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Status and Issues for Idling Reduction in the United States

Alternative Fuel and Advanced Vehicle Technology Market Trends

Argonne National Laboratory

Linda Gaines and Patricia Weikersheimer

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Clean Cities
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Prepared by
ARGONNE NATIONAL LABORATORY
Lemont, IL 60439
managed by
U-CHICAGO ARGONNE, LLC
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Executive Summary

Idle reduction (IR) is the long-acknowledged low-hanging fruit of fuel economy. For a variety of reasons, however, IR has been slow to reach its full potential.

IR implementation has two components: vehicle-operator education and technology solutions. Where idling occurs simply out of habit—and not because of the stationary vehicle's power needs—education about the effects of idling and the benefits of reducing it is the appropriate approach. Where idling occurs because the vehicle operator needs power for HVAC, lighting, and other systems, technology solutions that reduce or eliminate the need for idling—while reducing fuel use and environmental impact—should be considered. Even in these cases, an education component (i.e., "why reduce idling?") is critical to buy-in and vehicle operators' proper, ongoing use of the technologies.

Investment in IR technologies has been limited by barriers including initial expense, perceived long time to return on investment (ROI), and technologies not performing as expected or requiring more maintenance than anticipated. To help Clean Cities facilitate IR adoption, we present in this paper three "good-fit scenarios" between fleet-vehicle type, or market niche, and IR technology solutions. They are:

1. Long-haul trucks: *Diesel APUs for operation in cooler climates and electrified parking spaces (EPS) for operation in warmer climates*
2. Police vehicles and ambulances: *Battery APUs for police vehicles and EPS for ambulances at emergency rooms*
3. School buses: *Heaters for operation in cooler climates*

For each, we describe current market status, top-level trends/projections, opportunities, benefits quantification, and key barriers.

Even though personal-vehicle idling is not a defined niche in this paper—personal-vehicle idling covers nearly the total population and thus is not a narrow target niche that might be reached through a few well-considered strategic channels—we do address such idling because outreach to the general public is part of Clean Cities' mission.

The paper is not a survey of all IR technologies and approaches available and should not be read to suggest a "one best" technology or approach for any sector. There are many IR technology options and many stationary-vehicle power needs. The specific needs of any individual fleet determine the technologies that will be most appropriate.

1. INTRODUCTION

In the 10 years since Clean Cities introduced idling reduction (IR) to its portfolio of petroleum-reduction strategies, the range of technologies available to reduce idling has grown. Most notable is the introduction/advancement of IR systems for vehicles beyond long-haul, heavy-duty trucks. There has been an increase in battery-powered systems; growth of hybrid systems for a range of vehicles, including work trucks; the recent addition of some alternatively fueled systems; and the use of global positioning systems (GPS)/telematics to collect data about the number and duration of idling episodes.

The adoption of IR technologies, however, has been underwhelming for a variety of reasons. In some cases, the return on investment (ROI)—or perceived ROI—has not been sufficiently favorable. Some technologies have not performed as expected or require more maintenance than anticipated. Some technology applications have not been a good fit with the vehicle's engine-off power needs.

Also significant is that while there are many idling regulations at the state and local levels, the laws have been, with a few exceptions, minimally enforced. However, there has been a trend toward limiting the idling of a broader range of vehicles, including personal vehicles. (For a database of idling laws applicable to all types of on-road vehicles, see Clean Cities' IdleBase at http://cleancities.energy.gov/idlebase.)

In this paper, we present three "good-fit scenarios" between fleet-vehicle type, or market niche, and technology solutions.

1. Long-haul trucks: *Diesel APUs for operation in cooler climates and electrified parking spaces (EPS) for operation in warmer climates*
2. Police vehicles and ambulances: *Battery APUs for police vehicles and EPS for ambulances at emergency rooms*
3. School buses: *Heaters for operation in cooler climates*

The paper is not a survey of all IR technologies and approaches available. Furthermore, the good-fit scenarios should not suggest a "one best" technology or approach. There are many IR technology options and many stationary-vehicle power needs. The specific needs of any individual fleet determine the technologies that will be most appropriate.

In the same vein, there are several technologies that do not themselves reduce idling but can be used to reduce the stationary vehicle's energy requirements and thus allow the use of smaller, lighter, and less-expensive IR equipment. These technologies, such as improved insulation and window glazing, can be applied to numerous vehicle types. Similarly, telematics systems do not directly reduce idling, but the data they collect facilitate understanding of idling patterns. The analyzed data can inform decisions on how to reduce idling most cost effectively.

While less abundant than during the Recovery Act era, grants supporting IR projects continue to be available. The U.S. EPA and U.S. DOT have programs—the Diesel Emissions Reduction Act (DERA) and Congestion Mitigation and Air Quality Improvement (CMAQ) Program, respectively—for which funding "trickles down" to state offices and/or metropolitan planning organizations. Examples of current state opportunities include the Delaware Valley Regional Planning Commission's CMAQ Program (http://www.dvrpc.org/cmaq/) and Arkansas' Reduce Emissions from Diesels Program (http://www.dvrpc.org/cmaq/). *National Idling Reduction Network News* (http://energy.gov/eere/vehicles/vehicle-technologies-office-national-idling-reduction-network-news) posts current funding opportunities each month.

It is important to note that because IR projects do provide ROI in reasonable amount of time,[1] the reduced grant funding available should not present an implementation barrier. Alternative approaches to funding, such as loan programs, are very viable means of supporting such projects. Some state offices (e.g., the Pennsylvania Department of Environmental Protection and the Minnesota Pollution Control Agency) have loan programs targeted to pollution prevention, small businesses, or both. Clean Cities coalitions can guide interested stakeholders to the appropriate offices.

