



NO_x Reduction Program

The Dow Chemical Company
Case Study



Topics To Cover

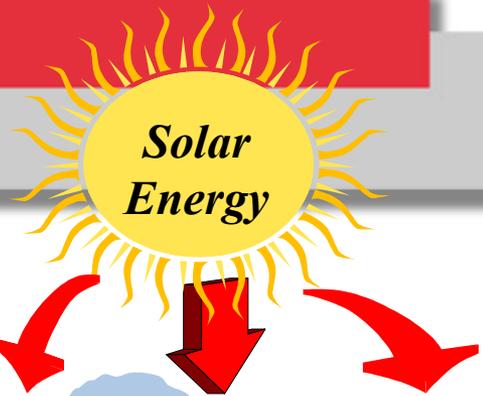
- ↓ Background
- ↓ Regulatory Impact On Dow
- ↓ Project Approach
- ↓ Cap Management

What Is NO_x?

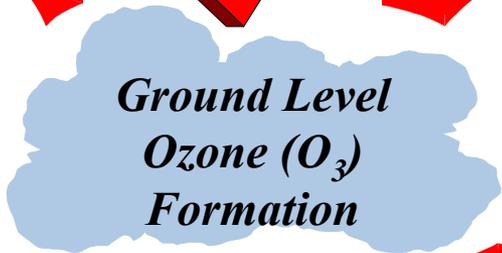
- During combustion, nitrogen in the air and/or the fuel is thermally oxidized into nitric oxide (NO) or nitrogen dioxide (NO₂)



Referred to as “NO_x”



Solar Energy



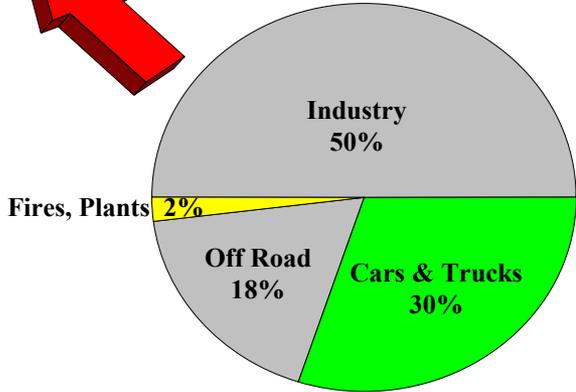
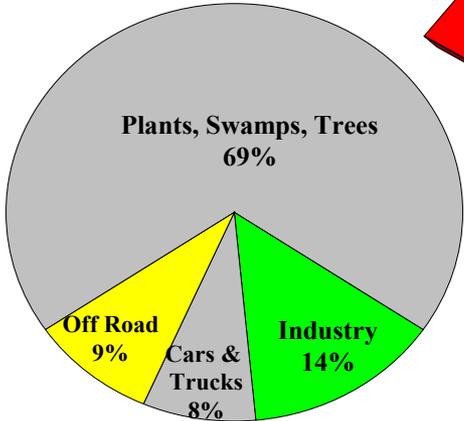
Ground Level Ozone (O₃) Formation

- Little or No Wind
- High Temperatures
- Clear Skies

Oxygen (O₂)

Volatile Organic Compounds (VOC)

Nitrogen Oxides (NO_x)



Source: TNRCC Point Source Database -1997



Why Do We Care About NO_x?

- NO_x is a precursor to formation of low level ozone
 - NO_x, in the presence of sunlight, forms ozone at ground level
 - Ground level ozone is considered a respiratory health hazard

Regulation Of NOx

- Federal Clean Air Act of 1990 established ambient air quality standards for 6 pollutants (ozone being one)
- All states were required to be in “attainment” under those standards
- States having “non-attainment” areas were required to submit a State Implementation Plan (SIP) to the EPA detailing how attainment would be reached

