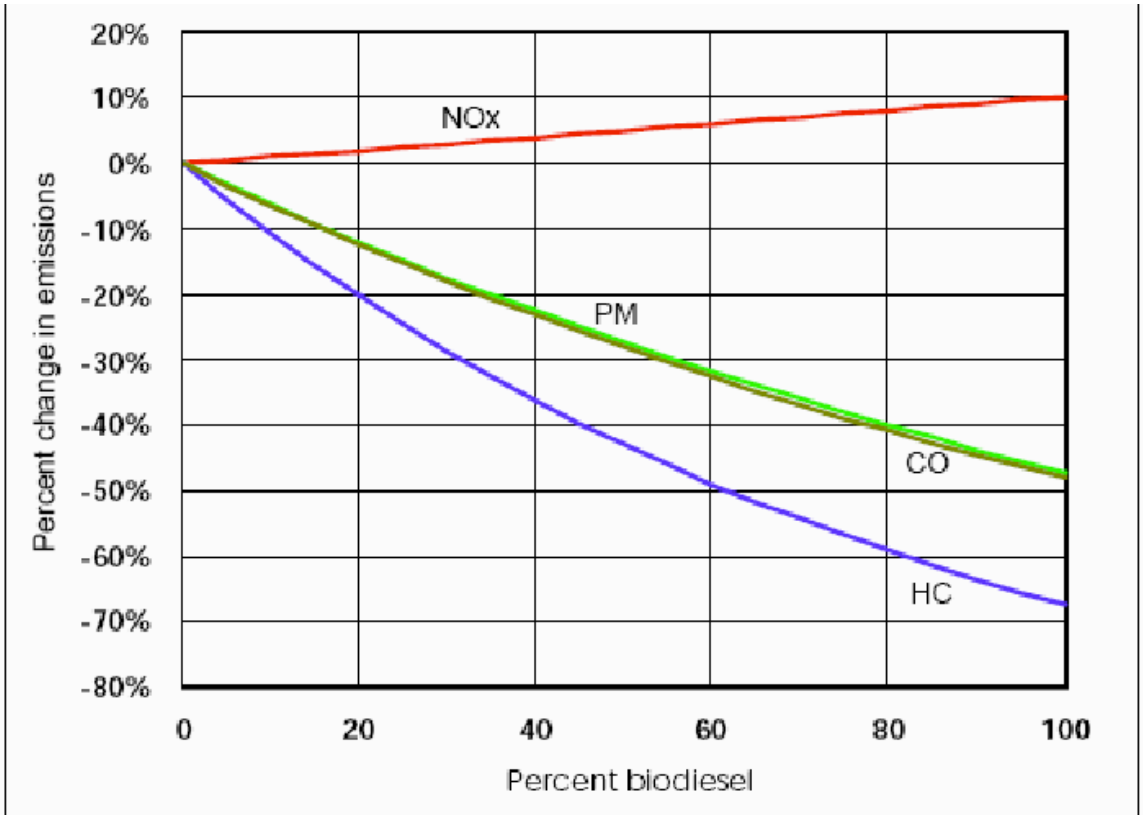
The plant-based fuel that is suitable for diesel engines, including the heavy-duty diesel engines in commercial trucks, is called biodiesel. It is produced using vegetable oils from plants such as soy. Biodiesel was mentioned by a couple of the owner-operators we interviewed, and one was very enthusiastic about it and used it whenever it was available to him.

According to the EPA, a 20 percent biodiesel blend will result in a 1-2 percent deduction in fuel economy. Overall toxicity of the exhaust is expected to be lower, although this varies from component to component. Carbon dioxide emissions differences were not significant, but the CO_2 benefits of biodiesel lie mainly in its renewability, and the photosynthetic process involved in its manufacture (EPA, 2002: iii).

Figure 3 shows that the level of oxides of nitrogen emitted from biodiesel is slightly higher than that of petrodiesel. As the blend of biodiesel to petrodiesel approaches 100% the increase in oxides of nitrogen approaches 10%. Particulate emissions which include black carbon (discussed earlier) approach a reduction of 50% as

biodiesel concentration approaches 100%. Hydrocarbon emissions are reduced by nearly 70% with the use of 100% biodiesel.

Figure 3: Average Emission Impacts of Biodiesel for Heavy-duty Highway Engines *(Source: U,S, EPA)*



As biodiesel becomes more readily available it is becoming the fuel of choice of many, both in passenger cars and trucks, including some independent long-haul truck drivers, its higher price notwithstanding. This solution is still in its infancy, and may represent an increasing part of the solution to the problems associated with commercial trucking.

Truck Idling Policy, a Bounded Rationality Perspective

Throughout this paper many factors that contribute to the issue of truck idling have been explored. These include the economic magnitude of the trucking industry, jobs generated and our dependence on trucks to supply us with the goods required to maintain our lifestyle. External prices we pay as a global community in terms of environmental degradation and public health consequences to keep those trucks rolling have also been noted. The role of many of the players -- independent truck owner-operators, trucking fleets, idling reduction solution providers, environmental protection interest groups (representing individuals with environmental protection concerns), public health researchers, and state and federal environmental and highway safety regulatory agencies – have been discussed. These are by no means exhaustive lists; but they begin to demonstrate the complex and potentially conflicting nature of the issues.

Indeed, we are dealing with a myriad of moving targets as we grapple with the issue of truck idling. The trucking industry continues to grow at a staggering pace even as the cost of fuel is soaring. Tightening emissions regulations are changing the nature and degree of pollution produced by new trucks, while the built-in longevity of these trucks keeps older, dirtier models on the road for many years to come. New and different technologies are coming on line to meet the challenges, while older technologies quickly become obsolete, some even contributing to the problem. An example of this is that many auxiliary power units (APU's) actually produce more harmful pollutants per hour than the idling of a newer, post-2006 truck's primary powerplant.

