



# *Environmental solutions . . .*

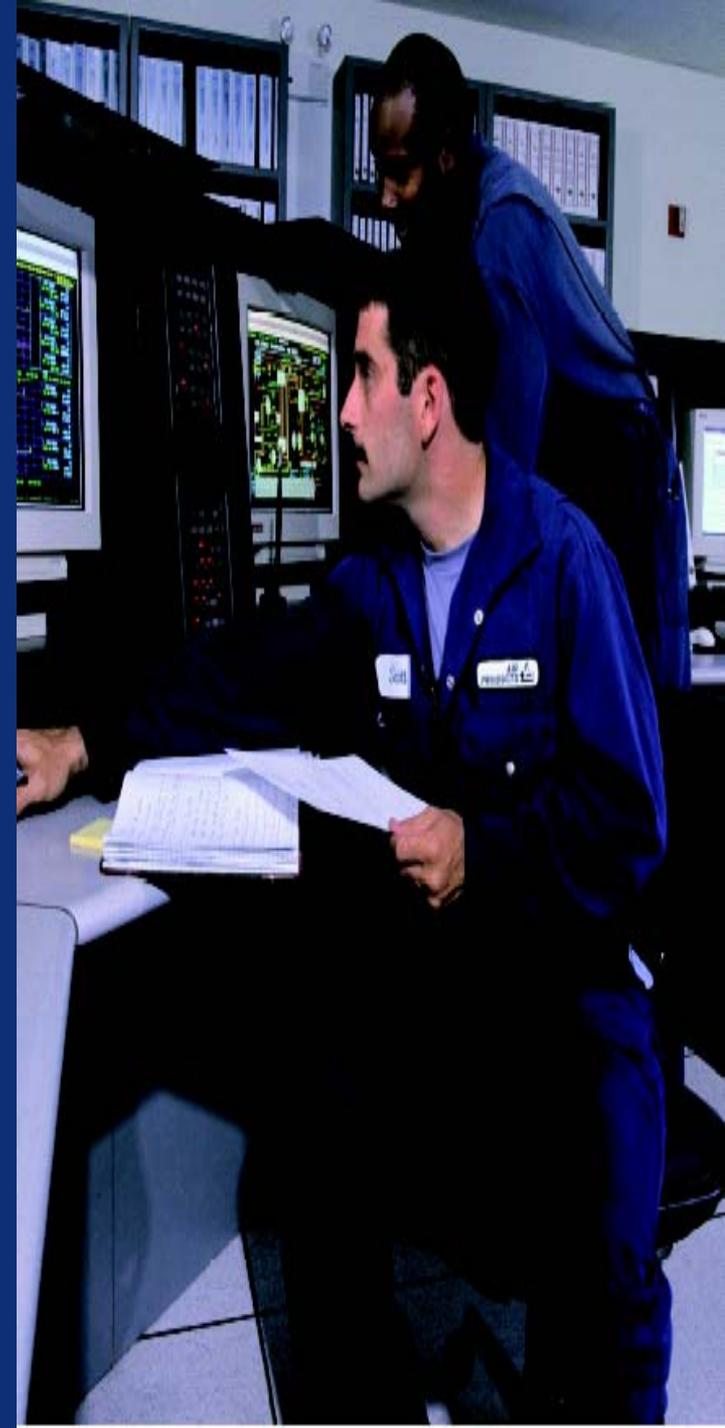
*Emissions Optimizer and  
Large Scale Vortex<sup>TM</sup> –  
Ultra Low NOx burner*

# Environmental Solutions

*Novel Emission Optimizing Technology*

## *Environmental Technologies*

- Low NOx burners- Large Scale Vortex™ Burner
- VOC emission reduction and polyolefin recovery
- Environmental Management Information Systems
- Cogeneration



