

# Burlington Northern Santa Fe Corporation

## Railroad Emissions Technology

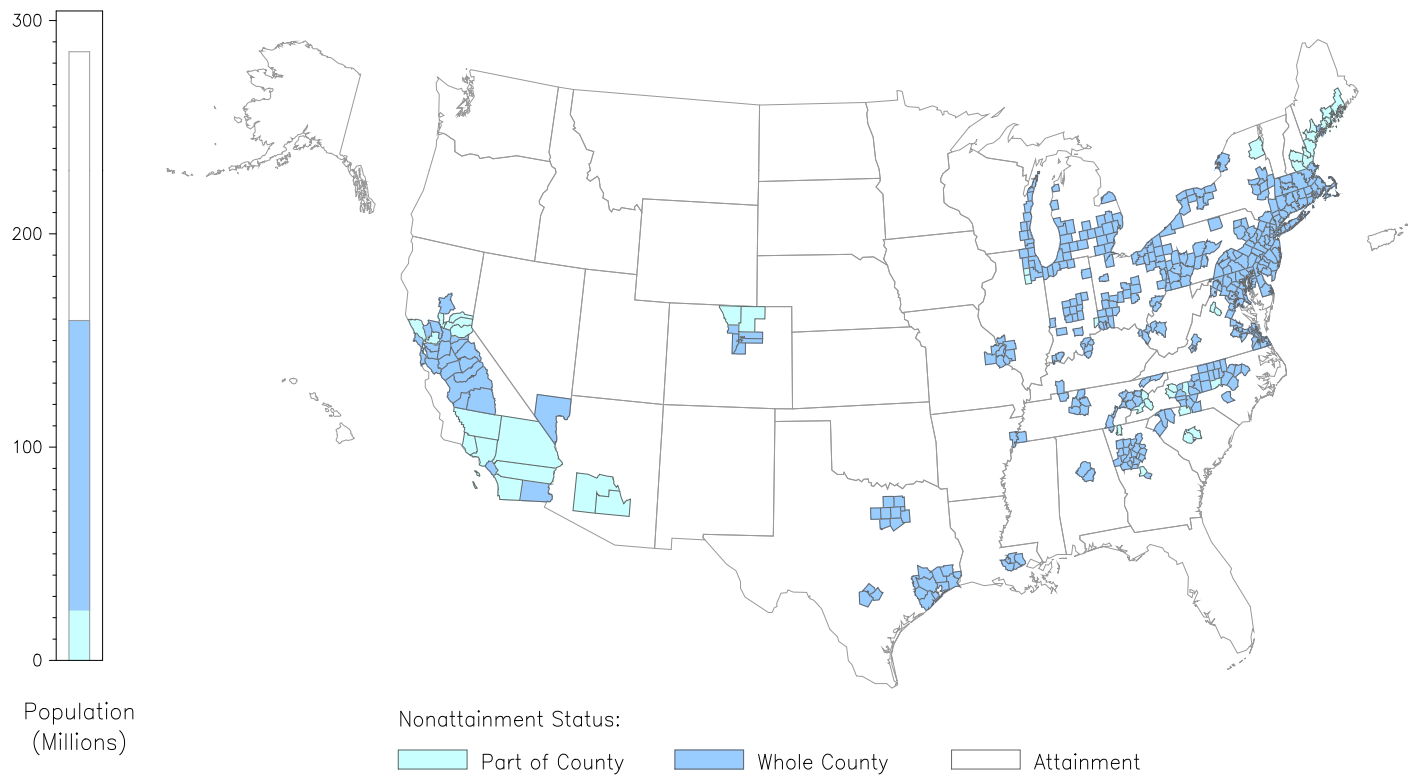
Mark Stehly  
September 17, 2008



# Ozone Non-Attainment Areas

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

AirData



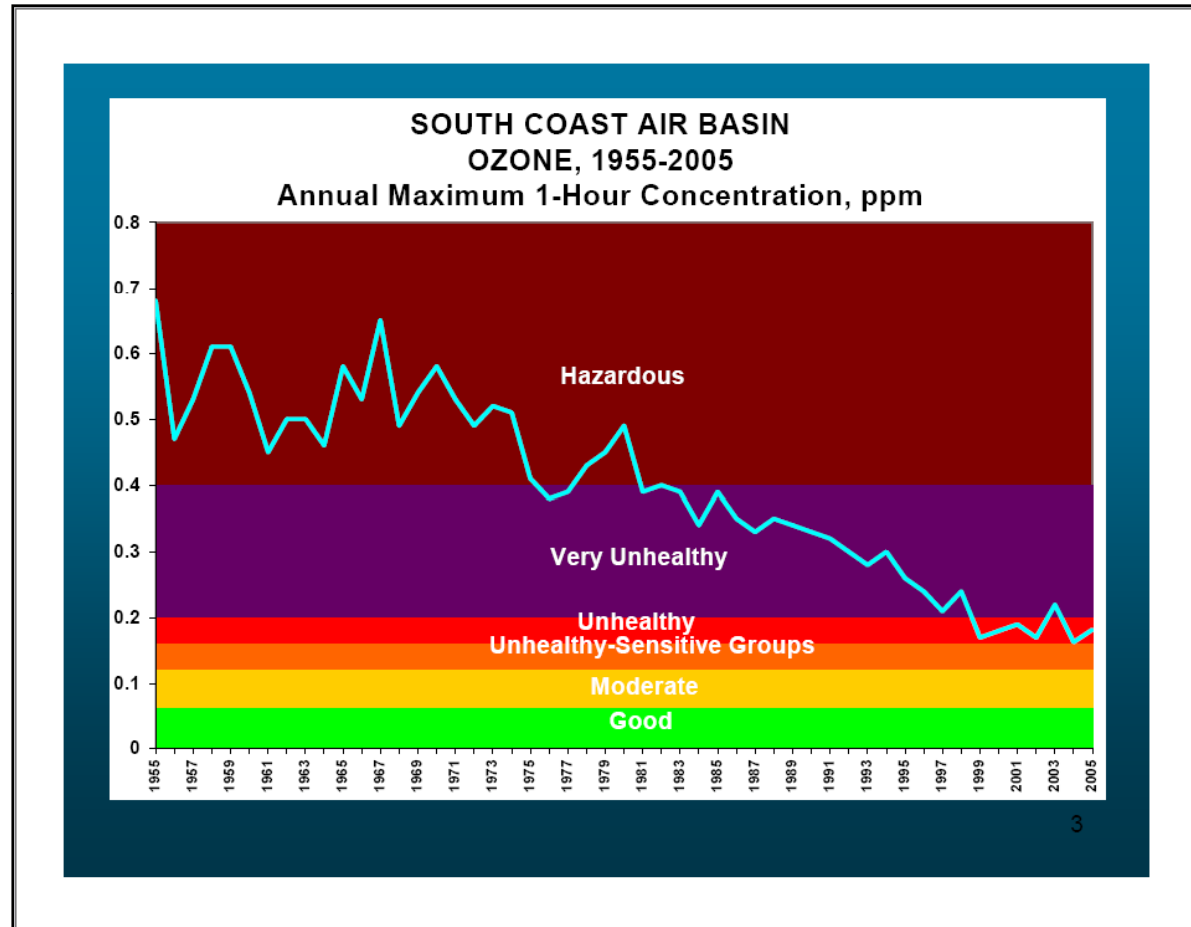
Source: US EPA Office of Air and Radiation, AIRS Database

