

Burlington Northern Santa Fe Corporation

Railroad Emissions Technology

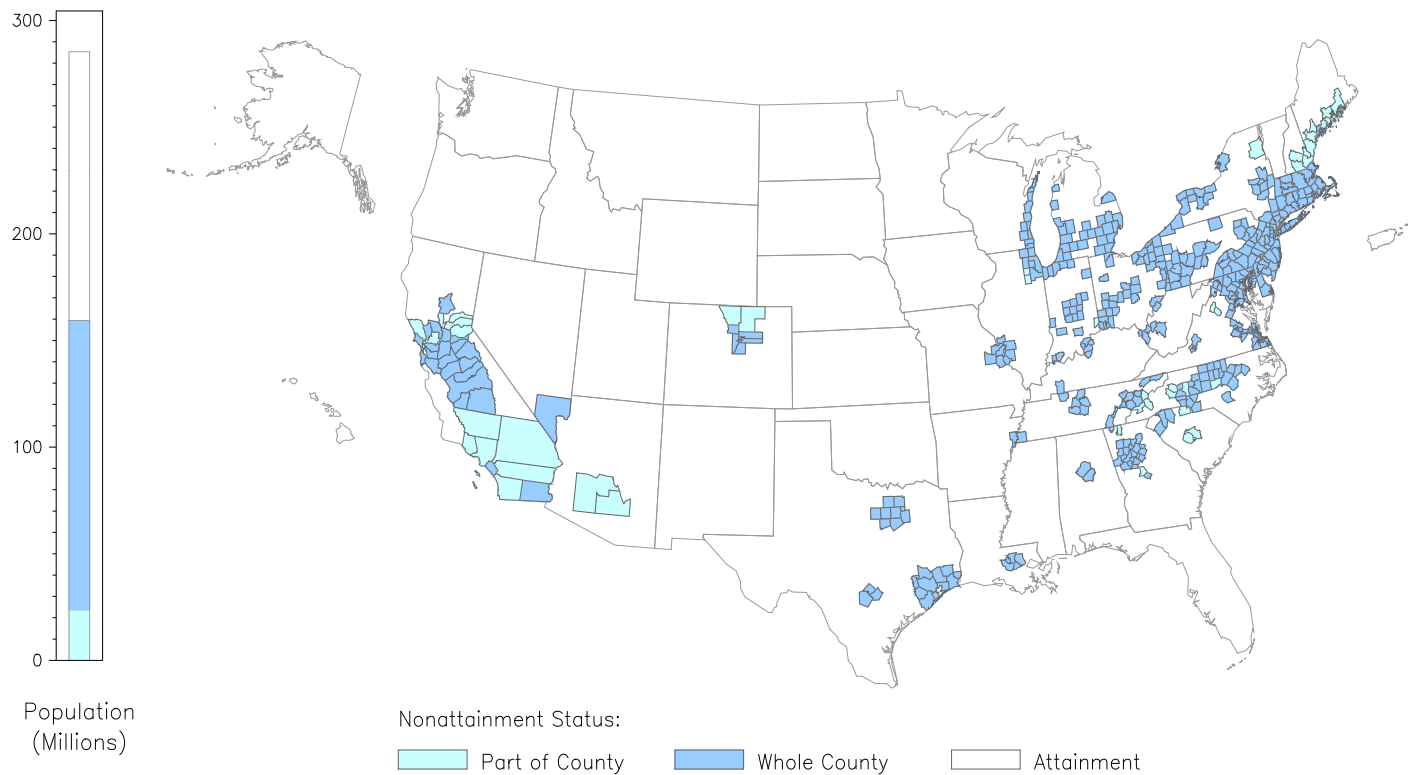
Mark Stehly
September 17, 2008



Ozone Non-Attainment Areas

Nonattainment Areas Map – Ozone (8-hour)
United States

AirData



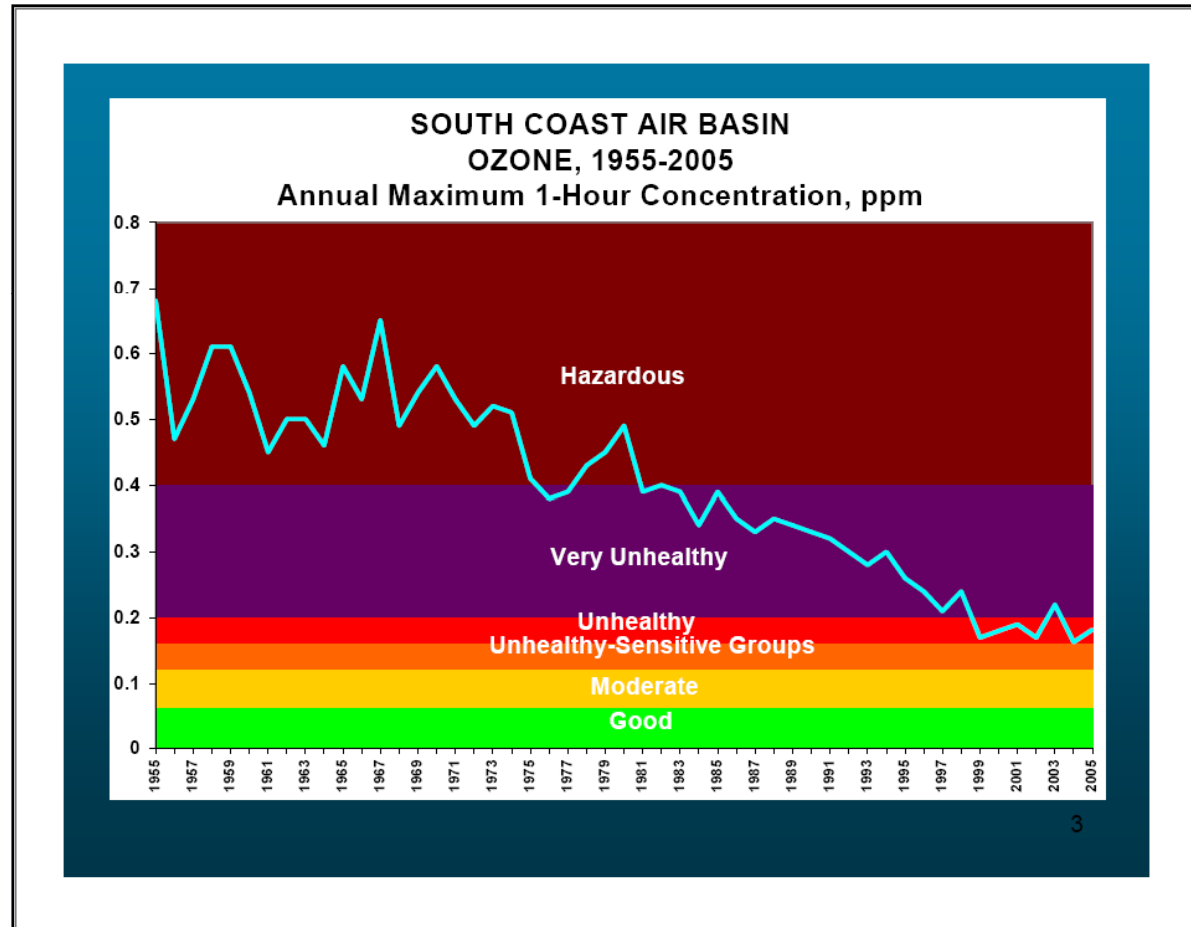
Source: US EPA Office of Air and Radiation, AIRS Database

