Heavy Vehicle Idling:

How to Reduce its Impacts

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Argonne National Laboratory

A U.S. Department of Energy Laboratory
Operated by The University of Chicago

What kinds of vehicles idle?

- **Long-haul trucks (1000-5000 h/y)**
- **Locomotives (3000-6000 h/y)**

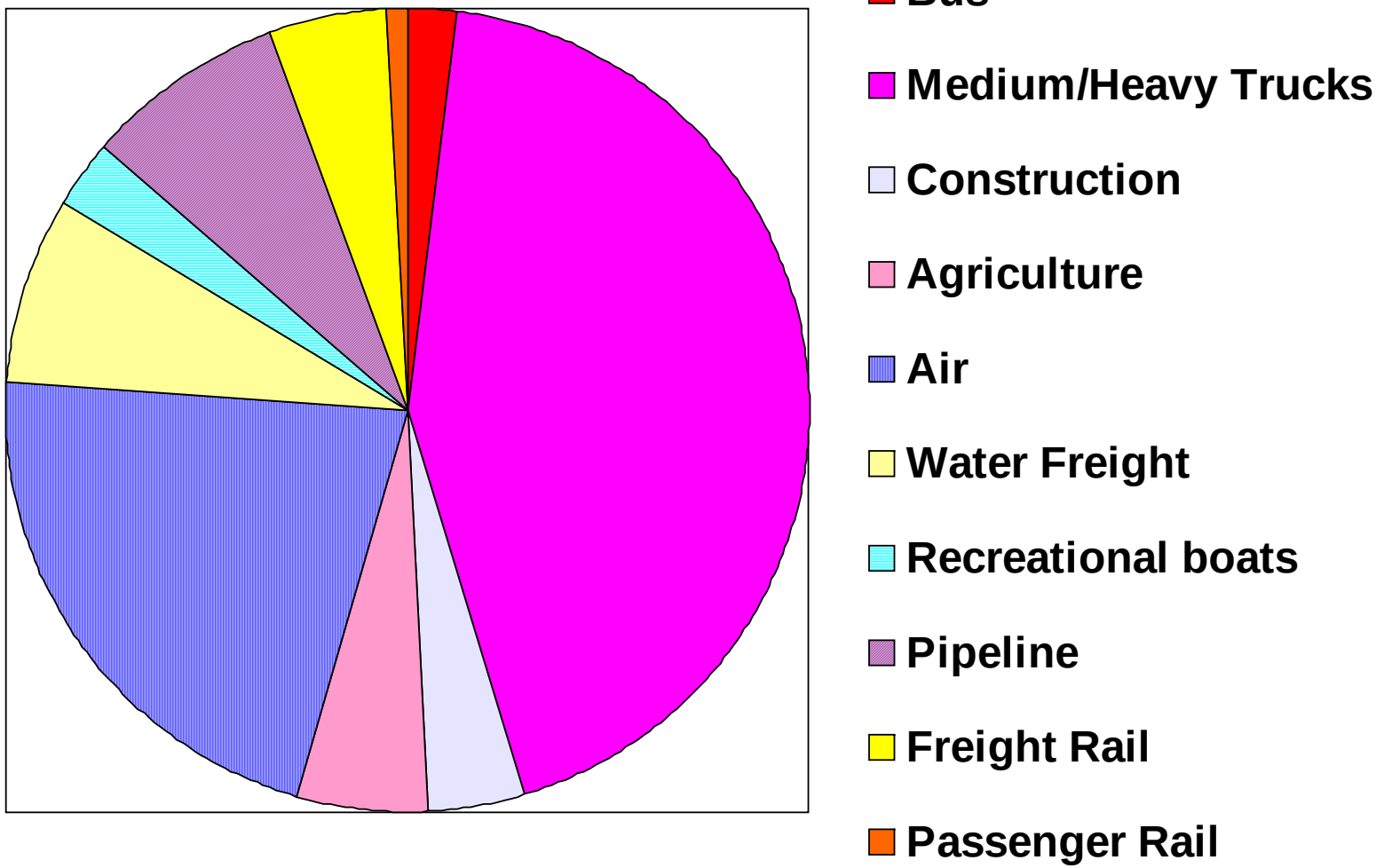
- **Buses**

- **Off-road equipment**

- **Marine vessels**

How much energy do these vehicles use?

Total = 11.4 Q/y*



*1 Q= 7.4 billion gallons; 11.4 Q/y = 500,000 barrels/d
Total US crude imports ~9 million barrels/d

Locomotives idle for several reasons

- **To keep engine warm to ensure it starts**
  - antifreeze generally not used
- **For hotel load while waiting**
  - on sidings and at terminals
- **To keep battery charged**
- **To heat toilet water**
  - frozen toilets cause service loss
- **To avoid Terminal Brake Test**
- **Perceived futility of shutdown**
- **Ingrained operating habits**

What are the impacts of locomotive idling?