Thursday, September 2, 2004

# US Railroad Intermodal Flows

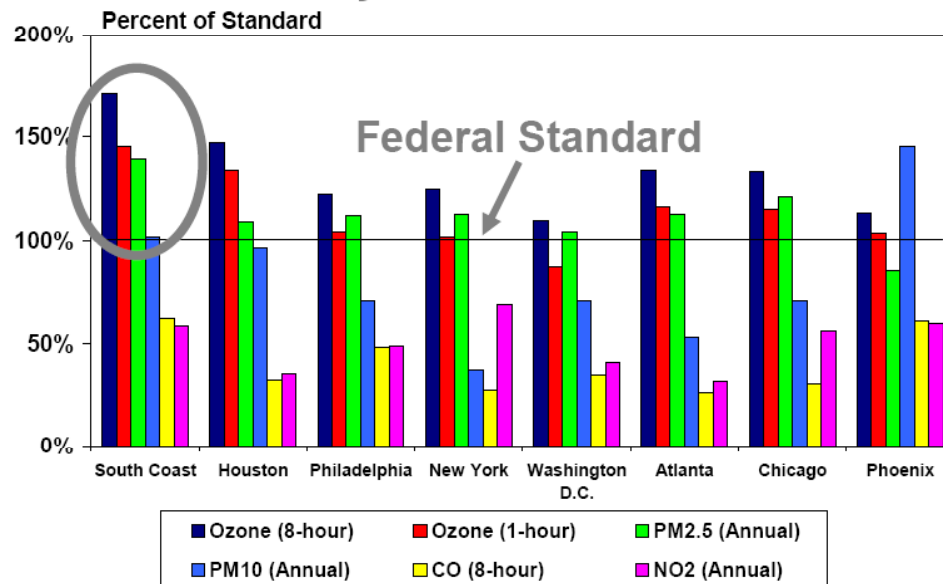


# So. California Historical Air Quality

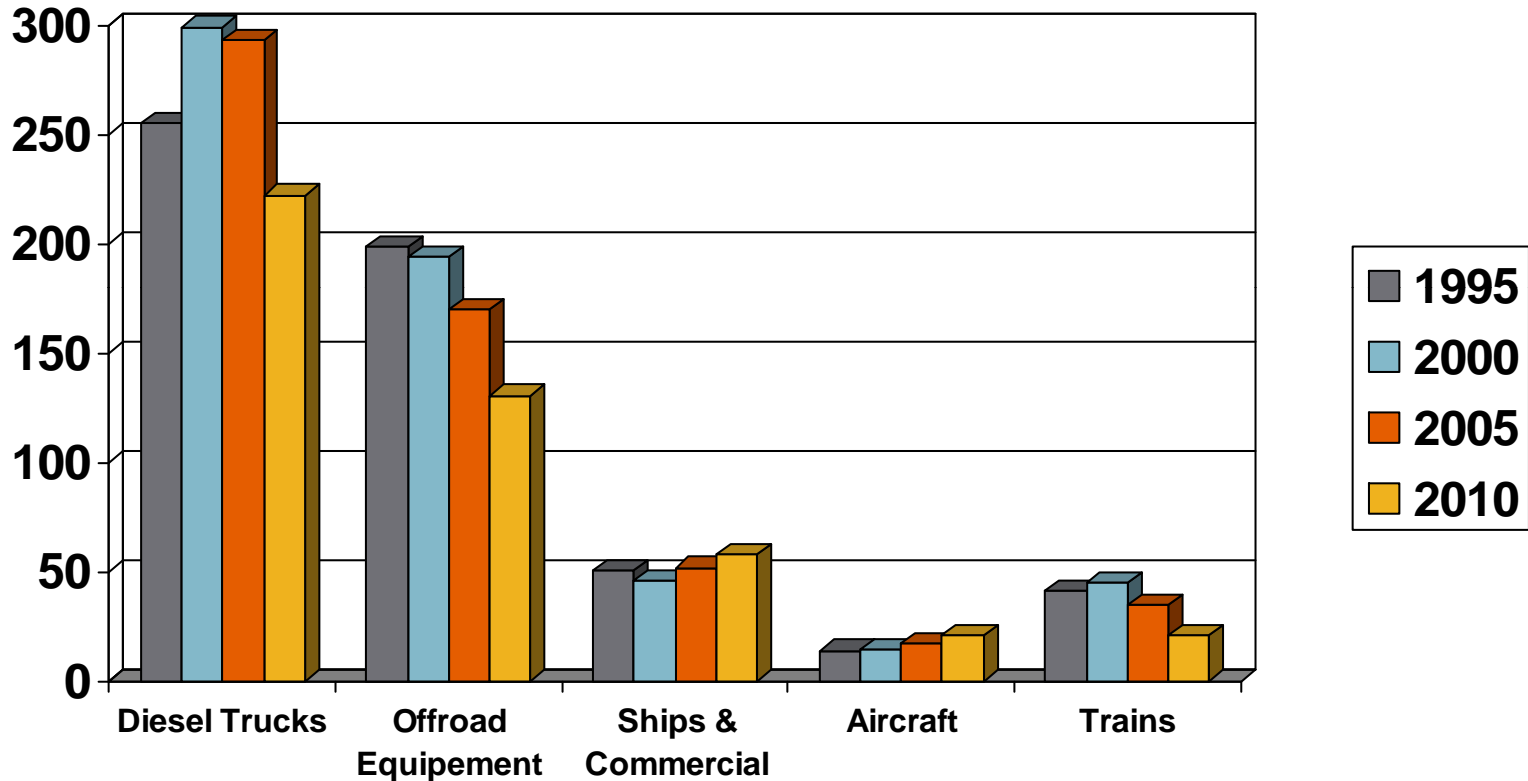


# Air Quality in Metropolitan Areas

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