# The considerations

Regulatory Compliance



Scenarios Planning



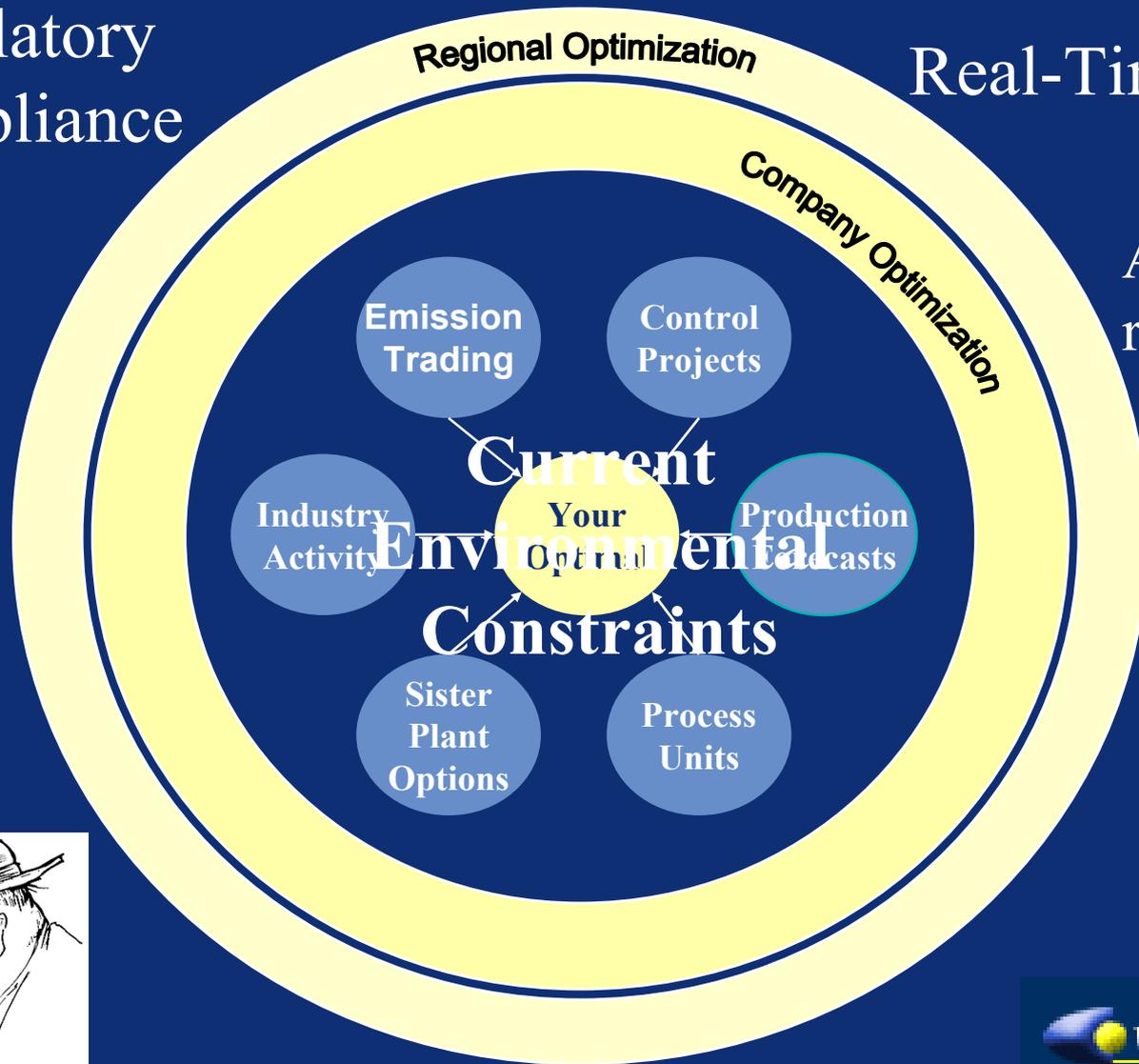
Regional Optimization

Real-Time

Air Products requirements

Integrate with EMIS

Flexible

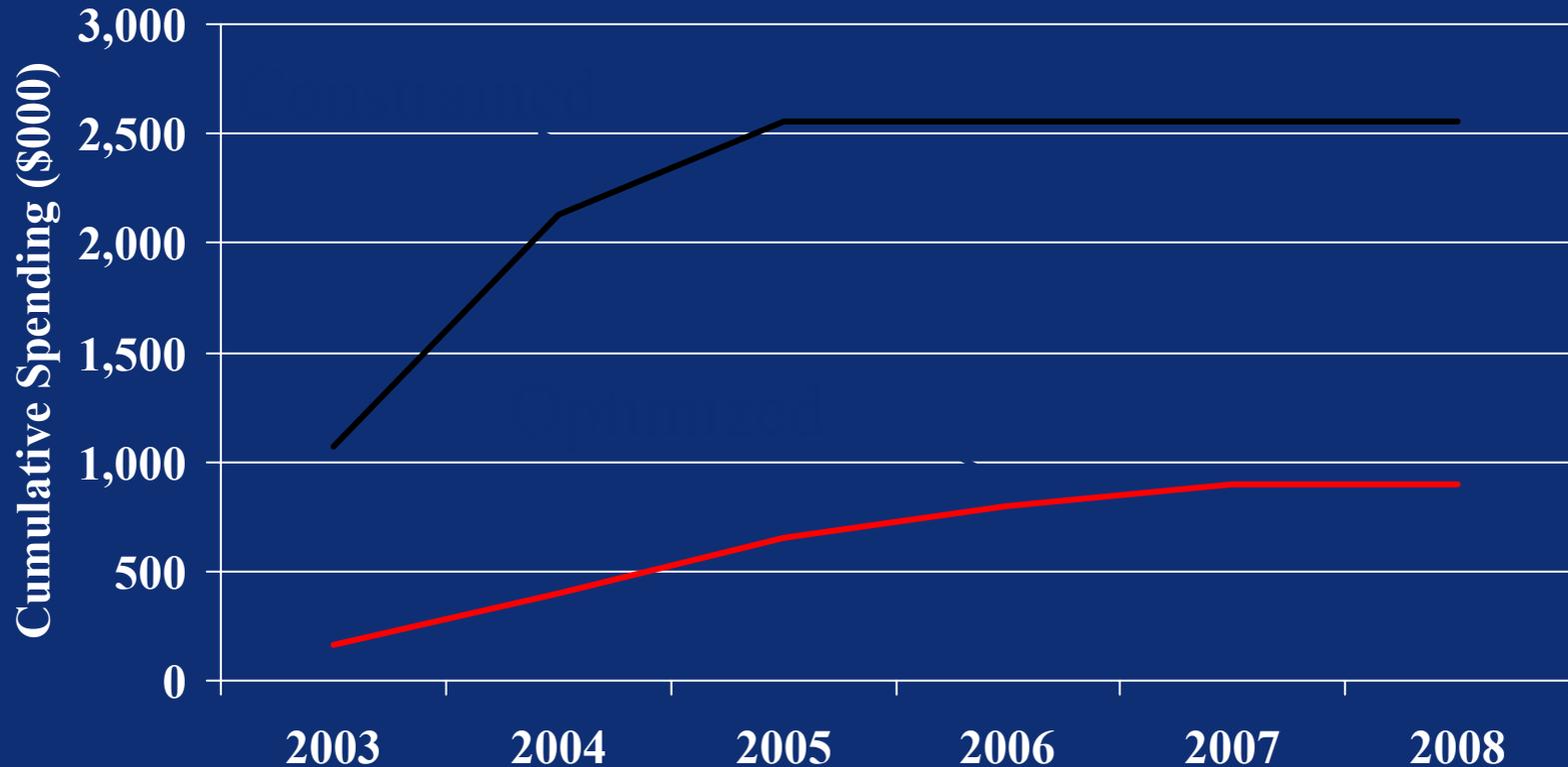


# A Company's Solution



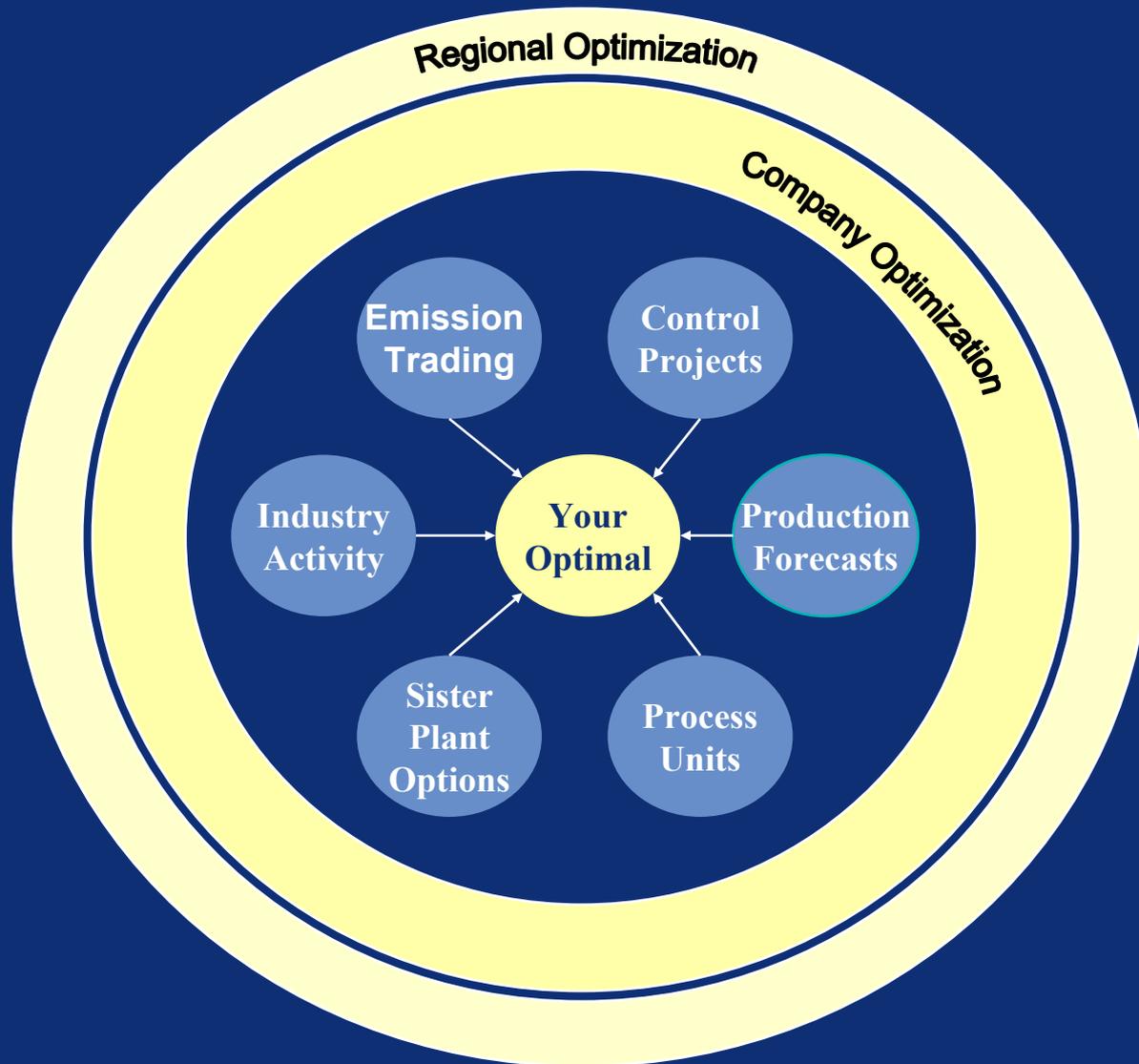