- **Petroleum use**
  - Fuel
    - Union Pacific spends $300,000/day to fuel idling locomotives
    - **Over 230 million gal/y (6.3% rail freight energy) is wasted**
  - Lubricating oil
    - Up to 0.1 gallons per gallon of fuel*
- **Emissions**
  - New EPA regulations set emission limits
- **Noise**
- **Engine wear**
  - Reduces interval between rebuilds
- **Added maintenance costs**
  - Union Pacific estimates $1 per idling hour

Typical 4400 hp locomotive diesel engine
… weighs 46,000 pounds

***** CSX estimate

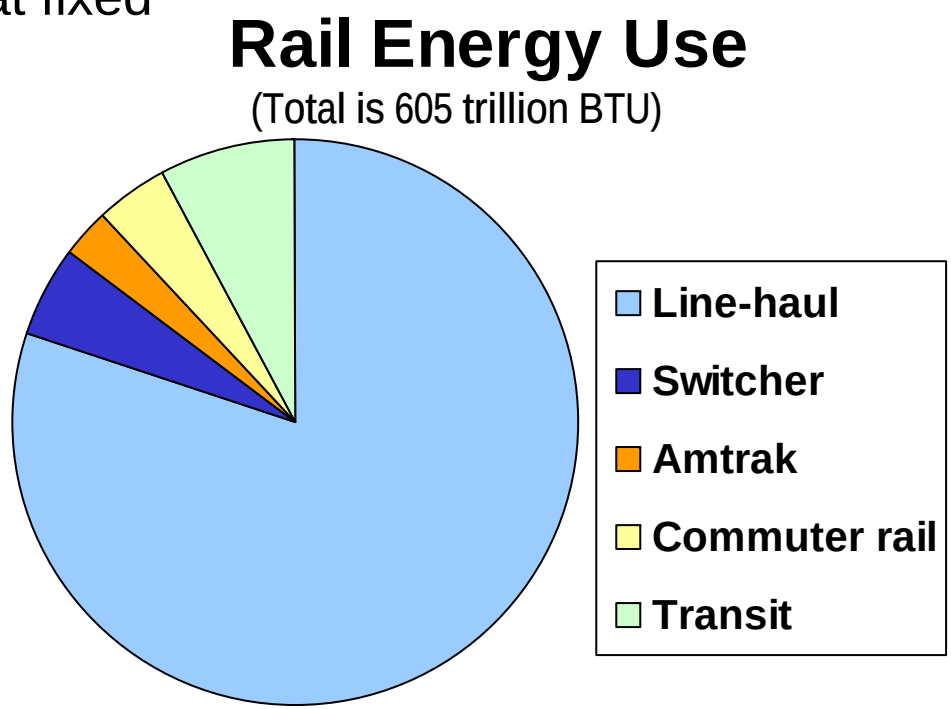
Emissions are a serious problem

“The time of maximum carbon accumulation is when they (locomotives) are idling or operating at minimum power output. The time of maximum carbon ejection is when power is applied after a period of idling.”

Source: Railroad Fire Prevention Guide

Different considerations apply for different types of trains

- **Passenger rail**
  - Idle commuter trains cluster at fixed locations
  - Schedules are rigid
  - Loads relatively light
- **Freight rail**
  - Road units (line-haul)
    - Heavy loads
    - May idle in remote locations (up to 55%)
    - Dominate rail energy use
  - Yard units (switchers)
    - Locations fixed
    - **Long idle times (up to 75%)**
    - **Source of noise and pollution in populated areas**



