California's Success in Controlling Large Industrial Sources

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AIR RESOURCES BOARD

Today's Presentation

- Background
- New Source Review in California
- Industrial Source NOx Control Overview
  - Power Plants
  - Oil/Gas Production and Refining
  - Other Sources: Glass Manufacturing, Cement Manufacturing, Stationary Diesel Engines
- Questions

Background:

California Regulatory Structure

- ARB regulates mobile sources, consumer products, and air toxics
- Local air districts regulate stationary sources and other emission sources
  - 35 local air districts
  - Responsible for permitting/prohibitory rules
- ARB has oversight authority

Background:

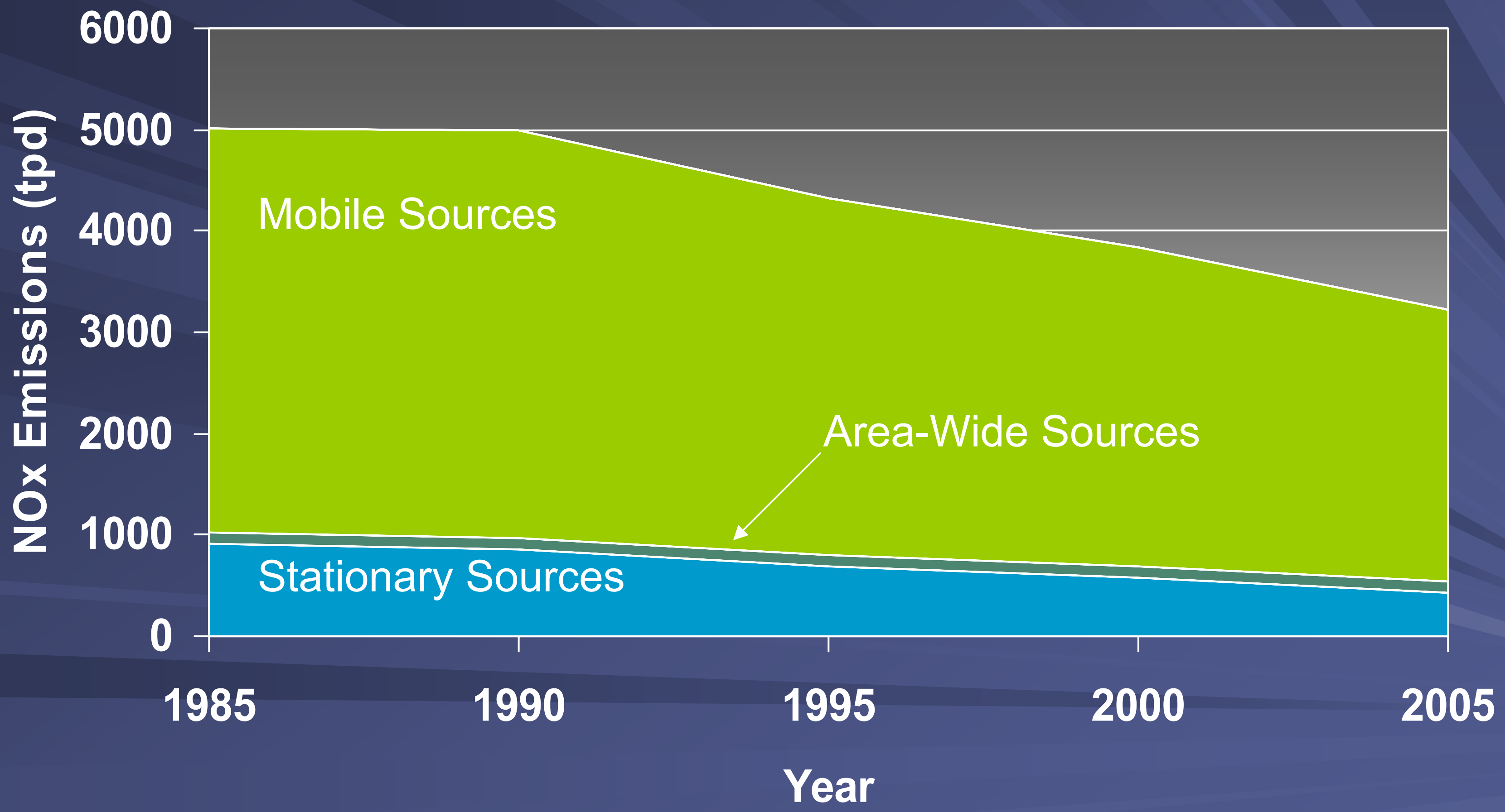
2005 Annual Average Emissions Statewide

Category	NOx (tpd)	ROG (tpd)	SOx (tpd)
Total Stationary Sources	**420** (13%)	**473** (19%)	**112** (37%)
Total Fuel Combustion	324	48	38
Total Waste Disposal	3	14	<1
Total Cleaning and Surface Coatings	<1	210	<1
Total Petroleum Production & Marketing	9	145	46
Total Industrial Processes	84	55	28
Total Area-Wide Sources	**112** (4%)	**750** (31%)	**11** (4%)
Total Mobile Sources	**2687** (83%)	**1207** (50%)	**179** (59%)
TOTAL STATEWIDE	**3,219**	**2,430**	**302**

Source: ARB Almanac Emission Projection Data

Background:

Statewide NOx Emission Trends (1985-2005)