IR continues to be a low-hanging fruit of fuel economy. Because fuel represents a significant operational cost for most fleets, reducing fuel cost remains a top priority. Not least of all, IR presents a significant opportunity to reduce emissions.

1.1 Clean Cities and Argonne National Laboratory

Argonne National Laboratory has provided Clean Cities with technical support on IR for more than 10 years. In 2013, it launched IdleBox (http://www1.eere.energy.gov/cleancities/toolbox/idlebox.html), an electronic, modular education and outreach toolkit, for Clean Cities. With an idling savings calculator, presentations, print products, templates, and other resources, IdleBox helps Clean Cities coordinators and others educate fleets, policy makers, and others about the benefit of IR and implement IR initiatives.

Clean Cities coalitions are using IdleBox in a variety of ways. In addition to using IdleBox to perform direct outreach to stakeholders, coalitions have used IdleBox to research existing idling ordinances in preparation for drafting their own ordinances; to prepare for an interview on IR for local television; and to reach out to Meals on Wheels, which relies on volunteer drivers.

Clean Cities' Alternative Fuels Data Center (AFDC) hosts IdleBox. The AFDC contains an IR portal (http://www.afdc.energy.gov/conserve/idle_reduction_basics.html) that offers a range of IR resources, from Argonne's idling calculator (http://www.transportation.anl.gov/pdfs/idling_worksheet.pdf) to Clean Cities case studies and publications to the truck-stop electrification locator (http://www.afdc.energy.gov/tse_locator/).

Argonne also supports Clean Cities' interagency initiatives, such as its work with the U.S. National Parks Service (NPS) to develop a program to reduce fuel use and emissions by NPS visitors, employees, and concessioners (http://www.nps.gov/climatefriendlyparks/). Finally, Argonne also supports Clean Cities at the local level, through activities such as reviewing proposals for IR grant funding and giving presentations at meetings.

The Clean Cities-Argonne relationship forms a feedback loop. Clean Cities coalitions conduct IR outreach to fleet managers, local and regional officials, and policy makers; they disseminate the information to fleets and the driving public. When a Clean Cities coalition works with a stakeholder on an IR project, ideally it identifies opportunities to validate the financial, environmental, and health benefits of that IR application. Argonne's IR team is available to provide technical expertise to support the coalitions' efforts and help document experiences, best practices, and lessons learned for use by others interested in developing such programs. This information is used to expand current tools, such as IdleBox, and can be shared through *National Idling Reduction Network News*, which reaches nearly 4,000

[1] Gaines L., Levinson T, 2011, Cruising the Fuel *In*efficiency Highway. http://www.transportation.anl.gov/pdfs/EE/700.PDF

subscribers monthly. The coalitions and labs form a feedback loop that helps researchers keep the program up-to-date and helps provide the best technical support possible in the field.

1.2 Personal-Vehicle Idling vs. Fleet Idling

While none of the three niches presented in this paper addresses personal-vehicle idling, a brief, top-level overview of the reasons drivers idle is helpful for understanding the broader IR landscape.

Idling behaviors fall into two categories, “idling out of habit” and “idling for power.” Idling out of habit can occur with any vehicle type. Much passenger-car idling (e.g., parents dropping off or picking up their children at school) is idling out of habit. Some drivers idle out of a belief that idling is better for the engine or uses less fuel than stopping and restarting. Others have the misconception that extra starts will wear out the starter and battery. A number of sources, including Argonne[2] and auto manufacturers,[3] make clear that for contemporary vehicles (fuel-injection equipped rather than carburetor-equipped), engine idling is not only unnecessary but undesirable.

While Clean Cities coalitions have typically reached out to fleets to maximize petroleum-displacement impact, coalitions can also educate the general public (consumers) about the benefits of IR. Table 1.1 presents information about the larger impact of personal-vehicle idling in the U.S. Reducing “out of habit” idling is indeed very low-hanging fruit; it presents only the smallest—if any—inconvenience, and there are no equipment costs to recover. Reducing such idling simply results in fuel savings and emission reductions. It is indeed hard to quantify the results of reducing such idling, but educating the public on the value of IR is consistent with Clean Cities’ mission. (IdleBox contains a PowerPoint presentation, One Easy Habit To Help You “Go Green”: Reducing Personal-Vehicle Idling, https://www1.eere.energy.gov/cleancities/toolbox/docs/reducing_personal_vehicle_idling.ppt, geared to a general audience).

[2] L. Gaines, et al. Which Is Greener: Idle, or Stop and Restart? Comparing Fuel Use and Emissions for Short Passenger-Car Stops, paper for Transportation Research Board, January 2013 meeting of the http://www.transportation.anl.gov/pdfs/EE/893.PDF; Argonne National Laboratory, Stop and Restart Effects on Modern Vehicle Starting System Components: Longevity and Economic Factors, forthcoming.

[3] Ford Motor Company, 10 Eco-Driving Tips for Everyone, http://ophelia.sdsu.edu:8080/ford/01-24-2009/about-ford/news-announcements/press-releases/press-releases-detail/pr-10-ecodriving-tips-for-everyone-28946.html; Suburu of America, Subaru of America Supports Fall Car Care Month, Offers Fuel Savings Tips, http://www.prnewswire.com/news-releases/subaru-of-america-supports-fall-car-care-month-offers-fuel-savings-tips-131158158.html

Table 1.1. Benefits Quantification: IR for Personal Vehicles

Number of Vehicles	250,000,000[4]
Hours Idled per Day	0.1
Idling Days per Year	300
Annual Idling Hours	30
Idling Fuel Use (gal/h)	0.4
Promising IR Approach	Turn off engine
Annual Fuel Savings per Vehicle (gal)	12
Total Potential Savings (million gal/y)	3,000
Total Potential CO_2 Reduction (million tons/y)	30

Drivers of fleet vehicles might also idle out of habit, of course, but the real challenge is when fleet-vehicle drivers idle because they need power for HVAC, communications equipment, and such while stationary. In these cases, simply telling drivers to "just turn it off" doesn't work. A technology solution—one that uses less (or no) fuel—is needed. This paper describes three such fleet niches.