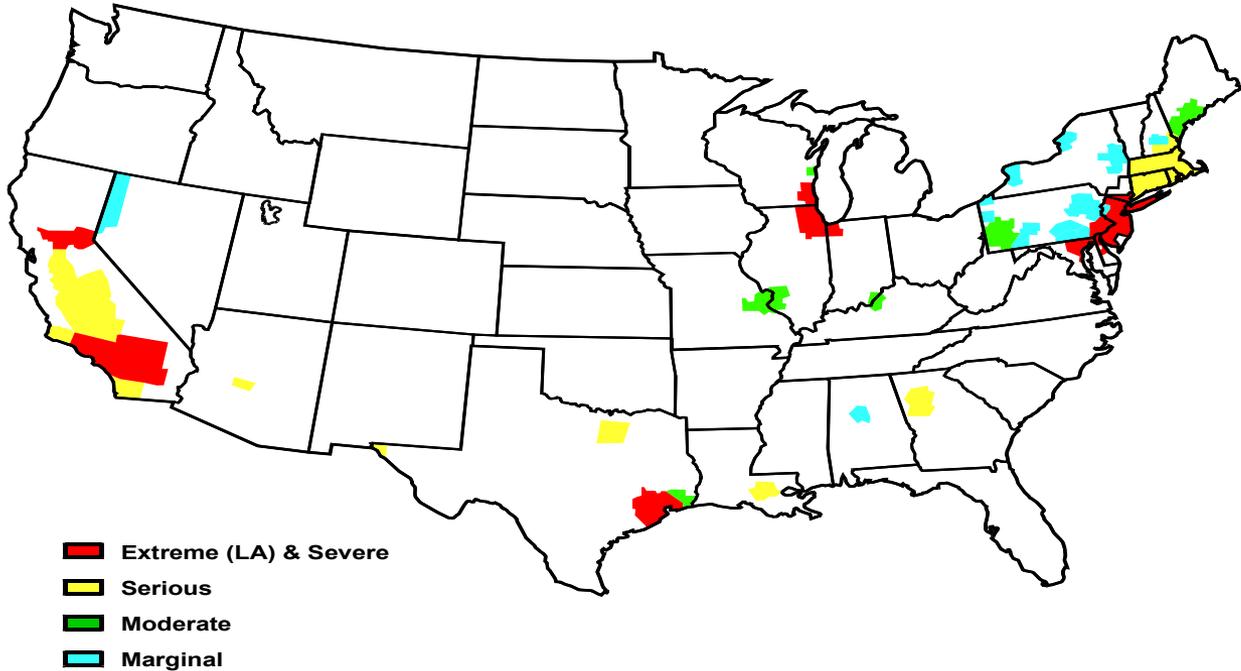
Houston-Galveston Area (HGA)

- HGA consists of eight counties in Houston metro area
- Designated as “nonattainment-severe”
- Attainment date of November 2007

Clean Air Act of 1990

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Ozone Nonattainment Areas, January 2001

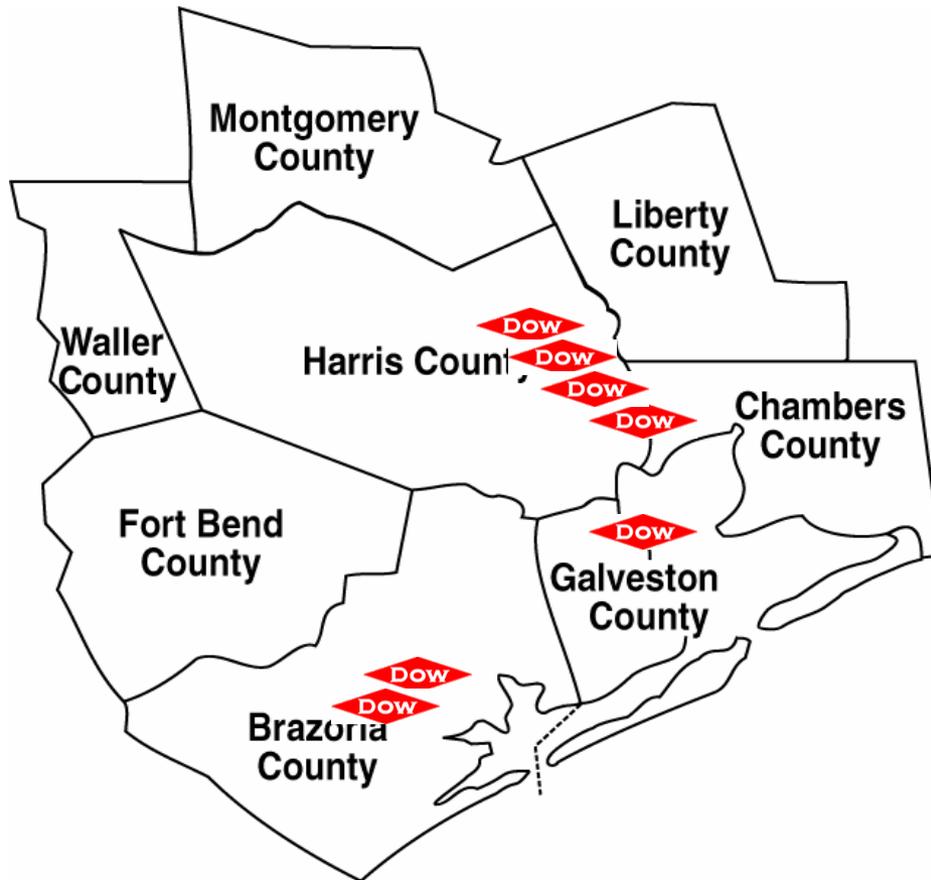


Source: Cambridge Energy Research Associates, and EPA, 10/24-13

10324-13



Dow Sites in HGA



- Freeport A/B/OC
- Oyster Creek Cogen
- Laporte
- Texas City
- Deer Park
- Jacintoport
- Sheldon