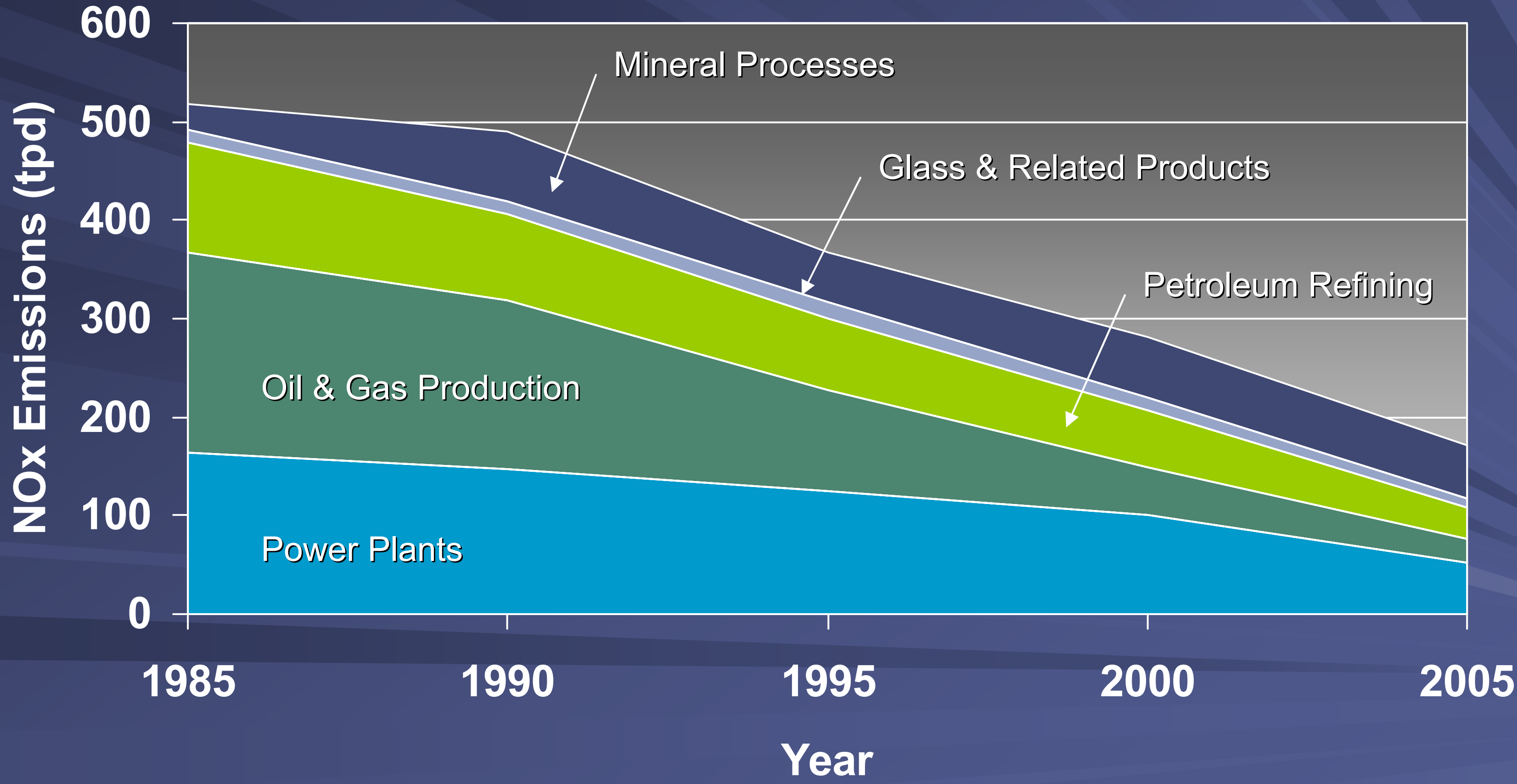


Background:
2005 State Top 10 NOx Sources

	2005 Annual Average Emissions
1	Heavy Duty Diesel Trucks
2	Light Duty Cars
3	Ships & Commercial Boats
4	Off-road Equipment (construction and mining)
5	Trains
6	Off-road (other)
7	Farm Equipment (tractors)
8	Manufacturing & Industrial (boilers, engines)
9	Heavy Duty Gas Trucks
10	Service & Commercial (boilers, engines)

Background:

Industrial Source Statewide NOx Emission Trends (1985-2005)



