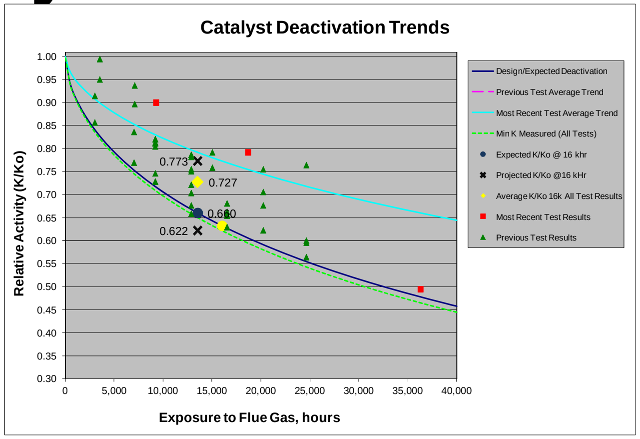
**McIlvaine Hot Topic Hour Presentation**

# Catalyst Management – Considering SCR Mercury Oxidation Co-Benefit

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IBIDEN

**Presented by: Noel Rosha**

**February 27, 2014**

# Presentation Topics

- SCR Mercury Oxidation Overview
- Catalyst Mercury Oxidation Testing
- Catalyst Management Planning Considering MATS
- Case Example for MATS Compliance Optimization

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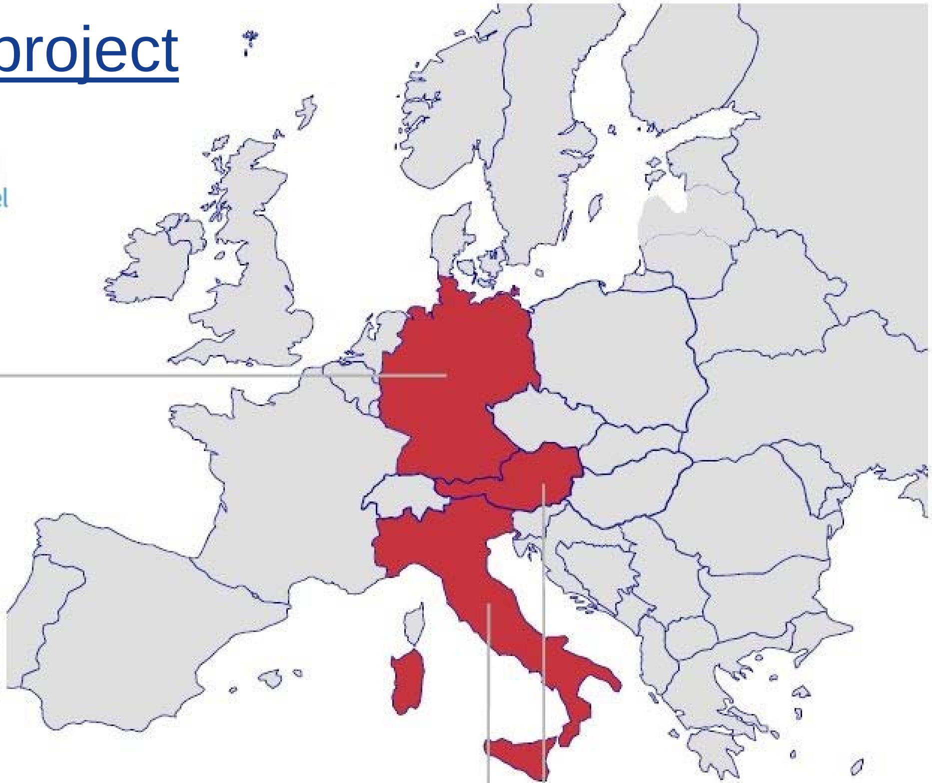
# SCR DeNOx Catalyst Development and Mercury Research in Mid-Europe

EU-funded research project

Research Fund for Coal & Steel



EnBW – Germany
E.ON – Germany
IFK – Germany
RECOM - Germany

EnBW

RECOM SERVICES

e-on

ifk

ENEL - Italy

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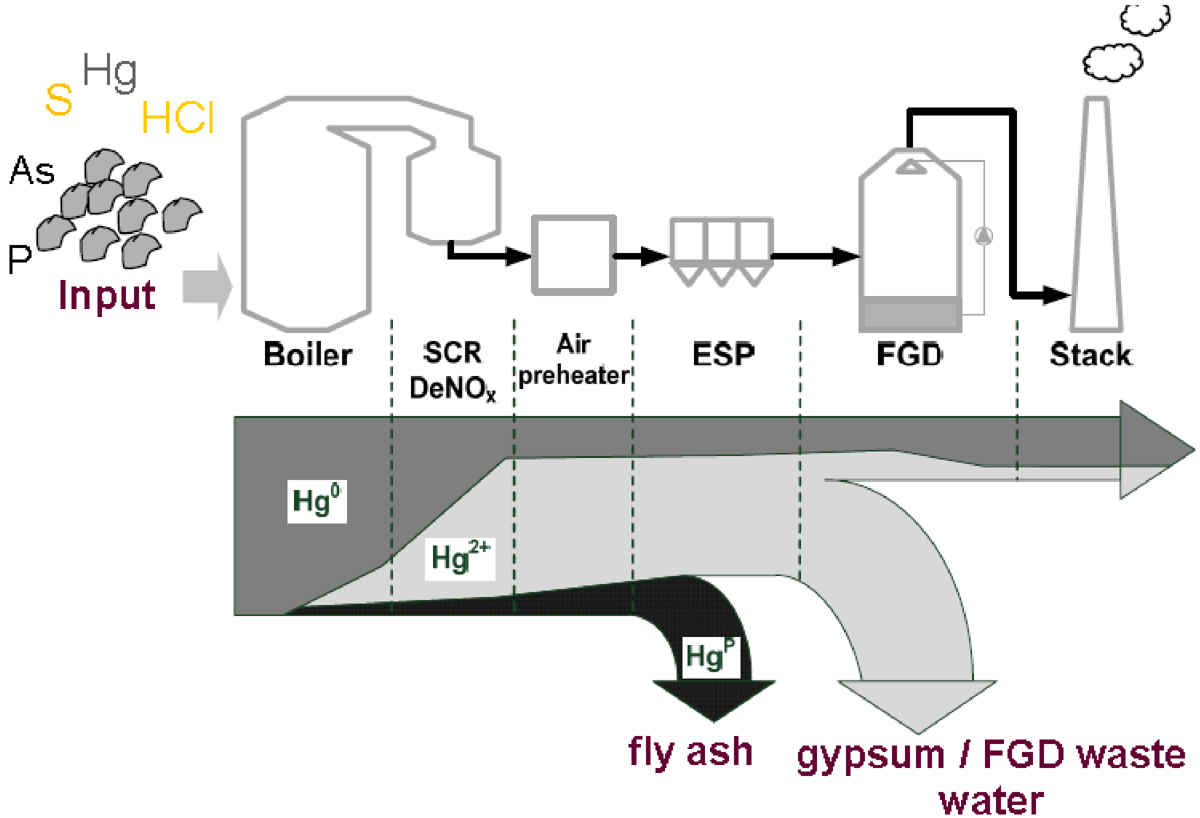
# Mercury Behavior in Coal-Fired Power Plants




