



# ***Locomotive Idling***

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*National Idling Reduction Planning Conference*

*Albany, NY*

*May 17-19, 2004*

***Center for Transportation Research  
Argonne National Laboratory***



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

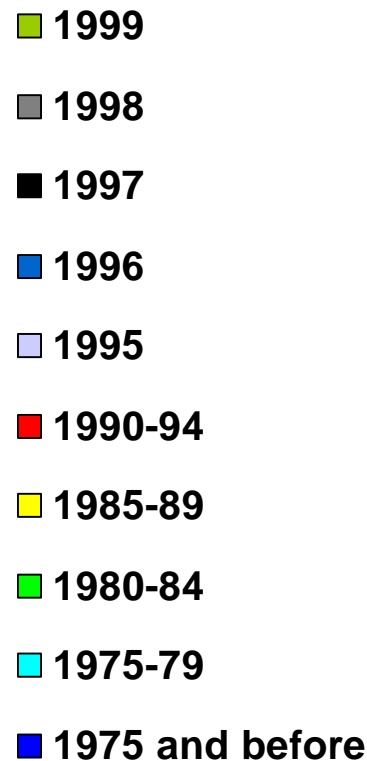
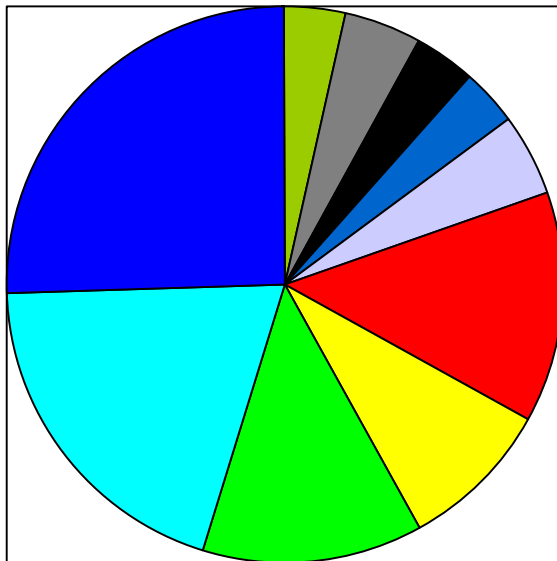