Current Status In Texas

- Latest SIP revision submitted to EPA in December 2002
- SIP Emission Reductions
 - 80% average NOx reduction in industrial point sources
 - 64% HRVOC reduction

Regulatory Impact On Dow



NOx Sources At Dow

- Boilers and Process Heaters
- Stationary Gas Turbines
- Stationary Internal Combustion Engines
- Pyrolysis Furnaces
- Boilers & Industrial Furnaces
- Incinerators

80% Rule Compliance

Of Control Projects  ~ 15

Cost  ~ \$100MM

NOx Reduction

▶ Retrofit projects = 5,600 tons

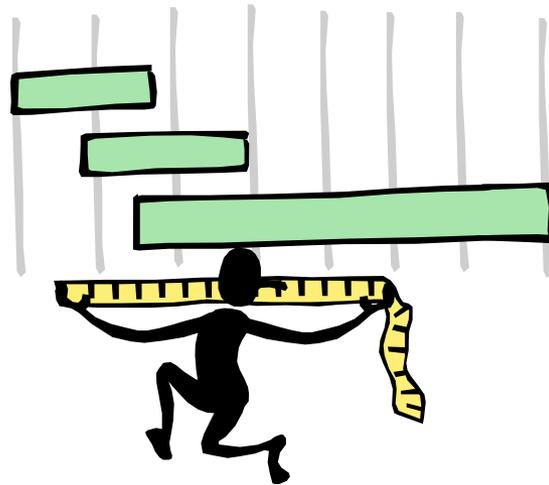
▶ Planned shutdowns = 4,600 tons

▶ Earlier reductions = 1,800 tons



Total Estimated Annual
Reduction (1997-2007)

NOx Project Approach



Project Team

- NOx Project Team assembled in fourth quarter 2000
- Project team of 50 people
- Dow Team consists of project management, engineering, and operations representatives
- Supplemented Dow know-how with consulting and design expertise from Technip-Coflexip (Technip)



Project Strategy

- Identify control alternatives for all sources (Feasibility Studies)
- One control plan for all Dow sites
- Maximize NOx reductions on gas turbines in Freeport
- Partner with businesses to determine shutdown timing
- Establish “cap margin”

Feasibility Studies

- 20 complete studies conducted by Technip
- Study contents
 - determined current emissions
 - technology alternatives to attain emission limits
 - cost estimate for each alternative,
 - recommended alternative

Control Plan

- ▶ Sources grouped by Site/Cap
- ▶ Identifies individual source fired duty & emission factor
- ▶ Identifies base & final allowances for each source
- ▶ Allows selection of NOx abatement technology
- ▶ Calculates source NOx reduction based on technology
- ▶ Identifies cost for each abatement technology
- ▶ Calculates annual cost effectiveness
- ▶ Sums costs & predicted emissions of all sources over time

Cap Margin

- Needed to ensure aggregate of sites not short of NOx allowances at end of year
- Margin utilization
 - Source variability
 - Capacity creep
 - Abatement device shortfall
 - Shifting turnaround schedules

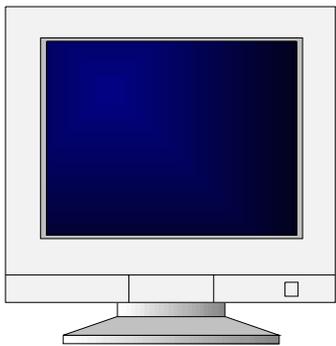
- **Size validated by Six Sigma Black**

Cap Management



The Challenge!

- Seven separate sites
- Over 150 point sources



Tool to manage cap on a “real time
basis

Tool Functionality

Needs

-  Collection, processing, & data storage for each source
-  Daily management of total emissions at each site
-  Regional emissions data from all seven sites
-  Annual roll up for regulatory reporting by site
-  Management of Dow inter-site cap & trade

NOx Data Flow

- One minute operational data from each NOx source
- Three area servers collecting data; one server functioning as “regional” server

Software

- Aspen-Tech IP.21 on standard Dell servers is the foundation
 - Provides data acquisition
 - Historian of raw data & summarized data
- Pavilion Environmental Portfolio Manager (EPM) serves as calculation engine to perform:
 - “Flat line” detection
 - Agency approved data validation & substitution
 - Agency approved calculations with results recorded in IP.21 “tags”
 - Agency report generation
 - Process Explorer displays for monitoring

Long Term Cap Management

- Plan is static but the environment is dynamic
 - Production levels change
 - Expansion projects will occur
 - New plants will be built
- Long term needs
 - Owner to maintain control plan
 - Business rules to allow for optimum solutions

Benefits

- ▷ NOx reductions of 21,000 tons annually from 1997 baseline
- ▷ Estimated \$60 million in savings (avoided costs)
- ▷ Turbine NOx emissions of 2.5 ppm (reduction from 160 ppm)

Questions?