# **Air Products' Optimized Scenario**

## **Savings of \$1.6 Million**

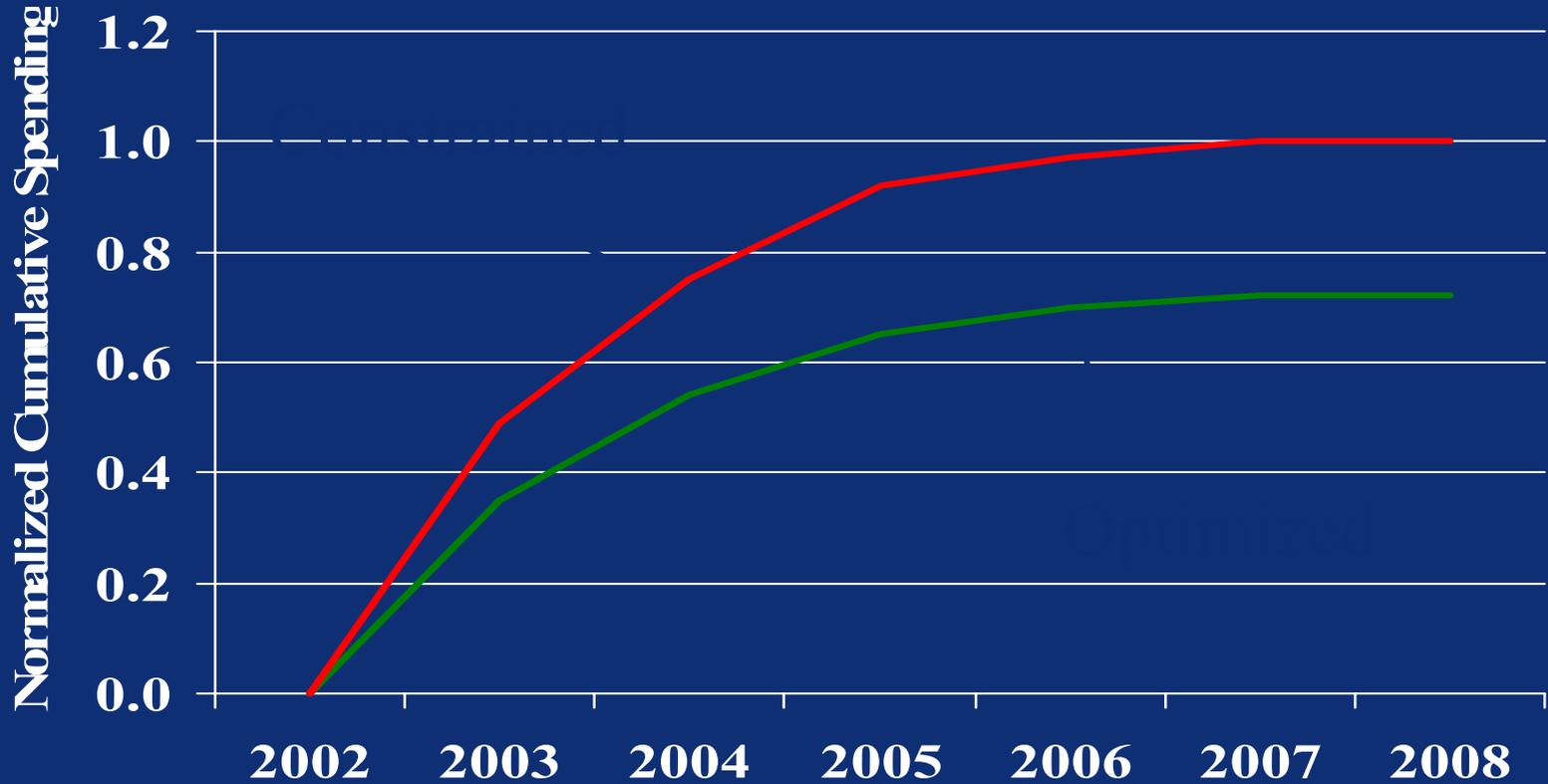


*Based on LaPorte and Pasadena sites*

# Industry Solution



# Industry Optimization Up to 25% Savings

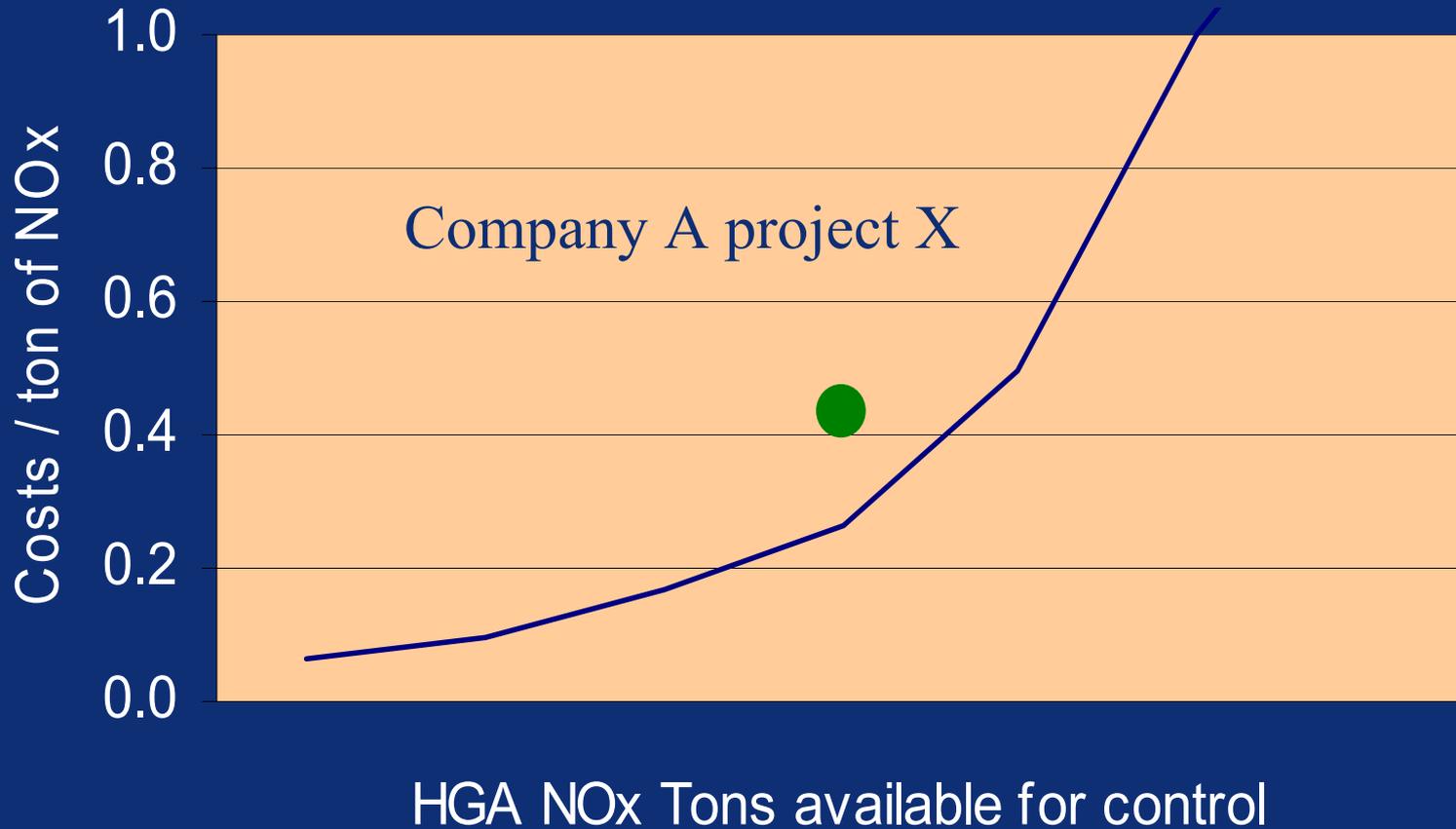


# **Air Products'**

## **Emissions Optimizer Features**

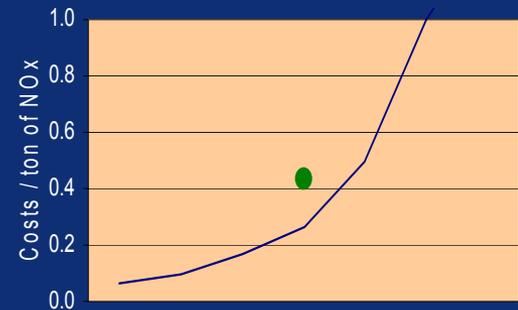