Thursday, September 2, 2004

US Railroad Intermodal Flows

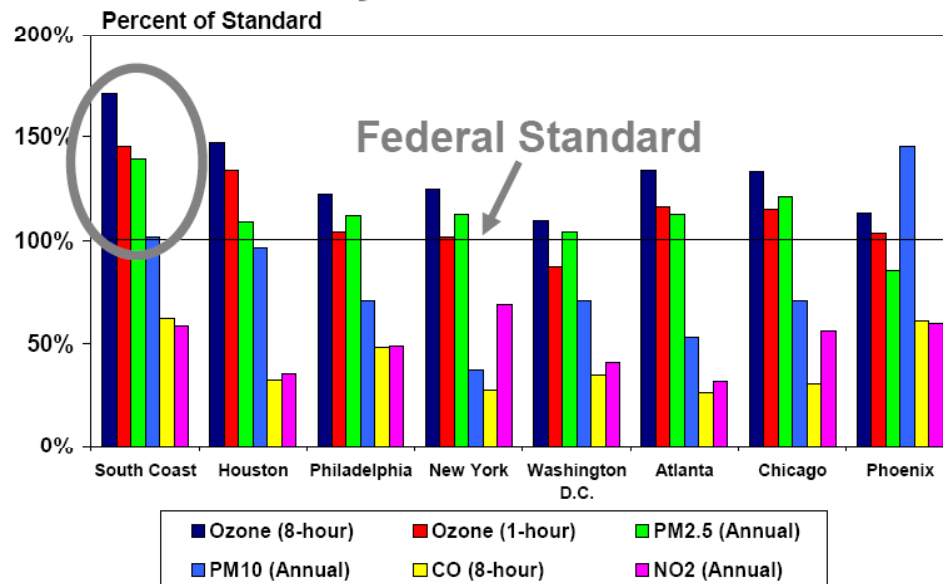


So. California Historical Air Quality

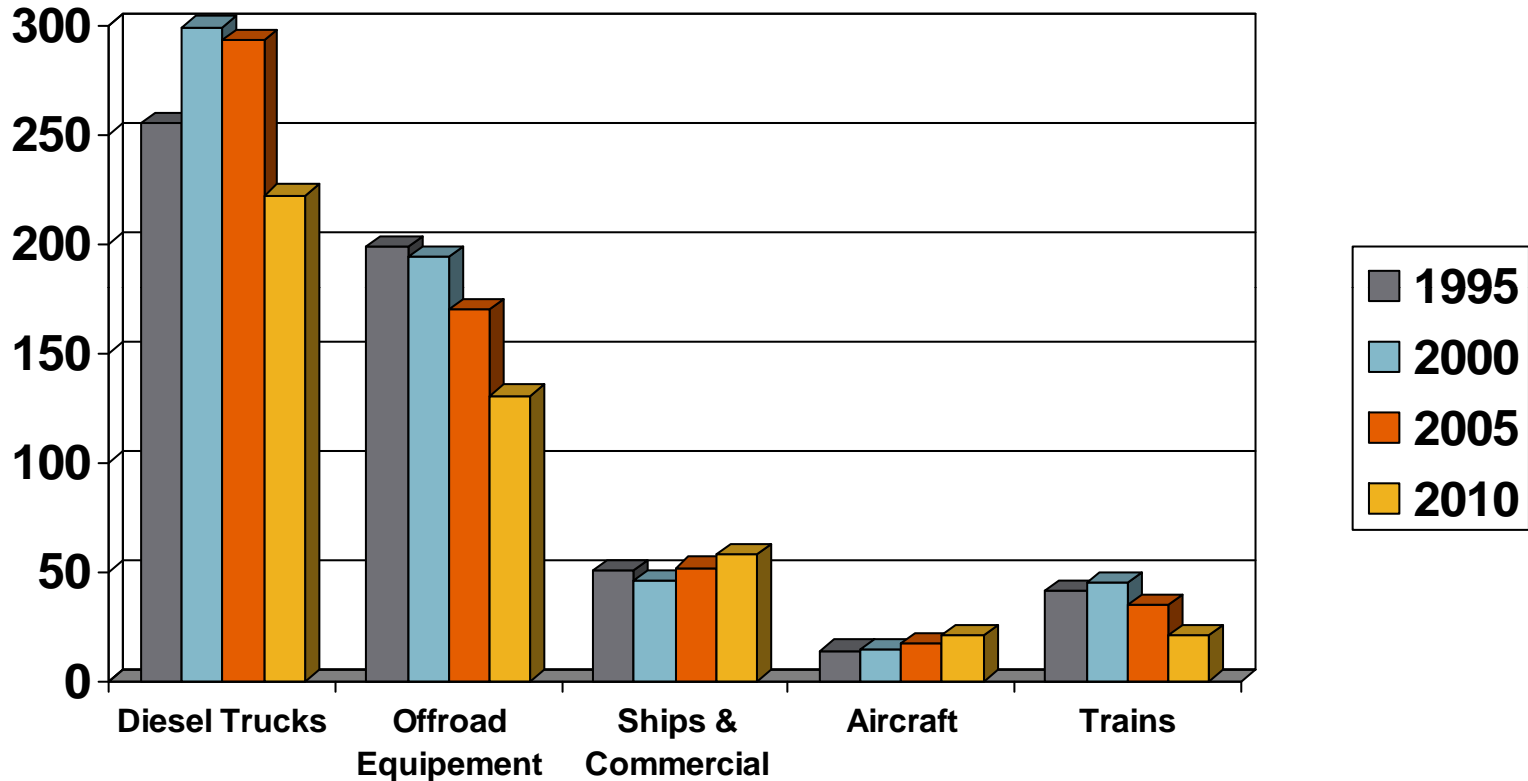


Air Quality in Metropolitan Areas

