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Heavy Vehicle Idling Reduction

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U.S. Department of Energy

UChicago Argonne LLC

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Background

Many heavy vehicles idle to stay warm

- Trucks
  - To keep fuel and engine warm
  - For resting driver's comfort
  - To mask out noises and smells
  - For safety
- Buses
  - To warm up
  - While waiting
- Locomotives
  - So it starts
  - For hotel load
  - To keep battery charged
  - To heat toilet water
  - For air brakes
  - Habit

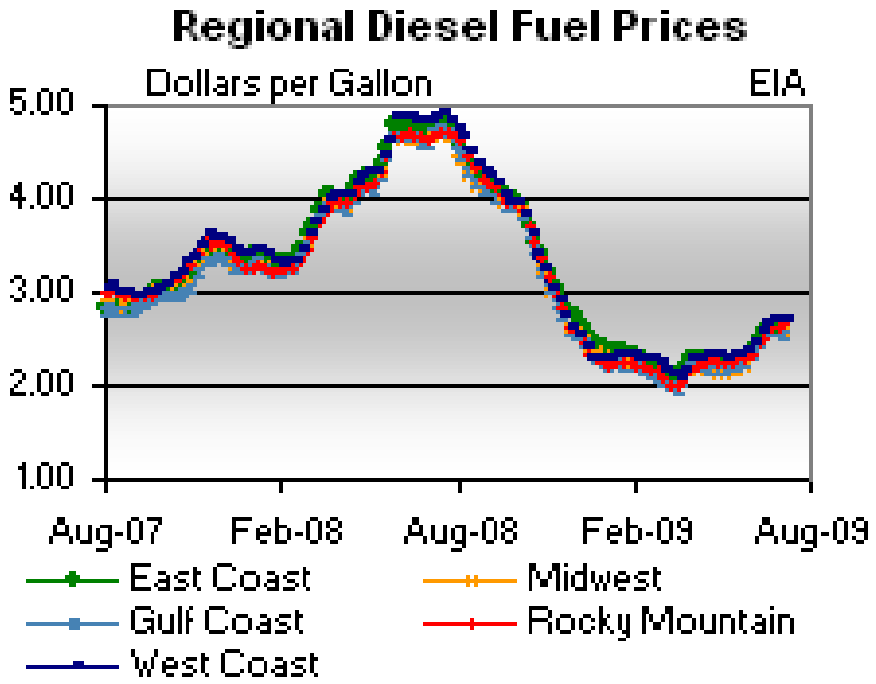
Idling wastes expensive fuel, pollutes the air

- Petroleum use
  - Over 25 million barrels per year (>$ 2 billion) just for trucks idling overnight
    - *~2% of heavy vehicle fuel*
  - Equivalent to about 1% of our imports
- Emissions
  - 140,000 t NO_x, 2400 t CO, and 7.6 million t CO_2 from trucks
  - Often near high or sensitive populations
- Engine wear
  - Reduces mileage to overhaul
- Added maintenance costs

Transportation consumes > 2/3 of our 7 billion bbl/y

The price of diesel is very variable

- Idling a Class 8 truck uses 0.6-1.2 gallons per hour
- That could total over $50 a night!
- Even without regulations, there's an incentive to reduce idling
- When the price goes down, idling reduction still makes sense



Sleeper cabs can have all the conveniences

Workday idling is also important

- Long-duration idling occurs at
  - Ports and terminals
  - Busy delivery sites
  - Border crossings
  - Restaurants
  - Tourist destinations (tour buses)
- All truck types may idle during the day
  - We focus on long-duration idling (>30 minutes)
    - *Power take-off excluded*
  - Idling reduction devices do not enable slow movement in queue ("creep mode")
  - Scheduling can reduce workday idling
  - Daytime idling represents significant use of fuel

Idling uses over 8% of commercial truck fuel

	Fuel use (million gallons/year)			
	Gasoline	Diesel	Other	Total
Overnight idling	0	666	0	666
Workday idling	1,416	1,002	73	2,491
Total long-duration idling fuel use	1,416	1,668	73	3,157
Total fuel use for commercial trucks	13,922	22,681	378	36,982
Idling % of total use by fuel type	10.2%	7.4%	19%	8.5%

Technology Description

Several technologies can reduce idling

- Most could be used for all heavy vehicle modes
- All reduce fuel use, emissions, and noise

- On-board equipment
  - Automatic engine stop-start controls
  - Cylinder deactivation
  - Auxiliary power units (APU) and similar devices
  - Cab and block heaters
  - Air conditioners
- Wayside units
  - Single system electrification
    - *requires no on-board equipment*
  - Dual system (shore power)
    - *Allows driver to plug in on-board equipment*
  - Fluid circulation systems (bus)

Simple measures can reduce energy demand

- Reduce heat transfer with insulation
- Reduce solar load with shades
- Recover waste heat from coolant
- Reduce peak with load management
- Can be retrofit or OEM option

Engine controls are inexpensive

- Automatic start-stop senses sleeper temperature
  - Turns engine on when too warm or cold
  - Minimal savings in extreme weather
  - May disturb sleep
  - Adds to engine wear, emissions
  - Cost for factory option or retrofit $1,200+ for truck, $7,500 for loco
- Cylinder deactivation limits combustion to part of engine
  - Enables small reduction of fuel use and emissions
  - Not commercial

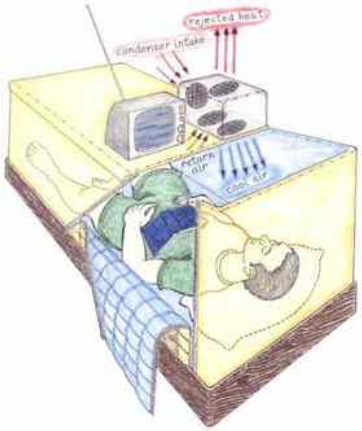
Various on-board designs provide full service

- Supply HVAC, electricity, and charge battery
- Auxiliary power unit (APU) or gen set
  - Diesel-fueled engine and generator
  - Some models can be plugged in
  - Fuel cell in development
- Inverter/charger with batteries
  - Heat pump system now available
- Cost is ~$8,000+ for truck, $25,000+ for locomotive
- Add up to 400 lb to truck
  - Energy law includes weight waiver to avoid lost revenue capacity
  - “News” includes current state-by-state status
- Lighter, less expensive truck units desirable
  - OEM integration is key