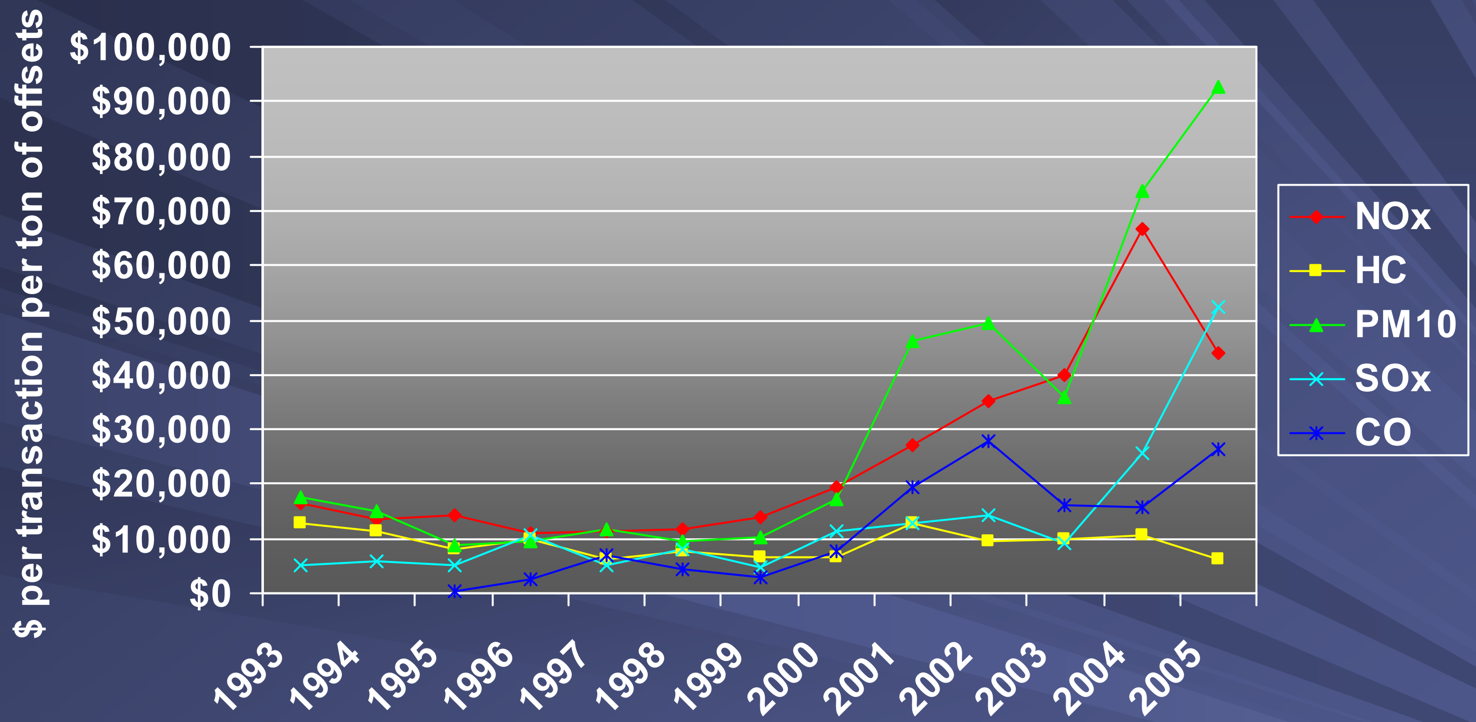
NSR's Success in California

- California's NSR in effect over 20 years
- BACT is cornerstone
- California BACT akin to federal LAER
  - Applied on emissions unit basis
  - In severe areas, BACT at 10 lb/day; some areas have BACT triggers of ≤2 lb/day
- NSR contributes to air quality improvements
- NSR not deterrent to economic expansions

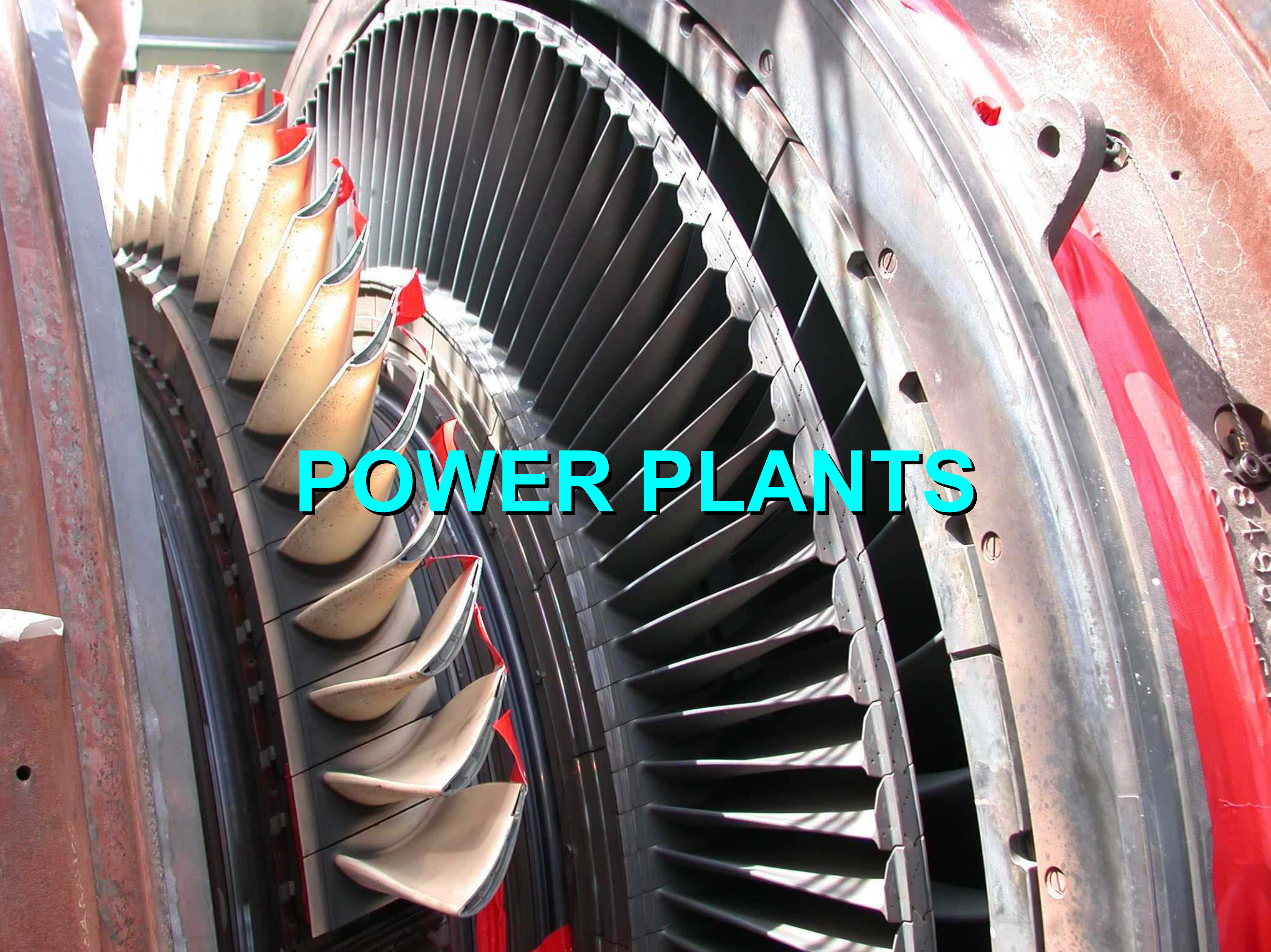
NSR Challenges: Offsets

- Offsets available in some areas, constrained in others
- 1999 power plant expansion impacted supply/cost
- “Surplus” criteria difficult due to air quality problems
- Focus now on “non-traditional” sources
- South Coast pilot credit rules are U.S. EPA approved for RECLAIM
  - truck stop electrification and marine vessel repowering
  - South Coast only district in California to modify NSR rules to allow use of limited-life offsets