South Coast Air Basin Compared to Other Major U.S. Metro Areas



SCAQMD NOx Inventories



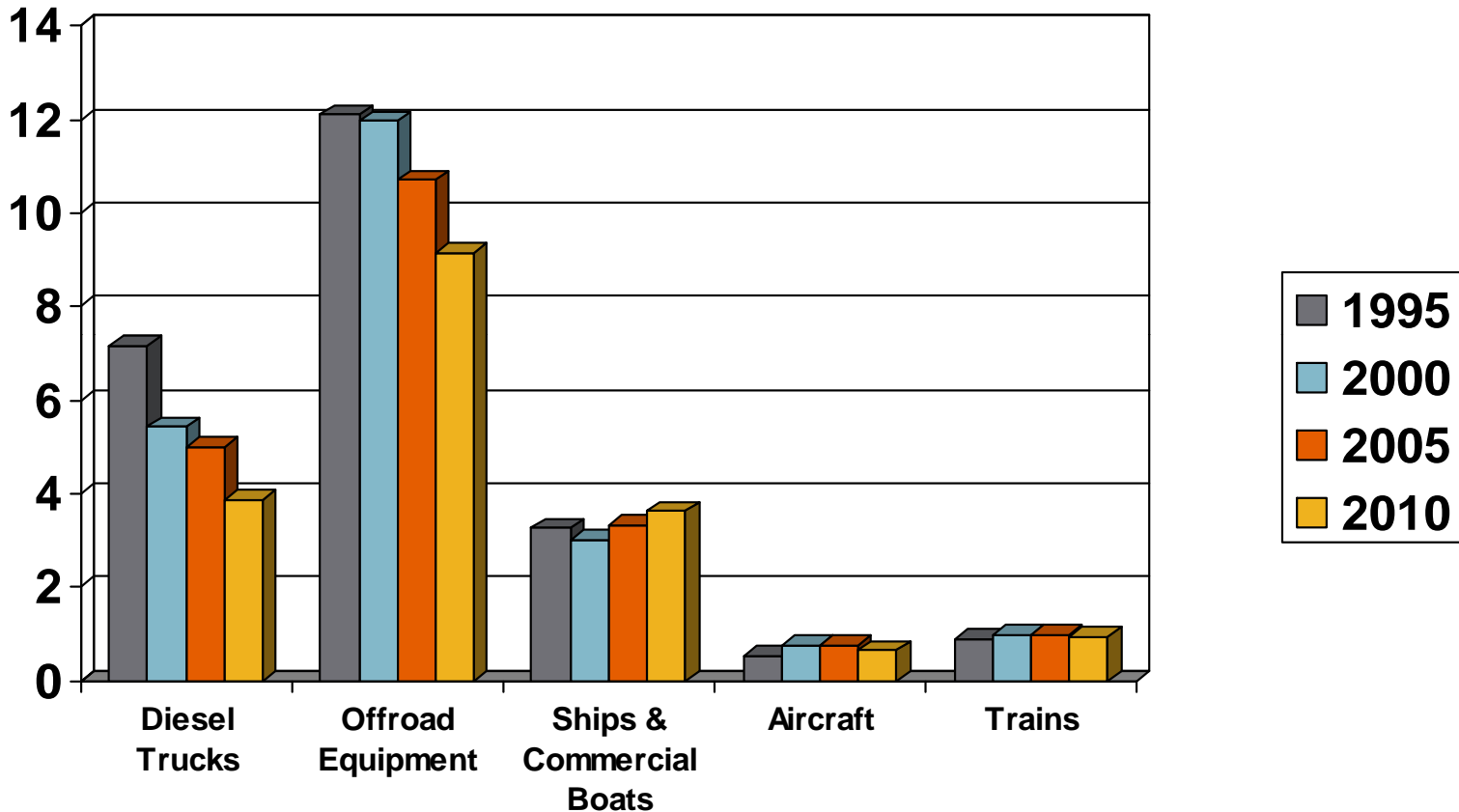
2010	Diesel Trucks	Offroad Equip	Ships	Aircraft	Trains
% SCAQMD NOx Inventory	28.5%	16.7%	12.6%	2.4%	2.7%