2. LONG-HAUL SLEEPER TRUCKS

2.1 Current Market Status

Many trucks still idle overnight to provide "hotel load"—heating, cooling, and electricity—for drivers taking their mandated rest periods. Argonne estimates that rest-period idling of long-haul sleeper trucks consumes up to 1 billion gallons of fuel annually at a cost of around $3 billion. The associated emissions consequences for CO_2 alone are 10 million tons annually. Additional idling occurs at places like loading docks and border crossings, where trucks must often wait for extended periods in queues.

The Federal Motor Carrier Safety Administration's (FMCSA) Hours of Service (HOS) rule regulates the minimum hours long-haul drivers must rest.[5] Recent data on the number of sleeper trucks traveling far enough daily to require an operator rest period are hard to obtain. In 2006, Argonne[6] estimated 660,000 trucks based on the U.S. Census Bureau's Vehicle Inventory and Use Survey (VIUS),[7] last performed in 2002. In the absence of new sleeper-truck data, ANL estimates that there are now about 1 million sleeper trucks whose drivers rest overnight in the cab.

Solid data about the use of IR technologies in any vehicle type are hard to find; long-haul, heavy-duty trucks with sleeper cabs are no exception, because no trade association or government agency tracks overall usage of IR devices. The 2002 VIUS estimated that IR equipment was installed on 126,000

[4] Oak Ridge National Laboratory, Transportation Energy Data Book, http://cta.ornl.gov/data/index.shtml.
[5] FMCSA, Summary of Hours of Service Regulations, http://www.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations.
[6] Gaines L., et al. Estimation of Fuel Use by Idling Commercial Trucks. Presentation for Transportation Research Board (TRB) Meeting, January 2006, http://www.transportation.anl.gov/pdfs/TA/374.pdf.
[7] U.S. Bureau of the Census, Vehicle Inventory and Use Survey 2002, https://www.census.gov/svsd/www/vius/2002.html.

tractor-trailers, and a 2006 report[8] by the American Transportation Research Institute indicated that equipment was installed on 36% of their small sample; no comprehensive data are available.
In its 2014 report on IR for heavy-duty, long-haul trucks, *Confidence Report: Idle-Reduction Solutions,*[9] Trucking Efficiency, a partnership of the North American Council for Freight Efficiency (NACFE) and the Carbon War Room, reported that of the fleets it surveyed, idling times ranged from 7% to 40%, with an average of 15%. NACFE's 2014 Fleet Fuel Efficiency Benchmark Study[10] gives a broad picture of IR equipment use in sleeper trucks (Figure 1.1).