Statewide Average Offset Costs

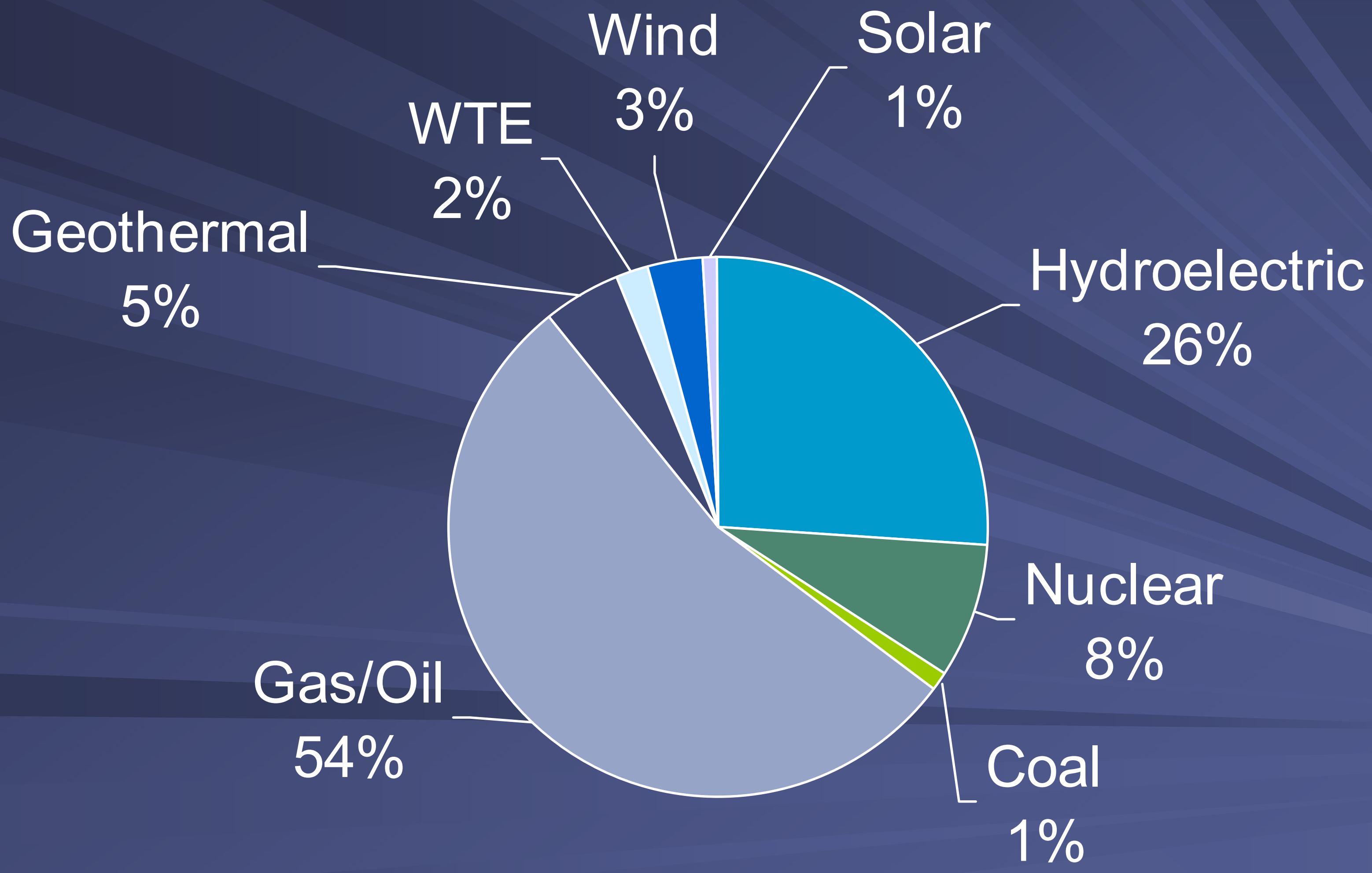


- Prices for several pollutants rose with California energy crisis; significant increase in PM10 cost since 2001
- Offset availability a factor in driving emission reductions