Existing idling restrictions and regulations are, in general, an inconsistent and often incoherent mish-mash of widely varying and sometimes contradictory regulations, statutes, and guidelines (ATRI, 2007). Some are state regulations, some county, and others are overseen by municipalities. In some areas, a 400 pound Gross Vehicle Weight addition is allowed for trucks with an on-board APU, while in other areas this extra weight is not allowed. Some truck drivers have been cited by local authorities under local anti-idling ordinances for using an APU, because an idling APU engine is considered an idling truck. In some areas, using an APU on a newer vehicle is illegal due to the higher levels of pollution emitted when compared to the more efficient primary powerplant, which is fitted with emissions-reducing technologies. Some local areas provide exemptions if the APU's exhaust is routed through the truck's pollution control mechanisms, although others don't. The EPA sums it up in this way: "…the patchwork of state and local idling laws and the impracticality of the provisions of these laws make knowledge, understanding, and ultimately compliance an issue for truck drivers and owners." (EPA, 2006).

The Basis of the Policy

So how do we move toward a more coherent and consistent set of idle reduction policies that will provide cleaner air and reduced emissions for the public good? First we might look at a description of what such policies would hope to accomplish. In the earlier cited EPA *Model State Idling Law*, the stated purpose is "…to protect public health and the environment by reducing emissions while conserving fuel and maintaining adequate

rest and safety of all drivers of diesel vehicles." (EPA, 2006). Based on the multifaceted and ever-changing landscape surrounding this issue, I believe that an incremental, evolutionary approach to creating and changing policy is necessitated. While rationality is desired in the policy-making process, this implies that all factors are known and all actors will act in a predictable way. Therefore, known methods of analysis (such as cost-benefit analysis) can be applied to the static set of circumstances and will lead us to a near-perfect solution. Yet clearly this is not the case in the policy problem of truck idling. Circumstances are far from static, and if we could bring all the actors to the table we would find many interests that have not yet been considered in the quest to create policy in this area.

Recognizing that many modern problems are not simple, linear or easily predictable in nature, Simon (1957) introduced the qualifier "bounded" to the rational actors model. This qualifier suggests that policy can still be created in a reasoned way, but within the bounds of objective reality, which includes what is known of conflicting priorities, regulations, practices and perceptions of the many actors. Policy makers can act as rationally as possible within the limits of present information, time limitations, dynamic features of the issue and future projections, and the "limited human ability to recognize every feature and pattern of [the] problem" (Birkland, 2001, p.211). Idling policy in different states and municipalities varies widely, presumably because policy makers are responding within their own set of limitations, which are different than those of their neighboring governmental unit. This would suggest that the policy process may

be ever in flux, with policy changing incrementally as more is known, as information is shared, and as the landscape changes. To be responsive to the challenges faced by those affected by evolving policy it is necessary for policy makers to add these challenges to the pool of information from which the policy is drawn. This requires flexibility that government is not generally renowned for. Often, obsolete or unworkable laws remain on the books due to lawmakers' resistance to change, inattentiveness or laziness.

Bounded Rationality Applied

Yet perhaps some degree of flexibility can be built into the policy process at its inception to allow for a certain amount of adjustment in response to changing circumstances or the finding of new information. The "sunset clause" may be an example of this flexible approach.

The Oregon Interstate 5 Idle-Free Corridor Project is part of a bigger project, the Interstate 5 Idle-Free Corridor Project which spans the entire U.S. West Coast. This is part of an even larger project which includes many other interstate highway systems. This is part of an even larger comprehensive effort by the U.S. EPA called SmartWay Transport Partnership to bring the actors together to (1) share knowledge and foster greater understanding; (2) raise mutual awareness of the issues and needs of the competing actors (environmental groups, the trucking industry, governmental units); (3) propose and facilitate idling reduction solutions in advance of policy implementation in order to aid the trucking industry in compliance, and; (4) bring the actors together to help draft suggested idling policy for consideration by governmental agencies.

The EPA is seeking to create a larger pool of knowledge and to quantify rates of change in the circumstances surrounding the issue in order to help policy makers around the nation move toward creating more cohesive, consistent and comprehensive idling policy. This represents a reasoned, realistic approach to a multi-faceted, growing and ever-changing problem, recognizing that the full extent of the problem can never be fully known or understood by all the actors, nor would today's "full understanding" represent full understanding six months hence. This approach represents a clear-headed application of the bounded rationality model of policy decision-making.

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Appendix A: Interview Protocol

1. Please tell me about your job in long-haul trucking
2. Can you tell me about any of your long-haul trucks that stop and idle for any extended period in Oregon on the Interstate 5 corridor? (for fleets)
3. Many people think that idling is a problem. What do you (or your company, for fleets only) think about idling and idling reduction?
4. What are your impressions of presently available idling reduction technologies? How useful and effective do you consider each of these?
    - On-board auxiliary power units (APUs)

- Batteries
- Shurepower
- Idle Aire
- Fuel cells

5. Do you have plans for implementing idling reduction technologies in the future?
6. Low cost loans may be available to help cover the costs of idling technology. In order to qualify for the Oregon programs, however, you need to meet one of the following requirements:
   - Truck is base-plated in Oregon
   - You spend half your time driving or idling in Oregon
   - You work for an Oregon-based company
   - You do the majority of your drop-offs or pick-ups in Oregon
   - The owner of the truck is an Oregon resident

   Do you qualify under any of these criteria? Which one(s)?
7. What other questions would you like to ask us? Do you have additional comments?