case study

Diesel Engine Idle Reduction in Class 8 Trucks Using On-Vehicle Shore Power—Lessons Learned

Electric Transportation Program

Introduction

This project was created to demonstrate the potential cost savings and emission reductions realized through the use of alternatives to idling truck main engines during driver rest periods. Using grant funding from the EPA with cost share from the fleets, and our partner Sacramento Municipal Utility District, electrical air conditioning equipment was installed on 34 trucks from nine fleets and utilized by drivers during rest periods.

Results

These trucks are realizing annual cost savings of at least $46,248 on an investment of $226,561. Fuel savings of more than 16,968 gallons per year and extended engine life are driving these savings. In addition, these fleets are reducing NO_x emissions during rest periods by 6500 lbs per year.

The project leveraged federal grant funds by cost sharing initial equipment installations and then requiring fleets to reinvest savings in additional equipment. Federal funds of $113,400 were matched by funding from the nine fleets. Perhaps the most successful aspect of the project is that the fleets have invested more than five times the annual savings generated by the project in idle reduction equipment, $266,247 as of the last tally.

Challenges & Objectives

Project emphasis was placed on getting equipment into the hands of drivers and fleet managers to learn about their needs, and to start generating cost savings. This meant less emphasis on data acquisition, and more emphasis on number of fleets and trucks involved. Although the original hope was to install electric air conditioning systems that would use shore power for extended rest periods, fleets universally elected to install larger battery packs enabling grid autonomous rest periods of 8–10 hours. The result of this need was an increase in air conditioning system complexity and cost and a decrease in the number of trucks actually outfitted compared to the original plan. The eventual systems installed included electric air conditioners, inverter-chargers, batteries, and controllers and were cost competitive with auxiliary power units (APUs) or generator sets currently being considered as an alternative to truck main engine idling.

Lessons Learned

Through performance of this project, the lessons in order of their description are as follows:

- Trucking fleet managers are motivated by cost savings.
- It is difficult to measure the savings.
- Data collection methods could be improved beyond Engine Computer Modules (ECMs).
- Driver behavior is an important variable.
- Consideration of driver comfort and choices.
- Financing is an issue for owner operators.
- Keep the program simple.
- Keep the technology simple.
- Climate has an affect on equipment effectiveness in reducing idling.

Trucking Fleet Managers Are Motivated by Cost Savings

This seems obvious, but after months of trying to get fleets to participate in the project, the increase in fuel costs to $2.50 per gallon diesel created a great deal of interest in equipment intended to help reduce fuel consumption. Fleet managers also stated that they wanted payback periods in the range of two years for the bigger independent fleets to five years for smaller fleets operating mainly for a single retailing organization.

Every trucking fleet involved in this project had to make the cost savings calculation work for them before they agreed to try the equipment. The fleets are highly aware of the significant increases in fuel costs, but it is often difficult to attribute cost savings to the idle reduction equipment, since the actual savings may be masked by variations in routes, driver behavior, and destination climates. The opportunity to save a minimum of 1,800 gallons of diesel fuel each year and to reduce maintenance costs seems significant—but it is important to understand that adoption of idle reduction equipment is a change in equipment practice, and not every fleet manager or executive is convinced of the benefit.

It is Difficult to Measure the Savings

Savings in fuel consumption is not easy to measure, and one fleet owner said that his drivers might vary by 1 mile per gallon in a 7 mile per gallon truck, depending on the route, the climate, and on driving and idling styles. More than one fleet manager participating in the project expressed uncertainty with fuel consumption reductions deriving from the project.

Savings of fuel and fuel cost due to idling reduction do not necessarily relate to total fuel consumption. Idling fuel consumption for a truck that idles roughly 1,800 hours per year is roughly 1,800 gallons—out of a total per vehicle fuel consumption of as much as 24,000 gallons per year. Truck fuel consumption varies with load, terrain, average speeds, and other factors. If improved equipment on the truck allows a reduction in main engine idling, the fleet may see a consumption savings of 6% or so over a year long period—a significant cost savings, but possibly difficult to identify and track relative to total truck fuel consumption. This was the primary reason for a reliance on relatively conservative assumptions for calculating the cost savings and reinvestment commitment of the fleet participants.