Reduction of Hg emissions ⇨ Use of installed APCD ⇨

DEVCAT - Holistic research approach:

- Advanced SCR-DeNOx-catalyst design
- Optimisation of FGD operation

➢ **Hg-Oxidation on SCR Catalyst**

➢ **Removal of particulate Hg (ESP, bagfilter)**

➢ **Separation of oxidized Hg in FGD**

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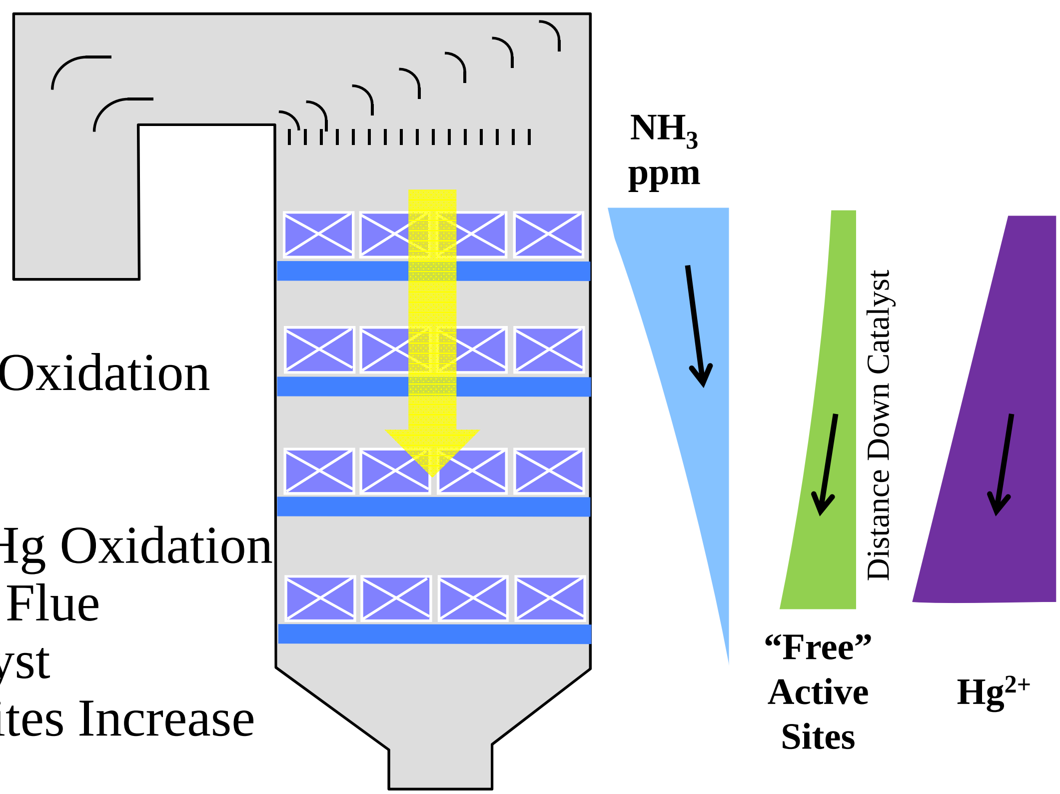
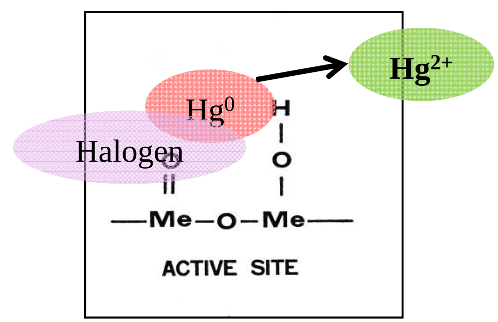
# Hg-Oxidation Increases as Gas Flows Through Reactor




- $NH_3$ Present in SCR Inhibits Hg Oxidation
  - Active Sites Preferentially Occupied by $NH_3$
- Halogens (Cl, Br, I, F) Promote Hg Oxidation
- $NH_3$ Concentration Decreases as Flue Gas Flows Down Through Catalyst
  - Available or “Free” Active Sites Increase Down Through Reactor
- Active Sites Decrease With Catalyst Aging

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# Factors Affecting Mercury Oxidation

| Positive Influences | Negative Influences |
|---|---|
| Long Residence Time (Low Area Velocity, Space Velocity) | Ammonia (molar ratio) |
| High Halogen Content | Catalyst Deactivation |
| Lower Temperature (< 680°F) | Higher Temperature (> 750°F) |
| Catalyst Composition ($V_2O_5$, other) | Increased $SO_2$ , CO, and $H_2O$ Concentrations |
| Catalyst Geometry (smaller pitch) | |