# Rail's fleet turns over slower than truck's

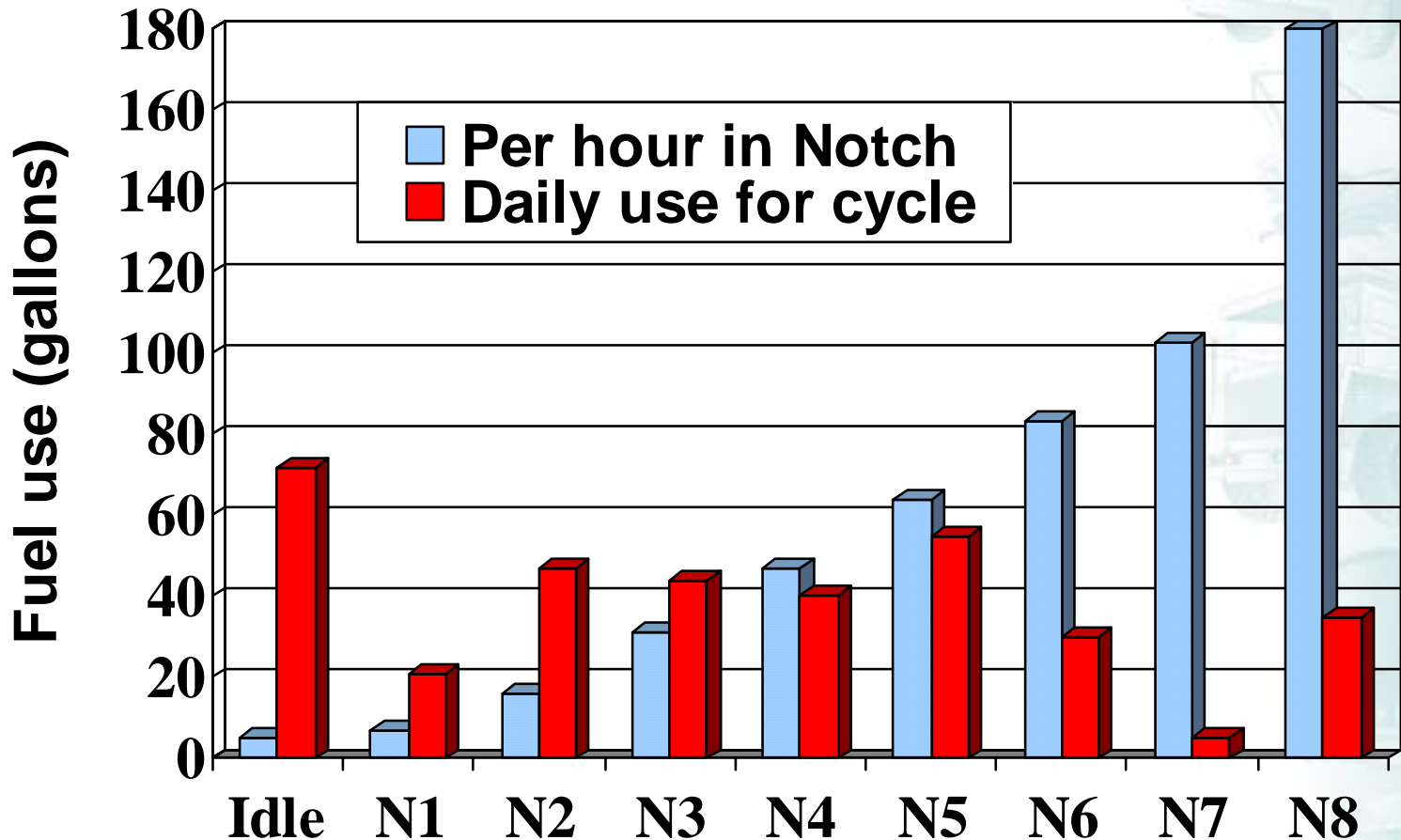
## ■ Class I freight railroads

- Own 20,000 locomotives but only buy 2-5% new each year
- 15,000 greater than 3000 horsepower
- Consume 500 trillion BTU (3.7 billion gallons) of fuel

Locomotive Vintage



# Switcher uses most fuel in idle for EPA cycle (GP38-2 data)



# Several technologies can reduce idling

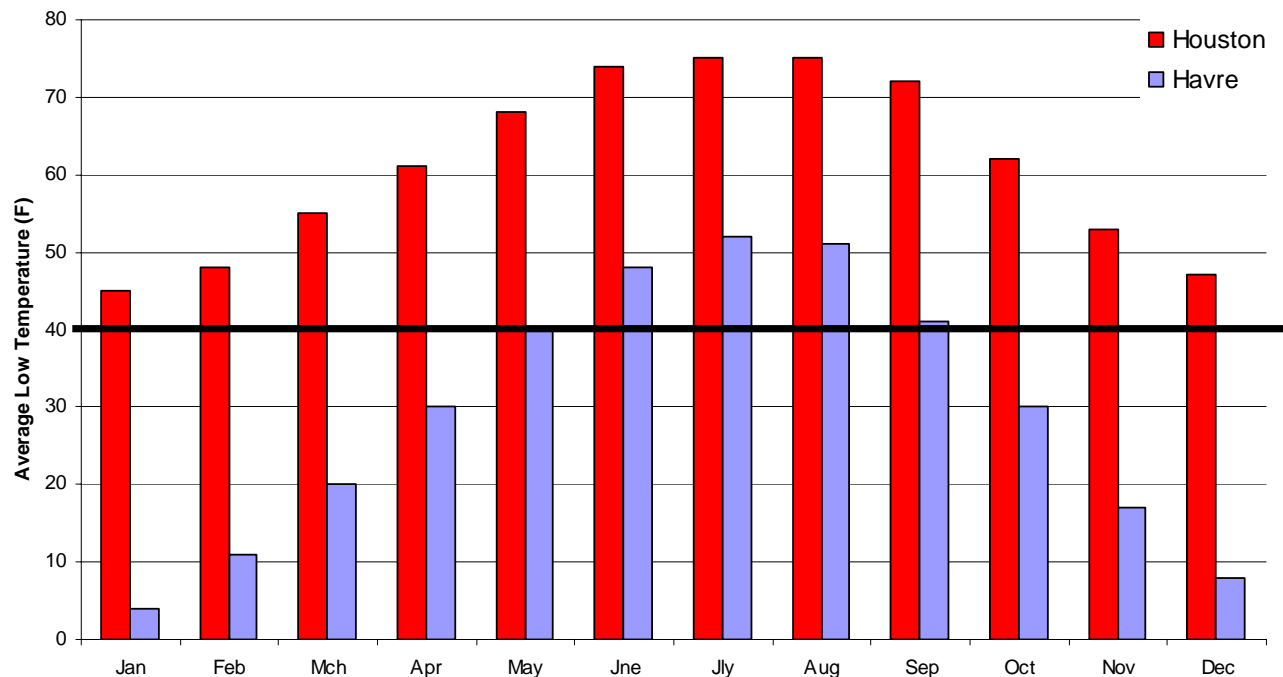
- Automatic engine stop-start controls (AESS)
- Auxiliary power unit (APU)
- Diesel-driven heating system (DDHS)
- Shore power plug-in unit
- Hybrid switching locomotive
- All devices can be used on locomotives from any manufacturer
- All reduce impacts