Heaters and air conditioners are available

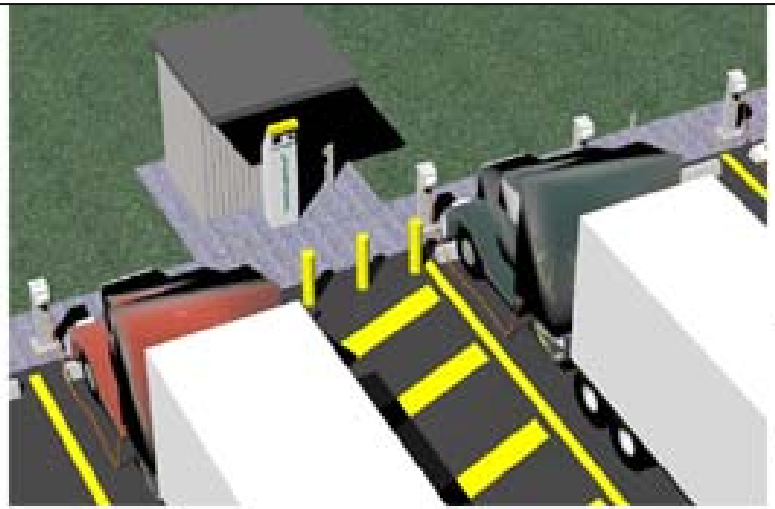
- Small, inexpensive, diesel-fueled heaters are efficient
  - For sleeper and engine
  - Used in Europe, on trucks, buses, boats
- Waste heat recirculation inexpensive

- Most air conditioners rely on batteries
  - One system uses evaporative cooling
  - Thermal storage also available
  - May just cool bed



Dual system TSE supplies electrical services*

- On-board electric HVAC required
  - Cost up to $8,000
- Parking space costs up to $6,000
- Plug-in pedestal like campground
- Use costs ~$0.50-$1.00/h
- Standardized plugs desirable
  - 120V and/or 240V AC
- Payback projected <2 years
- Chicken and egg problem



Control Kiosk and Power Pedestal Installations

*TSE= truck stop electrification, also called EPS= electrified parking space

Single system electrified parking spaces require no investment by truck owner

- User satisfaction high
  - No investment by truck owner
  - May cost less than fuel for idling
- Truck stop gets part of revenues
- System owner could sell emission credits
- About 130 locations available nationwide
- Several purveyors offer similar service
  - Long-term financial viability remains to be seen
  - Best-known purveyor was acquired by new entity

Technologies have pros and cons

System	Services	Advantages	Disadvantages
Idling	All	No investment	High emissions, noise, fuel use
Automatic start-stop	All, intermittently	Low cost	Noisy, minimal benefit in winter
APU or similar device	All	Anywhere, anytime	High cost and weight
Truck stop electrification	All	No local emissions, pay-per-view, quiet	Requires equipped location, cost
Heater	Heating	Low cost and weight	Not full service
Air conditioner	Cooling	Low cost	Not full service, E storage may be heavy

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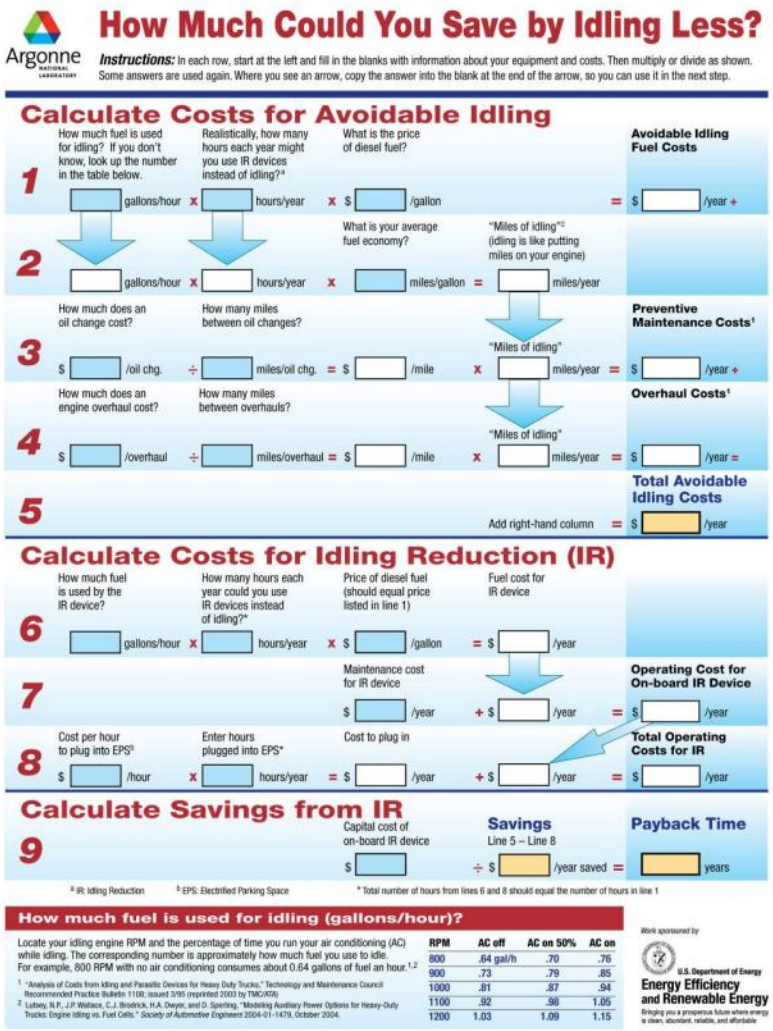
Cost Information

Estimated costs for alternatives vary widely

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

Payback time depends on operating practices

- Fuel savings are main financial benefit
  - Payback is faster if more idling hours are displaced
- Savings also accrue from reduced maintenance costs
  - Routine maintenance can be performed less often without idling
  - Mileage to overhaul can be increased without idling
  - Worksheet for trucks is based on TMC RP 1108
- Low-idling history should increase vehicle resale value
- Device has residual value



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How Much Could You Save by Idling Less?

Instructions: In each row, start at the left and fill in the blanks with information about your equipment and costs. Then multiply or divide as shown. Some answers are used again. Where you see an arrow, copy the answer into the blank at the end of the arrow, so you can use it in the next step.