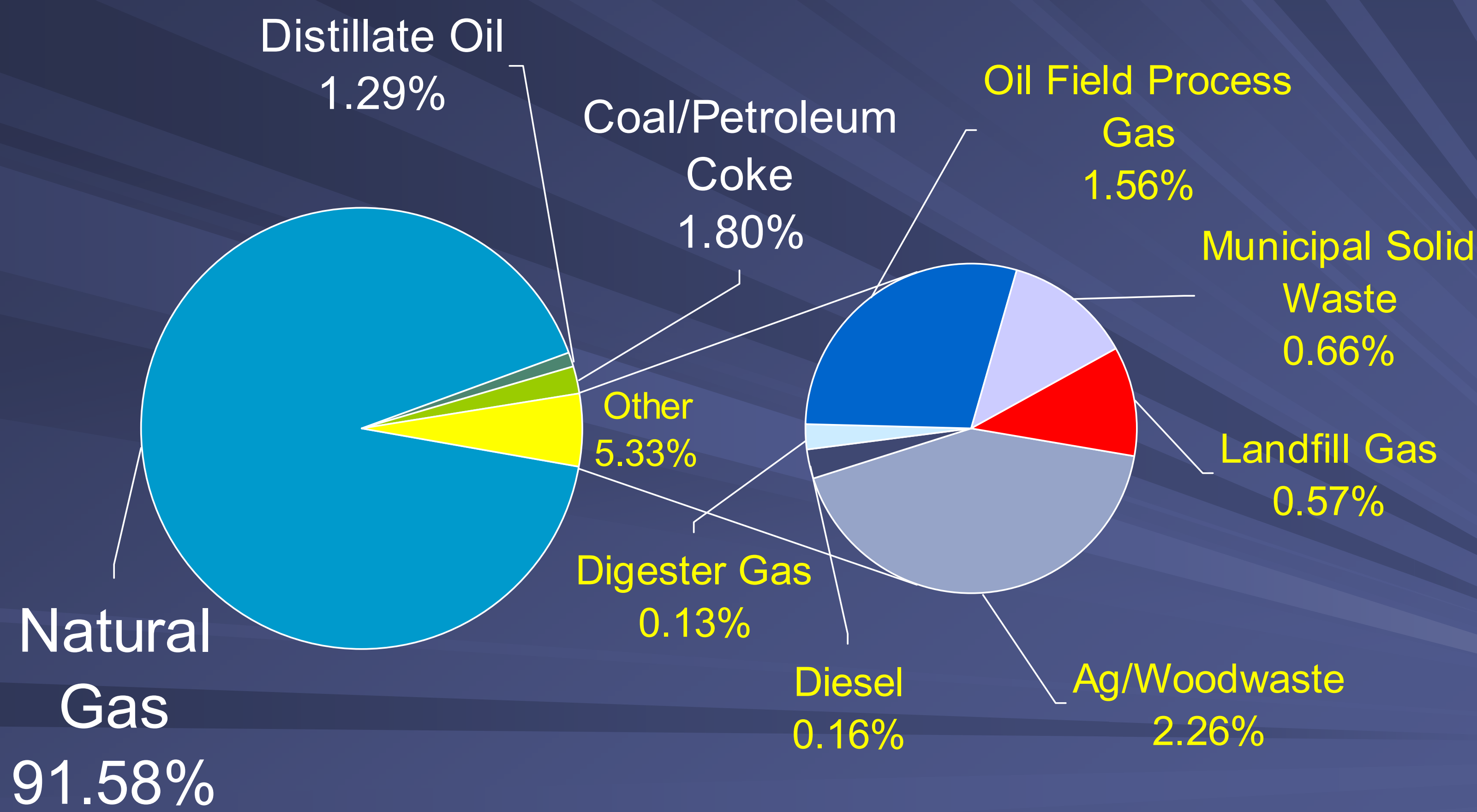

POWER PLANTS

California Power Mix

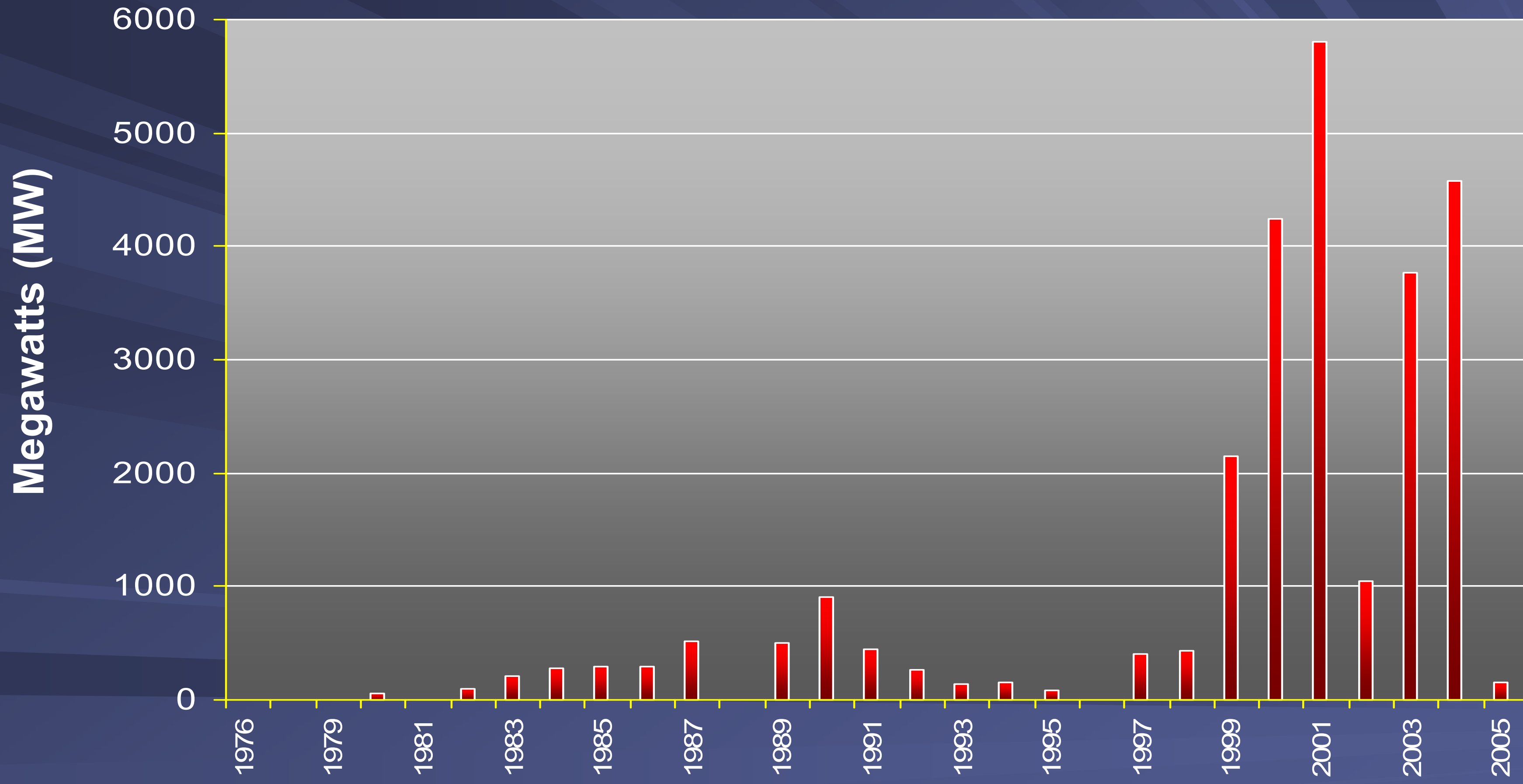
(Based on Installed Capacity)



California In-State Fuel-Fired Generation



Power Plant Projects Approved By Year (1976 to 2005)