Data Source: ARB – Almanac Emission Projection Data (Published in 2005).

Diesel Trucks – LHDD1, LHDD2, MHDD, HHDD



SCAQMD PM2.5 Inventories




2005	Diesel Trucks	Offroad Equip	Ships	Aircraft	Trains
% SCAQMD NOx Inventory	3.2%	7.5%	5.6%	0.5%	0.8%

Data Source: ARB – Almanac Emission Projection Data (Published in 2005).

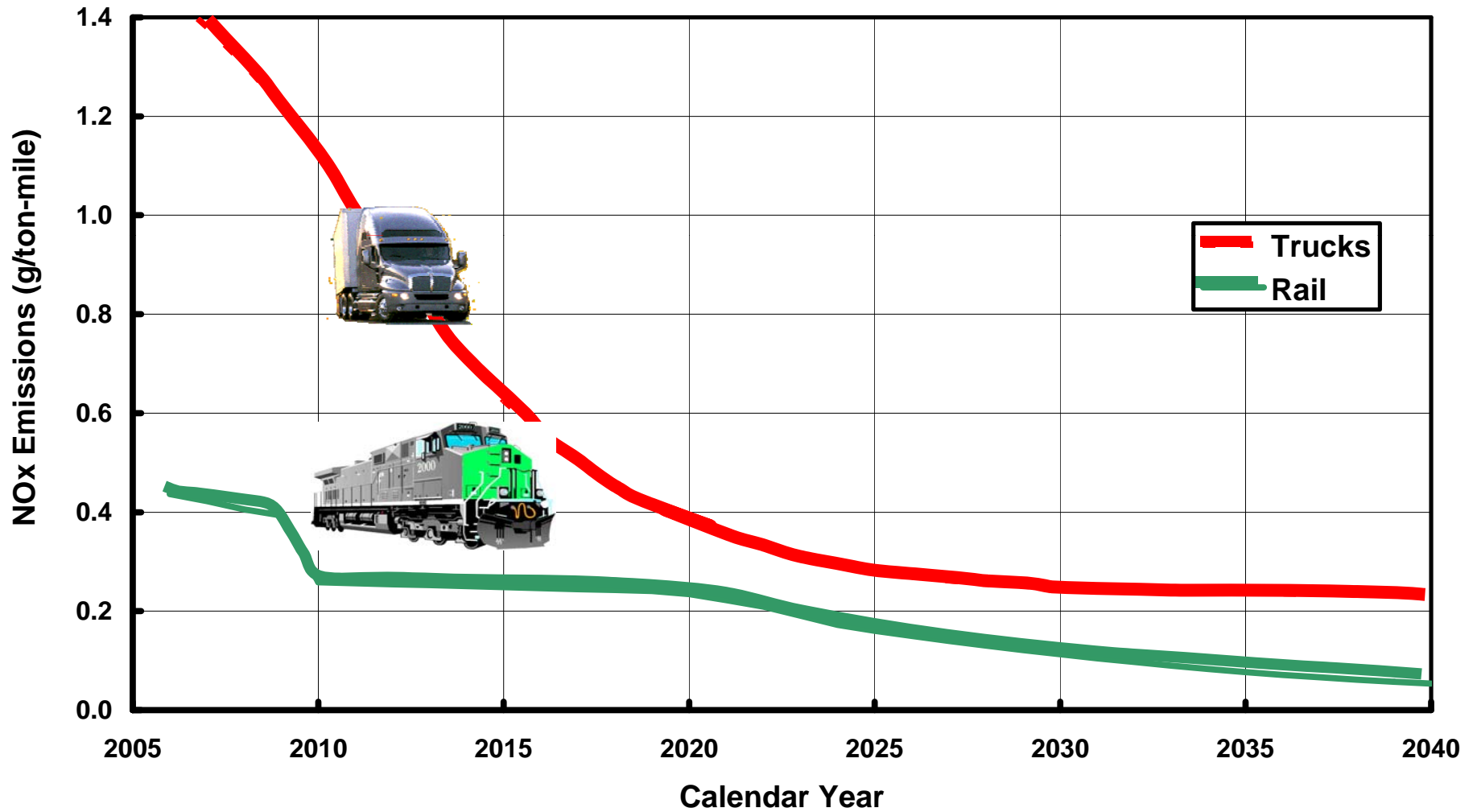
Diesel Trucks – LHDD1, LHDD2, MHDD, HHDD