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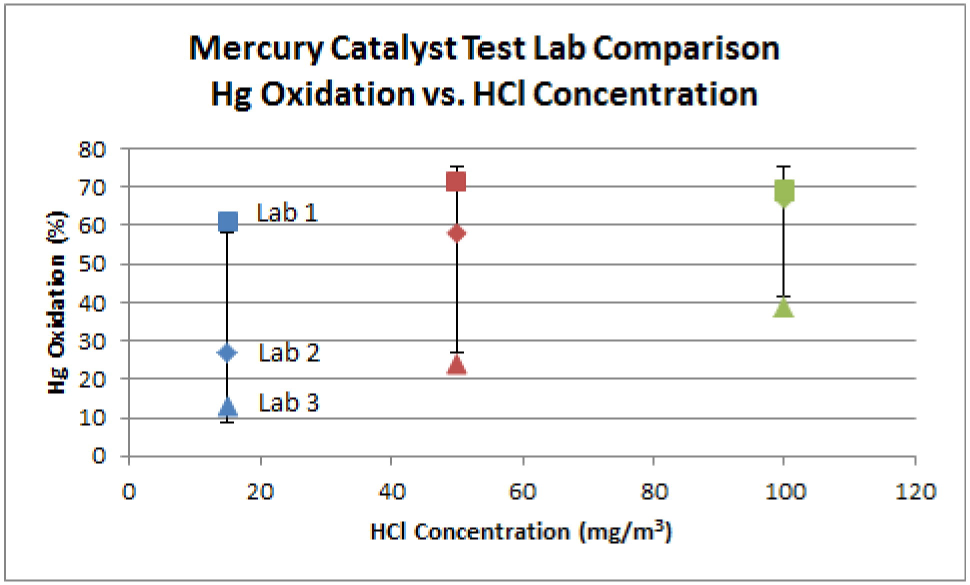
# Hg Oxidation Planning Must Consider Field Results

- Hg oxidation testing is difficult and relatively new
- Lab performance does not usually reflect field performance
- No industry protocol exists for laboratory Hg oxidation
- CERAM’s 6-year EU funded study included Round-Robin testing of 3 major European Hg oxidation labs
  - Large variances between labs exist
  - Third party may not be representative of field results
- Hg CEMS helpful for correlating lab HgOx to field performance

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# Affect on Catalyst Management Planning

| Current Practice: NOx and $NH_3$ Slip Based Plans | Future: NOx, $NH_3$ Slip and HgOx Based Plans |
|---|---|
| • Consider Required NOx/$NH_3$ Slip Performance | • + Consider HgOx Targeted Performance |
| • Track K/Ko Trends | • + Track HgOx K/Ko Trends |
| • Assess Fuel Quality | • + Assess More Fuel Quality Data |
| • Assess Operations | • + Assess More Operations Data |
| • Assess Catalyst Pluggage | • + Consider Halogens /ACI |

**Optimization and Effective Planning Will Minimize Outage Schedule Impacts, Halogen Additions, and/or Activated Carbon Additions**

**CERAM Has Adapted Proprietary Manage CATLife® Model for Combined NOx and Hg Ox Catalyst Management Planning**

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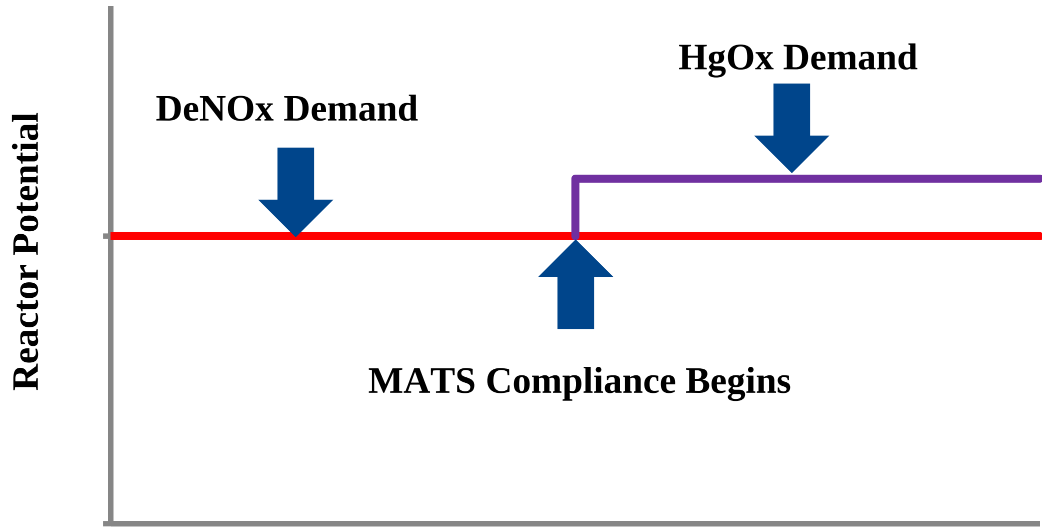
# Catalyst Management With MATS Compliance

- Optimizing Catalyst Hg Oxidation Performance Necessitates Increasing Minimum Required Reactor Potential
- DeNOx Demand ($P_{req}$) = Reactor Potential Required to Meet NOx Removal and $NH_3$ Slip Requirements
  - Calculated based on NOx removal requirements, $NH_3$ slip, and SCR reactor pluggage and distributions (velocity, $NH_3$/NOx, temperature)




**Enhancing Catalyst HgOx Requires Increased Minimum Reactor Potential**

**More Frequent Catalyst Events or More Active Catalyst Necessary**

# Case Study: Catalyst Management Effects With MATS Compliance

- Case Study Intended to Illustrate Possible Catalyst Management Effects and Necessity to Optimize Integrated Approach
- Example Basis:
  - 600 MW Unit Currently Burning PRB (700 to 730 F), but is also Capable of Burning Illinois Basin Coal (650 to 655 F)
  - 3 Layer Reactor Design; NOx In/Out 0.4/0.06 lb/MBtu PRB, 0.6/0.06 lb/MBtu Illinois Basin
  - Max $SO_2$ to $SO_3$ Conv: 3% at 730 F for PRB, 1.3% at 655 F for IL Basin
  - PRB Fuel Transition Led to Installation of Larger Pitch Catalyst
  - Mixture of Plate and Honeycomb Catalyst Currently Installed
  - Future Events a Mixture of Regenerated and New Catalyst
- Economic Analysis:
  - Catalyst (New and Regen) at Current Market Values
  - Includes In and Out Costs, ID Fan Energy Costs