Calculate Costs for Avoidable Idling

1 How much fuel is used for idling? If you don't know, look up the number in the table below. ____ gallons/hour x Realistically, how many hours each year might you use IR devices instead of idling?[a] ____ hours/year x What is the price of diesel fuel? $ ____ /gallon = **Avoidable Idling Fuel Costs** $ ____ /year +

2 ____ gallons/hour x ____ hours/year x What is your average fuel economy? ____ miles/gallon = "Miles of idling"[2] (idling is like putting miles on your engine) ____ miles/year

3 How much does an oil change cost? $ ____ /oil chg. ÷ How many miles between oil changes? ____ miles/oil chg. = $ ____ /mile x "Miles of idling" ____ miles/year = **Preventive Maintenance Costs**[1] $ ____ /year +

4 How much does an engine overhaul cost? $ ____ /overhaul ÷ How many miles between overhauls? ____ miles/overhaul = $ ____ /mile x "Miles of idling" ____ miles/year = **Overhaul Costs**[1] $ ____ /year =

5 Add right-hand column = **Total Avoidable Idling Costs** $ ____ /year

Calculate Costs for Idling Reduction (IR)

6 How much fuel is used by the IR device? ____ gallons/hour x How many hours each year could you use IR devices instead of idling?* ____ hours/year x Price of diesel fuel (should equal price listed in line 1) $ ____ /gallon = Fuel cost for IR device $ ____ /year

7 Maintenance cost for IR device $ ____ /year + $ ____ /year = **Operating Cost for On-board IR Device** $ ____ /year

8 Cost per hour to plug into EPS[b] $ ____ /hour x Enter hours plugged into EPS* ____ hours/year = $ ____ /year Cost to plug in + $ ____ /year = **Total Operating Costs for IR** $ ____ /year

Calculate Savings from IR

9 Capital cost of on-board IR device $ ____ ÷ **Savings** Line 5 – Line 8 $ ____ /year saved = **Payback Time** ____ years

[a] IR: Idling Reduction [b] EPS: Electrified Parking Space * Total number of hours from lines 6 and 8 should equal the number of hours in line 1

How much fuel is used for idling (gallons/hour)?

Locate your idling engine RPM and the percentage of time you run your air conditioning (AC) while idling. The corresponding number is approximately how much fuel you use to idle. For example, 800 RPM with no air conditioning consumes about 0.64 gallons of fuel an hour.[1,2]

RPM	AC off	AC on 50%	AC on
800	.64 gal/h	.70	.76
900	.73	.79	.85
1000	.81	.87	.94
1100	.92	.98	1.05
1200	1.03	1.09	1.15

[1] "Analysis of Costs from Idling and Parasitic Devices for Heavy Duty Trucks," Technology and Maintenance Council Recommended Practice Bulletin 1108; issued 3/95 (reprinted 2003 by TMC/ATA)

[2] Lutsey, N.P., J.P. Wallace, C.J. Brodrick, H.A. Dwyer, and D. Sperling, "Modeling Auxiliary Power Options for Heavy-Duty Trucks: Engine Idling vs. Fuel Cells." *Society of Automotive Engineers* 2004-01-1479, October 2004.

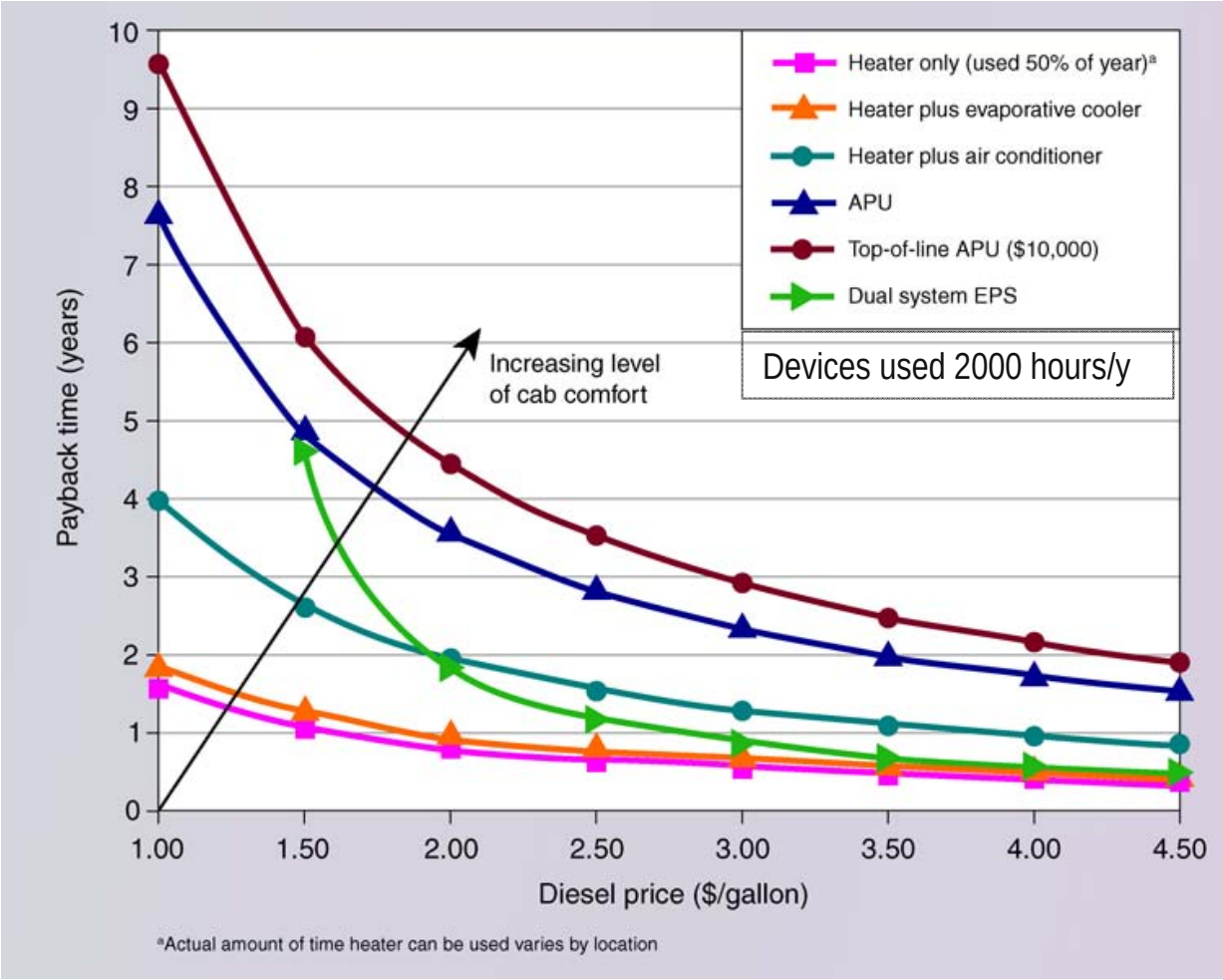
Work sponsored by U.S. Department of Energy Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Idling reduction pays for itself