# SCAQMD NOx Inventories



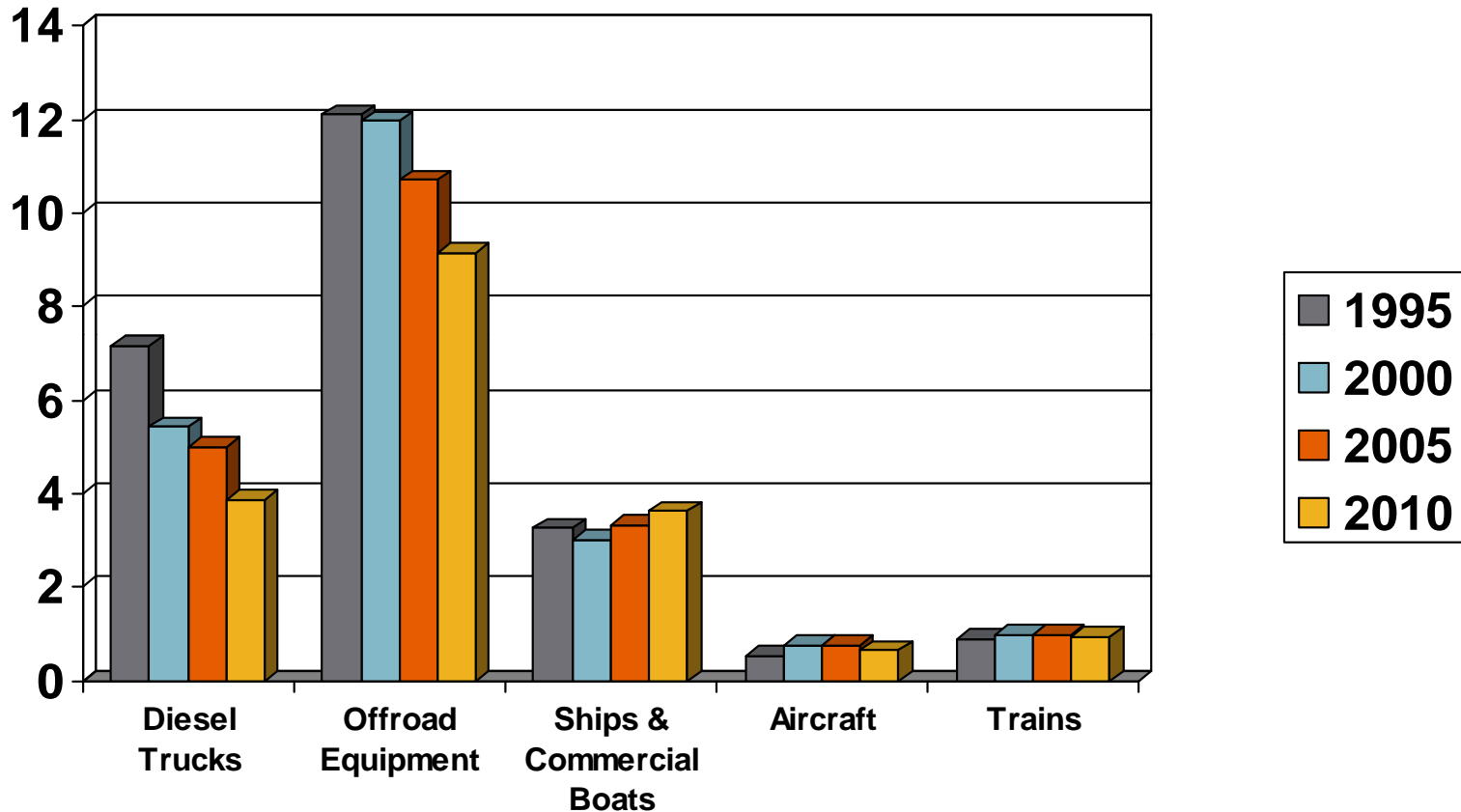
2010	Diesel Trucks	Offroad Equip	Ships	Aircraft	Trains
<b>% SCAQMD NOx Inventory</b>	28.5%	16.7%	12.6%	2.4%	2.7%

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
<b>% SCAQMD NOx Inventory</b>	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