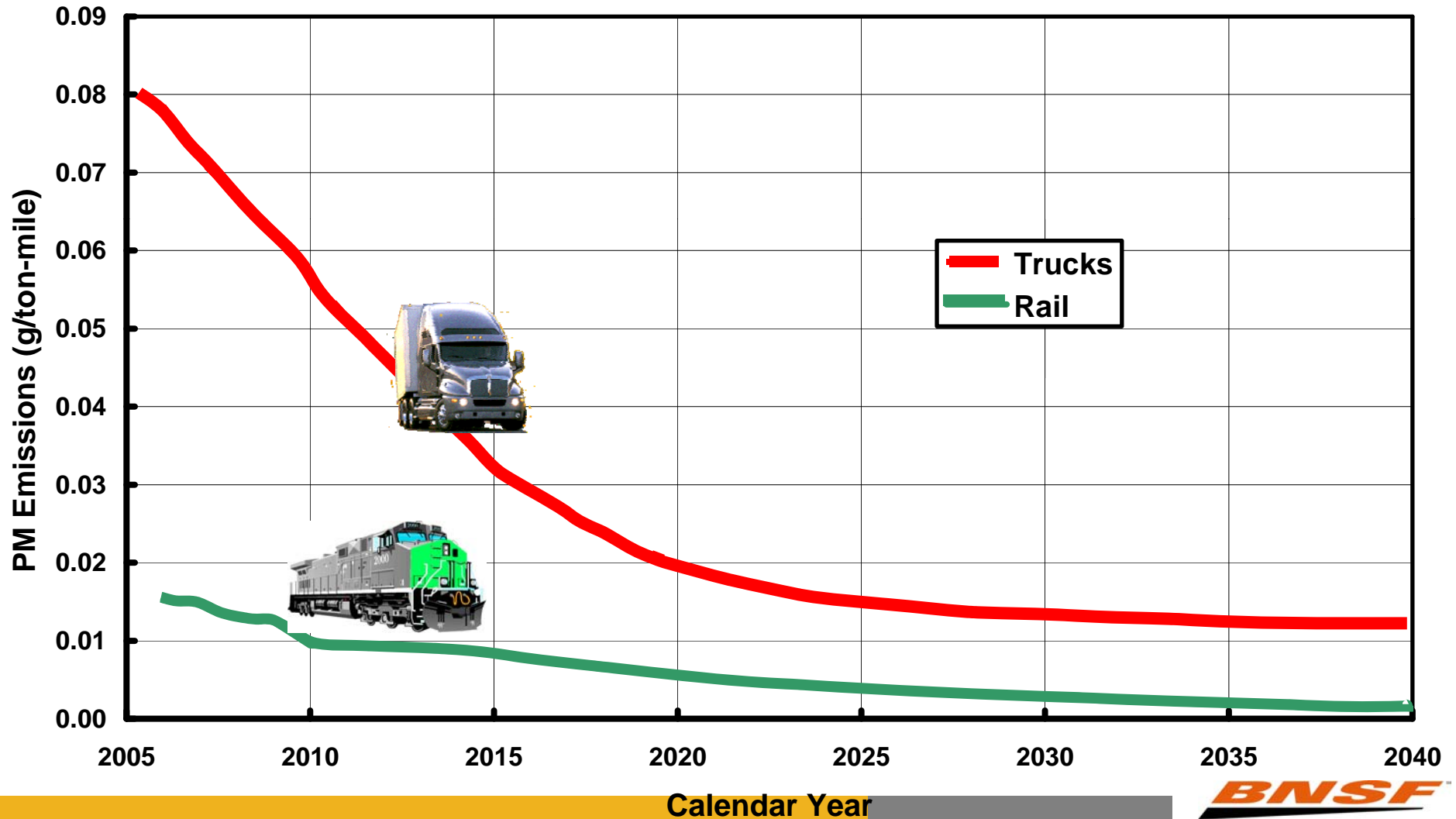
Inherent Efficiencies of Rail

	 A BNSF locomotive (number 7587) is shown on the left, and a semi-truck is shown on the right. The text "vs." is centered between them.
Capacity	1 double stack train equals volume of up to 280 trucks
Fuel Efficiency	Trains are <u>2-4 times more fuel efficient</u> than trucks on a ton-mile basis
NOx Emissions	Trains are <u>2-3 times cleaner</u> than trucks on a ton-mile basis

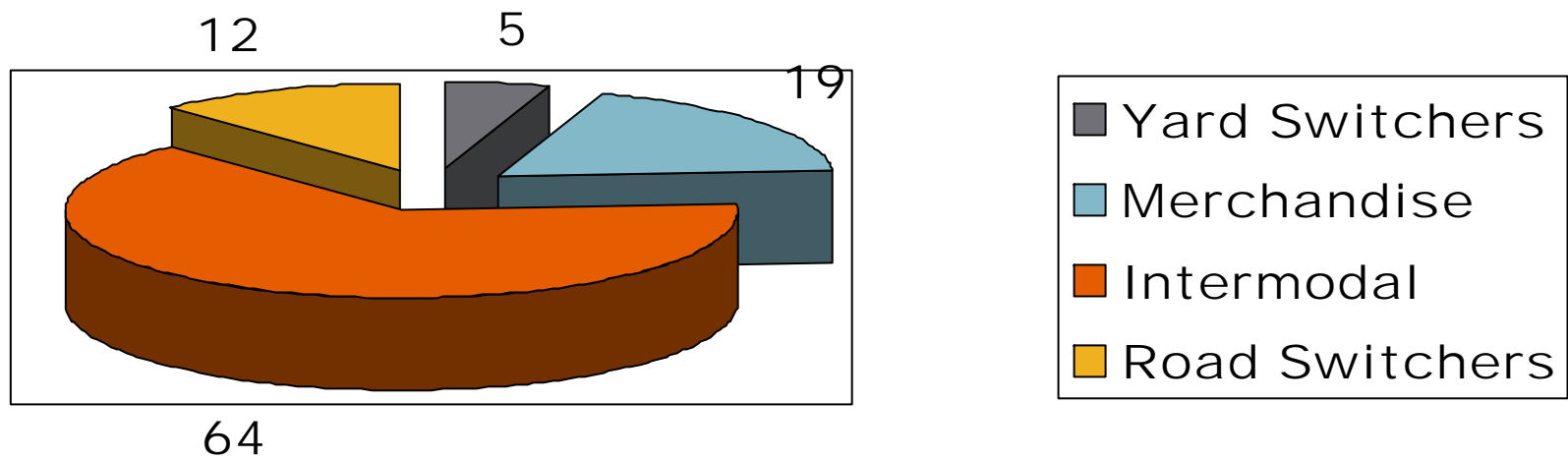
NOx Emissions per ton Mile of Freight South Coast Air Basin



