



Locomotive Idling

Linda Gaines

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*

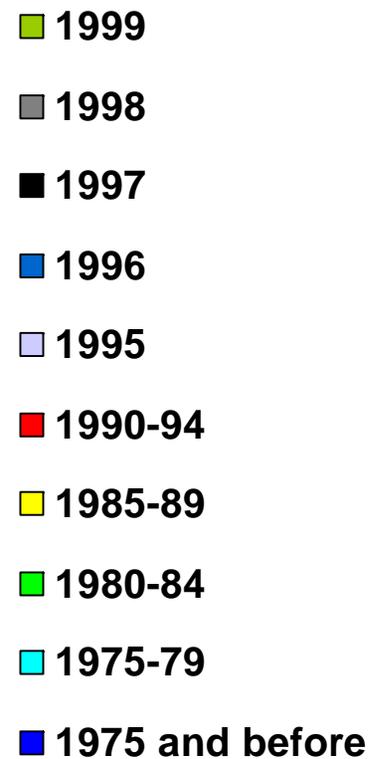
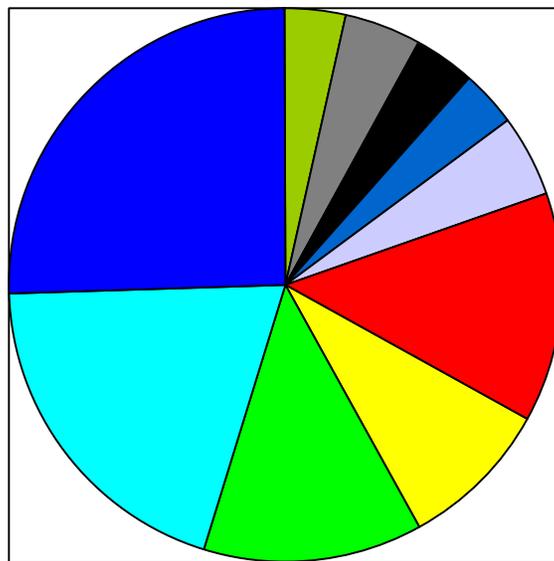