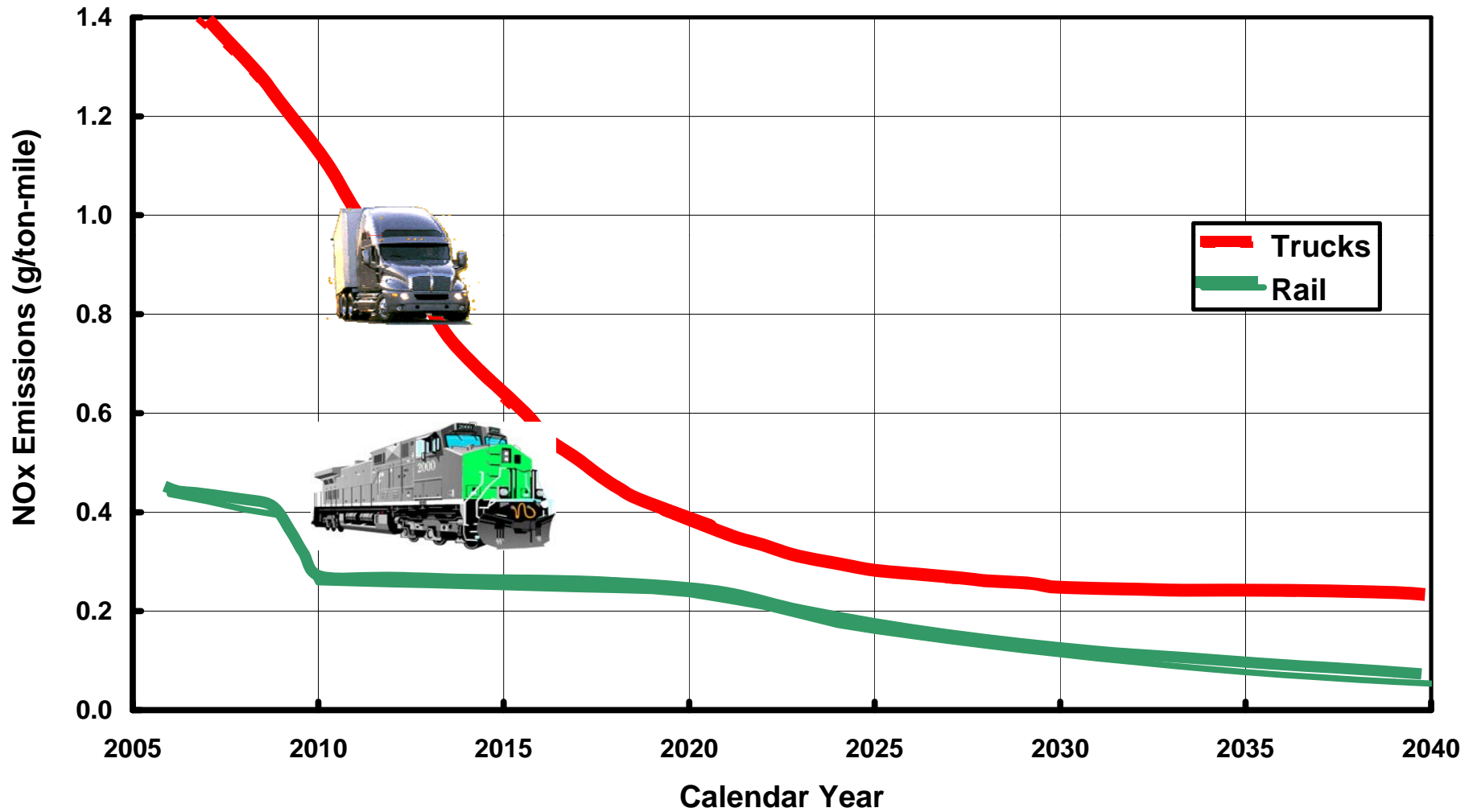


# Inherent Efficiencies of Rail

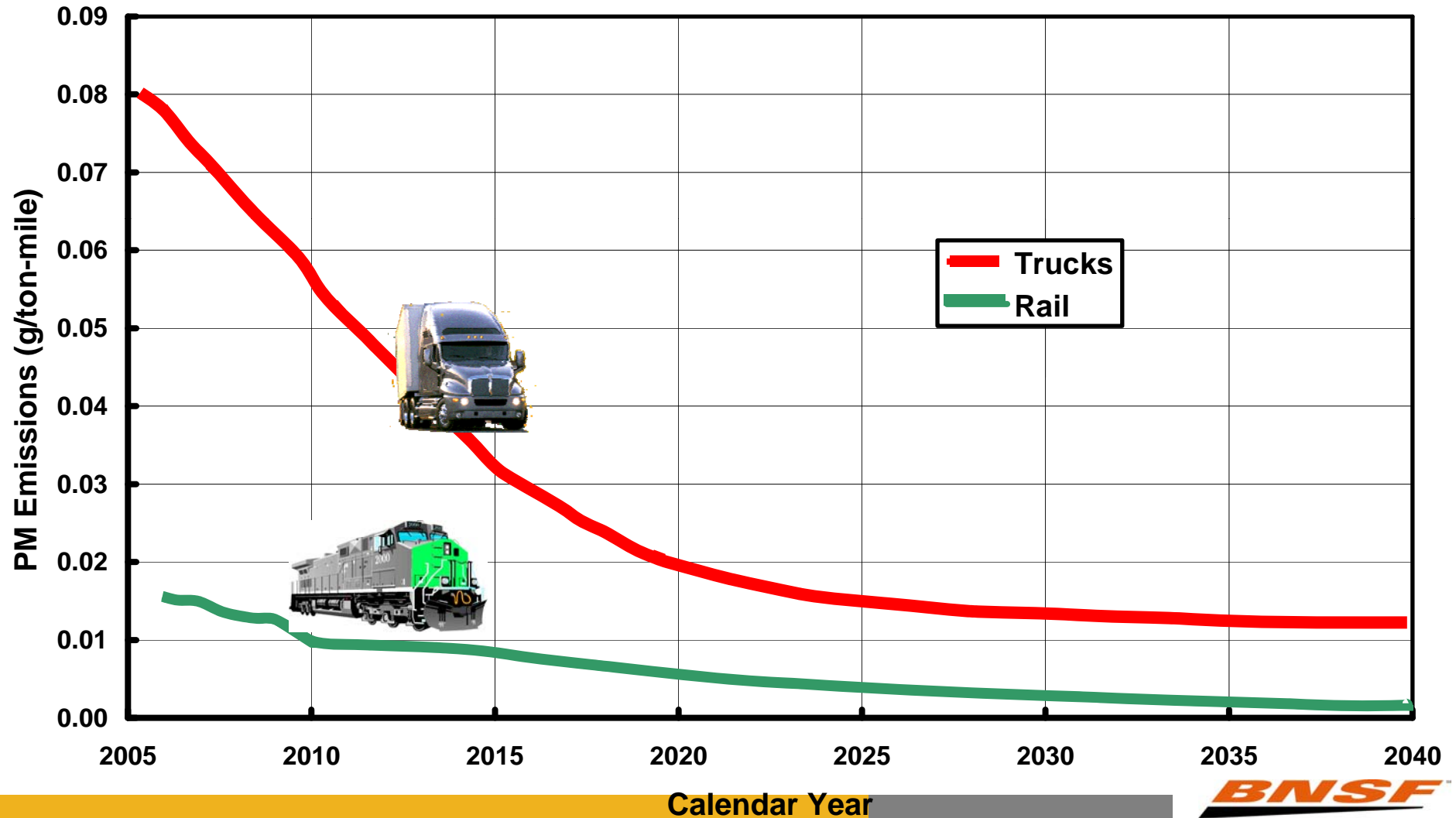
	 A BNSF locomotive (number 7587) is shown on the left, and a semi-truck is shown on the right. The text "vs." is centered between them.
<b>Capacity</b>	1 double stack train equals volume of up to 280 trucks
<b>Fuel Efficiency</b>	Trains are <u>2-4 times more fuel efficient</u> than trucks on a ton-mile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