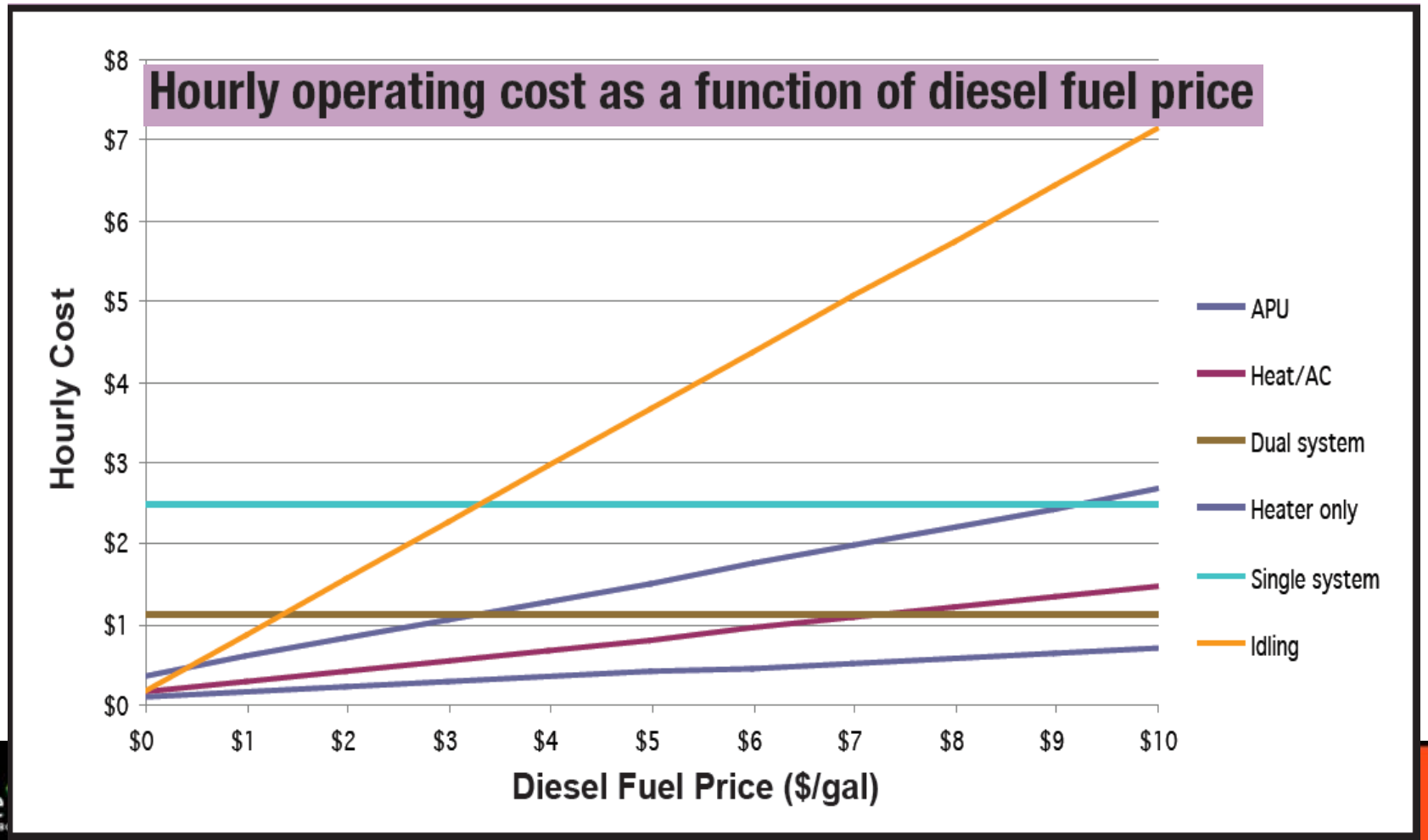
This is win-win situation!

- IR reduces emissions and saves fuel costs
  - Contrast with emission-reduction strategies that increase fuel use
  - These compete for grants on $/ton basis
- Loans or grants can speed deployment
- Loan money can be used again when it's paid back