PM Emissions per ton Mile of Freight South Coast Air Basin



Work Done By Train Type, in percent



Switcher Locomotives



Green Goat® Locomotives

- “Hybrid” light-medium duty switcher
- Reduces fuel consumption and atmospheric emissions by 60 percent
- Emits 80 to 90 percent fewer pollutants than conventional train engines
- Batteries recharged by 290 HP EPA off-road Tier 2 diesel gen set (significantly exceeds EPA locomotive Tier 2 requirements)

Liquefied Natural Gas Locomotive

- BNSF operates the only four environmentally friendly liquid natural gas locomotives that reduce emissions and fuel consumption
- 1200 sustainable horsepower, spark ignited



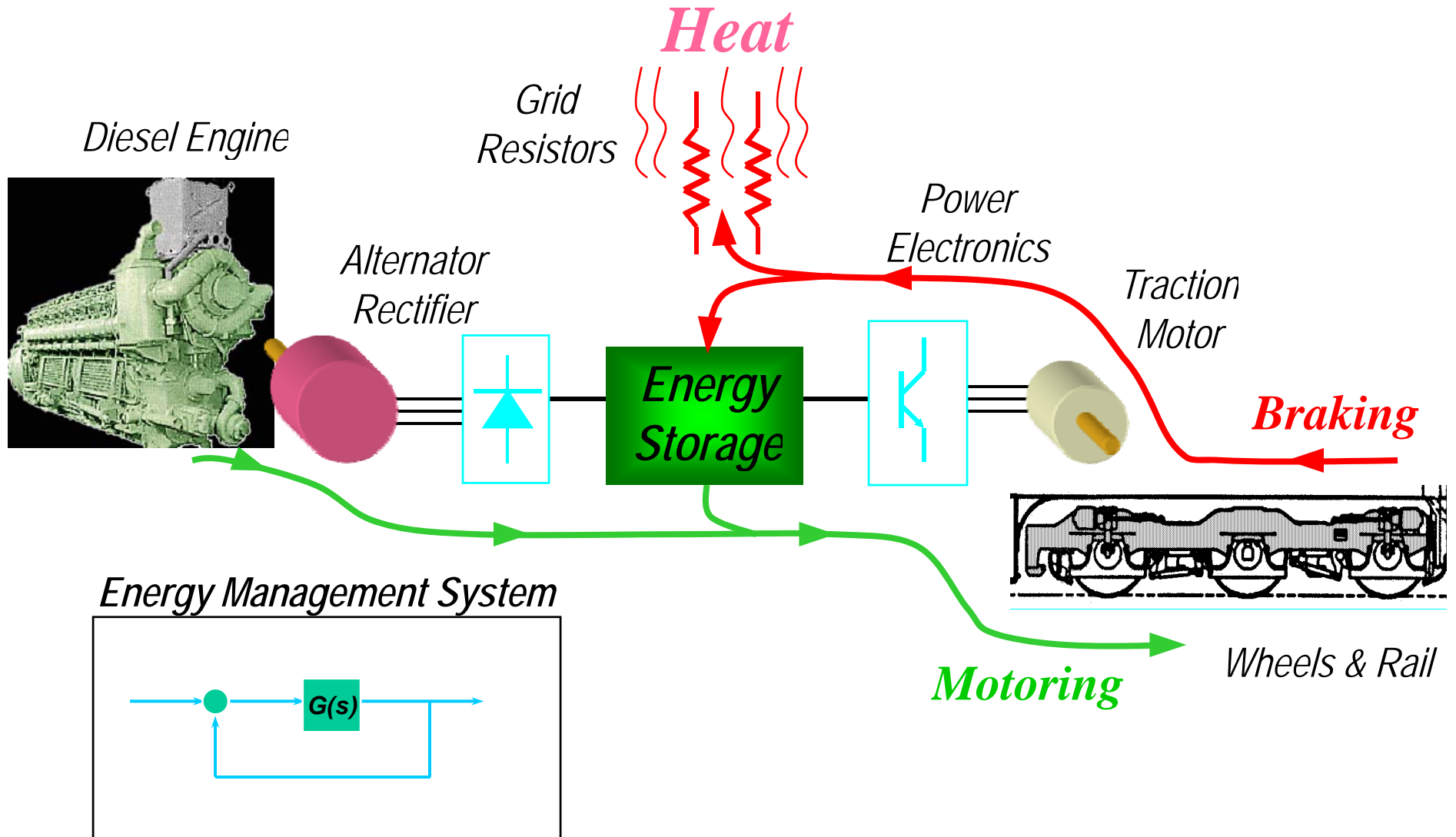
Multiple Gen Set Switcher

- Powered by multiple diesel gen sets with truck-like engines
- 700 sustainable horsepower from each gen set
- Typically 3 engines per locomotive