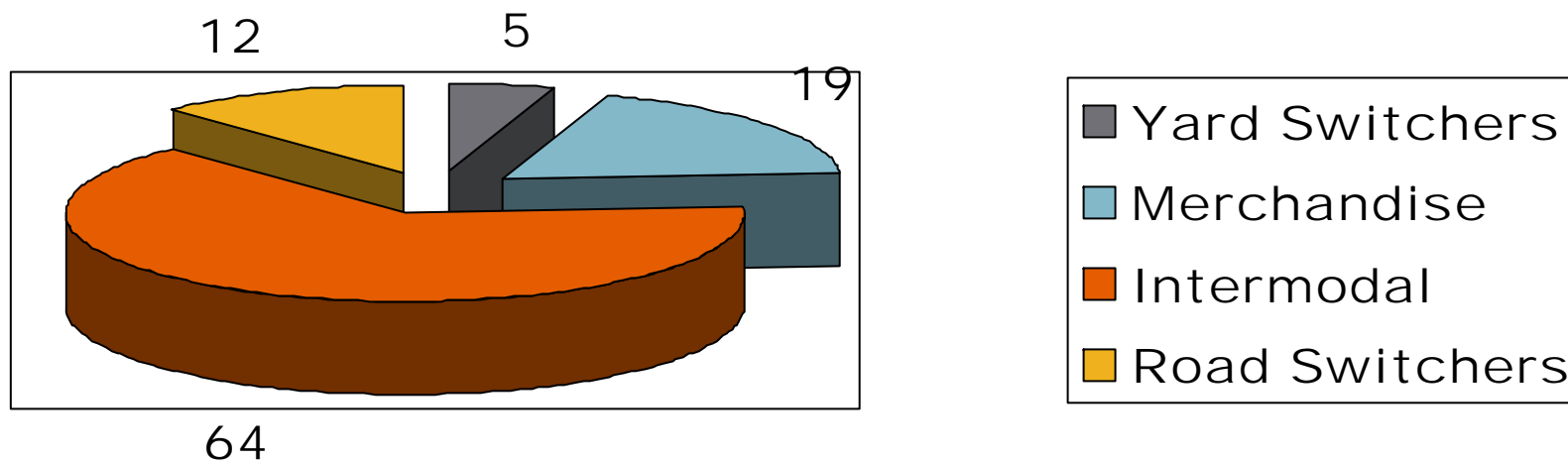
# NOx Emissions per ton Mile of Freight South Coast Air Basin