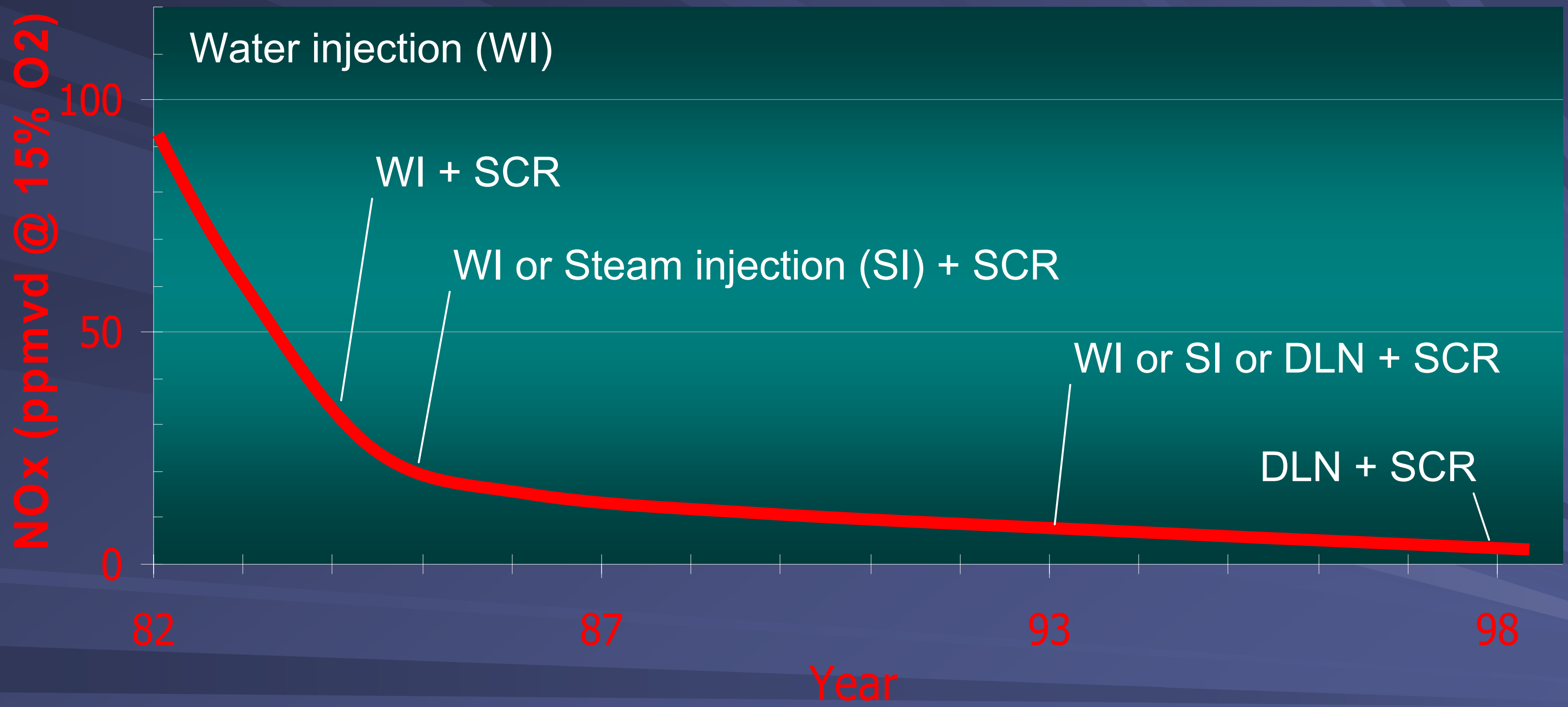


Source: California Energy Commission

Power Plant NOx BACT Trend:

Combined-Cycle/Cogeneration Turbine Configurations

97% Reduction Since 1982



Typical Turbine NOx Requirements

	Turbine Configuration	NOx (ppm @ 15% O_2)
BACT (new units)	Simple cycle, gas-fired	2.5
	Combined cycle, gas-fired	2.0
BARCT (existing units)	Simple cycle	5* (gas)/ 25 (oil)
	Simple cycle ≤ 877 hr/yr	25** (gas)/ 42** (oil)
	Combined cycle	5* (gas)/ 25 (oil)

* Sources opting for extended compliance date must meet 3 (gas)

** Sources opting for extended compliance date must meet 5 (gas)/25 (oil)

- Common combustion controls: water/steam injection, dry low-NOx combustors
- Common add-on controls: SCR, SCONOx

Cost of Emission Controls

- Typical 500-MW combined-cycle plant costs $250 to $300 million
- Cost of NOx/CO controls $6.5 to $7.5 million
- Percent of capital cost less than 3%
- Additional cost of 0.2¢ per kWh generated

National vs. California Emissions

For Thermal Electric Generation

	lb/MWh		Tons/yr	
	NOx	SOx	NOx	SOx
California (2005) South Coast air basin	0.357 0.232	0.033	26,400	1,900
Western U.S.*	1.74	1.32	616,000	470,000
U.S. Average*	2.99	7.79	4,400,000	11,400,000

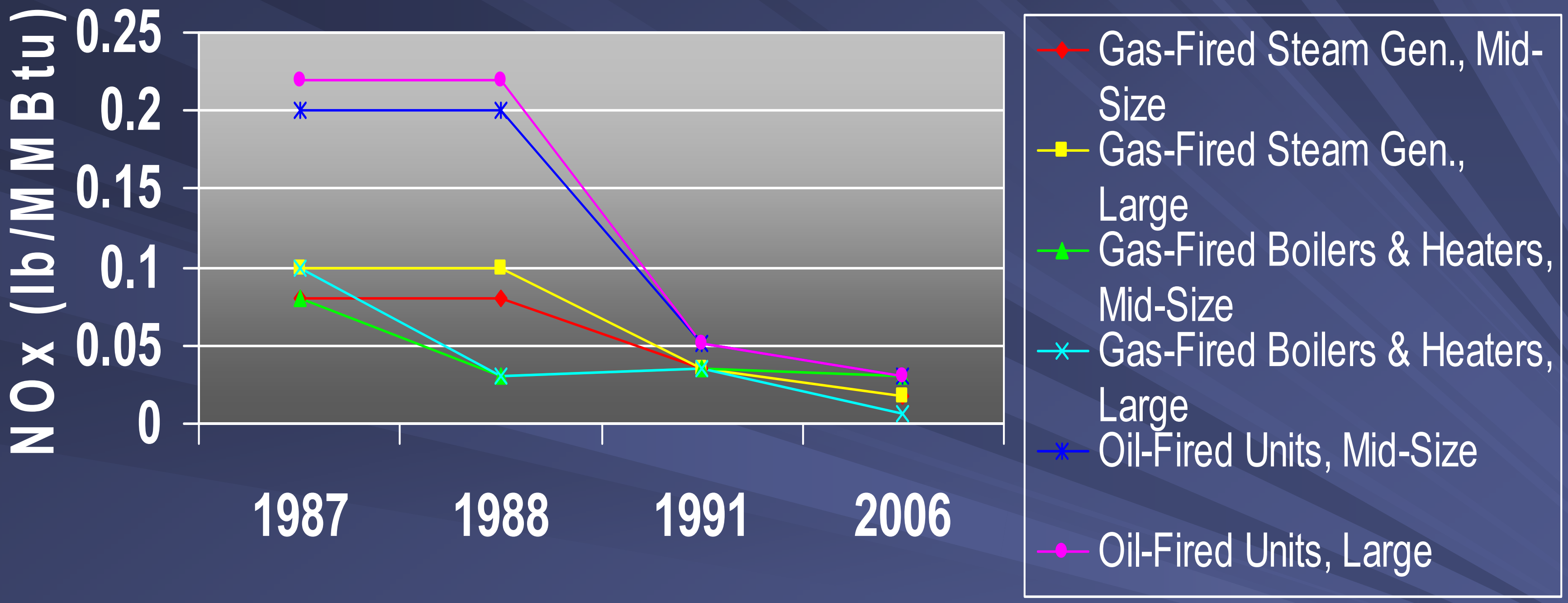
* Based on Energy Information Administration (EIA) data for 2004