Several technologies can reduce idling

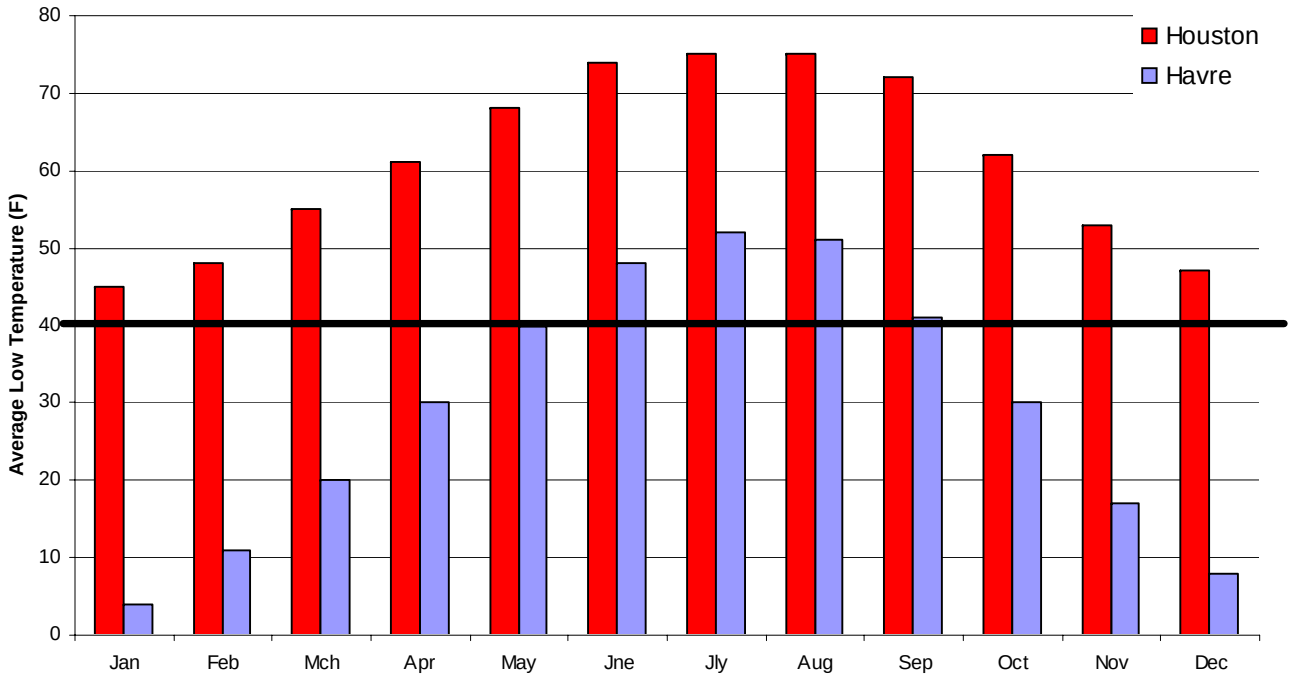
- **Automatic engine stop-start controls (AESS)**
- **Auxiliary power unit (APU)**
- **Diesel-driven heating system (DDHS)**
- **Shore power plug-in unit**

Can be retrofitted

- **Hybrid switching locomotive**
- **All devices can be used on locomotives from any manufacturer**
- **All reduce fuel use, emissions, and noise**
- **Each has advantages and drawbacks and provides different services**

Start/stop systems avoid impacts when engine is off

- **Engine is shut down after set idle time**
  - Idling reduced up to 50% for road unit, 70% for switcher
- **Sensors monitor water T, brake P, battery charge**
  - Engine restarts if any parameter out-of-range
- **Engine stays on below 40°F**
- **Installed on new locomotives and as retrofits**



Pioneering Science and Technology

Center for Transportation Research

APU supplies heat, power, and cab comfort

- **Shuts off and restarts engine**
  - No operator required
- **Heats water and oil**
- **Enables 60 Hz power**
  - Cost-effective, reliable appliances
    - optional air conditioning
    - lighting and communication
- **Heats cab and toilet**
- **Maintains brake air pressure**
- **Keeps batteries charged**
- **Enables engine shut-down in winter**
  - Down to –30ºF in Alaska
- **Installs behind engine or on walkway**
- **CSX has 1400 installed**

DDHS heats water and oil with waste heat

- **Variable engine speed generates optimum waste heat**
  - No 60 Hz power
- **Charges batteries and powers cab heaters**
- **Year-round system**
  - Locomotive starts easily in Alaska
- **Start/stop system optional**
  - Maintains brake pressure
  - Fuel savings reports
  - Remote monitoring
  - Failsafe redundancies

- **Installed on 11 different railroads, 14 different locomotive models**

Plug-in units are inexpensive

- **Heat and circulate water and oil, optional battery charger**
- **Minimal equipment required**
- **Ideal for commuter trains**
- **Can also be used for yard units**

- **Over 2,000 installed on commuter, short line, regional, and Class 1 locomotives**
- **Locomotive must be at equipped location**
  - Probably not appropriate for line-haul locomotives
- **No local impacts**
  - Yard is quiet and pollution-free
  - Impacts from electricity generation are relatively small