Rail's fleet turns over slower than truck's

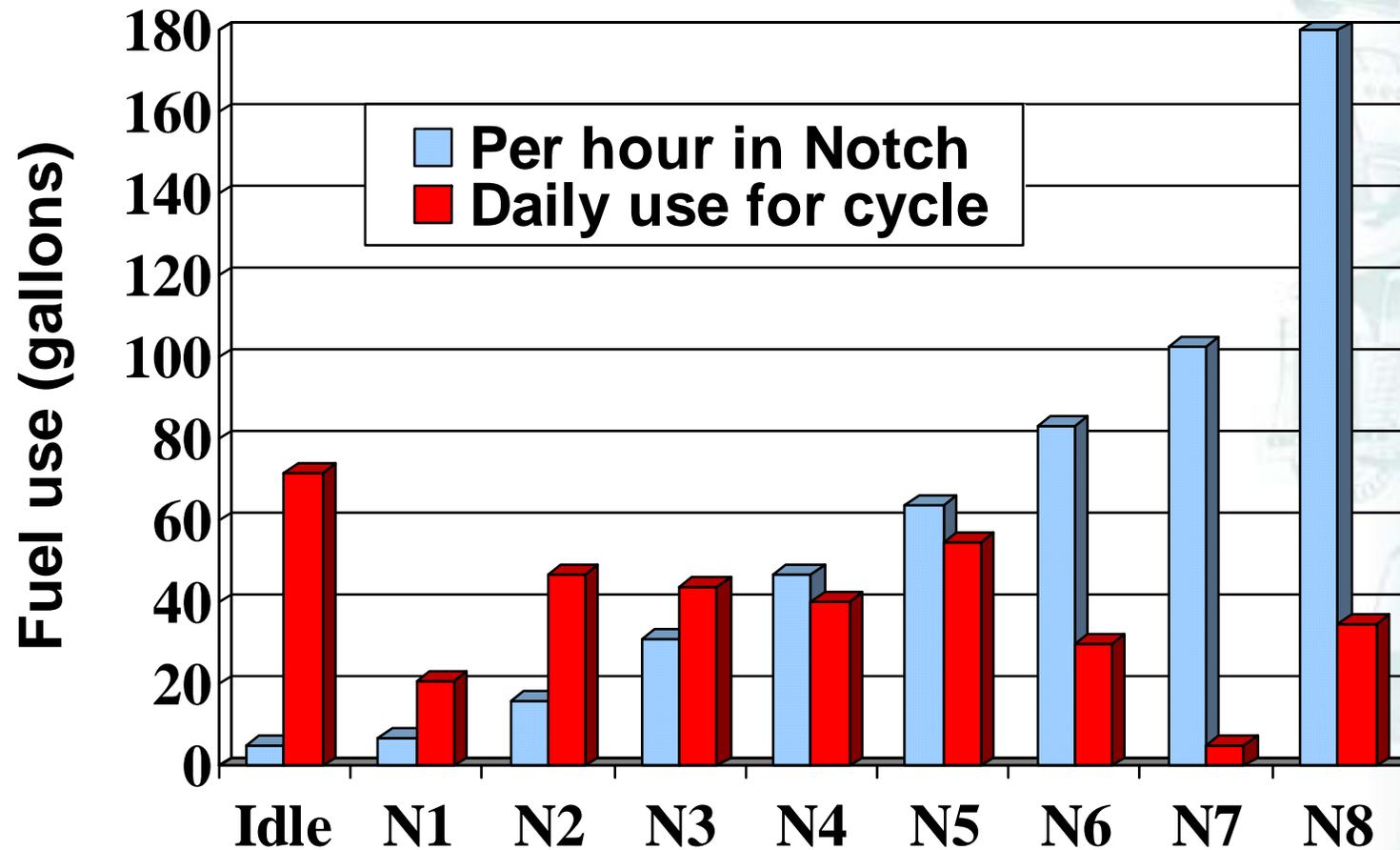
■ Class I freight railroads

- 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

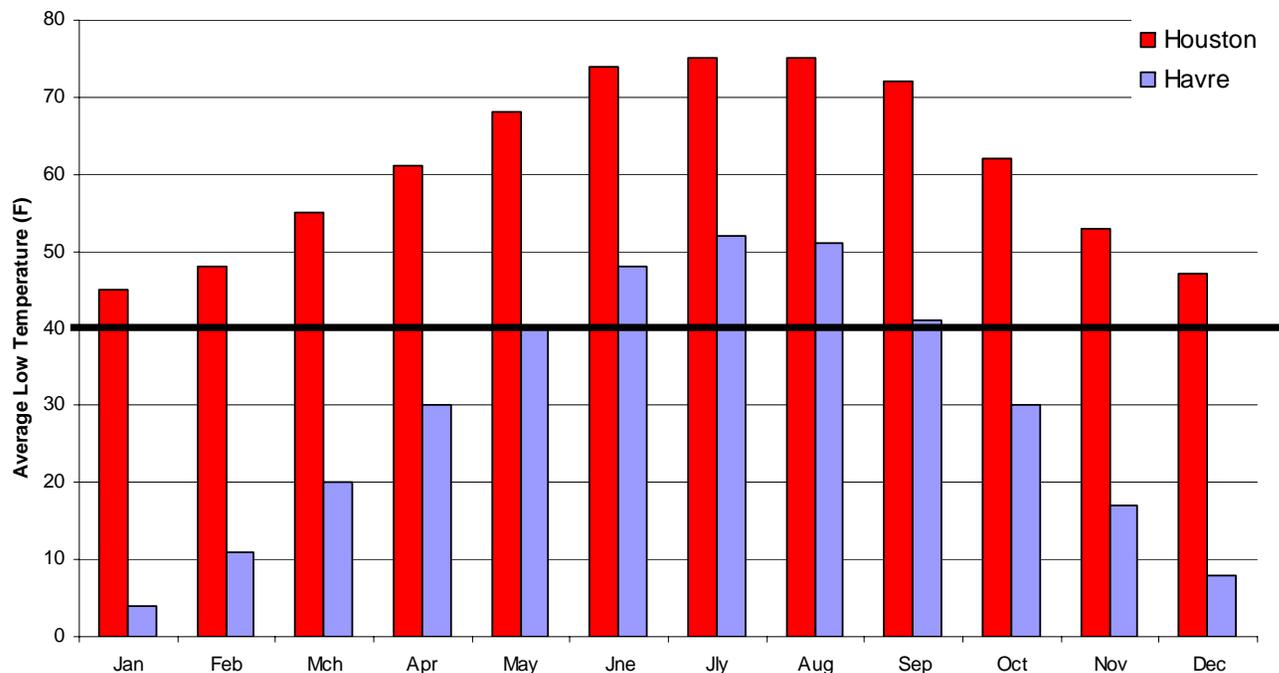
- Automatic engine stop-start controls (AESS)
- Auxiliary power unit (APU)
- Diesel-driven heating system (DDHS)
- Shore power plug-in unit
- Hybrid switching locomotive
- All devices can be used on locomotives from any manufacturer
- All reduce impacts