Comparison of Existing and New EPA locomotive emission regulations

		Nitrogen Oxides		Particulate Matter	
		Existing	New Reg	Existing	New Reg
Tier 0	1973-1992	9.5	8.0	0.6	0.22
Tier 1	1993-2002	9.5	7.4	0.6	0.22
Tier 1	2003-2004	7.4	7.4	0.45	0.22
Tier 2	2005-2011	5.5	5.5	0.20	0.10
Tier 3	2012-2014		5.5		0.10
Tier 4	2015		1.3		0.03

Road Locomotive Hybrid Concept



Sources of Emissions at a Large Intermodal Yard

- **Drayage trucks** **40%**
- **Cargo handling equipment** **20%**
 - **Cranes**
 - **Yard Tractors**
- **Linehaul locomotives** (Arriving & Departing trains) **10%**
- **Transportation Refrigeration Units** **10%**
- **Switch Engines** **10%**
- **Adjacent Mainline Freight** **5%**
- **Adjacent Commuter Rail** **3%**
- **Other** **2%**

New Intermodal Yard Green Technology

- **Electric Rail-Mounted Gantry (RMG) cranes**
 - Reduced air emissions, noise and light
- **Clean diesel yard hostler tractors**
- **LNG or multi-engine diesel switch engines**
- **Low-sulfur fuel and idle shut-down feature for road locomotives**
- **Low emission drayage trucks (2007 or later)**

At the end of 2007

- **Total fleet is 6800 locomotives**
- **Installed 3300+ locomotives with AESS**
- **Retrofit 2200 locomotives to Tier 0**
- **Purchased 620 Tier 1 locomotives**
- **Purchased 880 Tier 2 locomotives**
- **Fleet average nitrogen oxides emissions reduced 30% since 2000**
- **2260 more locomotives to retrofit to Tier 0**
- **900 locomotives pre 1973 (not subject to retrofit)**

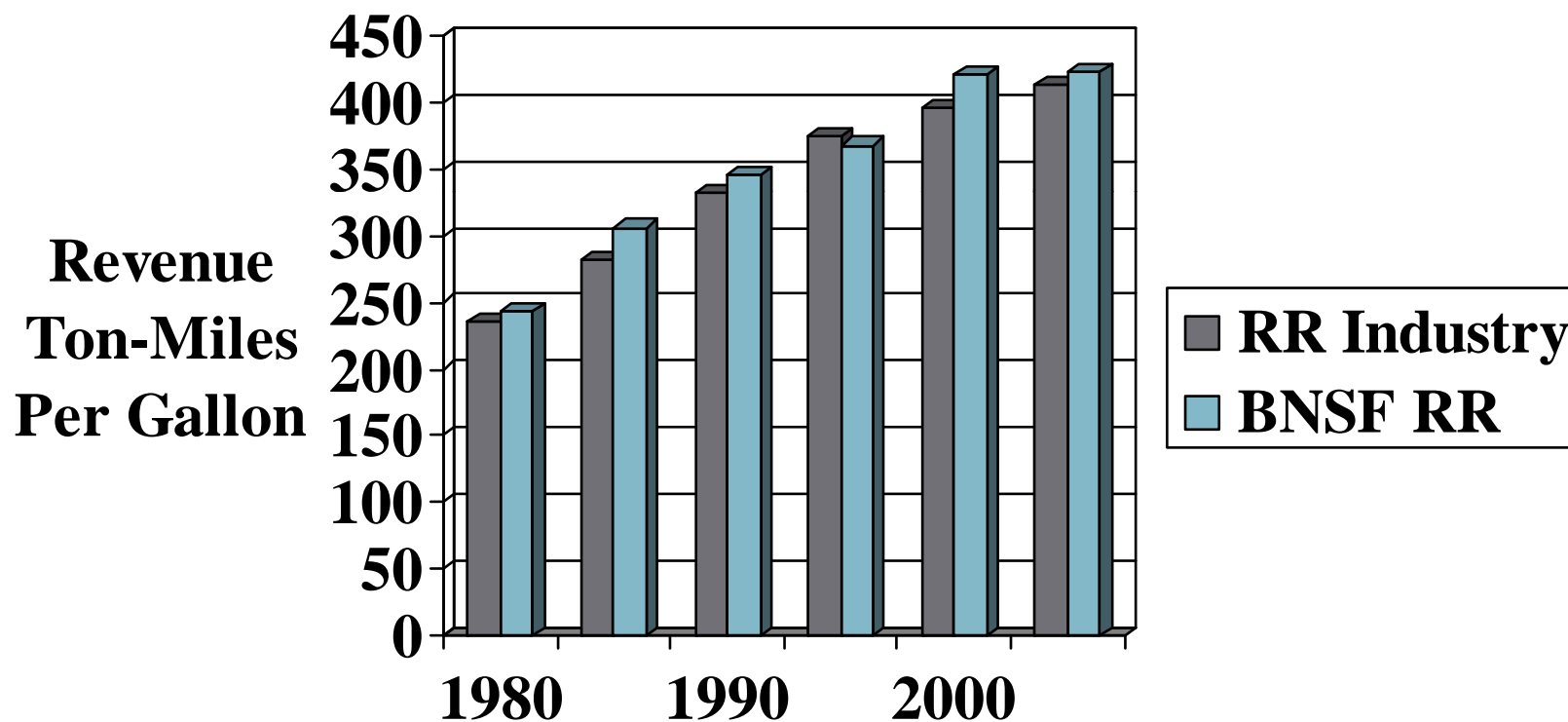
Summary

- **Railroads are part of the environmental solution**
- **Railroads contribute only small amounts to the problem and will achieve large reductions in emissions**
- **Railroads do more than other mobile sources**
- **Railroads are addressing needs around our yards**
- **If stationary sources were mobile, they couldn't achieve their current reductions either**