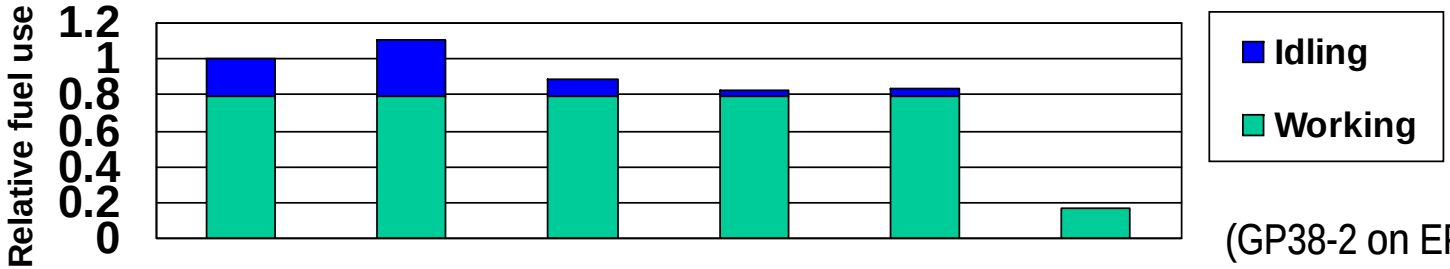
The Green Goat is a battery-diesel hybrid switcher

- **Replaces 2000 hp switcher**
- **Uses 125 hp diesel and 60,000 lb of sealed Pb-acid batteries**
- **Small diesel charges batteries**
  - Runs when switcher in use
  - And a bit more
- **Batteries expected to last 10–15 years**
  - Kept at 80% SOC
  - Lifetime unproven
- **Hybrids are in demonstration stage**

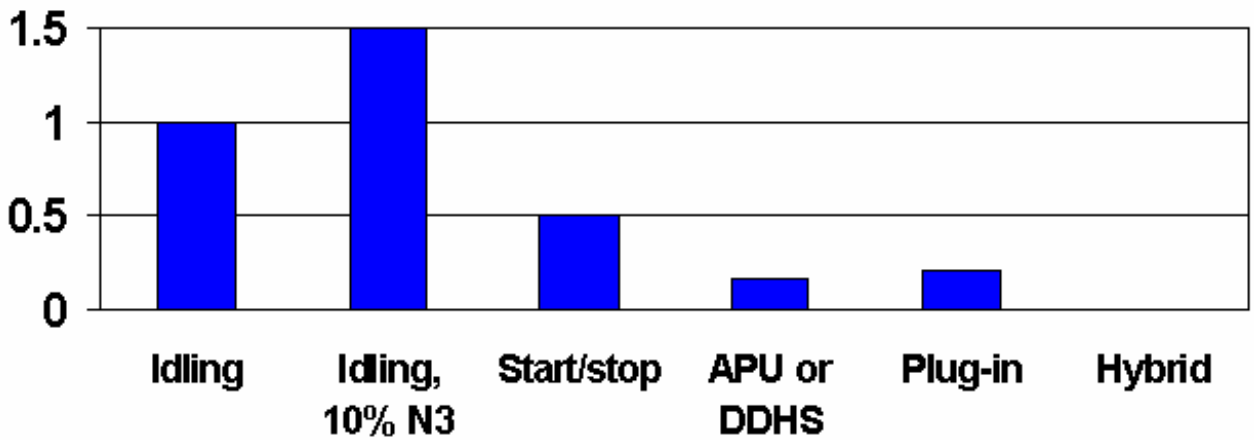
Hybrid switcher has pros and cons

- **Small engine is quieter and cleaner than large diesel**
- **Small diesel at full load more efficient than large one at low load**
- **Goat or smaller Kid (1000 hp) can be remote-controlled**
- **Does not need to idle**
- **Designed for yard switching but could haul short distances**
  - Top speed 40 mph
  - Not suitable for long-haul use
- **Costs much more than add-on device**
  - Costs $200 K on old locomotive bed
  - Rebuild costs $100 K– $350 K
  - Competitive with rebuild
  - Cheaper than new unit at $1.5 million

Alternatives reduce energy use & emissions



(GP38-2 on EPA switcher cycle)



All of the options have good payback times

System	Energy saving (gal/d)	Annual savings ($1000s)	Cost ($1000s)	Payback (months)
Start/stop	36	15	7.5–15	6–12
APU or DDHS	60	25	25–35	12–17
Plug-in	50	19	4–12	3–11
Green Goat	291	122	200	20
Basis: GP38-2 with EPA switcher cycle for all technologies, 330 d/y, 50% idle replacement by AESS; (will be less in cold climate), 90% by APU, DDHS, or plug-in unit, .05 gal oil used/gal fuel, $0.10/kWh				

Caveats:

Costs depend on vendor and options included.

Energy savings depend on climate, duty cycle, locomotive type.