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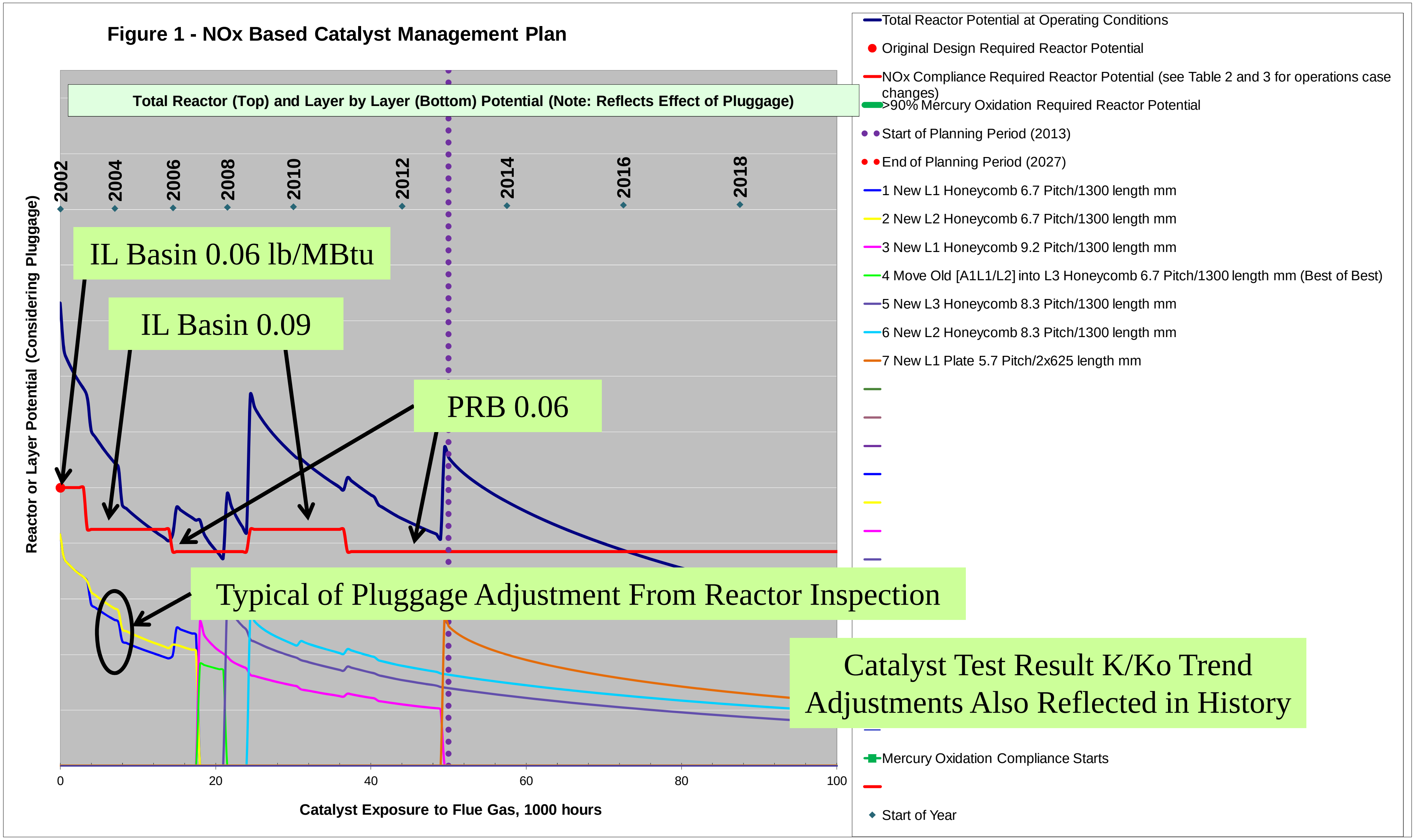
# The History Up To Now – Fuel Switches, Reactor Inspection Results and K/Ko Results

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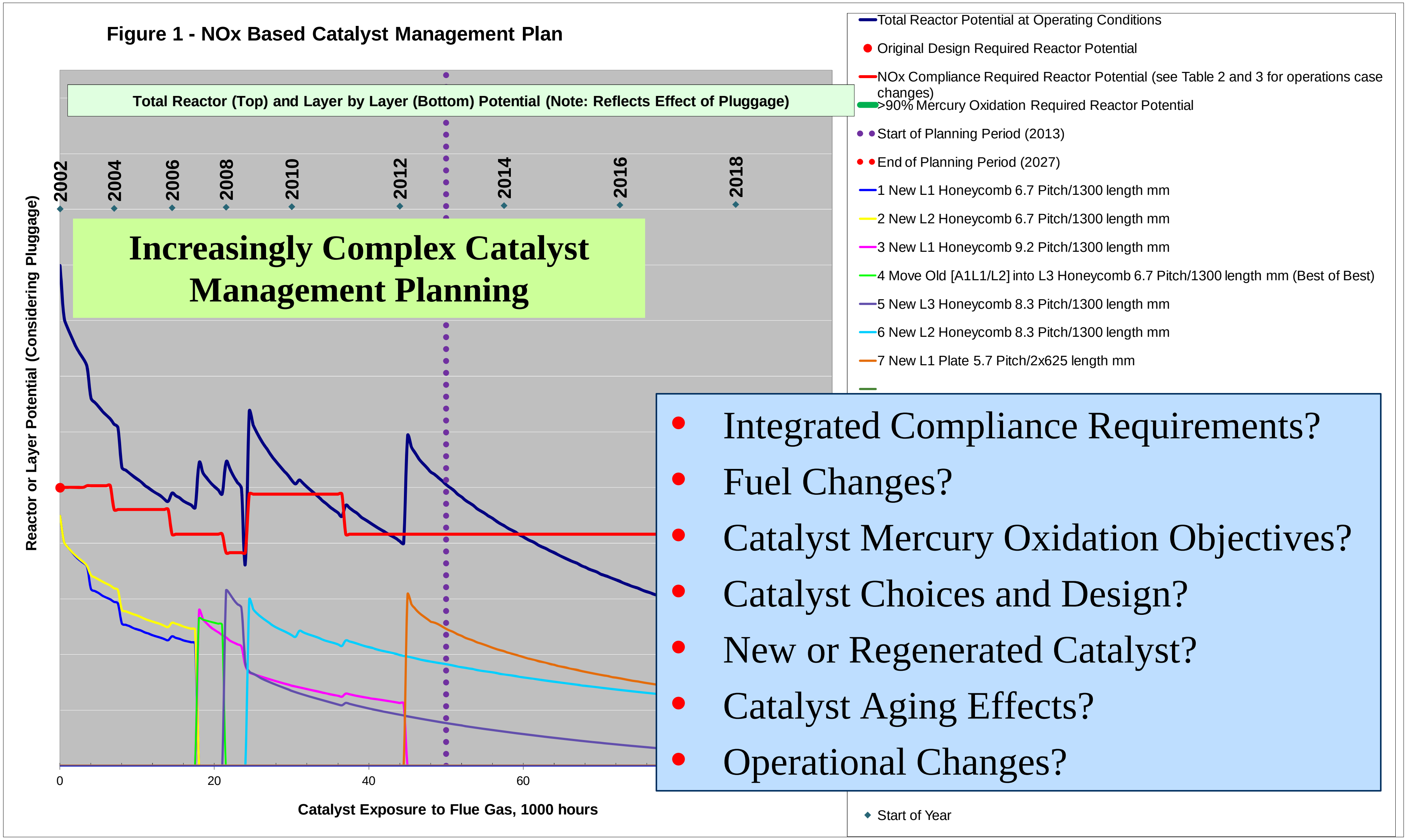
**Manage CATLife® Model**

