Which Idling Reduction Technologies Are the Best?

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Introduction

Two main factors have combined to create a surge of interest in idling reduction (IR):

- Increasing restrictions on idling for heavy vehicles
- The price of diesel fuel.

Because stakeholders focus their efforts on reducing different factors, they do not necessarily agree on the most advantageous technological alternatives to implement.

In addition, although many equipment manufacturers have tried to educate customers and government agencies, they often provide conflicting claims about the comparative merits of different devices. This makes it difficult for truck owners to choose the right equipment for their needs.

This study presents the first comparison of idling-reduction technologies with each other and with idling on the basis of both costs and full fuel-cycle emissions, for different locations, fuel prices, and idling patterns. The preferences described are for the technologies that reduce total emissions the most and cost truck owners the least.

All of the idling-reduction technologies considered here reduce emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), and particulate matter (PM_{10}) by a factor of 3 or more compared to idling. All pay back the truck owner's investment in 2 years or less at the current diesel fuel price of over $4.00 per gallon.

Cab comfort (heating and cooling) is required during extended rest periods because the operator generally sleeps in the truck. In the past, idling the main engine was the standard method of providing these services. But, in light of skyrocketing fuel prices and widespread regulations against idling, several alternatives have emerged. These include on-board systems

- Small diesel-fired heaters
- Air conditioners that use thermal or battery storage to store energy generated during the truck's operation (and therefore increase fuel use during driving by a small amount) to cool the driver while he/she rests
- Auxiliary power units (APUs) that convert diesel fuel to electricity to supply space conditioning and power for appliances

and wayside systems (electrified parking spaces or EPS) that allow the driver to plug into stationary power. These can include electrical devices on-board the truck (dual system EPS) that simply plug in, or complete wayside units that supply all services for an hourly fee, through a window module (single system EPS). The module can be mounted on a pedestal or an overhead gantry.

Technology Costs

Table 1: Cab Comfort Technology Summary

System	Services	Fuel Use/hr	On-board Cost ($)	Maintenance ($/hr)*	Infrastructure cost ($/space)	Usage Charge ($/hr)
Idling 2001 truck	All	0.77 gal heating 0.98 gal cooling	0	0.12	0	0
Idling 2007 truck	All	0.53 gal heating 0.72 gal cooling	0	0.12	0	0
Cab/bunk heater	Heating	0.06 gal	1,250	0.07	0	0
Storage air conditioner	Cooling	0.20 gal	4,000	0.13	0	0
APU or generator set	All	0.23 gal	8,000**	0.33	0	0
Electrified parking space (single on gantry)	All	2.4 kWh heating 1.7 kWh cooling	10	0	16,700	2.45
Electrified parking space (single on pedestal)	All		10	0	9,000-11,000	1-2
Electrified parking space (dual system)	All		2,500	0.07	Up to 6,000	1

* Estimated for IR technologies by pro-rating annual maintenance over 1,500 hours per year
** Add $1,000 for diesel particulate filter (DPF)

Table 1 compares typical costs and fuel consumption of selected idling reduction options to those for idling. These costs were obtained from an informal survey of equipment manufacturers. Both costs to the truck owner for on-board equipment and costs to the infrastructure provider for capital equipment are shown. Operating costs for the infrastructure are not shown. These depend strongly on labor costs.

These graphs describe costs to the truck owner for idling and alternatives.

Figure 1: For on-board options, the hourly cost is directly proportional to the price of diesel fuel, while for EPS, the hourly cost is fixed. Wayside systems therefore become more attractive as the fuel price rises.