Technology comparison summary

System	Reduction in energy use and emissions	Working noise	Non-working noise	Advantages/ Disadvantages
Idling	None	Noisy	Noisy	---
Start/stop	Minimum	Noisy	Alternates noisy/silent	No cab comfort, minimal benefit in winter
APU or DDHS	Good	Noisy	Quiet	Anywhere, any time; APU supplies all services
Plug-in	Good	Noisy	Silent	Requires equipped location
Hybrid	Maximum	Quiet	Silent	Switcher only

Locomotive installation proceeding rapidly

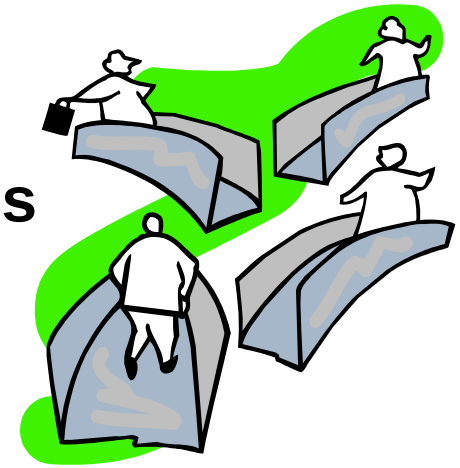
- **Only 4 companies own 20,000 locomotives**
- **One of these manufactures its own APUs**
- **Limited number of equipment manufacturers**
- **Retrofit of locomotives common practice**
- **All available devices have short payback times**
- **Idling reduction facilitates NO_x compliance**
- **Emission credits can be sold**
  - See "Trading Locomotive Emissions: A Potential Success Story," AWMA 2002

What's the story for trucks?

- **Trucks idle for cab comfort, to mask out noises and smells, to keep fuel and engine warm, because other drivers do it, and for safety**
- **Idling impacts include wasted money, excess oil use, pollution, and noise**
  - ~500,000 trucks idle overnight
  - 838 million gallons/y diesel (0.11 Q) wasted
  - 5% of heavy truck fuel
- **Devices available to reduce idling include APUs, heaters, and plug-in units**
- **Many states and localities restrict idling**
- **For more details, go to** http://www.transportation.anl.gov/idling.html

There are recent developments

- **Technology options have changed**
  - Air conditioners are on the market
  - Wayside services are installed in limited areas
- **Agencies have been busy with programs**
  - DOE, EPA, NY, CA, IA
- **Legislation has been written**
  - Energy bills, state/local laws
- **Hours of service rules have changed**
  - NY reported in 2002 “25% fell asleep while driving last year.”
  - Longer rest time increases need for idle-reduction devices
- **Guidelines for SIP credits have been drafted**
- **Trade organizations have been formed**



BUT most trucks still idle overnight!

Why are trucks still idling?

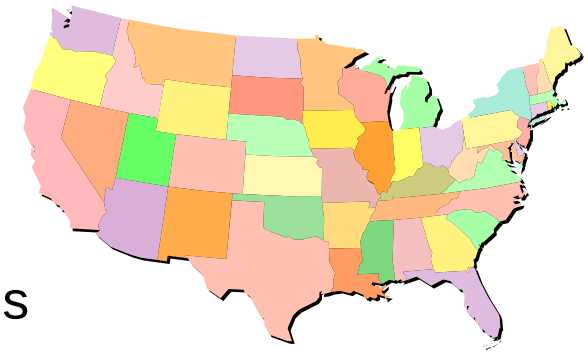
- **Regulatory picture is unsettled**
  - **Will the device I buy be allowed in the future?**
- **Technology choices may be confusing**
  - **Different services are provided**
    - Which is right for me?
    - Will service be available when/where I need it?
- **Capital is scarce**
  - **Some devices are expensive, so payback may be slow**
  - **Funding needed for engineering and production-line**
- **Owner/operators are independent**
- **There is no incentive for truck-stop owners to electrify**

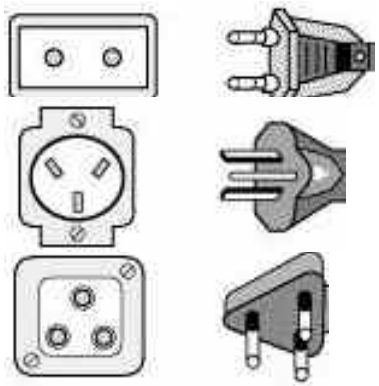
What can we do to speed the process for trucks?

- **Encourage a level playing field**
- **Create financial incentives**
- **Develop and demonstrate more attractive technology**
- **Continue education**
- **Facilitate coordination among stakeholders**

How can we level the field?