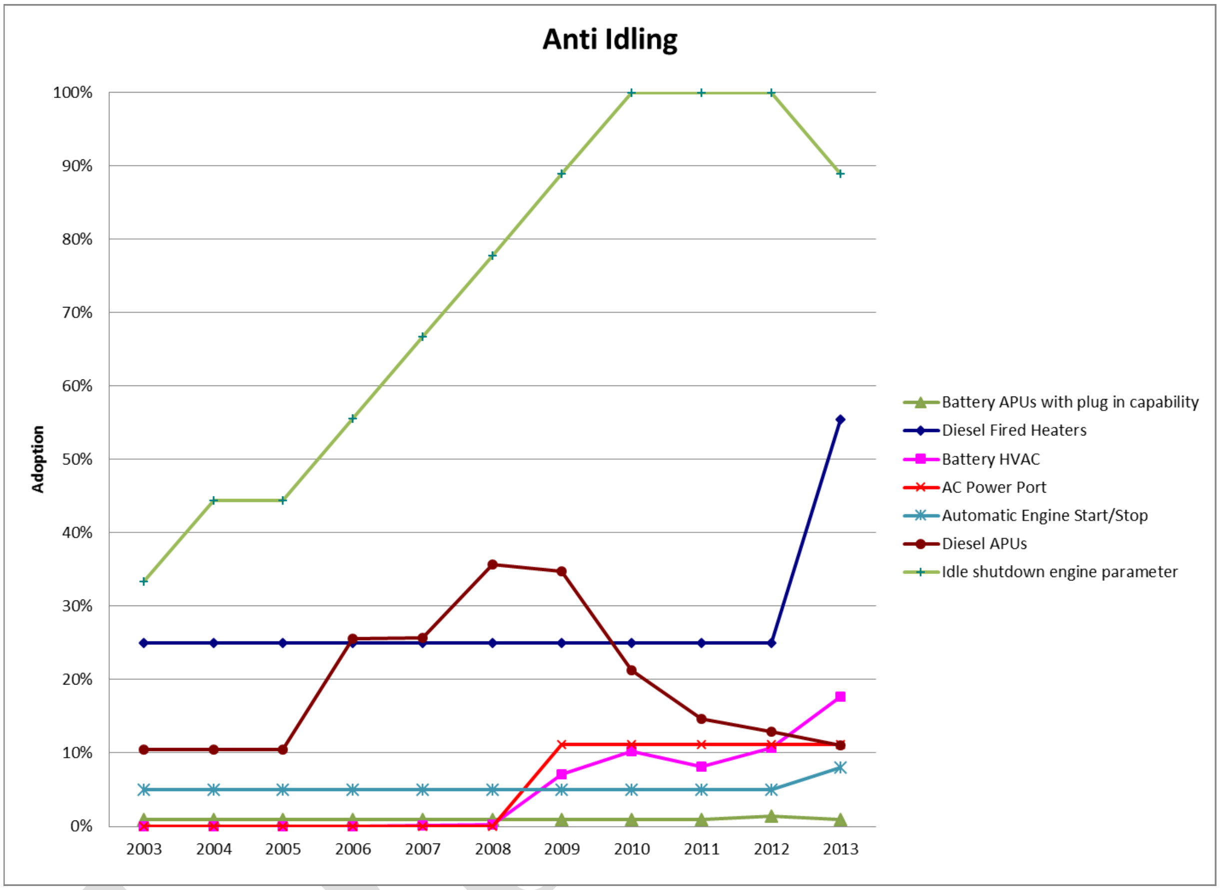

Figure 1.1. Idle-reduction technology adoption data, 2003 to 2012, reproduced from NACFE's 2014 Fleet Fuel Efficiency Benchmark Study (http://nacfe.org/wp-content/uploads/2014/09/NACFE-2014-Study-Report-FINAL-083114.pdf).

For sleeper-truck IR technologies, market penetration has been slow for a variety of reasons. In many cases, the cost and ROI, or perceived ROI, have not been sufficiently favorable. Money for purchase and installation may be tight, and the grants made available through the American Recovery and

[8] Idle Reduction Technology: Fleet Preferences Survey, NYSERDA for ATRI, February 2006, http://www.atri-online.org/research/results/IdleReductionTechnologyFleetPreferencesSurvey.pdf.
[9] Trucking Efficiency, *Confidence Report: Idle-Reduction Solutions,* 2014, http://carbonwarroom.com/sites/default/files/reports/Idle-Reduction_Confidence_Report.pdf.
[10] North American Council for Freight Efficiency, 2014 Fleet Fuel Efficiency Benchmark Study, http://nacfe.org/wp-content/uploads/2014/09/NACFE-2014-Study-Report-FINAL-083114.pdf.

Reinvestment Act (ARRA) of 2009, which reduced purchase and installation price and improved the ROI, are no longer available. (Funding opportunities continue, but are smaller in scope and found at the state or local level.) Additionally, some technologies have not performed as anticipated, or they require more maintenance than expected. Finally, some devices were installed that were not good fits with the vehicles' stationary power needs, and were thus found to be unsatisfactory.

While no federal law addresses idling, numerous states and jurisdictions regulate the idling of heavy-duty diesel vehicles. This means that long-haul carriers have to track and comply with a patchwork of laws. The American Transportation Research Institute (ATRI) produces a cab card of regulations and penalties[11] specific to heavy-duty trucks to help its members keep up to date and avoid potentially hefty fines. Complicating the picture is the spotty enforcement of these laws, so the effect of those regulations is uneven.

In California, for example, idling is restricted to 5 minutes. Fines start at $300 and rise to $1,000 per day.[12] However, California permits the idling of trucks that meet the low-NOx idling emission standard ($\leq$30 g/h) and are parked more than 100 feet from any residential area. (These trucks must display the CARB "Clean Idle" sticker. That these stickers can be purchased for a few dollars on eBay is concerning.) Although "Clean Idle" trucks have low NOx emissions, they still burn fuel and emit CO_2 when idling.

2.2 Top-Level Trends/Projections

In the last 5 years, battery-powered auxiliary power units (APUs) have started to displace diesel-powered systems. Some APUs, whether diesel or battery, are equipped to plug in for grid power (wayside, or shore, power) when available; this minimizes petroleum use and emissions.

Because battery APUs may be heavier than diesel APUs, the added weight can be an issue for carriers. The Energy Policy Act of 2005 allowed states to adopt a 400-pound exemption for the additional weight of idling reduction technology on heavy-duty vehicles. In 2012, Moving Ahead for Progress in the 21st Century (MAP-21) became law, increasing this weight allowance to 550 lb.[13] Most APUs are exempt from the federal excise tax, a benefit enacted with the Energy Improvement and Extension Act (EIEA) of 2008 (PL 110-343), Section 206.[14]

Other IR technology approaches include solar power, which has been harnessed for some IR applications, but current energy-storage technologies do not enable power for entire hotel load.

Some fleets meet their engine-off needs most efficiently by combining IR technologies, such as an electric air-conditioner and a fuel-fired heater. At least one commercial system packages the two together.

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[11] ATRI, Idling Regulations Compendium, http://atri-online.org/2013/02/20/idling-regulations-compendium/.

[12] California Air Resources Board (CARB), Facts About California's Commercial Vehicle Idling Regulations, http://www.arb.ca.gov/msprog/truck-idling/factsheet.pdf.

[13] U.S. Department of Transportation, Federal Highway Administration, MAP-21—Moving Ahead for Progress in the 21st Century: Miscellaneous Operations & Freight Provisions Questions & Answers http://www.fhwa.dot.gov/map21/qandas/qaoperations.cfm.

[14] SmartWay Technology Program, Federal Excise Tax Exemption, http://epa.gov/smartway/forpartners/technology.htm.

2.3 Opportunities

Because long-haul, sleeper trucks idle regularly and for long periods, IR for this sector offers the potential greatest "bang for the buck" for petroleum displacement and emissions reduction in fleets. Every day, for a driver's rest period alone, up to 10 hours of idling can be displaced per truck; for the 34-hour restart period required by the FMCSA's HOS rule, the potential savings are greater.