# 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



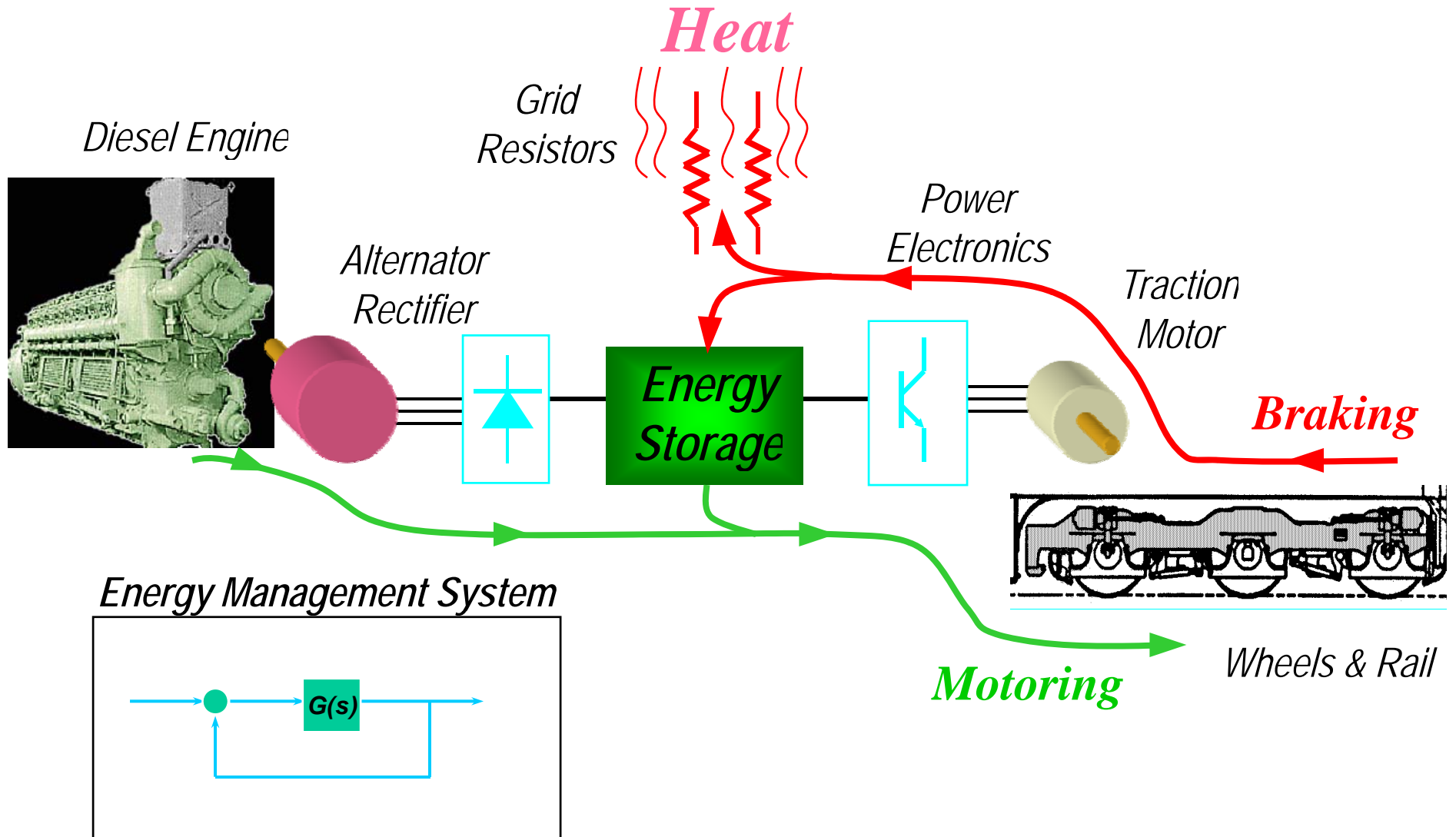
## Multiple Gen Set Switcher

- 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
<b>Tier 0</b>	<b>1973-1992</b>	<b>9.5</b>	<b>8.0</b>	<b>0.6</b>	<b>0.22</b>
<b>Tier 1</b>	<b>1993-2002</b>	<b>9.5</b>	<b>7.4</b>	<b>0.6</b>	<b>0.22</b>
<b>Tier 1</b>	<b>2003-2004</b>	<b>7.4</b>	<b>7.4</b>	<b>0.45</b>	<b>0.22</b>
<b>Tier 2</b>	<b>2005-2011</b>	<b>5.5</b>	<b>5.5</b>	<b>0.20</b>	<b>0.10</b>
<b>Tier 3</b>	<b>2012-2014</b>		<b>5.5</b>		<b>0.10</b>
<b>Tier 4</b>	<b>2015</b>		<b>1.3</b>		<b>0.03</b>