# What's Next and When?




**Increasingly Complex Catalyst Management Planning**

- Integrated Compliance Requirements?
- Fuel Changes?
- Catalyst Mercury Oxidation Objectives?
- Catalyst Choices and Design?
- New or Regenerated Catalyst?
- Catalyst Aging Effects?
- Operational Changes?

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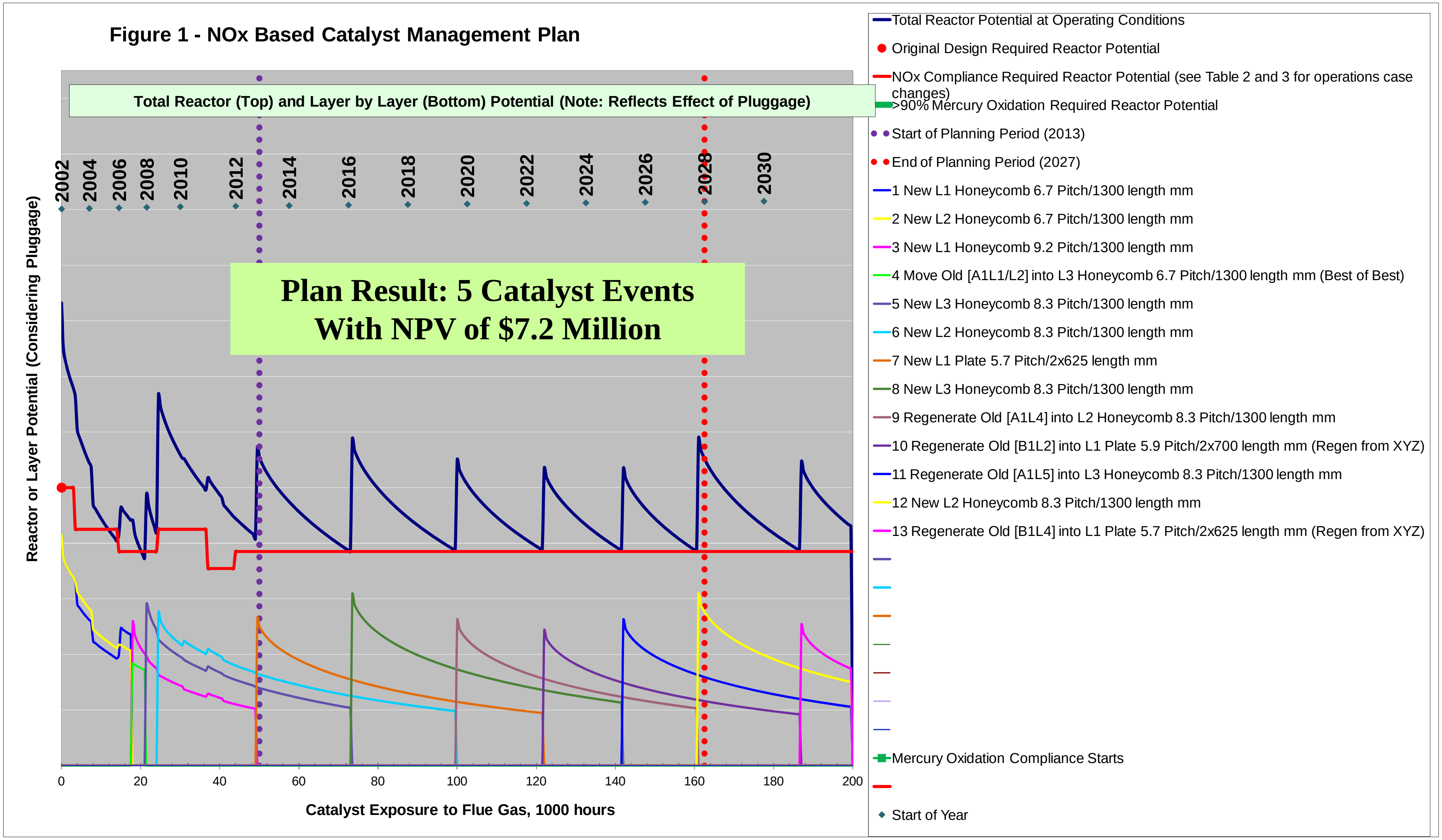
**Manage CATLife® Model**