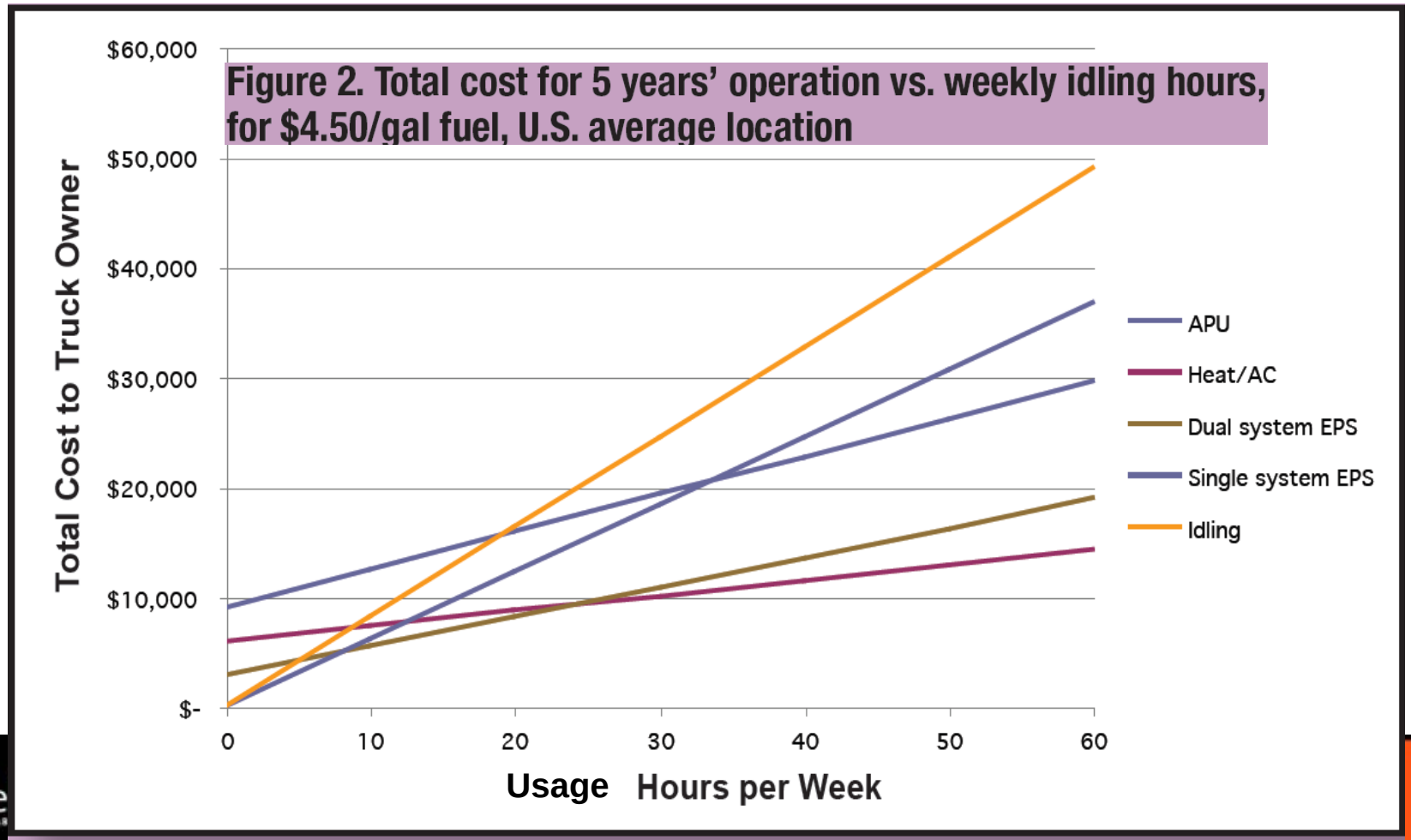
Hourly cost saving depends on fuel price

- Hourly costs fixed for wayside systems
- Rise with fuel cost for on-board options, including idling
- Operating cost for all options lower than idling if fuel >$3/gal



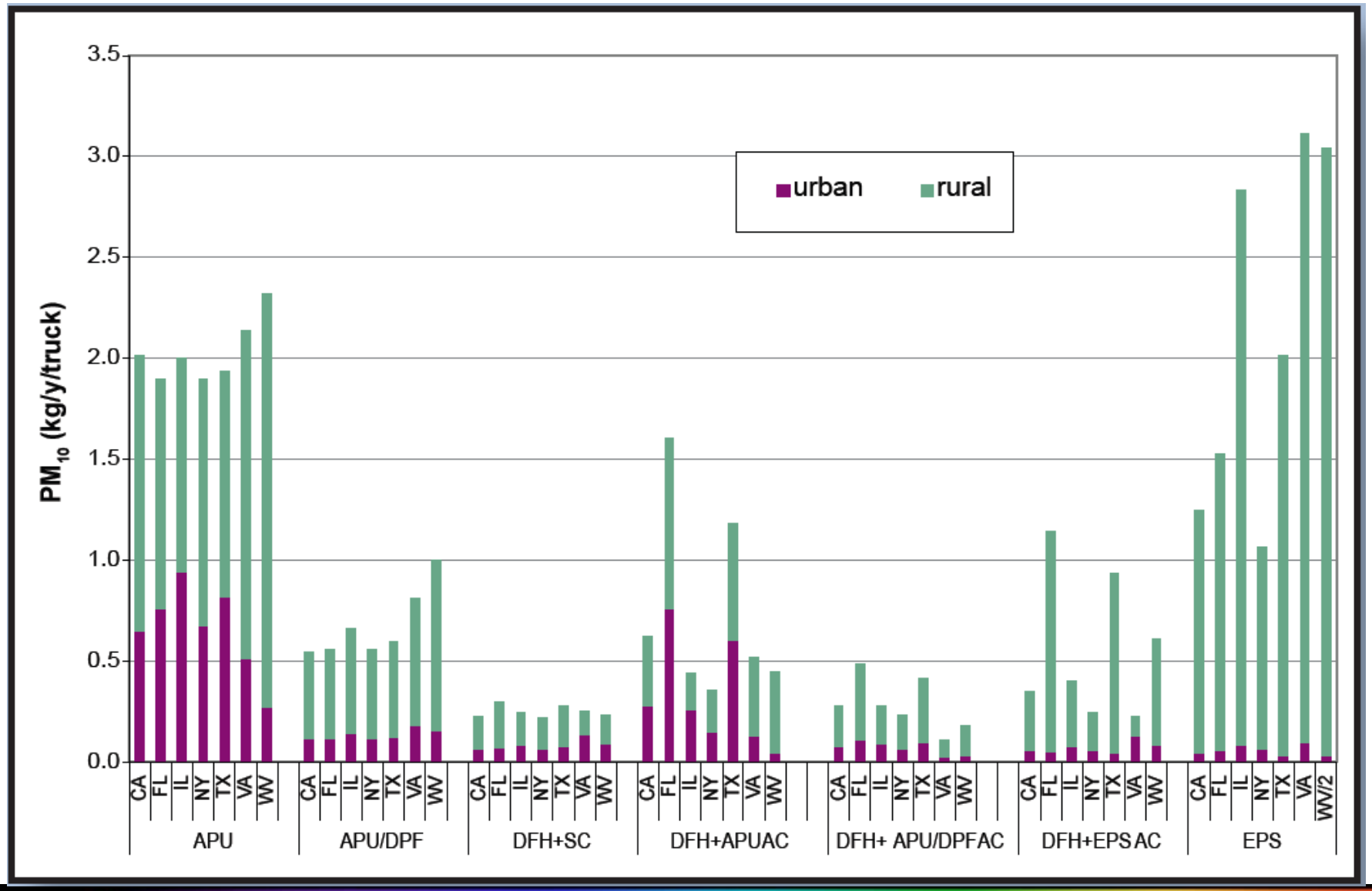
Savings to truck owner rise with idling hours