# 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)**

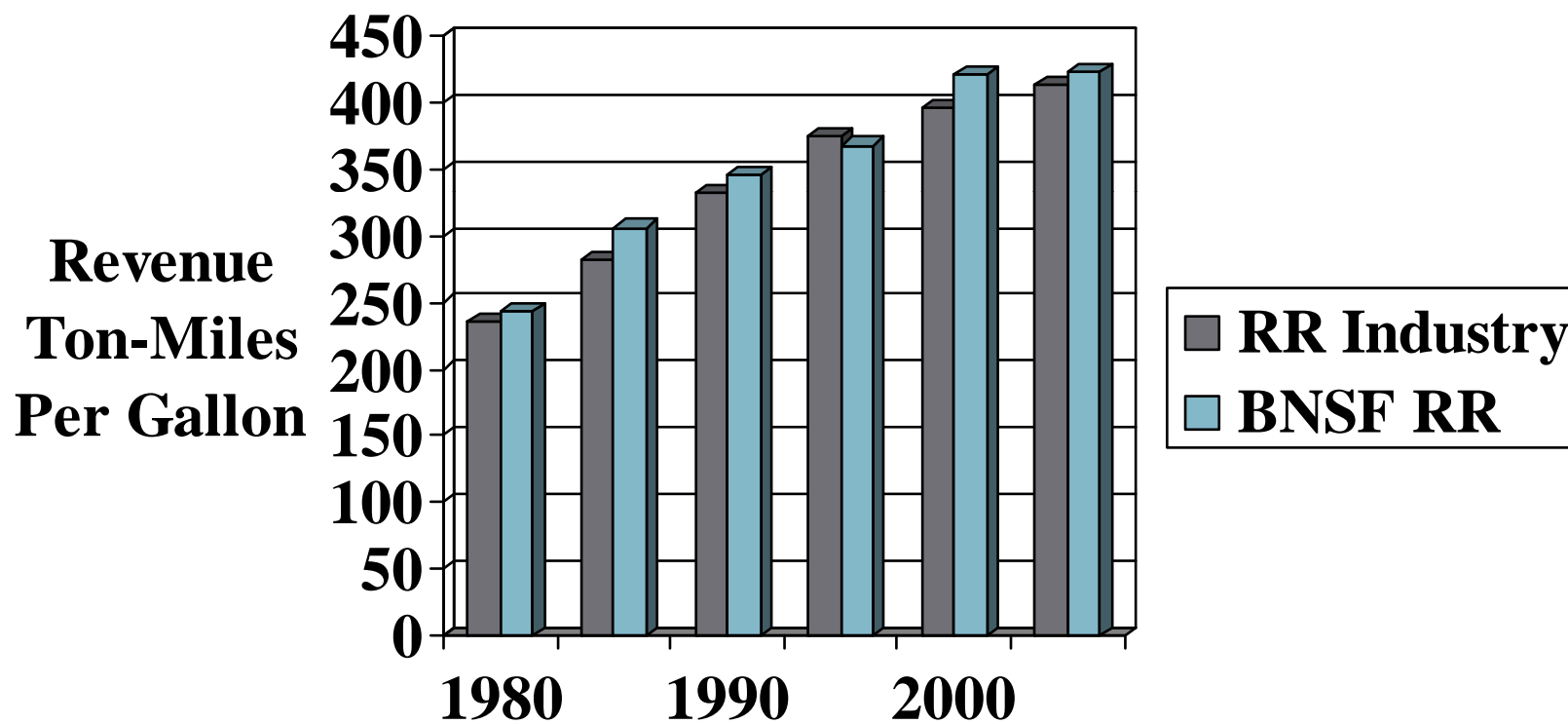
# Summary

- **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**

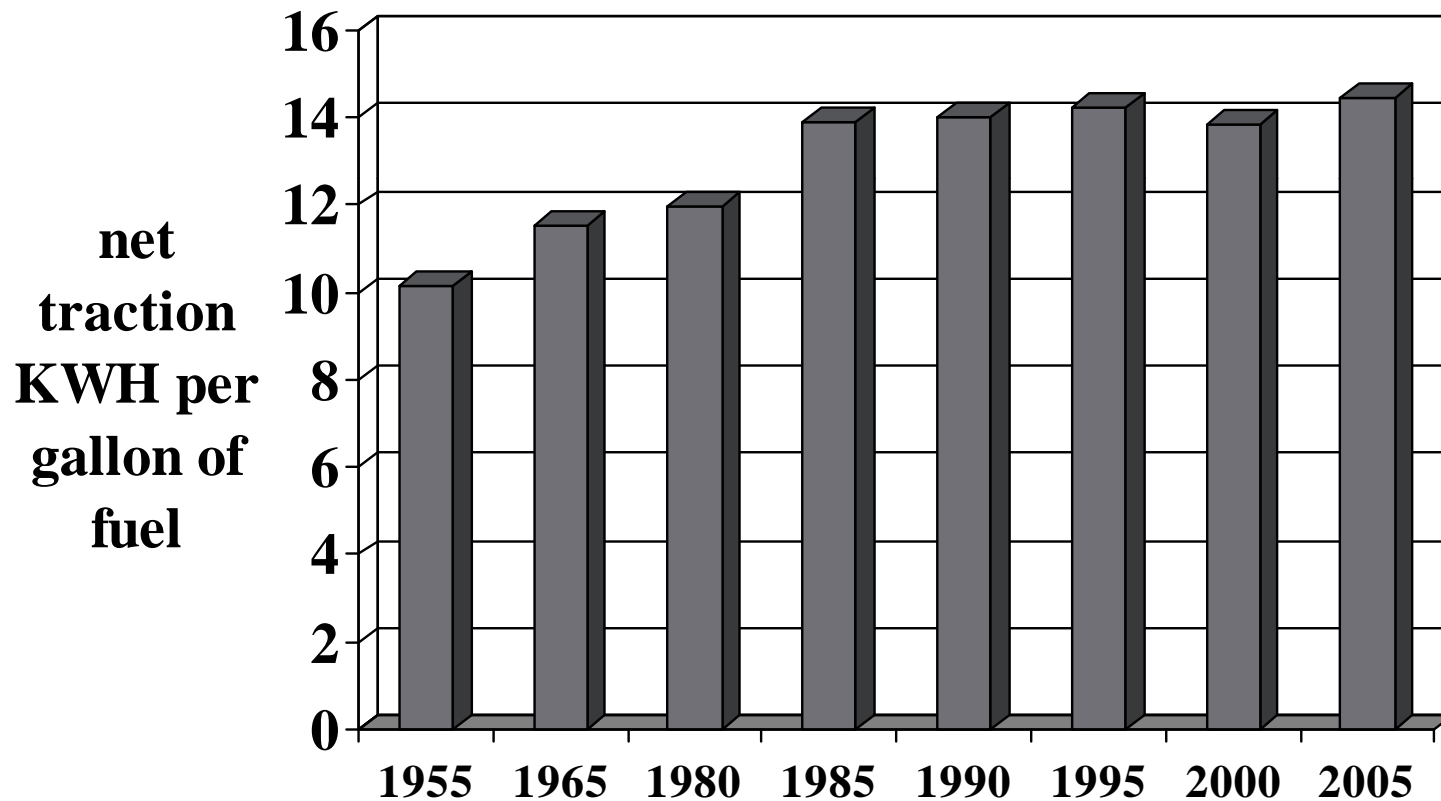
# Greenhouse Gas Emissions

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

# 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**

***BNSF***<sup>SM</sup>

The logo features 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".