Figure 1. Hourly operating cost as a function of diesel fuel price

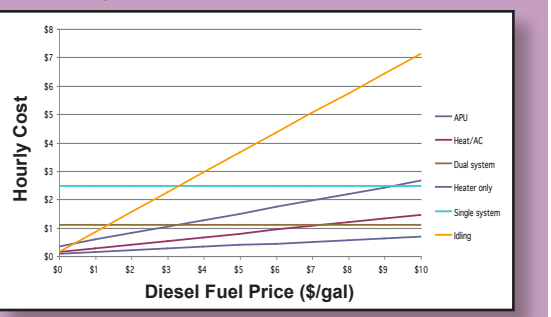
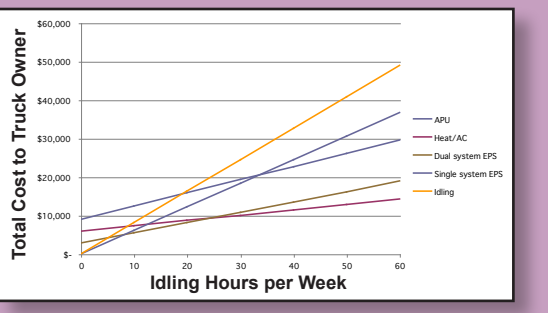


Figure 2 shows total cost to the truck owner, which includes the capital cost of the equipment as well as fuel and maintenance costs or hourly charges. For low idling rates, options with little or no capital investment are most economical for the truck owner, but for high idling rates, options with low hourly costs would be favored. Although costs to the owner of the wayside equipment have not been analyzed in detail, high usage rates would yield the highest revenues and therefore be favorable.

Figure 2. Total cost for 5 years' operation vs. weekly idling hours, for $4.50/gal fuel, U.S. average location



Emission Benefits

Figure 3. Hourly emissions for heating options, U.S. average location

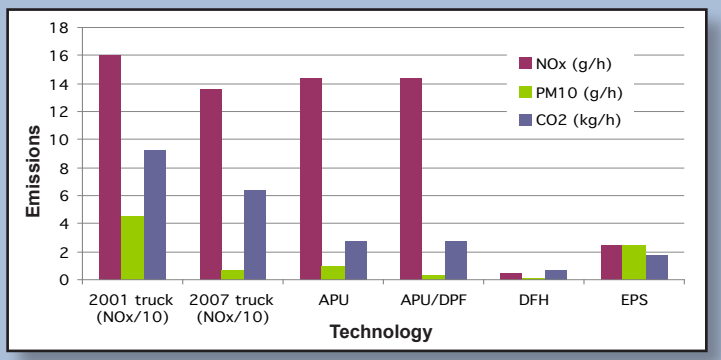


Figure 3 shows hourly emissions of NO_x, PM_{10}, and CO_2 for a 2001 truck and one meeting 2007 emission standards, and several options for providing heat to the resting driver. Of the IR options, the APU produces the highest emissions of NO_x and CO_2, and EPS the highest PM_{10} (although most of this is in rural areas). The direct-fired heater produces the least emissions in all categories. Note that none of the emissions from EPS are at the truck; all are upstream.

Figure 4. Hourly emissions for cooling options, U.S. average location

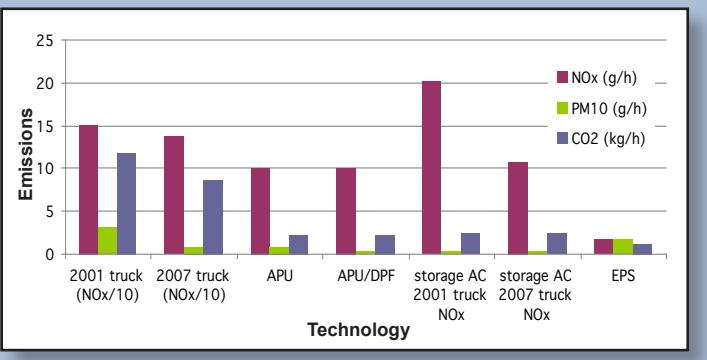
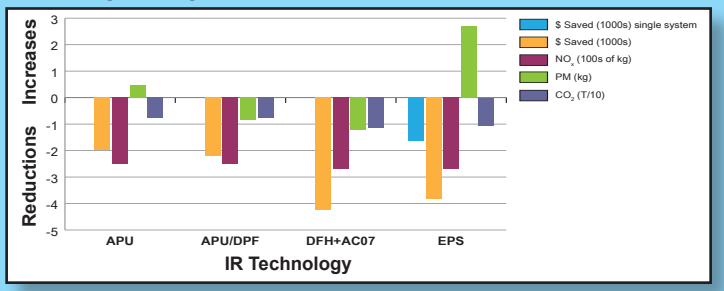