Data Collection Methods Could Be Improved Beyond ECMs

The data collection methodology for this project was unexpectedly problematic. Data collection is the primary method for measuring idling hours and calculating fuel savings. This is important for both the fleet cost share component of the project and for fleet manager tracking of the benefits of idle reduction. Data was downloaded from three different ECMs. The engine computer download provides an inexpensive way to verify idling hour reductions, but there are some uncertainties with the data. Relying on engine computer downloads does not indicate what choices the driver is making. It also does not provide any environmental information that might help understand the performance of the idle reduction equipment. In the future, ECM data downloads should be augmented with component hour meters or inexpensive data acquisition systems that record actual system operation and operating choices that are made by the drivers.

For limited demonstration programs, tracking the truck location with a global positioning system can also be valuable, assuming that driver and fleet concerns about the use of this information can be satisfied. The location of parked trucks is very important to the performance of the onboard shorepower capable system and may determine whether a truck operates autonomously off its auxiliary battery or has an available AC electrical outlet. Truck location is also important to understanding the impacts of idling emissions and to site areas for future infrastructure development.

Driver Behavior is an Important Variable

As with many new technologies, installing new equipment in the trucks resulted in very good utilization of the equipment immediately after installation because of the novelty of new equipment. After a period of time, the driver enthusiasm waned, and the extent of idle savings tapered off a little bit. Driver behavior is a variable that cannot be ignored in evaluating idle reduction measures. As shown in Table 1, there is quite a lot of variation in the amount of improvement in idling from truck to truck and driver to driver. This is a key project result. Maximum idle reduction seems to come from programs that include ongoing training and discussion of idle savings with drivers at weekly safety meetings. This project did not attempt to quantify the impact of behavior on the effectiveness of idle reduction technologies. The variability of our results suggests the importance of behavior as a variable.

Lots of variation in driver behavior is exhibited in the data. It is difficult to attribute the variation in the data to anything by a rather broad category of driver behavior. As previously noted, systems in the sleeper cab of one driver allows a very significant reduction in idling time, while in the cab of another, essentially no change is noted. While it is clear from the aggregate idling data that the onboard equipment provides the capabilities to potential eliminate a large fraction of idling, it is not possible to track the experience and behavior or every one of the systems to explain a lack of significant reduction in idling.

Consideration of Driver Comfort and Choices

This project emphasized understanding the cost equation for installing the equipment. This is valuable for persuading fleets to purchase equipment; however more understanding of driver behavior and driver choices might help the fleets choose solutions drivers want to use, and to discover how to train drivers. Some examples of this kind of data would include rest location choices, ambient temperatures in the sleeper during rest periods, and similar data.

Table 1. Engine Hours Breakdown: Before and After Idle Reduction Equipment

Fleet Designation	**A**	**E**	**I**	**C**	**G**	**H**
Before Installation of Idling Equipment:						
Monthly Mileage	8496.38	9114.26	15396.93	12255.12	7332.04	10314.25
Fleet Average Idling h/mi	0.0150	0.0144	0.0077	0.0150	0.0150	0.0150
Monthly Engine Time: (hours)	281.93	296.95	398.06	406.65	243.29	342.25
Monthly Driving Time (55 mph)	154.48	165.71	279.94	222.82	133.31	187.53
Monthly Idling Time (hours)	127.45	131.24	118.12	183.83	109.98	154.71
Idling %	45%	44%	30%	45%	45%	45%
After Idle Reduction Equipment:						
Average Idling Time (h/mi)	0.0104	0.0068	0.0050	0.0046	0.0083	0.0052
Monthly Engine Time: (hours)	242.77	227.33	356.98	278.70	193.95	241.11
Monthly Driving Time (55 mph)	154.48	165.71	279.94	222.82	133.31	187.53
Monthly Idling Time (hours)	88.29	61.61	77.04	55.88	60.64	53.58
Idling %	36%	27%	22%	20%	31%	22%