For long-haul truck drivers, the climate of operation is a key factor for hotel needs. Currently, sleeper-cab heating and cooling are most efficiently powered by different means, so individual truck owners must find their best compromise. With the technologies now available, there are two particularly promising good fits:

- **Target 1: Fleets with long-haul trucks that operate primarily in the north (cooler climate)**
- ***Solution: Conventional (diesel) APUs (bonus if the APU can be plugged in to run from electric power [shore power])***

In cooler climates, a diesel APU can satisfy all—not just some—hotel needs, even during a 34-hour mandated rest period; those APUs that are shore-power compatible maximize potential petroleum savings. APUs are especially beneficial to drivers who would otherwise log many idling hours, and therefore can quickly pay back the large investment with fuel savings. While battery-powered APUs are adequate during a 10-hour break, their capacity is currently insufficient for a 34-hour period, unless wayside electrical power is available or the engine is turned on intermittently to recharge charge the battery. Fuel-fired heaters have adequate heating capacity, at much lower cost, and may be sufficient if air-conditioning is not required.

- **Target 2: Fleets with long-haul trucks that operate primarily in the south (warmer climate)**
- ***Solution: Electrified parking spaces (EPS) (also called truck stop electrification, or TSE)***

In very hot locations, APUs may not be able to supply sufficient air-conditioning to keep the driver cool at night. (Newer battery APUs using lithium-ion technology and a more-efficient compressor would be lighter and perform much better in hot climates but would also be more expensive.) For hot locations, EPS has found a good market niche. Single-system EPS requires no equipment on the truck (except an inexpensive window adapter) and supplies all services through the truck's window. Dual-system EPS provides a pedestal where electrical equipment on board the truck can be plugged in.

For EPS, good siting along highly traveled truck corridors is crucial. Assured regular occupancy is critical to provide an adequate ROI for the wayside system's owner. The high-occupancy requirement makes EPS an especially good match for dedicated fleet terminals. Several such sites are in place or under construction.

For long-haul trucks, the especially low-hanging fruit might be fleets operating largely in areas where IR regulations are regularly enforced, such as in California or New England. Areas that have National Ambient Air Quality Standards (NAAQS) attainment-status issues are also good targets, especially for EPS, because EPS can help these regions meet their air-quality targets in State Implementation Plans. Finally, companies/fleets that have a sustainability component in their branding also make prime targets.

For possible "crossover" niches, successes with long-haul truck IR may apply to other trucks that idle for extended periods, particularly those requiring cab comfort (HVAC). These include some utility trucks and various delivery trucks that idle for hours while waiting for pick-ups and deliveries. Such niches are well represented by the Clean Cities' National Clean Fleets Partnership, which presents crossover opportunities.

2.4 Benefits Quantification

The estimated potential benefits of IR for the two niches described are shown in Table 2.1.

Table 2.1. Benefits Quantification: IR for Long-Haul Sleeper Trucks

	Long-Haul Sleeper Truck, Warm Climate	Long-Haul Sleeper Truck, Cool Climate
Number of Vehicles	500,000	500,000
Hours Idled per Day	6	6
Idling Days per Year	300	300
Annual Idling Hours	1,800	1,800
Idling Fuel Use (gal/h)	1	0.8
Promising IR Technology	EPS	Diesel APU
Fuel Use for Device (gal/h)	0	0.25
Electricity Use for Device (KWh/h)	2 KWh	0
Annual Fuel Saving per Vehicle (gal)	1,800	990
Total Potential Savings (million gal/y)	900	495
Total Potential CO_2 Reduction (million tons/y)	9	5

2.5 Key Barriers

One of the key barriers to IR adoption—across all technology types and vehicle sectors—is the perception that IR equipment has little value when fuel prices fall. When fuel costs dip, time to ROI on IR technologies indeed increases, which can make "selling" IR challenging.

If fuel savings are the primary or only incentive for a fleet, IR technology adoption will be less attractive than it will be for fleets that value emissions benefits, whether for sustainability goals or compliance reasons. However, even when fuel prices are low, fuel remains a large proportion of operational costs for long-haul carriers, and carriers are always seeking ways to reduce their largest expenses. Continued education and outreach to carriers about the benefits of IR will be an important strategy for Clean Cities.

At the user level, one barrier is that some truck drivers perceive IR as an undertaking to save money for the fleet at the cost of driver comfort. An important point is that the solutions described here provide for the full range of hotel needs and, in fact, allow a quieter, healthier rest period for drivers.[15] Providing legal cabin comfort (as opposed to having drivers idle illegally, or use a system that provides for only some hotel needs) should help fleets retain drivers, an important factor as the long-haul industry faces increasing driver shortages.

[15] Doraiswamy, P., et al. Air Monitoring Inside and Outside Diesel Truck Cabs During Long Term Idling. Proceedings, 99th Air and Waste Management Association Annual Conference, New Orleans, La., June 20–23, 2006.

Truck-stop EPS use requires two extra driver tasks: drivers must pay for the service and attach an air duct to the window and/or plug in an extension cord. For employee-drivers, running the engine overnight is “free” (paid for by the company). Providing drivers with member cards so that they do not have to pay out of pocket and file paperwork for reimbursement (or, worse, pay the bill themselves) reduces the cost and effort for the truck operator. Perhaps a larger barrier to EPS is the lack of availability; major routes must be well covered, or drivers will need to have on-board equipment to ensure overnight comfort wherever they stop.