- **Advocate consistent conditions nationwide**
  - Facilitate communication among regulators
  - Support national guidelines
  - Analyze the impacts of proposed regulations
    - Avoid regulations that categorically forbid engine use, including APU
  - Pay attention to enforcement, too
- **Standardization would reduce investment risk**
  - Industry can develop codes and standards
  - Government can endorse
  - Capabilities could be specified
  - Uncertainty about product design removed
  - Equipment would be compatible





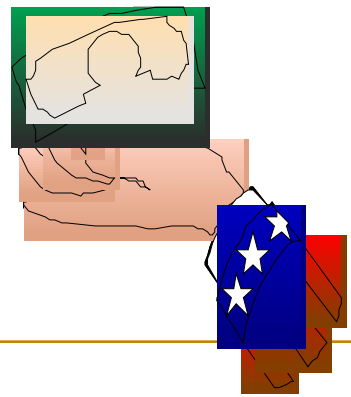
Plugs are just one example of items to be standardized.

Real help is needed

We received this note:

"As an owner of 1 truck, I am interested in reducing my idling. I would like to install an auxiliary power unit, but cannot find the funds to do this. Does the government have a program that could help an owner-operator get the money to buy one, like a grant or small business equipment loan?

I know there are a lot of people who would take advantage of anything that would help in defraying the cost, not only as a way to save money, but it would also help the environment."



What financial incentives could be created?

- **Excise tax exemption for idle-reduction equipment**
- **Weight waiver**
  - **250 pounds in latest Energy Bill**
- **Tax credit for equipment**
- **Fuel tax credit**
  - **Some states now offer tax refund for fuel consumed when idle**
  - **Possible difficulty differentiating idling fuel from APU fuel**
- **Low-interest loans for devices or production set-up**
- **Grants**
  - **California's Carl Moyer Program**
- **Leasing opportunities**
- **Emission credit trading**
  - **EPA draft guidelines allow credits in SIPs**
- **Regulations deter idling**
  - **Proposed CA restrictions**
  - **State/local idling ordinances**

Technologies are being demonstrated

- **NYSERDA has IdleAire installations on Thruway**
- **NYSERDA and EPRI demonstrating plug-in units**
- **EPA funding electrification**
- **DOE demonstrating on-board units on several fleets**

Better technologies are being developed

- **New technologies will be**
  - **Cheaper**
  - **Lighter**
  - **Smaller**
  - **Durable**
  - **Available from OEM**
- **DOE funds truck electrification program**
- **DOE funds fuel cell APU**
  - **UC Davis, Freightliner, *et al*.**
- **DOE to fund lightweight APU**
  - **Contract to be awarded soon**
- **DOD needs quiet APU (fuel cell)**
  - **National Automotive Center (TACOM)**
  - **Ballard Power Systems**
  - **University of Alabama**

Payback time depends on operating practices

- **Fuel savings are the main financial benefit**
  - Payback is faster if more idling hours are displaced
    - Large fleet that has reduced idling by 50% has long payback
    - Less efficient operations have shorter payback times
- **Savings also accrue from reduced maintenance costs**
  - Routine maintenance can be performed less often without idling
  - Mileage to overhaul can be increased without idling
    - But many fleets sell before overhaul
    - Might not factor overhaul costs into savings
  - Worksheet based on TMC RP 1108
    - Higher estimates generally based on earlier document
- **Low-idling history increases truck resale value**
  - APU can be left on or moved to new truck
  - APU itself has good resale value

Calculate Your Idling Costs

(Based on Maintenance Council Report RP1108, issued March 1995, and Argonne National Laboratory Reports, June 2000.)

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.