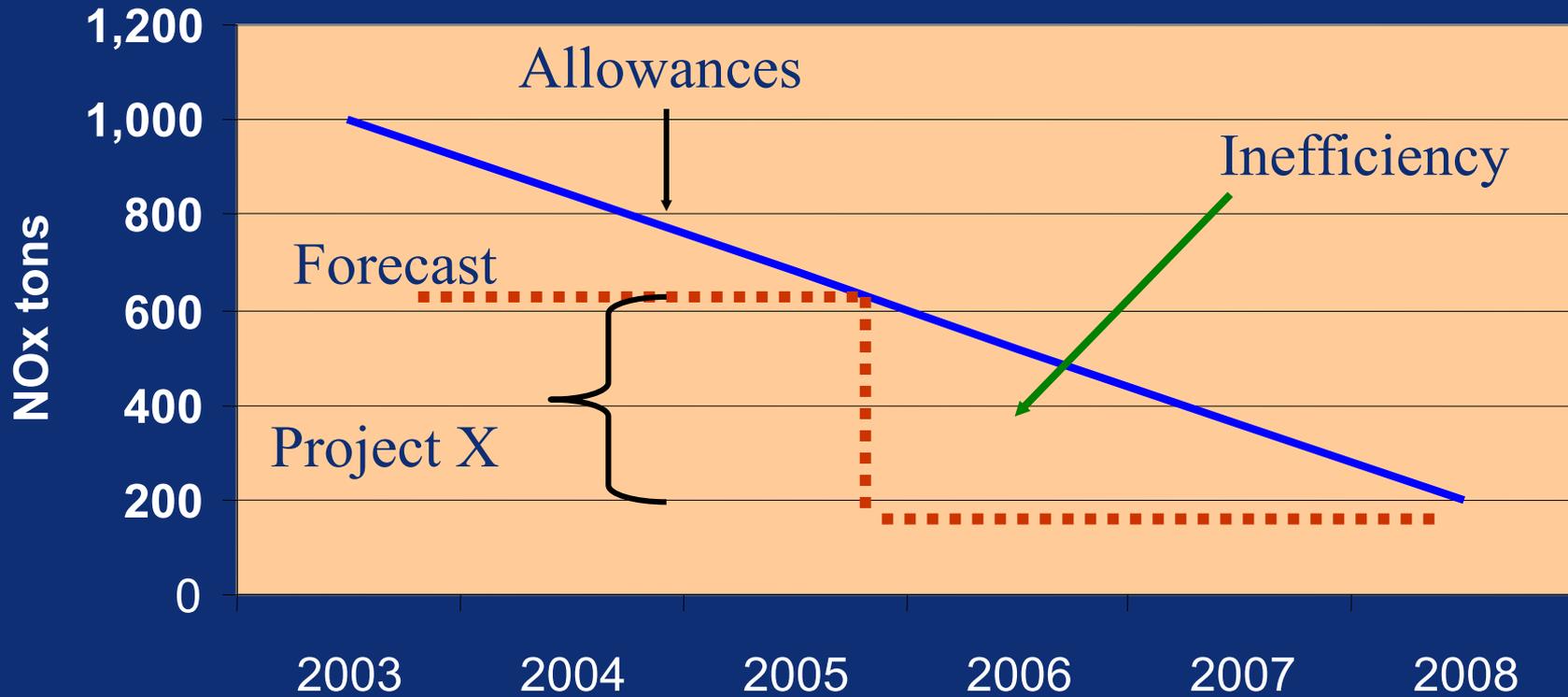
- **Best available technology -**
  - Mixed Integer Linear Programming (MILP)
- **Solving for an optimal economic cost solution:**
  - Capital projects, Forecast data and Regulatory- Cap and Trade, Reporting, permitting, new source reviews
- **Integration to existing emission databases**