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

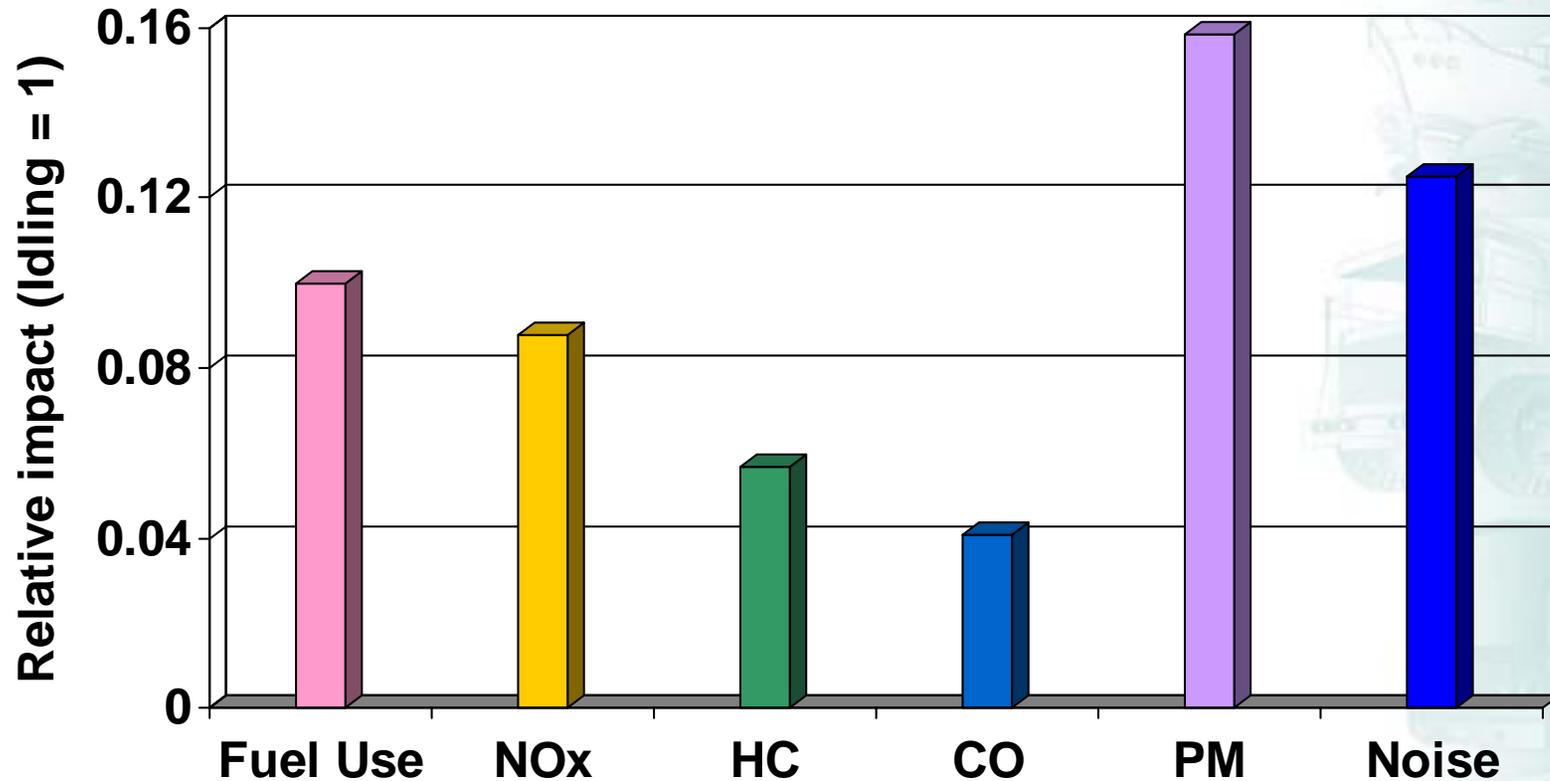


APU supplies heat, power, and cab comfort

- **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°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