# Catalyst Management Case Study Without MATS
# 600 MW Burning PRB Through Plan Period

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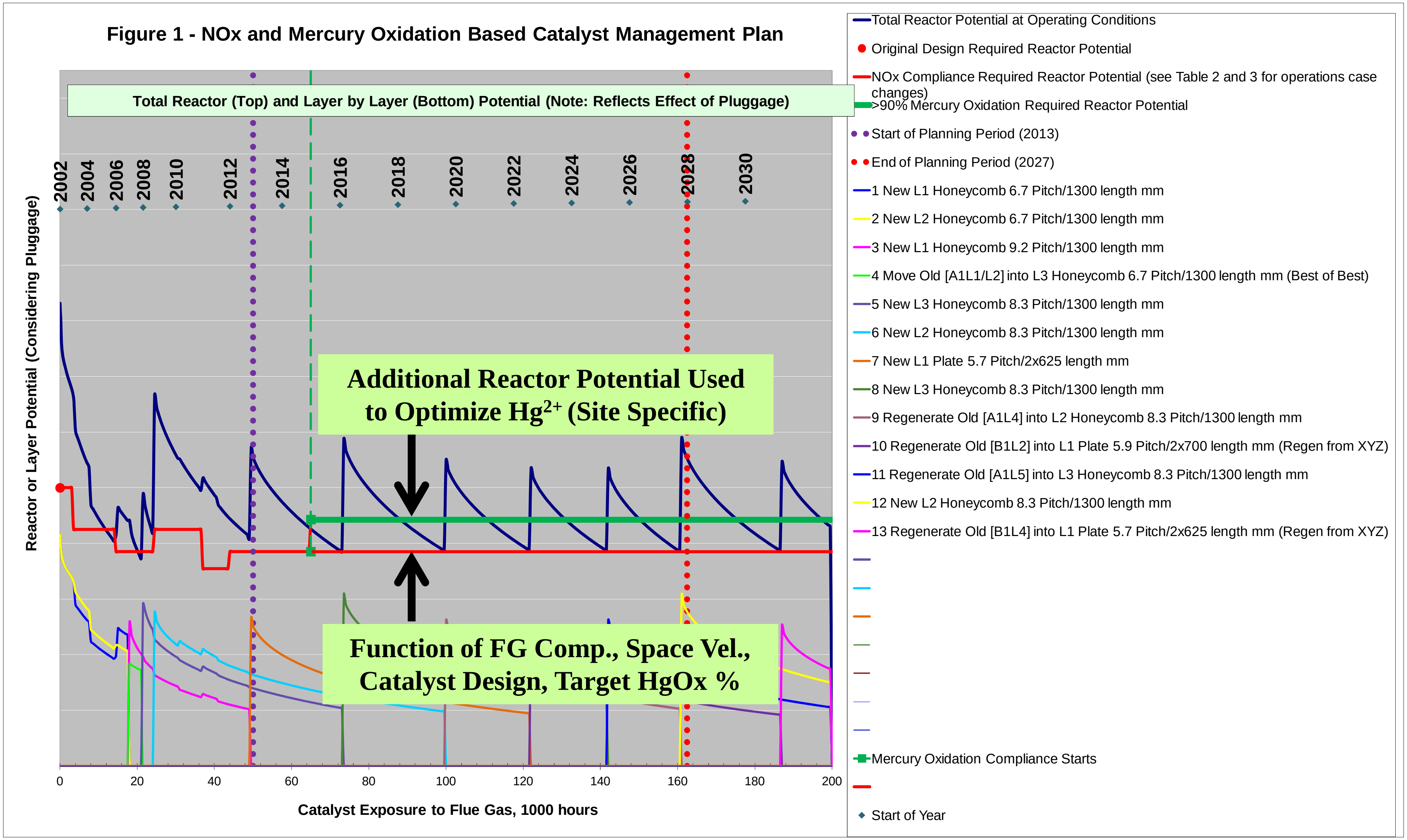
**Manage CATLife® Model**

# MATS Mercury Oxidation Will Change Required DeNOx Demand (especially for PRB)

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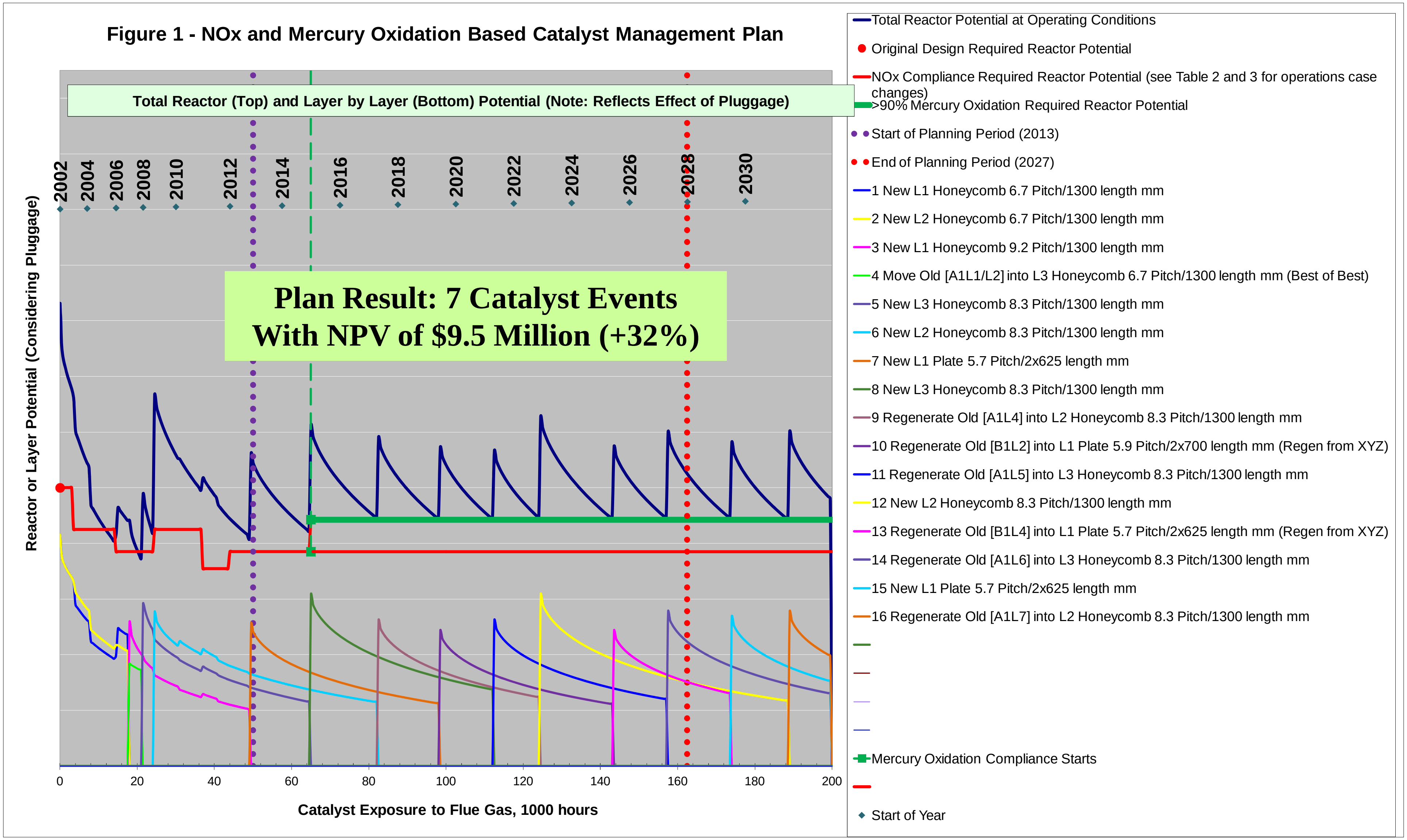
**Manage NOxOx CATLife® Model**