The long-haul, sleeper-truck sector has not been the typical target for Clean Cities coalitions, but the potential petroleum and emissions reductions are great, and the savings metrics fairly easy to calculate. This sector is an untapped opportunity for Clean Cities, and it presents an opportunity to cultivate synergies with the National Clean Fleets Partnership.

3. POLICE VEHICLES AND AMBULANCES

3.1 Current Market Status

Unlike some other vehicle types for which idling times are measured in minutes (e.g., package delivery trucks), emergency vehicles may idle for hours—indeed, sometimes for half or more of their operational time. In recent years, a number of technologies that provide an alternative to engine idling for emergency vehicles have come to market. While these technologies allow the more efficient and cleaner provision of stationary power than does idling, they have not yet been widely adopted.

Police cruisers spend a lot of time parked and running while officers patrol, work accident scenes, write reports, or wait for their next call. These vehicles need power for emergency lights and communications equipment in addition to heating and cooling. In a recent study on police-vehicle fuel consumption, a cruiser was found to idle 60% of the time during normal operation and used 21% of its total fuel while stationary.[16] Similarly, ambulances idle to maintain power for emergency lights, communications equipment, and heating and cooling. Power is also needed to keep medications and life-support equipment at proper temperatures.

According to the American Ambulance Association,[17] more than 48,000 ground ambulances operate in the U.S. For police vehicles, the most-recent data appear to be from 2003, showing about 410,000 police vehicles, including local, sheriff’s office, and state police vehicles.[18] No data describe the proportion of emergency vehicles equipped with IR equipment, but it is small.

3.2 Top-Level Trends/Projections

Emergency vehicles are almost always exempt from idling laws and regulations, but there is increasing recognition that using fuel at idle is not the best use of public monies, and that generating emissions—especially in neighborhoods or near emergency rooms—is inconsistent with the best public service. In 2014, the Santa Barbara County (California) Grand Jury asked that the Santa Barbara Sheriff’s Office find

[16] Rask E., et al., Final Report: Police Cruiser Fuel Consumption Characterization, Argonne National Laboratory, for the Illinois State Toll Highway Authority, February 2013.
[17] American Ambulance Association, Ambulance Facts, http://www.the-aaa.org/media/ambulance_facts.html.
[18] Bureau of Justice Statistics, Law Enforcement and Management Administrative Statistics, http://www.bjs.gov/index.cfm?ty=dcdetail&iid=248.

an alternative to idling after determining that the fuel used in idling cost taxpayers more than $1.25 million over about 5 years.[19]

While there are no federal-level incentives to reduce emergency vehicle idling, some state- and local-level initiatives have funded such IR projects. Most recently, the New York State Energy Research and Development Authority (NYSERDA) funded Shorepower, LLC, to design, install, and evaluate 10 street-side electric-connection stations to allow ambulances to plug in, rather than idle, for power. South Shore Clean Cities recently funded a project for the installation of MediDock units (power pedestals with a duct that provides conditioned air) at several northwest Indiana hospitals through the BP Cleaner Air through Diesel Emission Reductions (BP-CADER) program.

Increasingly, police departments are replacing sedans with SUVs. While this trend sometimes defies the general movement toward higher-MPG replacement vehicles, SUVs do allow more space than do sedans for the placement of auxiliary batteries. (Lack of space for these batteries has been a common complaint regarding these units for police cars.)

Alternative fuels have not been a significant option for emergency vehicles to date, probably in part because emergency vehicles have not counted toward a fleet's Energy Policy Act (EPAct) annual light-duty vehicle count (and the associated determination of AFV-acquisition requirements).[20] Because these vehicles are likely to remain more petroleum-dependent than other vehicle types for the foreseeable future, ways to reduce petroleum for this niche will be an important Clean Cities' offering.

3.3 Opportunities

Because emergency vehicles are normally exempt from IR laws, the best outreach targets will be where fleets are seeking to reduce fuel budgets, in areas with air-quality attainment issues and air inversions ("stale air"), and areas with known high or growing levels of commitment to sustainability.

- **Target 1: Police vehicles**
- ***Solution: Battery auxiliary power units***

Several types of IR devices are available for police vehicles, including new battery-powered APUs (Figure 3.1) that can provide all services required by on-duty officers, including air-conditioning. These can be recharged while the vehicle runs or from the grid while the vehicle is stopped. Lower-cost devices that simply monitor the vehicle battery's state-of-charge, and restart the vehicle to recharge the battery if the state-of-charge falls to a predetermined level, are also available.

- **Target 2: Ambulances**
- ***Solution: Wayside power near hospital emergency rooms***

Wayside units for ambulances can be located outside of hospital emergency rooms to prevent idling emissions that would impact a critically sensitive population. These EPS systems resemble those for long-haul trucks, supplying conditioned air and electrical power to maintain all ambulance functions while parked (Figure 3.2). APUs are also now available for ambulances.

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[19] Santa Barbara County Grand Jury, Idling Sheriff's Vehicles: It's About Dollars and Sense, http://www.sbcgj.org/2014/IdlingSheriffsVehicles.pdf.
[20] U.S. DOE, Office of Energy Efficiency & Renewable Energy, EPAct Transportation Regulatory Activities, Excluded Vehicles, http://www1.eere.energy.gov/vehiclesandfuels/epact/key_terms.html.

Figure 3.1. Police vehicle auxiliaries can be powered by a battery pack that fits in the vehicle's trunk. (Photo courtesy of ZeroRPM, Inc.)

Figure 3.2. Ambulance hooked up to a MediDock for power and conditioned air. (Photo courtesy of Craufurd Manufacturing)

Within these targets, promising locations are municipalities and/or hospitals whose branding includes a "green" or sustainability element. Municipalities that are in NAAQS nonattainment, or that are in danger of falling into nonattainment, may be especially receptive to these options. (EPA is proposing to tighten the ozone standard in 2015.)