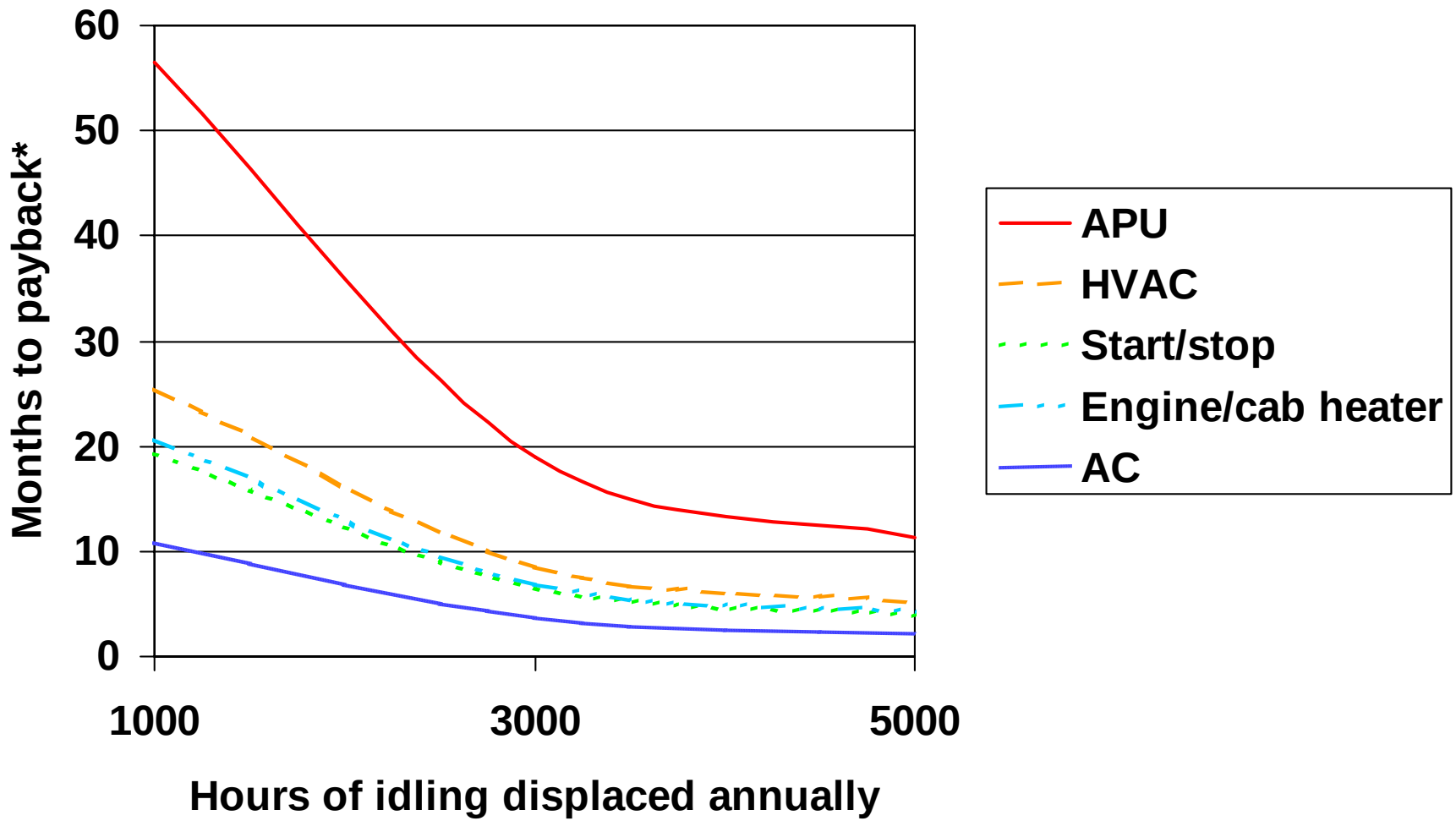
1	How many hours each year could you use auxiliary devices instead of idling?	How much fuel is used for idling? Look up the number in the table below.	What is the price of diesel fuel?			**Fuel Costs**
	1830 hours/year ×	1 gallons/hour ×	$ 1.75 /gallon		=	$ 3203 /year +
2			What is your average fuel economy?	"Miles of idling" (idling is like putting miles on your engine)		
	1830 hours/year ×	1 gallons/hour ×	7 miles/gallon	= 12810 miles/year		
3	How much does an oil change cost?	How many miles between oil changes?				**Preventive Maintenance Costs**
	$ 150 /oil chg. ÷	35000 miles/oil chg. =	$ .0043 /mile	× "Miles of idling" 12810 miles/year	=	$ 55 /year +
4	How much does an engine overhaul cost?	How many miles between overhauls?				**Overhaul Costs**
	$ 10000 /overhaul ÷	500000 miles/overhaul =	$ .02 /mile	× "Miles of idling" 12810 miles/year	=	$ 256 /year =
5	**Total Costs for Idling** (add right-hand column)				=	**Total Costs** $ 3514 /year

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

Locate your engine RPM and parasitic brake horsepower (BHP) at idle. The corresponding number is about how much fuel you use to idle. For example, 1000 RPM at a BHP of 10 consumes about 1.2 gallons of fuel an hour. Typical accessories require between 10 and 20 BHP.

RPM	Brake Horsepower of Accessories				
	0	5	10	20	30
800	0.6	0.7	1.0	1.4	1.7
1000	0.75	1.0	1.2	1.55	2.0
1200	1.0	1.2	1.5	1.8	2.25

On-board devices have good payback times



*No resale value assumed

Buses idle at various locations

- **Hot issue**
- **Energy use relatively small (.2 Q)**
  - Emissions proportionally small
- **Tour buses idle near monuments**
  - Very visible
  - Parking bans just move the buses
- **School buses (.08 Q) idle at schools**
  - Sensitive population
  - Many localities regulating
- **Transit buses (.09 Q) idle at depots**
- **Inter-city buses (.03 Q) idle while waiting for passengers**
- **Many buses idle to warm up in the morning**