# Cumulative HGA costs for NOx control projects

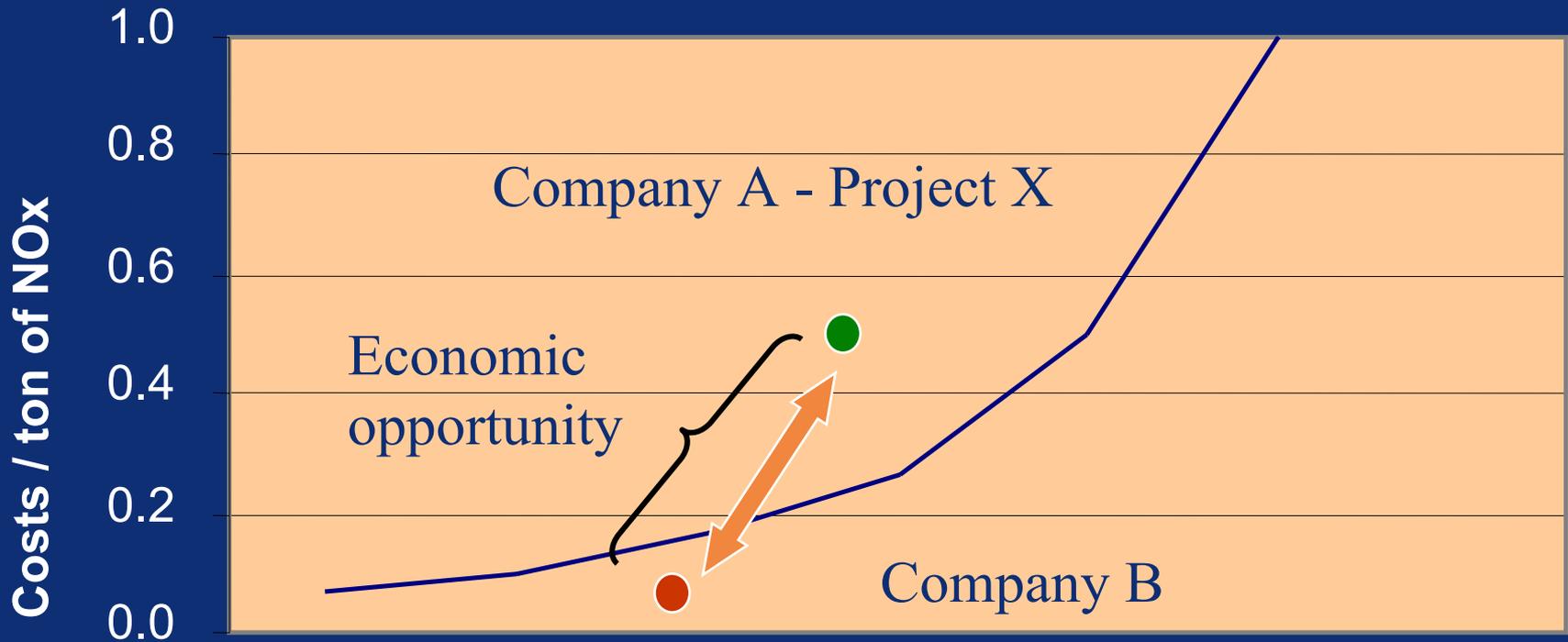


# Company A Strategy

## Reduce 220 NOx tons by 2005



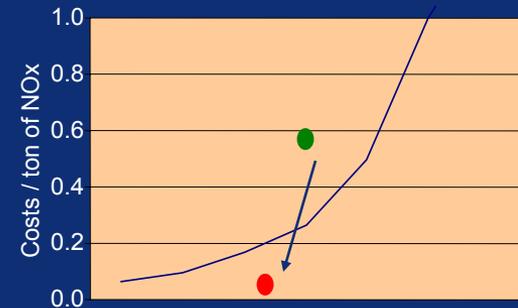
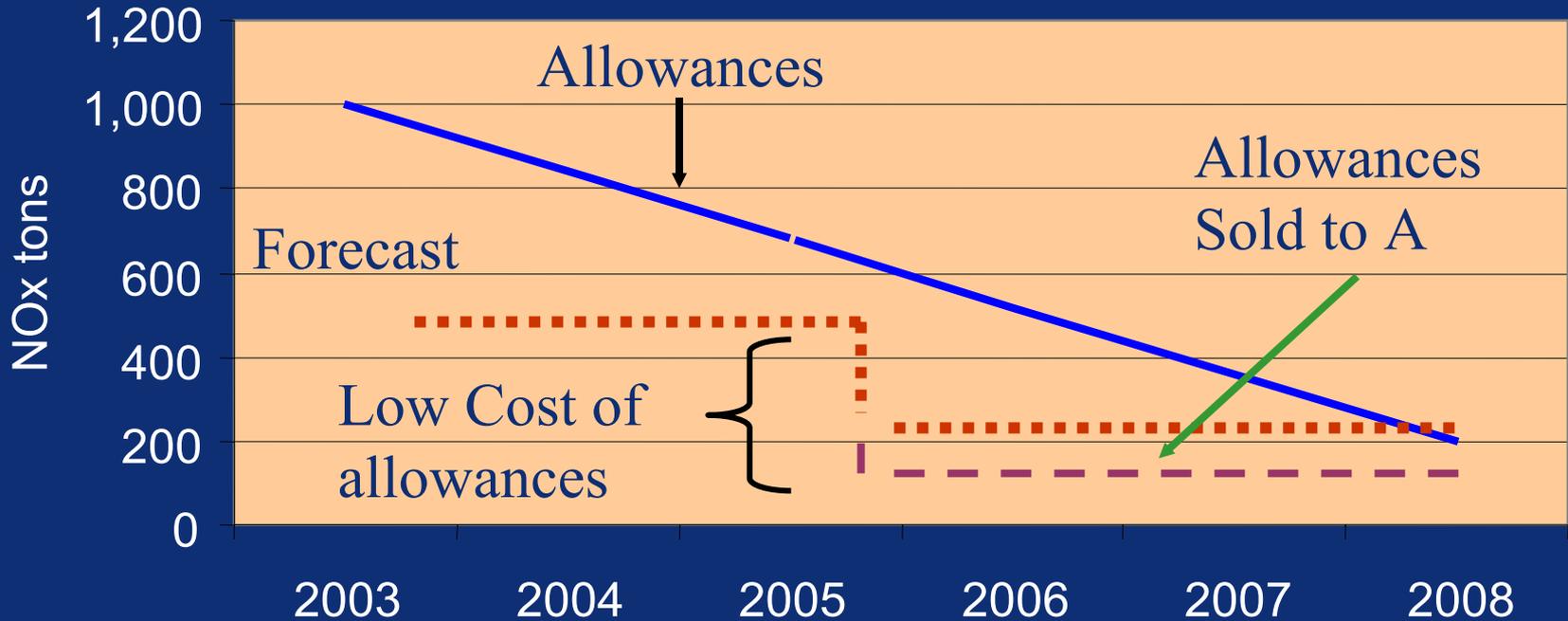
# Cumulative HGA costs NOx control projects