- Options with low investment save most for low idlers
- Options with low hourly cost save most for high idlers
- All alternatives produce savings for >18 hours/week idling ($4.50/gal diesel fuel)



Emissions

Emissions depend on technology and location

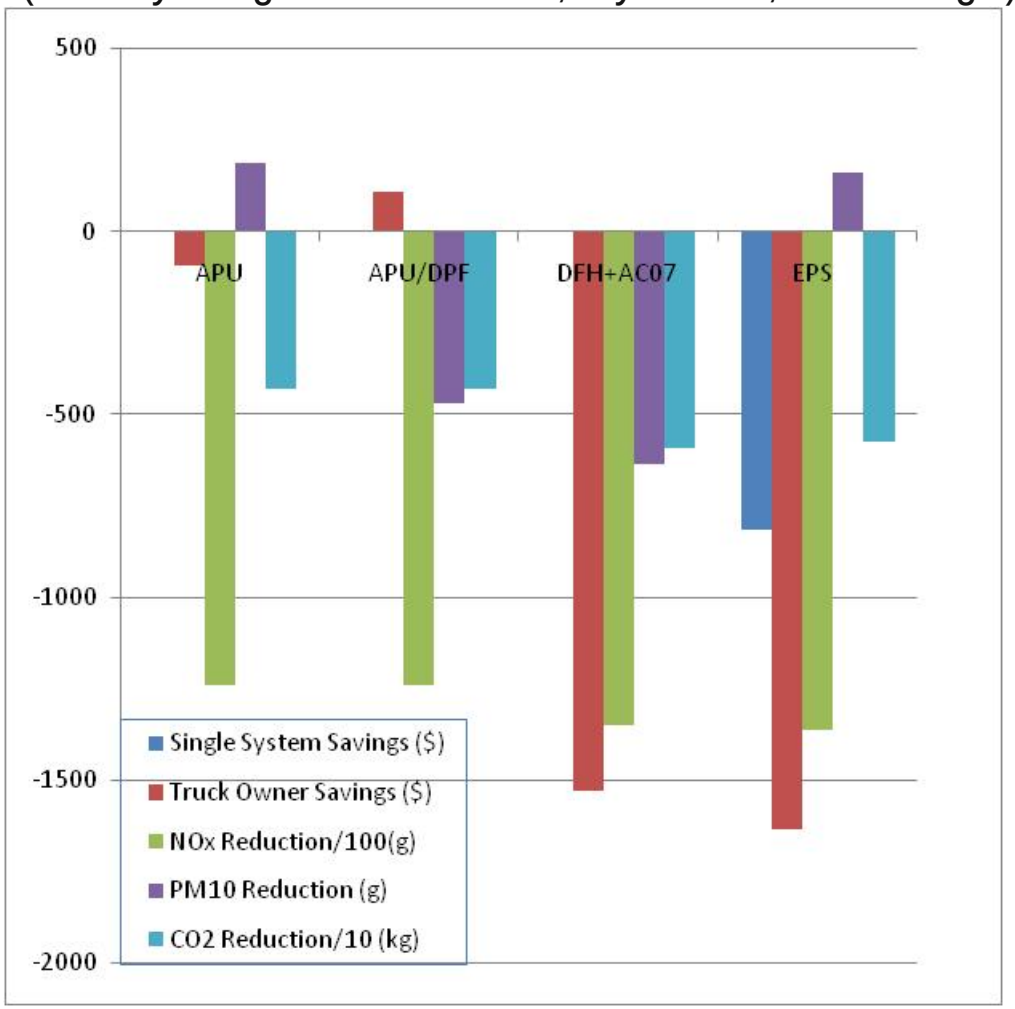


Relative benefits depend on fuel and capital costs, idling hours, and location

- All idling reduction options provide benefits
  - Cost savings
  - Emission reductions
- For low idling times, capital-intensive systems slowest to pay truck owner back (see graph)
- For high idling times, operating cost is key factor
- Emissions occur at truck and upstream
  - Differ for heating and cooling
  - Differ by state
    - *Heating/cooling mix*
    - *Power generation mix*
    - *Urban vs. rural locations*
- Heater plus energy storage air conditioner beneficial under all conditions

Annual savings and emission reductions

(1000 h/y idling 2007 truck in CA, 5 year loan, fuel $4.50/gal)

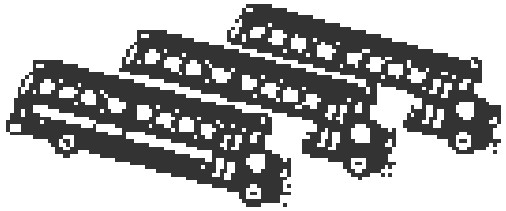


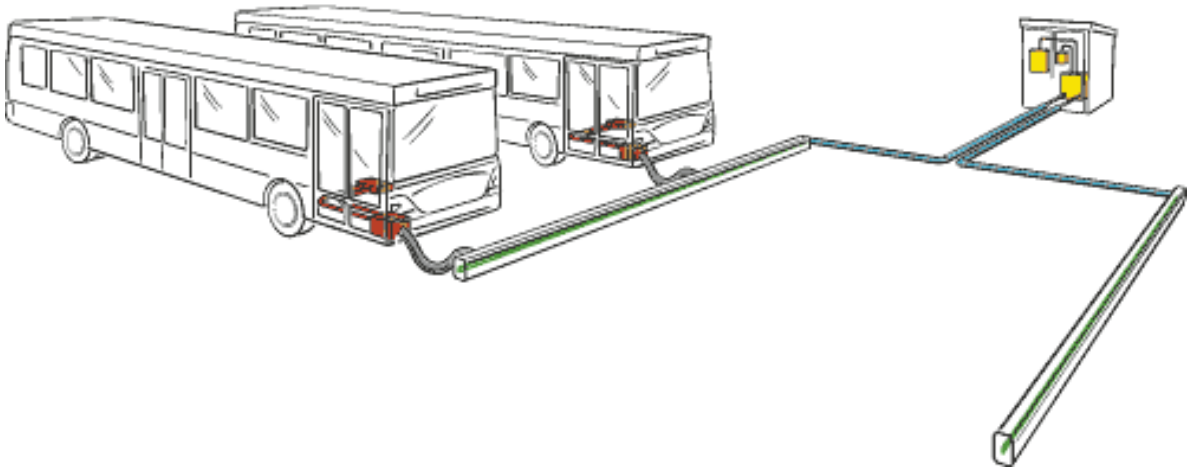
Other Heavy Vehicles

Bus idling and its impacts can be reduced

- Hot issue even though energy use and emissions small
  - School buses impact children
  - Tour buses visible at monuments