Push for California-Level Controls in Border Region

- ARB comments on cross-border projects, both transmission and power generation projects
- Concern over poorly controlled power plants that transport emissions into California
- Two turbine plants that will export electricity to CA agreed to emission levels close to CA BACT
  - 2.5 ppm NOx (SCR), 4 ppm CO (oxidation catalyst)
  - 3.5 ppm NOx (SCR), 30 ppm CO

OIL & GAS PRODUCTION AND PETROLEUM REFINING

NOx Control History: Boilers, Steam Generators & Process Heaters



- For gas-fired units, approximately 63% to 94% reduction since 1987
- For oil-fired units, approximately 85% reduction since 1987

Boiler NOx BACT

- Based on most stringent CA BACT guidelines

Size Rating	NOx Emission Level (@ 3% O_2)	Typical Technology	Rest of U.S.*
<20 MMBtu/hr, natural gas or propane	12 ppm (0.015 lb/MMBtu)	Low NOx burner	0.03 lb/MMBtu
≥20 MMBtu/hr, natural gas or propane	7-9 ppm (0.009-0.011 lb/MMBtu)	Low NOx burner, SCR or equivalent	0.034 lb/MMBtu
Dual fuel or oil fired	30 ppm or weighted average (0.036 for gas and 0.039 lb/MMBtu for oil)	Low NOx burner	

* Most stringent limit found in EPA RACT/BACT/LAER Clearinghouse

Refinery Process Heater NOx BACT

- Based on most stringent CA BACT guidelines

Size Rating	NOx Emission Level (@ 3% O_2)	Typical Technology	Rest of U.S.*
≤50 MMBtu/hr, natural gas and/or LPG	30.0 ppm, achieved (0.036 lb/MMBtu) 1.7-25.0 ppm, feasible (0.002-0.031 lb/MMBtu)	Low NOx burner Low NOx burner, low NOx burner + SCR	0.03 lb/MMBtu
>50 MMBtu/hr, natural gas or treated refinery gas	9.0 ppm, achieved (0.011 lb/MMBtu) 1.7-9.0 ppm, feasible (0.002-0.011 lb/MMBtu)	SCR LTO system, low NOx burner + SCR	0.08 lb/MMBtu

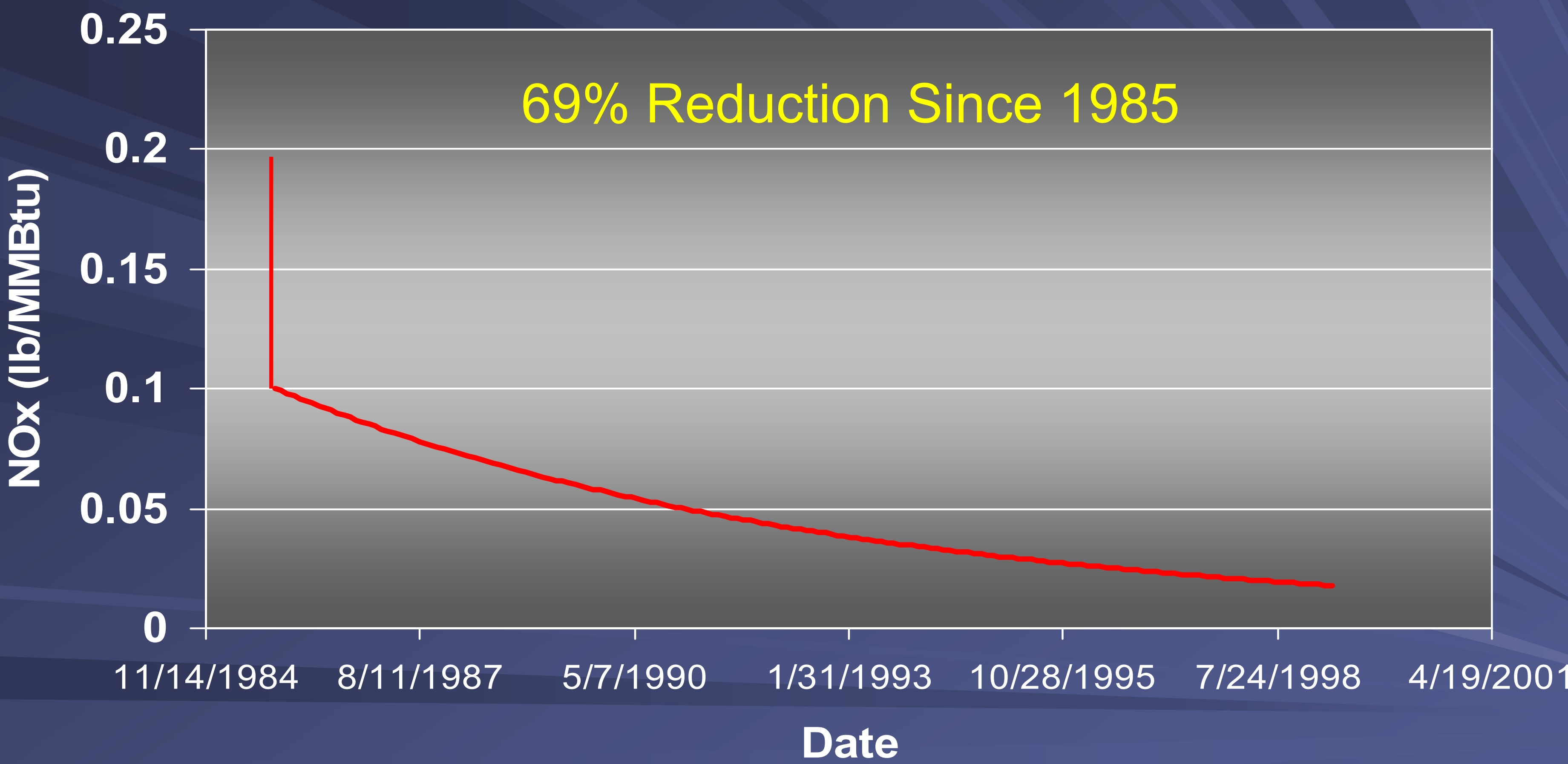
* Most stringent limit found in EPA RACT/BACT/LAER Clearinghouse