*Can be retrofitted*



# 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

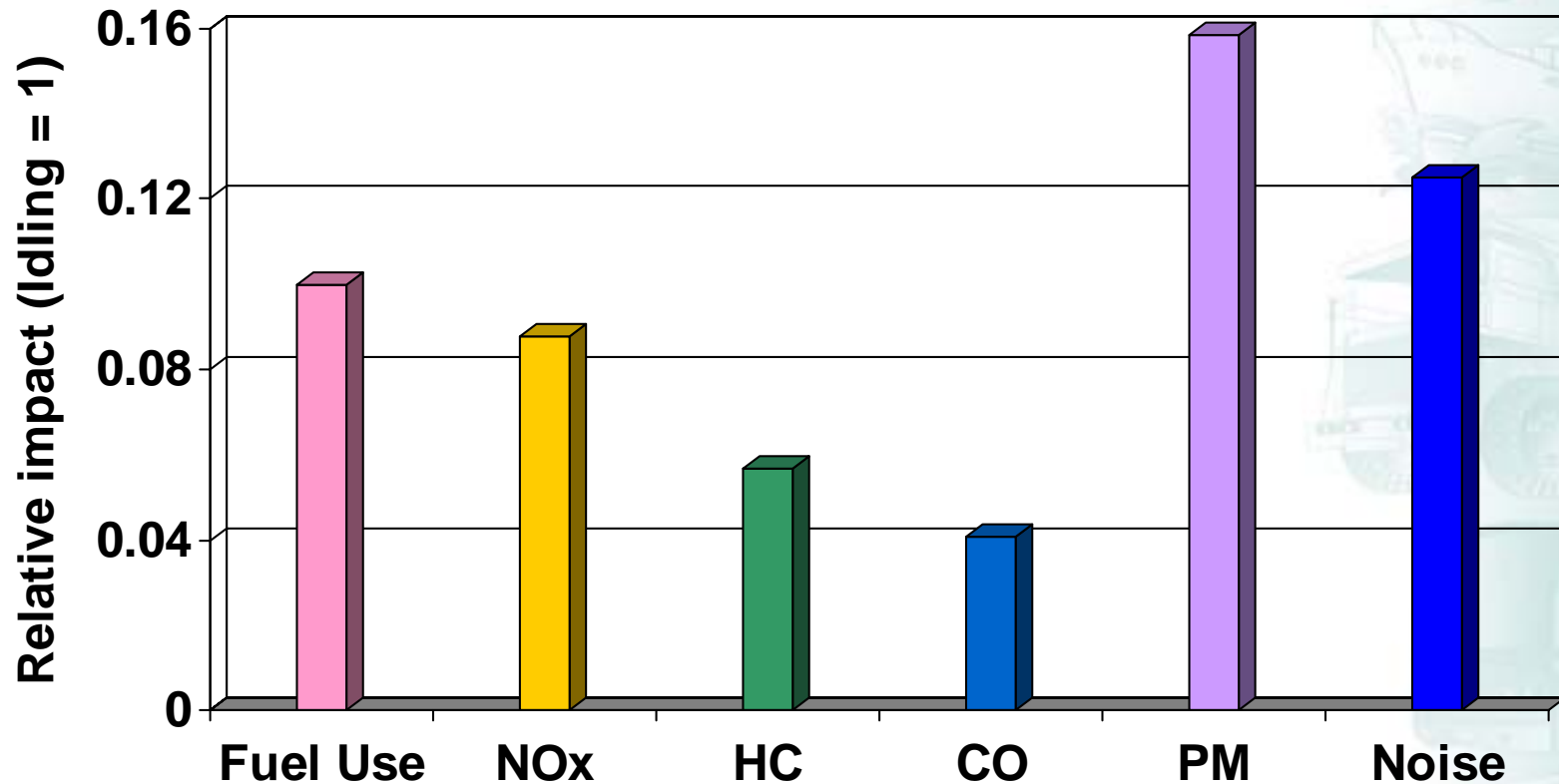


# APU supplies heat, power, and cab comfort

- **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  $-30^{\circ}\text{F}$  in Alaska
- **Installs behind engine or on walkway**
- **CSX has 1400 installed**