# MATS Mercury Oxidation Will Increase # of Catalyst Events to Maintain Performance (600 MW PRB Example)

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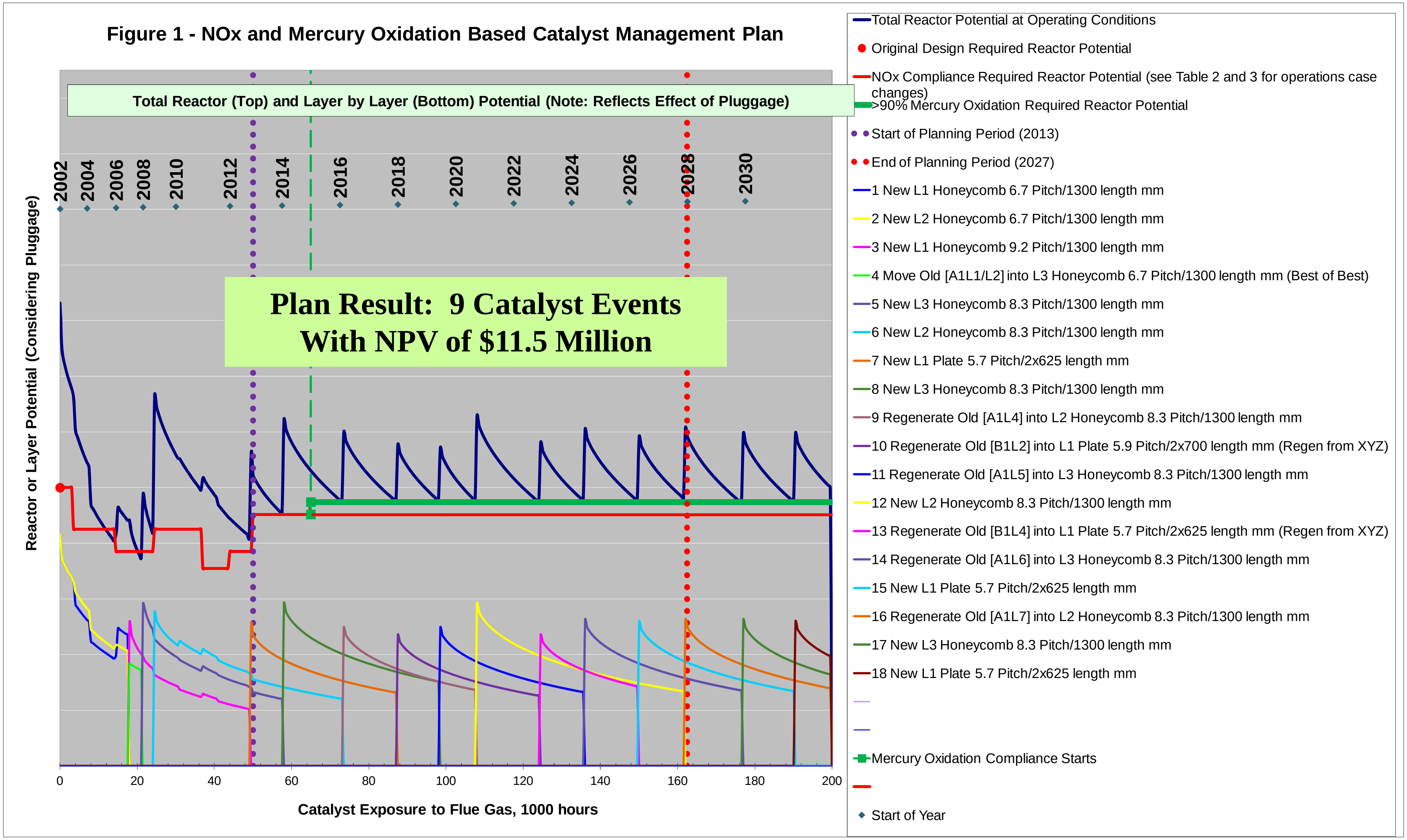
**Manage NOxOx CATLife® Model**

# The Impact of HgOx Will be Very Site Specific
# (600 MW Illinois Basin Coal Through Plan)

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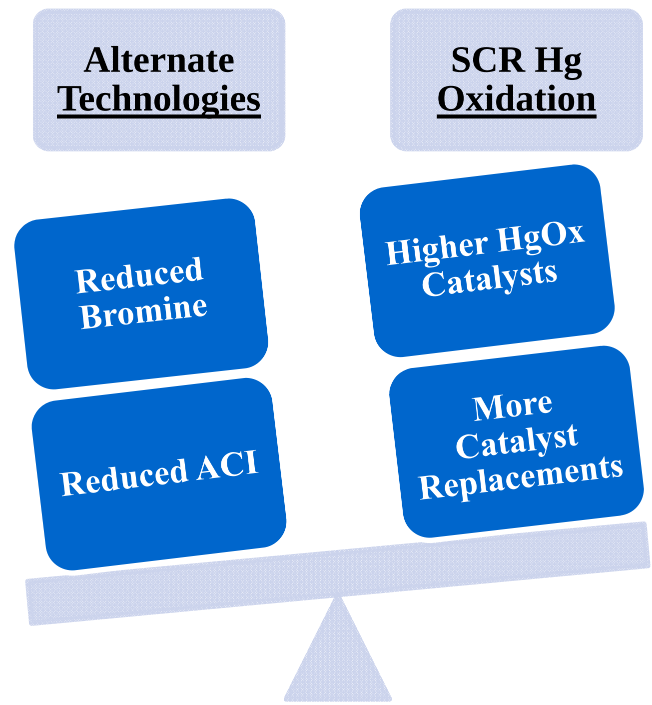
**Manage NOxOx CATLife® Model**

# Economic Considerations

- Manage CATLife® Model can Perform Economic Analysis Required to Evaluate:
  - Increased Cost of Catalyst to Increase Hg Oxidation
  - Cost of Halogen Addition or ACI
  - Are "Specialized" HgOx Catalysts Worth the Extra Money?