Oilfield Steam Generator NOx BACT

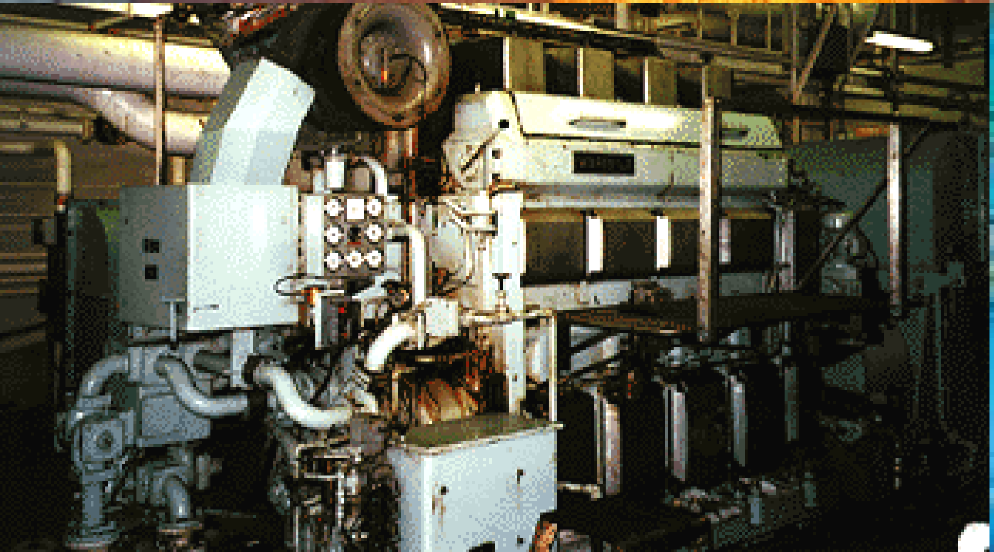
- Based on most stringent CA BACT guidelines

Size Rating	NOx Emission Level (@ 3% O_2)	Typical Technology
≥5 MMBtu/hr, natural gas, treated waste gas, or recovered gas	20.0 ppm (achieved) 9.0-14.0 ppm (feasible)	Low NOx burner Low NOx burner, SCR

Oilfield Steam Generator NOx BACT Trend




OTHER SOURCES:
Glass, Cement, Diesel




Typical Glass Furnace NOx Requirements

	Furnace Type	Combustion Type	NOx Limit (lb/ton glass pulled)
CA BARCT (existing units)	Container glass or fiberglass	100% air fuel fired, Oxygen assisted combustion	4.0 (24-hr block average)
	Flat glass	100% air fuel fired, Oxygen assisted combustion	9.2 (24-hr block average), 7.0 (30-day rolling average)
RACT, Rest of U.S.*	Container glass		5.5
CA BACT	Container glass	Using oxy-fuel system	3.0 (achieved in CA)
	Flat/float glass	Using SCR system	3.70
LAER, Rest of U.S.*	Float glass		6.5
BACT, Rest of U.S.*	Flat/float glass		7.0

* From EPA RACT/BACT/LAER Clearinghouse

Cement Kiln NOx RACT/BARCT

Type of Kiln	NOx Limit*
Preheater-precalciner	6.4 lb/ton clinker produced (30-day average)
Long dry	6.4 lb/ton clinker produced (30-day average)
Short dry	7.2 lb/ton clinker produced (30-day average)

* Adjustment to NOx limit for systems that recover waste heat and generate electricity

- Typical controls: combustion controls, low NOx burners, staged combustion, NOx reducing fuels (includes tire-derived fuels)

Stationary Diesel Engines

- 1998: ARB identified diesel PM as a toxic air contaminant
- Diesel PM contributes >70% of state estimated potential cancer risk levels and contributes to premature death
- 2000: ARB adopted a Diesel Risk Reduction Plan
- Goal: 85% reduction in diesel PM by 2020

Stationary Diesel Engines

- February 2004: ARB adopts ATCM for stationary diesel engines
  - Use best available diesel PM controls and lowest-emitting diesel engines
- After-treatment technology shown effective
  - Diesel Particulate Filter: $38/hp capital cost
  - Diesel Oxidation Catalyst: $10/hp capital cost
- 80% reduction in diesel PM from all stationary engines by 2020 relative to 2002

Summary

- NSR effective at time of installation
- Offsets are a continuing challenge
- Significant emission reductions achieved through cost-effective technology
- Controls applicable nationwide
- Future challenges exist to further reduce emissions due to ongoing air quality problems

QUESTIONS?