- Use idle-reduction devices
- Use no-tech solutions
  - Engine can be turned off
  - Revised parking arrangements reduce exposure
  - Alternative fuels reduce emissions





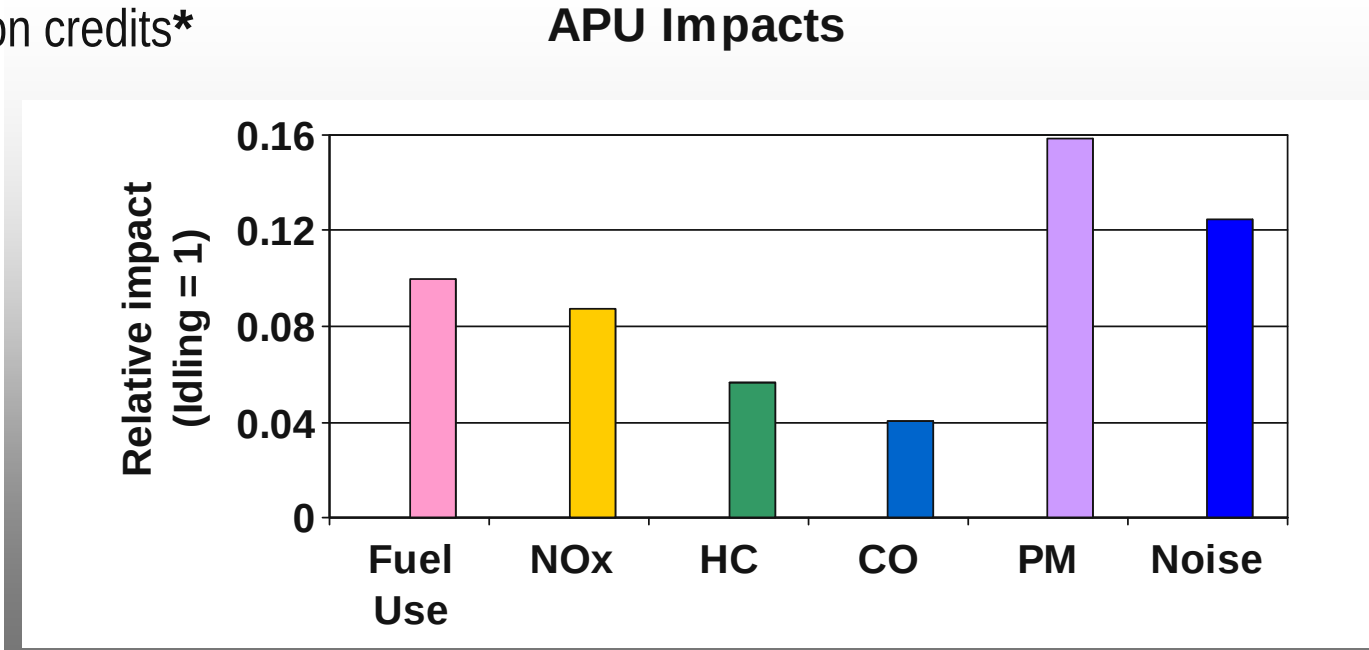
Marine vessels run engines in port

- Ocean-going ships in port
  - Have large power requirements
  - Use on-board generators
  - Low-sulfur fuel oil reduces emissions
  - Can plug into shore power ("cold ironing")
- Inland marine
  - Ferries use full power to hold to dock
    - *Strong-arm docker R&D in progress*

Four copper cables supply power from substation

Locomotive installation proceeding rapidly

- Fuel savings make payback rapid
  - Switchers idle 60% of time, line haul almost 40%
- Only 7 companies own 20,000 locomotives
- Limited number of equipment manufacturers
- Retrofit of locomotives common practice
- Idling reduction facilitates NO_x compliance
  - Can sell emission credits*



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*See: Trading Locomotive Emissions: A Potential Success Story (AWMA 2002)

Institutional Factors

ATRI keeps current list of regulations

- Last updated June 2009
  - Must be updated frequently because of continued legislative activity
- Includes 4-page cab card for truckers to carry
- Lists over 40 different sets of rules for states, counties, or cities
- Shows location, maximum idling time, exemptions, penalties
  - Maximum is 0-15 minutes
  - Buses may be included
  - Sleepers may be exempt!
  - Doesn't note if regulations are actually enforced
- Includes link to legislation for reference

ATRI American Transportation Research Institute

“News” provides current status

- Published monthly (more or less)
- Lists funding opportunities
- Provides status of 400 lb weight exemption
- Alerts readers to changes in regulations and enforcement
- Describes new programs and recognitions of excellence
- Lists upcoming meetings
- Provides links to information posted online
- Includes information about truck stops and rest areas
- Provides links to idling cost calculators

SOLICITATIONS FOR FUNDING AND AWARDS

[Red text indicates a new entry compared to last month.]