HGA NOx Tons available for control

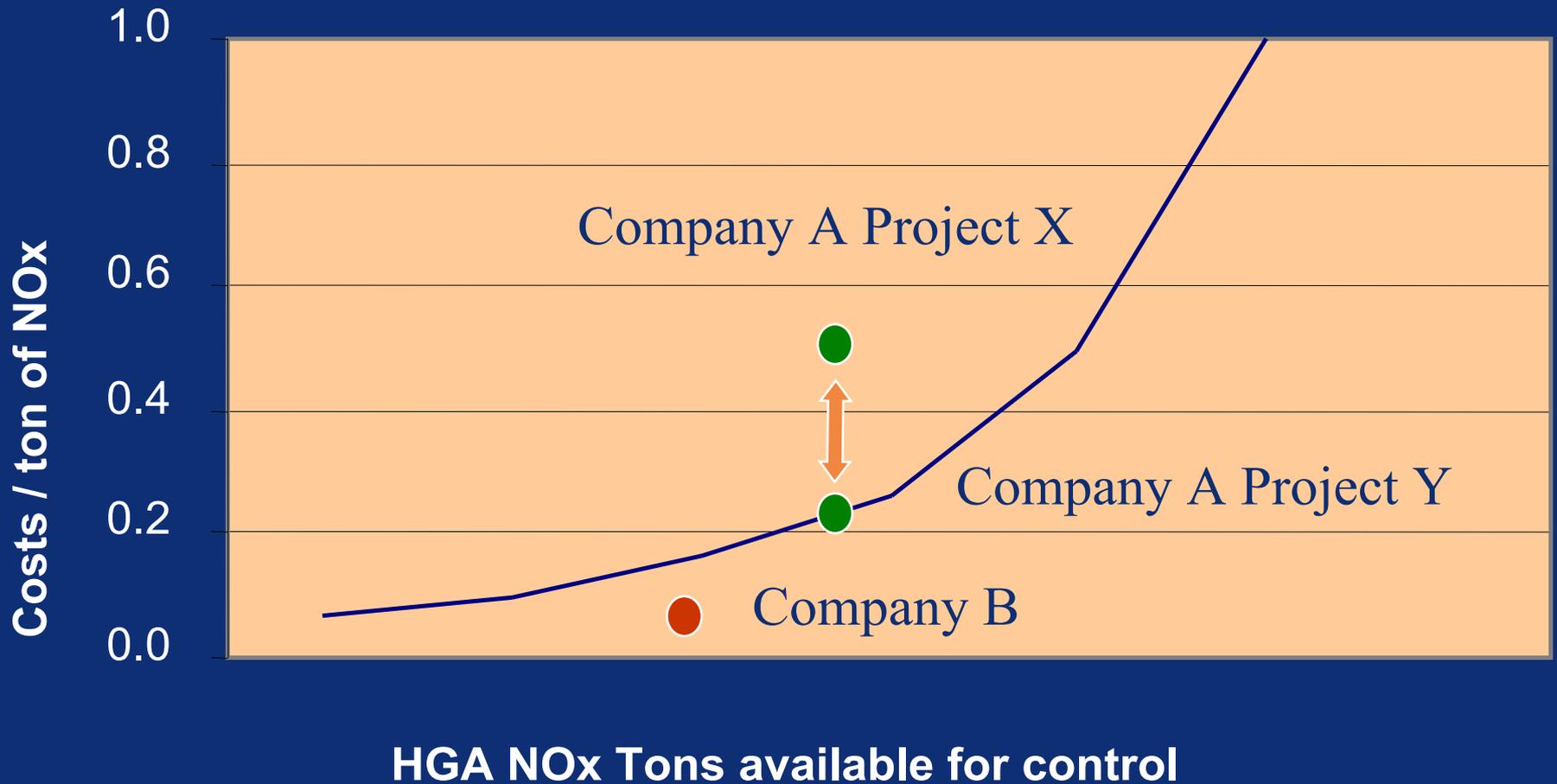
# Company B Strategy

## Optimized Scenario: over control 100 tons

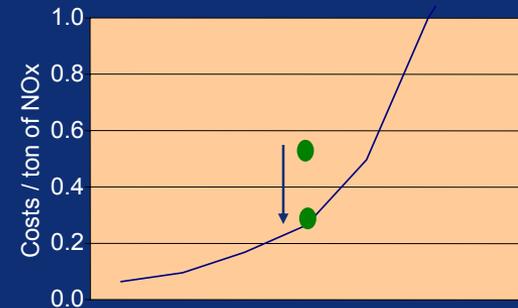
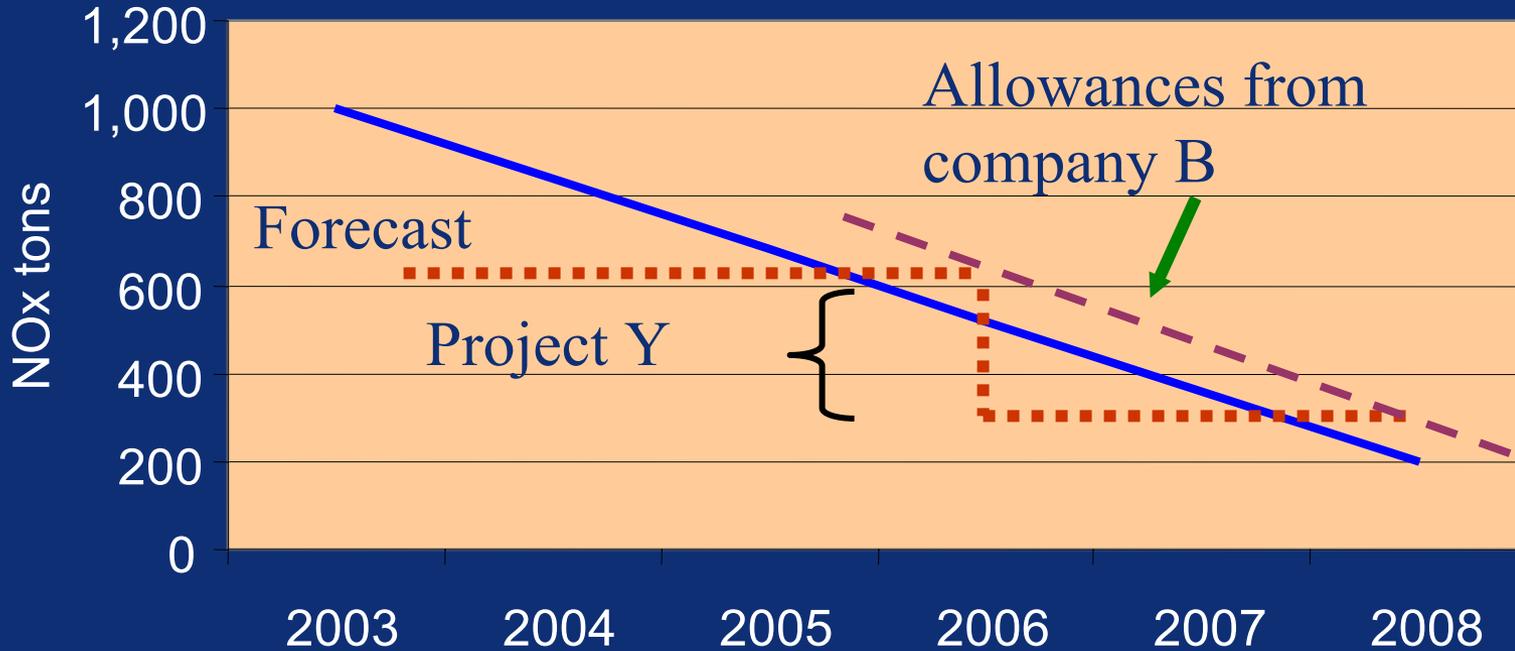


HGA NOx Tons available for control

# Company A: Optimized Strategy Selection of lower cost project



# Company A Optimized Scenario



# Emission Optimizer

## Sample Product Features

Scenario Builder

Portfolio | Control Project Scenario | Control Project | Production Scenario | Forecast Plan | Site Scenario | Company Scenario | Allowances

Home | **Optimizer**

Scenario Builder

Portfolio | Control Project Scenario | Control Project | Production Scenario | Forecast Plan | Site Scenario | Company Scenario | Allowances

### Control Project

Required fields are in **Red**

<b>Project Name</b>	<input type="text" value="Optimize_SMR"/>	<b>Site</b>	<input type="text" value="Pasadena Plant"/>
<b>Project Description</b>	<input type="text" value="Increase NH3 injection"/>	<b>Unit</b>	<input type="text" value="SMR"/>
<b>Total Project Cost</b>	<input type="text" value="5000"/>	<b>Depends On</b>	<input type="text" value="&lt;--NONE--&gt;"/>
<b>Yearly Operational Cost</b>	<input type="text" value="1500"/>	<b>Status</b>	<input type="text" value="Go"/>
<b>Duration Months</b>	<input type="text" value="0"/>	<b>On Stream Date</b>	<input type="text" value="January"/> <input type="text" value="2003"/>