From a financial perspective, it makes sense to install on-board equipment in new or recently acquired vehicles to maximize the benefits without accruing costs for deinstallation and reinstallation in another vehicle.

Possible "crossover" niches include vehicles that might benefit from similar on-board equipment, such as armored cars and various military vehicles, as well as non-PTO utility service trucks. For wayside power, food trucks are a possible crossover niche.

Clean Cities coordinators are likely to have some relationships with local fire and police departments or to have stakeholders who have relationships with these fleets, making these fleets easier to approach.

Of the three niches presented in this paper, this niche is the one for which IR technology use is newest and, therefore, where outreach is likely to find the most previously untapped audiences. Conferences, publications, and other forums devoted to public fleets (and, more specifically, emergency fleets) and sustainability would be especially good Clean Cities outreach targets.

3.4 Benefits Quantification

Conservatively, the idling of emergency vehicles is estimated to consume more than 725 million gallons of fuel annually, at a cost of more than $2.2 billion (see Table 3.1). The associated emissions consequences for CO_2 alone are 7 million tons annually. Actual impacts may be much greater. According to NYSERDA, the average New York City Fire Department ambulance idles 12 hours per day, using 14 gallons of fuel.[21]

[21] NYSERDA and the New York DOT, New York City Green Loading Zones Study: Final Report, http://energyplan.ny.gov/-/media/Files/Publications/Research/Transportation/New-York-City-Green-Loading-Zones-Study.pdf.

Table 3.1. Benefits Quantification: IR for Police Vehicles and Ambulances

	Police Car	**Ambulance**
Number of Vehicles in Use in U.S.	~410,000	~48,400
Hours Idled per Day	5	6
Idling Days per Year	350	350
Annual Idling Hours	1,750	2,100
Idling Fuel Use (gal/h)	0.8	1.5
Promising IR Technology	Battery APU	EPS
Fuel Use for Device (gal/h)	0	0
Electricity Use for Device (KWh/h)	0.3 KWh	2 KWh
Annual Fuel Savings per Vehicle (gal)	1,400	3,150
Total Potential Savings (million gal/y)	574	152
Total Potential CO_2 Reduction (million tons/y)	5	2

3.5 Key Barriers

Fuel prices fluctuate, of course; when fuel costs are low, time to ROI on technology adoption increases. If fuel savings are a fleet's primary incentive in considering IR, adoption will be less attractive when fuel prices are low than when they are high. In such cases, outreach to fleets where reducing emissions is of primary concern may be the most productive approach for Clean Cities.

Drivers of emergency vehicles face multiple tasks, not all of which are emergency related. IR options that are perceived to require extra work/steps may be especially onerous for these vehicle operators. Communicating that the IR technologies help protect not only the public from emissions but those operating the vehicles will be important.

4. SCHOOL BUSES

4.1 Current Market Status

School bus idling is an issue of long-standing concern. Among the least controversial of air-quality goals is protecting air quality for children, especially at schools.

School buses are idled to warm up the engine and passenger compartment before starting their routes on cold mornings. Available technologies include small heaters that warm up the engine and coolant, or the passenger compartment, or both (Figure 4.1). These heaters can be equipped with programming devices to turn them on at the appropriate time. In addition to the morning warm-up, buses may be idled throughout the day to keep the interior warm for children and the vehicle operator. Although most school bus heaters run on diesel fuel, models fueled by natural gas or propane have come to market recently, allowing alternatively fueled buses to reduce idling without the need for a second fuel tank.

Figure 4.1. Heat distribution for school bus heater. (Image Courtesy of Espar Climate Systems)

Many states (including California, Connecticut, Indiana, Massachusetts, Minnesota, Mississippi, Missouri, New Jersey, North Carolina, Utah, and Vermont) regulate school bus idling, as do many more counties and municipalities. In some states, such as Massachusetts, enforcement and penalties are significant. In addition, many school districts have no-idling policies.

Federal and state incentives for school bus IR and other emission-reduction technologies have diminished in recent years. EPA's Diesel Emissions Reduction Act (DERA) program funding has been sharply reduced relative to ARRA levels, and its Clean School Bus USA program funded projects from 2003 to 2007 only. Projects intended to reduce emissions in school buses now tend toward vehicle replacements and alternative fuels (and sometimes installing catalysts on older buses). Some states, however, including New York, Ohio, Illinois, Texas, and Washington, have ongoing funding opportunities for school bus IR.

4.2 Top-Level Projections

Although school buses use more fuel types than ever, diesel fuel accounted for 90% of school bus fuel use in 2012, with gasoline representing the remainder.[22] Totals for alternative fuels, such as propane and compressed natural gas (CNG), were too small to show up in the tabulation. However, use of alternative fuels in school buses is growing rapidly. These fuels are perceived as "greener" than diesel, and therefore little attention has been paid to IR. However, alternatively fueled school buses idle for reasons similar to those for diesel buses,[23] and the practice reduces the efficiency and cost-effectiveness of alternative fuel use. IR for propane- and CNG-fueled school buses is, therefore, is a developing concern. Heaters fueled with both fuels have recently emerged on the market.