Organization	Project	Funding	Deadline	Website
Allegheny County (Pennsylvania) Health Department	Allegheny County Diesel School Bus Retrofit Program	$500,000	Rolling deadline until funds are awarded.	http://www.achd.net/air/air.html and go to "School Bus Retrofit Program" on the right side of the screen
California Air Resources Board (CARB)	On-Road Heavy-Duty Vehicle Loan Program	~$48 million for loan guarantees	Rolling deadline until funds are awarded.	http://www.arb.ca.gov/ba/loan/on-road/documents/hdvloanprogram.pdf
Climate Trust	Greenhouse Gas Offset Projects	$8 million	Rolling deadline until funds are awarded.	http://www.climatetrust.org/apply.html
Efficiency Maine	Small Business Low Interest Loan Program	Indeterminate	Rolling deadline until funds are awarded.	http://www.efficiencymaine.com/business_programs_sblilp.htm
Florida Department of Environmental Protection	**Clean Diesel Rebate Program**	**$300,000**	**Rolling deadline until funds are awarded.**	http://www.dep.state.fl.us/air/msc/mobile_sources.htm
North Central Texas Council of Governments (NCTCOG)	Heavy-Duty Vehicle and Equipment Grant Program	$10.7 million	Rolling deadline until funds are awarded.	http://www.nctcog.org/trans/air/programs/terp/hdvegp/
Pittsburgh Public Schools, the Heinz Endowments, Clean Water Action, Group Against Smog and Pollution, and the Clean Air Task Force	Pittsburgh Healthy School Bus Fund	$500,000	Rolling deadline until funds are awarded.	http://www.dieselretrofitrebate.org
Border Environment Cooperation Commission and U.S. Environmental Protection Agency (EPA)	**Region 9 Border 2012 Program**	**$900,000**	**June 30, 2009**	http://www.epa.gov/Border2012
Kansas Department of Health and Environment	**Kansas Diesel Grant Program**	**$1.73 million**	**June 30, 2009**	http://www.kdheks.gov/bar/air-monitor/stimgrant.html
Nebraska Department of Environmental Quality	**State Clean Diesel Grant Program**	**$1.73 million**	**June 30, 2009**	http://www.recovery.nebraska.gov/infrastructure/enviroment/clean_diesel.html
New York State Energy Research and Development Authority (NYSERDA)	Clean Energy Business Growth & Development Program Opportunity Notice 1260	$6.4 million	Rounds close on August 5, 2009, and January 6, June 2, and November 3, 2010	http://www.nyserda.org/funding/1260pon.pdf
South Carolina Department of Health and Environmental Control	**Diesel Emissions Reduction Act Grant Program**	**$600,000**	**July 13, 2009**	http://www.scdhec.gov/DERA
Wisconsin Department of Natural Resources	**ARRA Wisconsin Clean Diesel Grant Program**	**$1.73 million**	**August 3, 2009**	http://dnr.wi.gov/air/mobile/CleanDieselGP.htm
U.S. Department of Energy (DOE)	Energy Efficiency and Conservation Block Grants – Recovery	$3 billion	**August 10, 2009 (deadline extended)**	http://www.grants.gov/search/search.do?mode=VIEW&flag2006=false&oppId=46340 or https://www.fedconnect.net/FedConnect/PublicPages/PublicSearch/Public_Opportunities.aspx
U.S. Department of Transportation (DOT)	**TIGER (Transportation Investment Generating Economic Recovery) Discretionary Grants**	**$1.5 billion**	**September 15, 2009**	http://www.dot.gov/recovery/ost/
Ontario (Canada) Ministry of Transportation	Green Commercial Vehicle Program	Can$2.9 million	March 31, 2012	http://www.forms.ssb.gov.on.ca/mbs/ssb/forms/ssbforms.nsf/AttachDocsPublish/023-05002E~3/$File/05001-2E_ProgramGuide.pdf

"News" updates status of weight exemption

- The Energy Policy Act of 2005 allowed for, **but does not mandate,** a national 400-pound exemption for the additional weight of IR technology on heavy-duty vehicles.

- Each State can adopt this exemption, at its own discretion, without being subject to any penalty related to withholding of highway trust fund monies.

State Enforcement of 400-Pound Auxiliary Power Unit Exemption to GVW Limit: 23 CRF 658.17(n)

Alabama	District of Columbia	Kansas	Mississippi	New York	South Carolina	West Virginia
Alaska	Florida	Kentucky	Missouri	North Carolina	South Dakota	Wisconsin
Arizona	Georgia	Louisiana	Montana	North Dakota	Tennessee	Wyoming
Arkansas	Hawaii	Maine*	Nebraska	Ohio	Texas	
California	Idaho	Maryland	Nevada	Oklahoma	Utah	
Colorado	Illinois	Massachusetts	New Hampshire	Oregon	Vermont	
Connecticut	Indiana	Michigan	New Jersey	Pennsylvania	Virginia**	
Delaware	Iowa	Minnesota	New Mexico	Rhode Island	Washington	

States in **black** allow the 400-lb weight exemption; states in gray do not permit the exemption.
* Effective September 17, 2009. ** Effective July 1, 2009

For more information see these websites

- National Idling Reduction Network News (monthly):

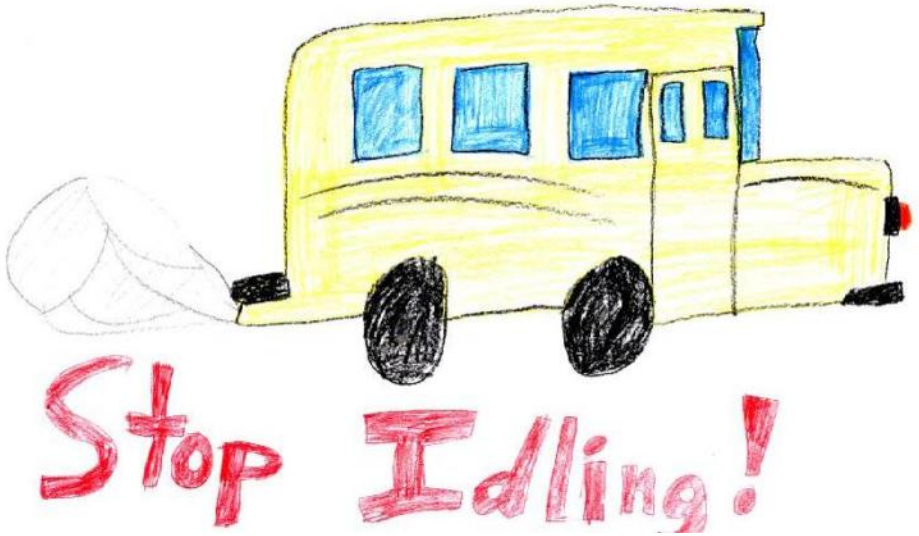
http://www1.eere.energy.gov/vehiclesandfuels/resources/fcvt_national_idling.html

- ANL idling publications: http://www.transportation.anl.gov/engines/idling.html
- EPA Smartway Program: www.epa.gov/smartway/
- DOT CMAQ Program: www.fhwa.dot.gov/environment/cmaqpgs/
- Transportation Infrastructure Finance: tifia.fhwa.dot.gov
- CARB activities: www.arb.ca.gov/msprog/truck-idling/truck-idling.htm
- ATRI Compendium of Regulations:

http://www.atri-online.org/research/idling/atri_IdlingCompendium6_22_09.pdf

- AFDC Incentives and Laws database: http://www.afdc.energy.gov/afdc/incentives_laws.html

Thank you!

- DOE Office of Vehicle Technologies

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