Bus idling and its impacts can be reduced

Idle-reduction devices:

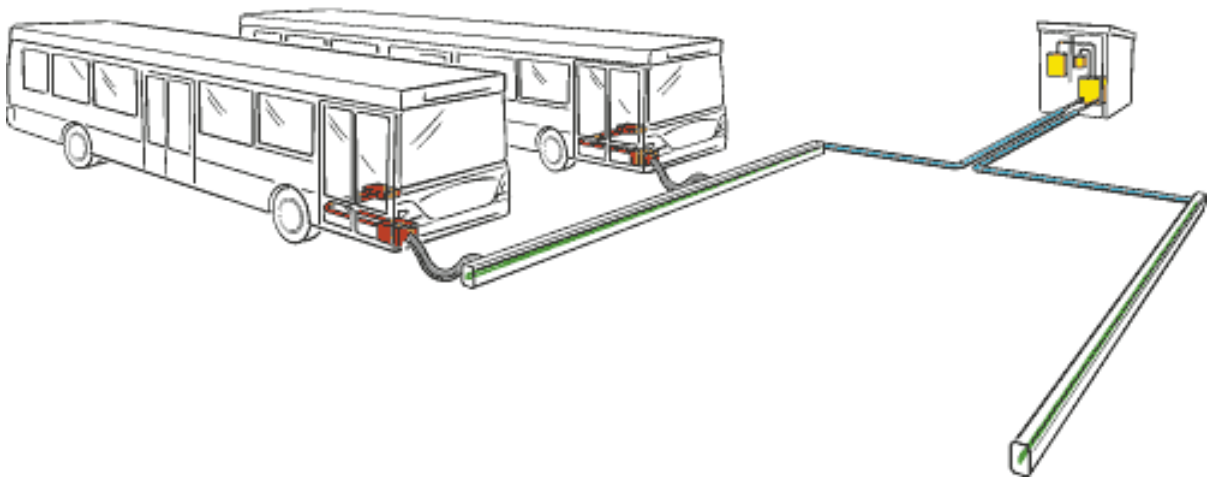
- Small on-board diesel heaters
- Electrical block heaters
- Immersion heaters for coolant
- Fluid circulation at depot

No-tech solutions:

- Engine can sometimes be turned off
- Alternative fuels reduce emissions
- Revised parking arrangements reduce exposure

Buses can be kept warm at depots

- **Commercial system circulates glycol and water**
  - **Heated in central location**
  - **Transport overhead or underground**
  - **Heat transfer via heat exchanger**
- **Electricity and compressed air available as well**
- **Outdoors or in unheated garages**
- **Optional timer**



Marine vessels vary in power needs

- **Ocean-going ships in port**
  - May have large power requirements
    - Passenger ships need hotel power and refrigeration
    - Cargo ships power cranes and pumps, refrigerate containers
  - Have onboard generators of appropriate size
  - Use high-sulfur fuel oil so are emission problem
  - Could use cleaner fuel or plug into shore power
- **Inland marine**
  - Also may need power to load and unload
  - Some ships use locomotive engines
  - Could use locomotive APU to keep warm?
  - Stay tuned!

Education must continue

- **DOE outreach**
  - Publications
    - Reports: ANL updating and expanding 2000 report
    - Brochure
  - Information on web (http://www.transportation.anl.gov/idling.html)
  - Presentations at major meetings
  - Booth at Truck Show
- **EPA**
  - Website (www.epa.gov/otaq)
  - SmartWay program
- **DIRP**
  - Website (www.stopIdling.org)
  - Truck show booth
- **Popular press**
  - Land Line (owner-operators) (http://www.landlinemag.com/)
  - Fleet Owner (http://www.keepmedia.com/PublicationHome.do?pub_id=48&extID=10005)

NATIONAL IDLING REDUCTION PLANNING CONFERENCE

Developing comprehensive, nationwide solutions for heavy-vehicle idling reduction

MAY 17-19, 2004
ALBANY, NEW YORK

- **All groups will be included**
  - Government at all levels
  - All heavy vehicle modes
  - Businesses: users, truck stop operators, vehicle and equipment manufacturers
  - Researchers
- **All relevant topic areas will be covered**
  - Technology and research
  - Legislation and regulation
  - Energy, environmental impacts, and economics
- **Objective is coordinated action**
- **E-mail tlevinson@anl.gov for more information**

Thank you

- **Sid Diamond –** DOE FreedomCAR and Vehicle Technologies Program
- **Mike Iden – Union Pacific**
- **Ted Stewart – CSX**
- **Terry Judge – Kim Hotstart**
- **Stephen Farrell – for RailPower**

- **Disclaimer: no endorsements are implied!**
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