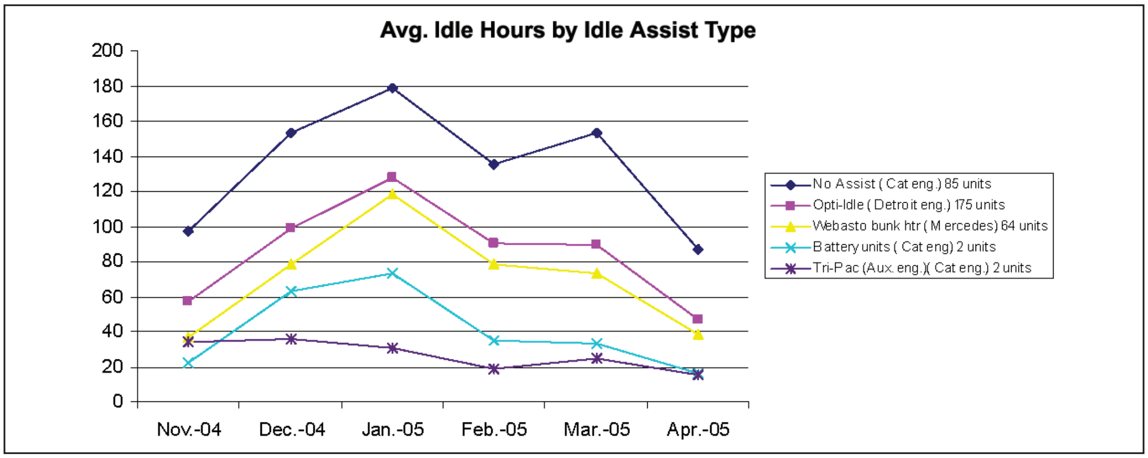

Figure 1. Idle Hours by Equipment Type and Month for Fleet H.

Financing is an Issue for Owner Operators

A number of small fleet owners and owner operators called during 2005 looking for ways to finance idle reduction equipment. Significant emission reductions and fuel and cost savings could accrue if a "pay as you save" financing program for APUs, gen-sets, and shore power-capable onboard systems was created.

Keep the Program Simple

This program included both a reinvestment of savings and a cost sharing of the original installed system costs. These requirements made the program seem more complex to some of the fleet managers. Many truck drivers are interested in receiving support for capital expenditures to reduce idling as they view the equipment as expensive. So far, there is not enough operating data to establish the reliability of this equipment which would further reassure truck owners.

To date, no fleet has independently provided a calculation of their cost savings, as required by the Participation Agreement. All the fleets have accepted the project calculations.

Keep the Technology Simple

On the several occasions where a site visit with a truck owner was several hours were spent explaining the function of the Amp-hour counter, and the battery isolator and charging with the alternator, and explaining how to determine if the system was working correctly. It could be that the controls accessible to the driver should be minimal, that is, only climate controls. Inclusion of a remote operation device and an instrument may be more complex than needed. A need for better operator training and a simple operation guide may be necessary. Perhaps some of the limited use by drivers could be rectified by better training or by simpler, more automated controls.

Climate Has an Affect on Equipment Effectiveness in Reducing Idling

Another variable is climate. The trucking industry would normally design air conditioning systems to be able to cool the sleeper in extreme climate conditions. This may be excessive for fleets that do not need such high performance, but the nature of the trucking business is that most trucks tend to go all over the country, wherever their customer's freight needs to go. This means that once in a while, they may need this peak cooling or heating capability.

The effectiveness of idle reduction equipment in limiting idling costs appears to be a function of the utility of the equipment installed to provide driver comfort. The interplay of climate and different technologies is illustrated in Figure 1.

In this figure, the APU systems reduced idling at Fleet H from the 180 hour fleet baseline in January to about 30 hours for the two outfitted trucks. The battery based HVAC Dometic units were second in effectiveness, reducing idling hours in January to a little over 50 hours. Climatic or seasonal variation can also be observed; it must have been cold in January, as fleet idling is more extensive than other months.

Notice that the Opti-Idle system is effective in reducing idle time about 25–30% of the fleet average idle time. Opti-Idle works by preventing the engine from idling more than a set time, often programmed for five minutes. Drivers who wish to have heat or air conditioning can activate the engine power take off setting, which operates the engine at a higher speed, which in turn overrides the Opti-Idle equipment. Perversely, the higher speed also means higher fuel consumption and higher emissions, possibly resulting in no fuel or emissions reduction even though the absolute number of hours at idle is reduced.

One lesson that can be taken from the fleet H comparison of different technologies is that simple things, like Opti-Idle, reduce idling a little bit. Systems that have more capability to meet drivers needs without idling the main engine are used more to displace idling. Lower powered air conditioners function properly when the outside temperature is in a range that does not overwhelm their cooling capacity, and reduce idling through the spring, part of the summer, and through the fall. Idling the main engine might still be necessary on trips to hotter climates. The smaller air conditioner might therefore result in substantial cost savings and emission reductions even though the driver needs to idle a few very hot days during the summer.

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