4.3 Opportunities

School buses are found in nearly all communities, with about 675,000 in operation in the U.S.[24] An advantage of the school bus sector is that school buses are fairly homogenous; IR solutions do not require

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[22] Oak Ridge National Laboratory, Transportation Energy Data Book, Ed. 33, July 2014 http://cta.ornl.gov/data.
[23] "Blue Bird Propane Vision buses start up in temperatures as low as minus 40 degrees Fahrenheit." (http://www.roushcleantech.com/content/cleveland-schools-replaces-49-diesel-buses-economical-and-clean-propane-autogas-0]) Even if alt-fueled buses start at low temperatures, the passenger compartment must be warmed.
[24] Oak Ridge National Laboratory, Transportation Energy Data Book, Ed. 33, July 2014, http://cta.ornl.gov/data.

the customization that other, more variable vehicle types, such as emergency vehicles, can. Additionally, IR solutions (i.e., heaters) are technologically well established and straightforward and have not suffered the reliability and maintenance issues that have plagued, for example, some truck APUs.

Many factors converge to make school bus IR an attractive market niche. Because school buses have long life cycles (a 2011 New Jersey bill extended the legal life span in that state from 12 to 15 years[25]), there remain many older school buses on the road for which the benefits of IR would be especially dramatic. The costs associated with idling come not only from fuel use and emissions but engine wear and increased maintenance. Where buses are preheated for a long time, requiring that an employee start the engines before dawn, IR devices would also save considerable labor costs. Finally, school districts can demonstrate good environmental stewardship while saving money.

- **Target: School buses operating in cooler climates (bus preheating necessary)**
- ***Solution: Engine and/or air heaters***

Diesel-fired heaters (DFHs) supply warm air to the passenger compartment. An engine block heater can also be included. Fuel use and emissions for diesel heaters are very low, because they supply heat directly from a small combustion flame to a heat exchanger. Standard diesel fuel from the bus's fuel tank is used. Operation of heaters fueled by propane or CNG is similar. Electric block heaters can be used to warm the engine, but they do not warm the passenger area. A school district in Cleveland, Ohio, estimated that powering block heaters to start their diesel buses in cold weather cost about $50,000 in electricity annually.[26]

The best targets will be fleets in cooler climates because the more the devices are used, the faster the ROI. Promising locations could also be defined as those where the regulations are strictest, where enforcement is highest, and where NAAQS nonattainment is an issue. Adopting IR in such cities could help these locations solve very real problems.

Another especially good target includes areas that have fewer options for other green-technology alternatives, such as alternative-fuel buses, for reasons of infrastructure, incentives, or funding, and where the average age of school buses is on the high side but where the buses are not due to be replaced in the coming few years.

That being said, IR is a valuable strategy not just for conventionally fueled buses but for alternatively fueled buses. Reducing idling in alternatively fueled buses reduces operating costs. Like diesel buses, alternatively fueled buses get 0 mpg when idling. Additionally, while alternative fuels may reduce emission impacts, they do not eliminate them.

Communities whose branding includes a "healthy" or "sustainable" element make good outreach targets, as do school districts that would especially benefit from good environmental PR. Every Clean Cities coalition will have access to numerous school districts and possibly existing relationships with some of them. If coalitions want to reach out to communities on the subject of idling—school bus idling and passenger car idling at schools both concern clean air for children—they can present the IdleBox presentation, One Easy Habit To Help You "Go Green": Reducing Personal-Vehicle Idling.

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[25] New Jersey School Boards Association, Bill to Extend School Bus Life Advances, June 7, 2011, http://www.njsba.org/sb_notes/20110607/bus.html.

[26] ROUSH Clean Tech, Cleveland Schools Replaces 49 Diesel Buses with Economical and Clean Propane Autogas, http://www.roushcleantech.com/content/cleveland-schools-replaces-49-diesel-buses-economical-and-clean-propane-autogas-0.

Coalitions that are involved in developing a project funding opportunity related to school buses might consider adding a requirement that awardees adopt an IR policy for their fleet.

Other vehicles for which school buses could be good examples include airport shuttles and transit buses whose routes include waiting for passengers. These would be especially good targets, because they operate and idle many more hours per year than do school buses, and therefore would have much faster ROI. Implementing school bus IR also presents an opportunity to educate parents about the effects of idling their vehicles near schools, and students about a range of environmental and energy issues.

4.4 Benefits Quantification

The estimated potential benefits of IR for school bus are shown in Table 4.1.

Table 4.1. Benefits Quantification: IR for School Buses

Number of Vehicles	675,000[27]
Hours Idled per Day	2
Idling Days per Year	150
Annual Idling Hours	300
Idling Fuel Use (gal/h)	0.8
Promising IR Technology	Heater
Fuel Use for Device (gal/h)	0.6
Annual Fuel Savings per Vehicle (gal)	222
Total Potential Savings (million gal/y)	150
Total Potential CO_2 Reduction (million tons/y)	1.5

4.5 Key Barriers

Unlike heavy-duty trucks, which idle about 1,800 hours a year for driver rest periods alone, school bus idling hours usually total less than 500 per year and might be much lower. When fewer idling hours are displaced, IR technology takes longer to pay back. Fleets likely to use the heaters less than 100 to 140 days per year will face an even longer ROI than school buses in colder climates. Longer payback is a potential barrier.

When fuel prices dip, time to ROI on technologies increases. Demonstrating that the benefits are real even when fuel prices are low and in the absence of rebates or grants will be key for Clean Cities coalitions.

Fleets that have moved to alternative fuels may have the perception that IR is unnecessary for their buses (that they have done their "green" duty) or may be unaware of the benefits of IR for alternative-fuel vehicles. Fleets that are considering moving to alternative fuels will not be good targets for conventional bus heaters, but they can be encouraged to look into IR options once they have made a choice about fuel type.

[27] Oak Ridge National Laboratory, Transportation Energy Data Book, Ed. 33, July 2014, http://cta.ornl.gov/data.