Modified By AIR_PROD Admin		Construction Start Date 1/1/2003	
Modified Date 3/12/2003 2:35:09 PM			

Save    Reset    Delete    Exit

### Rate Information

Updated Rate Information				
ID	Fuel Type	Emission Type	Emission Factor	Lowest Emission Factor
7958	DEFAULT	NOx	0.0065	0.004

Add

# Forecast Project Implementation Based on NPV

**PRODUCTS**  **VisionMonitor** home help log out

AIR\_PROD Admin (Air Products, L. P.) Wednesday, March 12, 2003

Home **Optimizer**

**Scenario Builder**

Portfolio | Control Project Scenario | Control Project | Production Scenario | Forecast Plan | Site Scenario | Company Scenario | Allowances |

Portfolio Summary for Air Products, L. P.

Company  Optimize1 Site Name  Select Site Select Site Scenario

Portfolio Summary Calculated As of 3/12/2003 2:42:28 PM

Year	2003	2004	2005	2006	2007	2008
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### Control Project Scenario Details

#### Optimize\_Pasadena

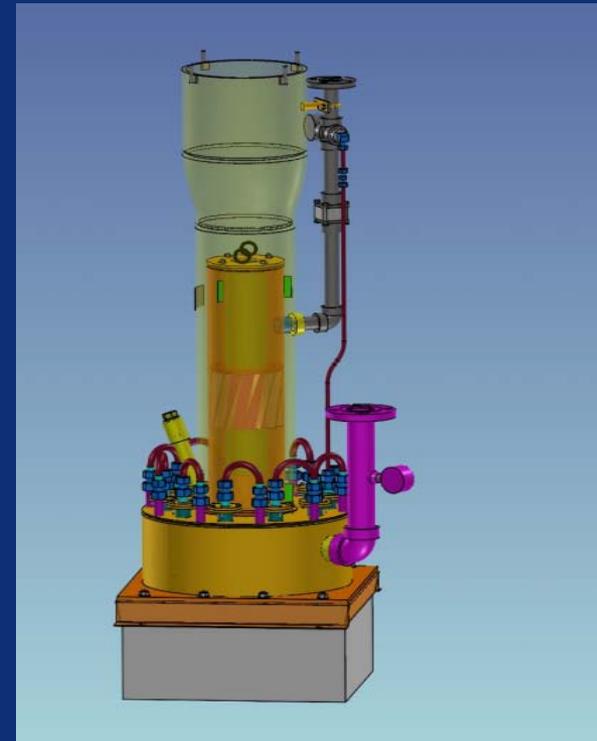
Unit	Project	Depends On	On Stream Date	EF to LEF Percentage	Total Project Cost	NPV
500-TUBN	OptimizeTech_Cogen		January, 2003	Normal EF (0%)	\$151,000.00	\$127,943.00
500-AUXBOIL	OptimizeTech_Aux		January, 2003	Normal EF (0%)	\$1.00	\$1.00
SMR	Optimize_SMR		January, 2003	Normal EF (0%)	\$5,000.00	\$9,829.00