- **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 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 use but could haul short distances**
 - Top speed 40 mph
 - Not suitable for long-haul use
- **Costs much more than retrofit**
 - Costs \$200 K on old locomotive bed
 - Rebuild costs \$100 K– \$350 K
 - Competitive with rebuild
 - Cheaper than new unit at \$1.5 million

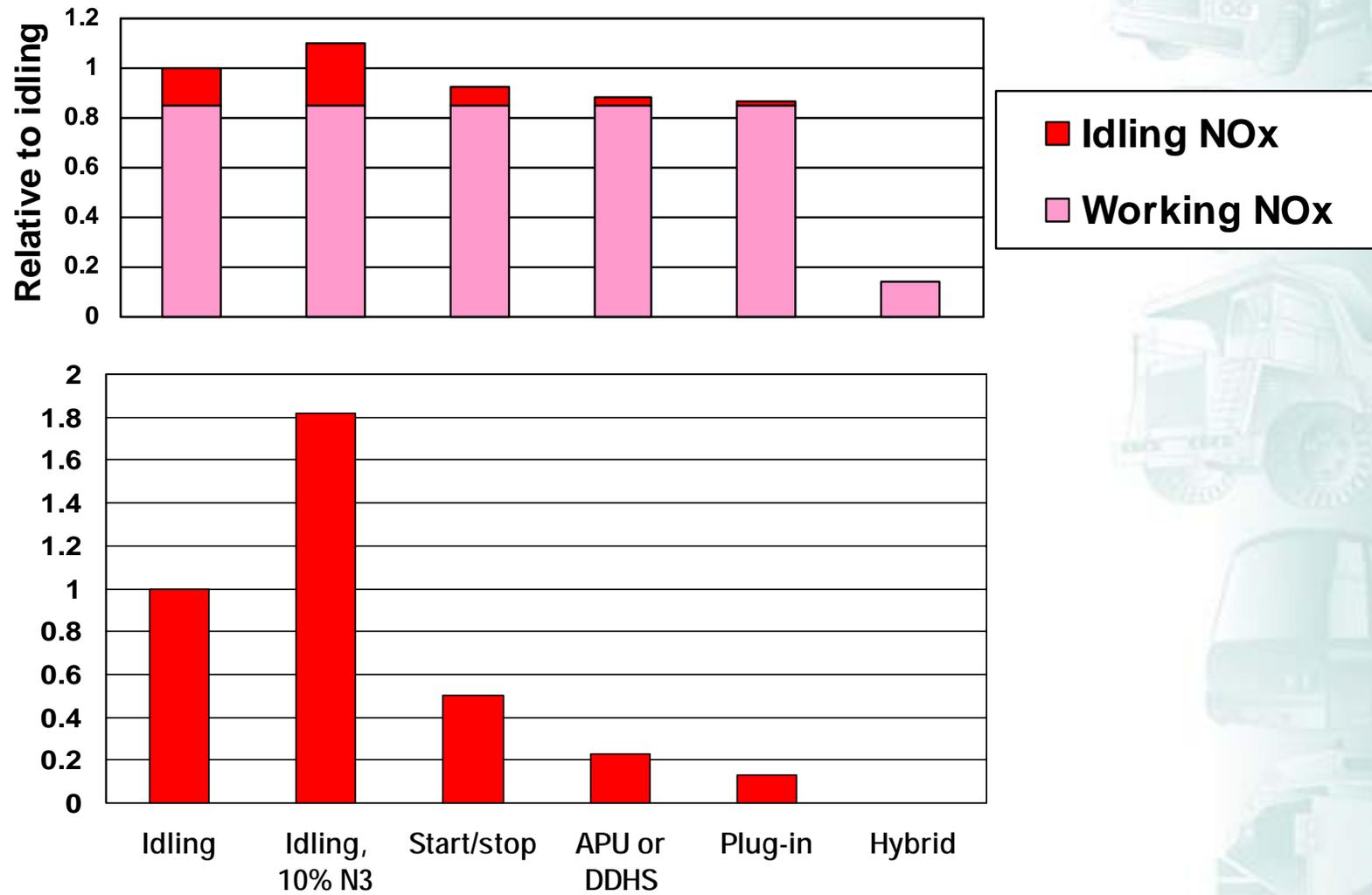


Technology comparison summary

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 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.**



NO ENDORSEMENTS IMPLIED!