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# Summary

- Catalyst Management Planning Becomes Increasingly Complex
- Accurate Catalyst Management Planning Considers ALL Aspects of SCR and Boiler Unit Operations
- MATS Will Change the Approach to Catalyst Management
- Catalyst Management Strategies Can Be Optimized to Support High Mercury Oxidation Rates
- Opportunities to Optimize Will be Site Specific and Fuel Dependent

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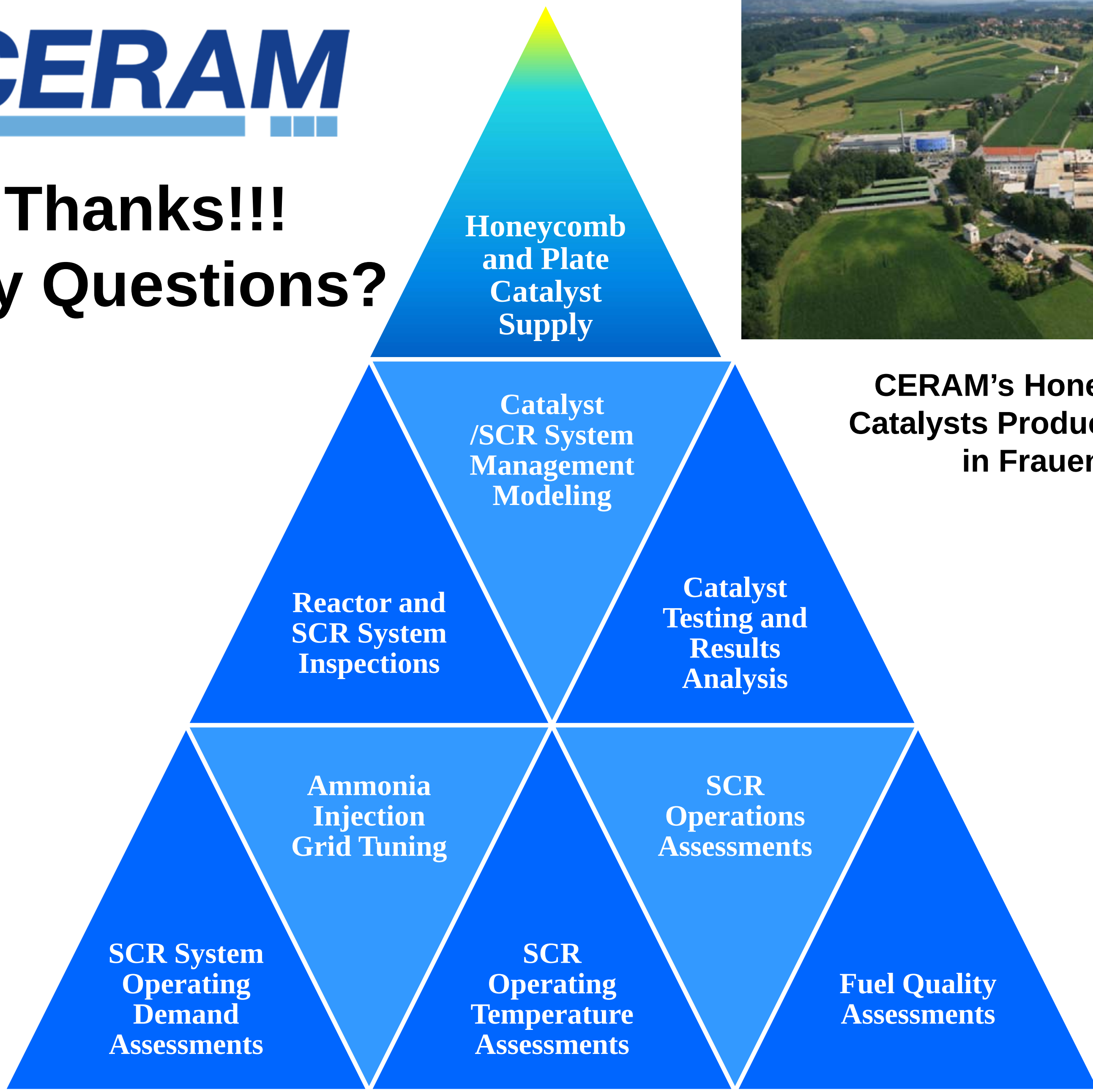
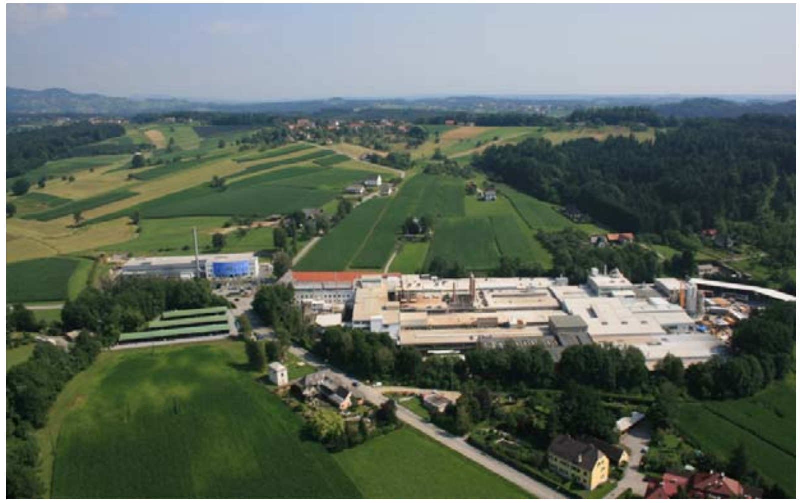
# Thanks!!!
# Any Questions?



**CERAM's Honeycomb and Plate Catalysts Production Plant Located in Frauental, Austria**