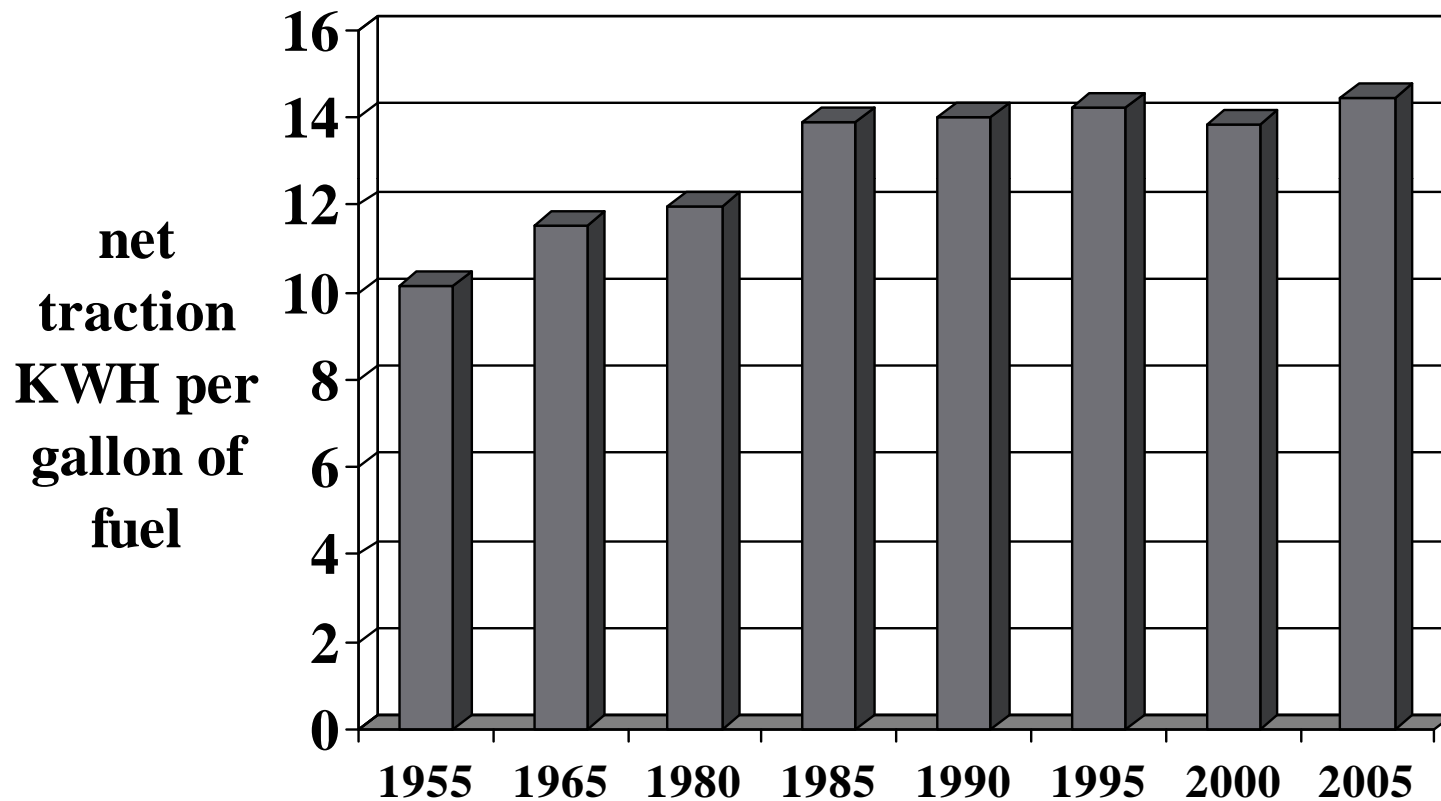
Greenhouse Gas Emissions

Year	GTM/Gal	Fuel Volume Gal	Million Tons of CO2
1995	693.3	1,080,878,000	12.10
1999	734.4	1,187,305,000	13.29
2000	747.2	1,172,949,000	13.13
2001	760.4	1,177,144,000	13.17
2002	760.3	1,148,682,000	12.86
2003	751.2	1,213,409,000	13.58
2004	752.9	1,344,000,000	13.98
2005	756.9	1,402,000,000	14.75
2006	757.6	1,478,000,000	15.02

Fuel Efficiency



Locomotive Fuel Efficiency, medium duty cycle



Reducing Greenhouse Gases

- **Reduce locomotive idling (install Idle Reduction Devices)**
- **Acquire new line haul locomotives (better fuel efficiency)**
- **Acquire new switch locomotives (GenSet multi-engine, and hybrid locomotives)**
- **Improve train performance through engineer training and evaluation programs**

Reducing Greenhouse Gases

- **Promote the use of Low Torque Roller Bearings**
- **Continue to improve wheel and rail lubrication**
- **Improve intermodal loading methods to reduce aerodynamic drag**

**From 1995 and 2006
11,066,000 tons of CO2 reduction**

BNSFSM

The logo consists of the letters "BNSF" in a bold, italicized, orange sans-serif font. A thick black horizontal bar is positioned below the letters, starting from the left edge of the "B" and extending to the right edge of the "F". A small "SM" trademark symbol is located to the upper right of the "F".