Figure 4 shows emissions for cooling options. Here, there is no overall winner, but the EPS has the lowest NO_x and CO_2 emissions. The NO_x emissions from storage cooling are created during truck operation and therefore decline as trucks meet more stringent regulations. So they will be reduced drastically on 2010-compliant trucks.

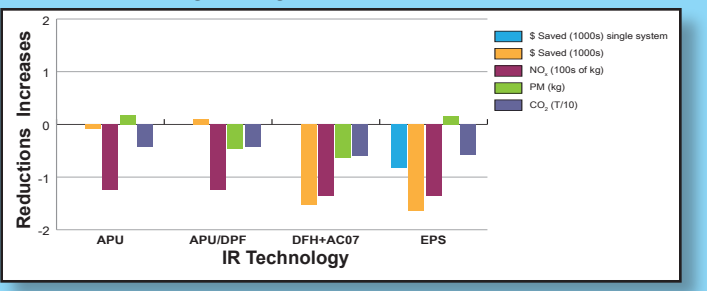
Cost Effectiveness

Figure 5. For Illinois, annual financial savings to truck owner and emission benefits compared to a 2007 truck for idling reduction options, 40 hours/ week idling, $4.50/gal fuel



In this case, there are enough hours to economically amortize the capital costs over 5 years, and hourly operating costs for single system EPS reduce savings. The heater plus storage air conditioner saves the most money and also minimizes all emissions. The high fraction of Illinois electricity generated by coal leads to high particulate emissions for EPS, although they are primarily rural.

Figure 6. For California, annual financial savings to truck owner and emission benefits for idling reduction options, compared to 2007 truck, 20 hours/week idling, $4.50/gal fuel



Again, the heater plus storage air conditioner minimizes emissions, with close-to-maximum cost savings. In this case, the increase in PM_{10} with electrification is less pronounced than for Illinois (Fig.5) because little coal-based power is used in California. In 20 hours per week, it is difficult to pay back a capital-intensive device like an APU in just 5 years. The added cost of a diesel particulate filter (DPF) (as required on 2007 and newer trucks with APUs in California) makes the device a net financial loser for this low-idling case.

Conclusions

For trucks that idle fewer than about 20 hours per week, technologies with low capital investment are the most attractive from a total cost perspective. These include EPS and idling. From an emissions standpoint, of course, idling is the least attractive alternative. Again, heaters supply heat with the lowest impacts, and the most desirable methods for supplying air-conditioning are storage AC if the truck is a 2007 or later model or EPS. For older trucks, there is a trade-off.

For trucks that idle over 20-30 hours per week, technologies using on-board equipment, including dual-system electrified parking spaces (EPS), result in the lowest total cost to the truck owner over five years of operation, while single-system EPS results in the highest total cost of idling alternatives. NO_x from pre-2007 trucks and CO_2 emissions canbe reduced by air-conditioning via EPS, but this results in an increase in PM_{10} because of the use of coal in the grid mix in all states. However, most of these PM_{10} emissions are upstream, in rural areas, leading to low population exposure and resultant health costs. One significant advantage of wayside systems is that they guarantee that local emission reductions occur at their locations, although this may be at the expense of emissions upstream.

In summary, heating plus storage air-conditioning and dual-system EPS are among the options preferred on both economic and environmental grounds over a wide range of idling behaviors, regardless of location.

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