#### Optimize\_LaPorte

Unit	Project	Depends On	On Stream Date	EF to LEF Percentage	Total Project Cost	NPV
HYCO3-FGPA	Optimize_HYCOA		January, 2003	Normal EF (0%)	\$5,000.00	\$3,472.00
HYCO3-FGPB	Optimize_HYCOB		January, 2003	Normal EF (0%)	\$5,000.00	\$3,472.00
GT-1	Aggressive Project		January, 2004	Normal EF (0%)	\$427,698.63	\$280,826.00
					<b>Total NPV :</b>	<b>\$425,543.00</b>

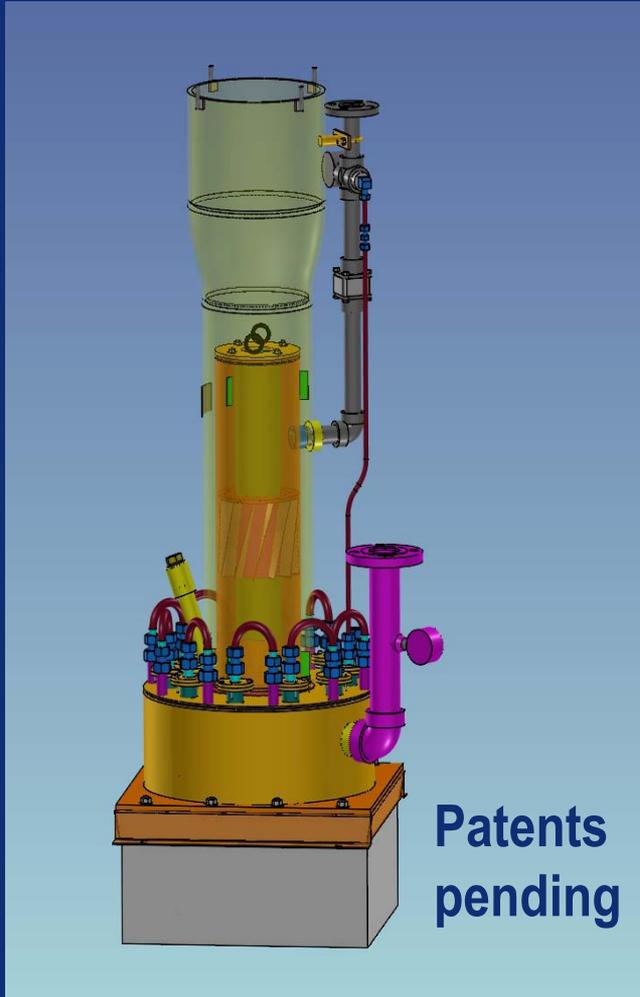
# Air Products Technology Large Scale Vortex™ Burner

New Orleans Reformer



Low NOx Burners

# Large Scale Vortex™ Burner



- Highly flexible fluidic flame stabilizer
- Extremely lean primary flame
- Unique nozzle design for rapid fuel dilution
- Low temperature spacious flame for uniform heat transfer
- $T_{\text{Spacious flame}} = T_{\text{Furnace}} + 500^{\circ}\text{F}$
- Fuel staging lances protected from radiation - run cool (no plugging)
- Multi-fuel capability
- Low fuel pressure requirements
- Robust design

# **Air Products' experience**

## **New Orleans – Hydrogen plant**

### *Objectives:*

**Reduce NOx (expect 10-15 ppm based on lab data)**

- **Maintain or improve production rate**
- **Maintain or improve thermal efficiency**



# Large Scale Vortex™ Burner Installation



# **Air Products – New Orleans SMR Operating Conditions**

- **Fuel – 120 mmbtu/hour**
  - 85% PSA purge gas; 15% Methane
  - PSA purge gas composition:
    - 50% CO, 30% H<sub>2</sub>, 10% CO and 10% methane
- **Burner specifics**
  - Thirty-nine (39) burners, three rows of 13 each
  - Designed firing rate: 3 mmbtu/hour
- **Hydrogen Reformer:**
  - Down fired and down flow
  - Induced draft
  - Bridgwall temperatures ~ 1800°F

# **NO<sub>x</sub> emission levels reduced 10 ppmv at 1600°F**

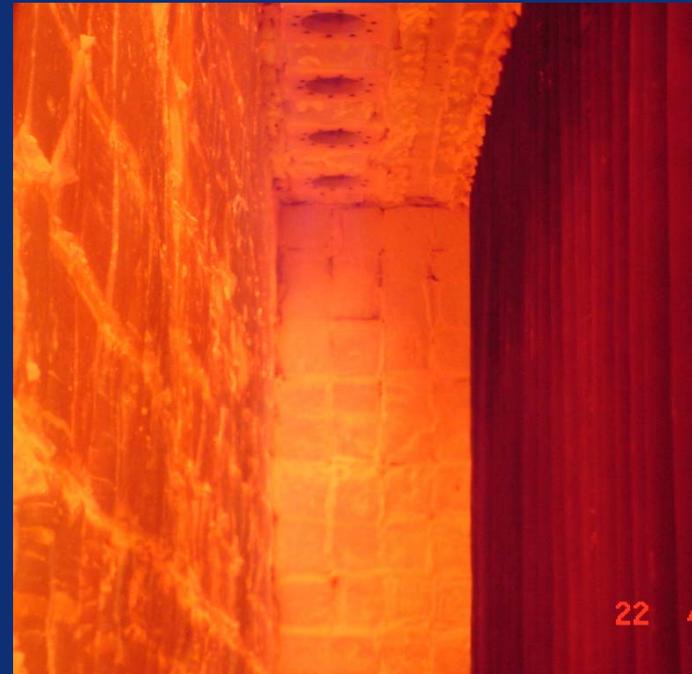
<b>Original Burners (Before)</b>	<b>LSV Burners (After)</b>
<b>NO<sub>x</sub> = 26 ppmv</b>	<b>NO<sub>x</sub> = 10 ppmv</b>

# Large Scale Vortex™

**Spacious Flame cools reformer components**



**Before  
(Original Burners)**



**After  
(New Burners)**

# Process Observations

- The Large Scale Vortex™ burner flames:
  - Spacious or flameless
  - Light off was easier
- Relatively cooler reformer tubes and refractory walls

	Original Burners	LSV Burners	LSV Burners
H2 Production Rate (%)	100%	102%	118%
Maximum TWT (°F)	1589	1577	1589
Average TWT (°F)	1519	1511	1520
Average Refractory wall temp (°F)	1684	1648	1663

# Conclusions

- Achieved 10 ppmv NO<sub>x</sub> emissions at steam methane reformer conditions
- Maintained operating conditions
- Increased production levels by 18%
  - ❖ Verified ability to debottleneck reformer due to lower tube wall temperatures
- Improved efficiency by ~1%



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