# APU has lower impacts than idling



# ***DDHS heats water and oil with waste heat***

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- **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 railroads, 14 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 2000 installed on commuter, short line, regional, and Class I 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 use but could haul short distances
  - Top speed 40 mph
  - Not suitable for long-haul use
- **Costs much more than add-ons**
  - Costs \$750 K on old locomotive bed
  - Cheaper than new unit at >\$1 million

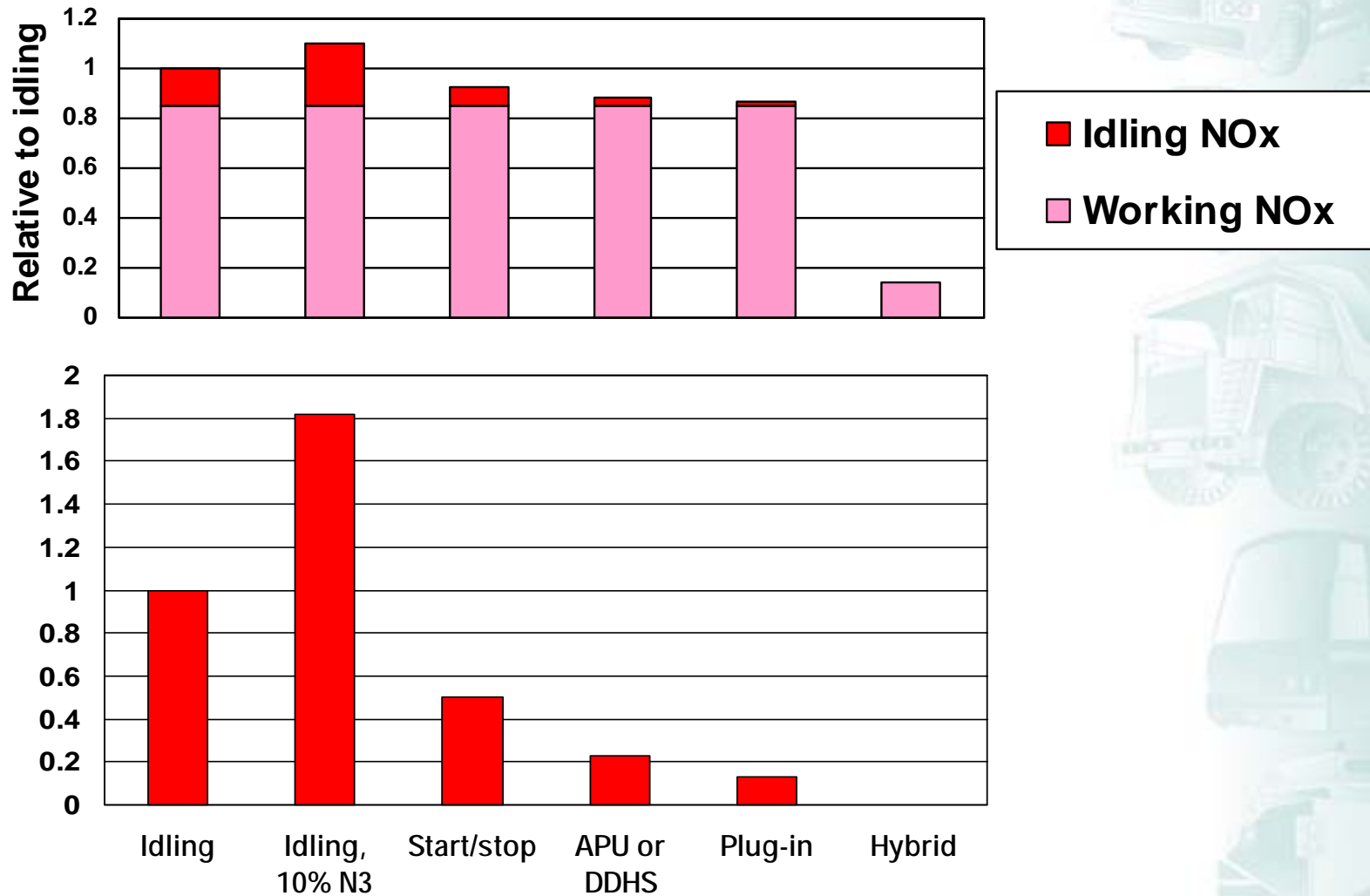


# Technology comparison summary

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



# Alternatives all reduce emissions



# All of the add-ons 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	700	69

*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.**



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