Integrating In-Furnace Measurements with Combustion Optimization

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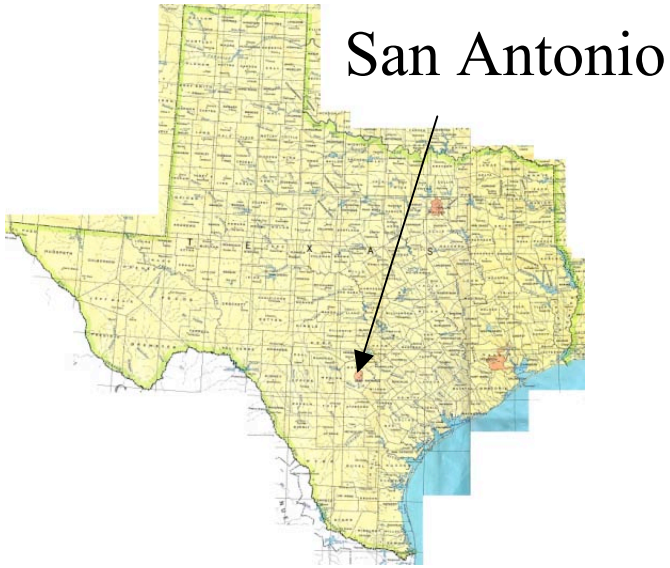
Outline

- CPS Energy J.T. Deely Power Plant San Antonio, TX.
- Integration of Combustion Optimization with In-Furnace Sensors.
  - Combustion Optimizer — CombustionOpt®
  - In-Furnace Sensor — Zolo*BOSS*™
- History of NO_x Reduction Commitment at CPSE.
- Technology Background.
- Initial Findings.
- Next Steps.

CPS Energy

- Nation's largest municipally owned provider of electric service and natural gas. Located in 7th largest city in USA San Antonio, TX

- Provides services to approximately 690,000 electric and 320,000 natural gas customers.



J.T. Deely Power Plant

- Owned and operated by CPS Energy.
- Calaveras Power Plant Complex, South East of San Antonio, TX.
- J.T. Deely 1 & 2 plants commissioned in 1977 and 1978.
- Boilers are identical 446 MW Alstom-CE T-fired units.
- Honeywell DCS.

- First in nation to integrate combustion optimization software with in-furnace spectroscopy sensors.

CPS Energy NO_x Reduction Commitment

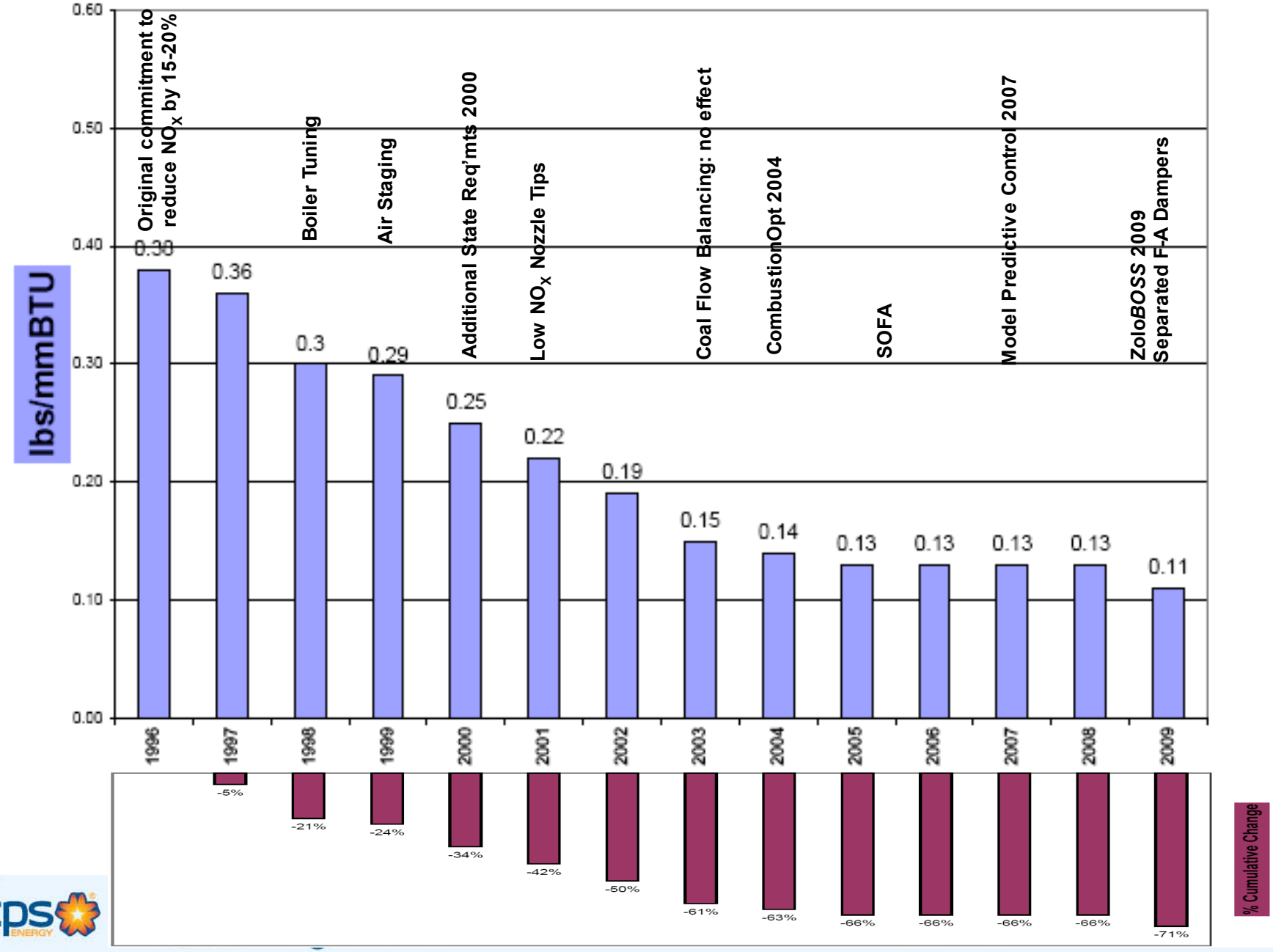
1998 CPSE committed to voluntarily reduce NO_x emissions by 15 to 20%

- Success was achieved through:
  - Combustion control tuning.
  - Staging of primary and secondary combustion air.
  - Installation of low NO_x nozzle tips.
  - Attempted balancing coal flow through coal pipes with no success.
- Derived benefits are:
  - Smaller SCRs when needed.
  - Lower associated capital and O&M costs.

CPS Energy NO_x Reduction Commitment

- TCEQ and State Senate enacted NO_x rules in 2000 requiring additional reduction of NO_x emissions.
- CombustionOpt installed on both units in 2004.
  - Primary objective: further reduction of NO_x emissions
  - Secondary objective: heat rate improvement
- Model Predictive Control (MPC) added in 2007
  - Explicit steam temperature control
  - Minimize attemperation sprays
  - Incremental heat rate and NO_x reduction

NO_X Reduction at Deely



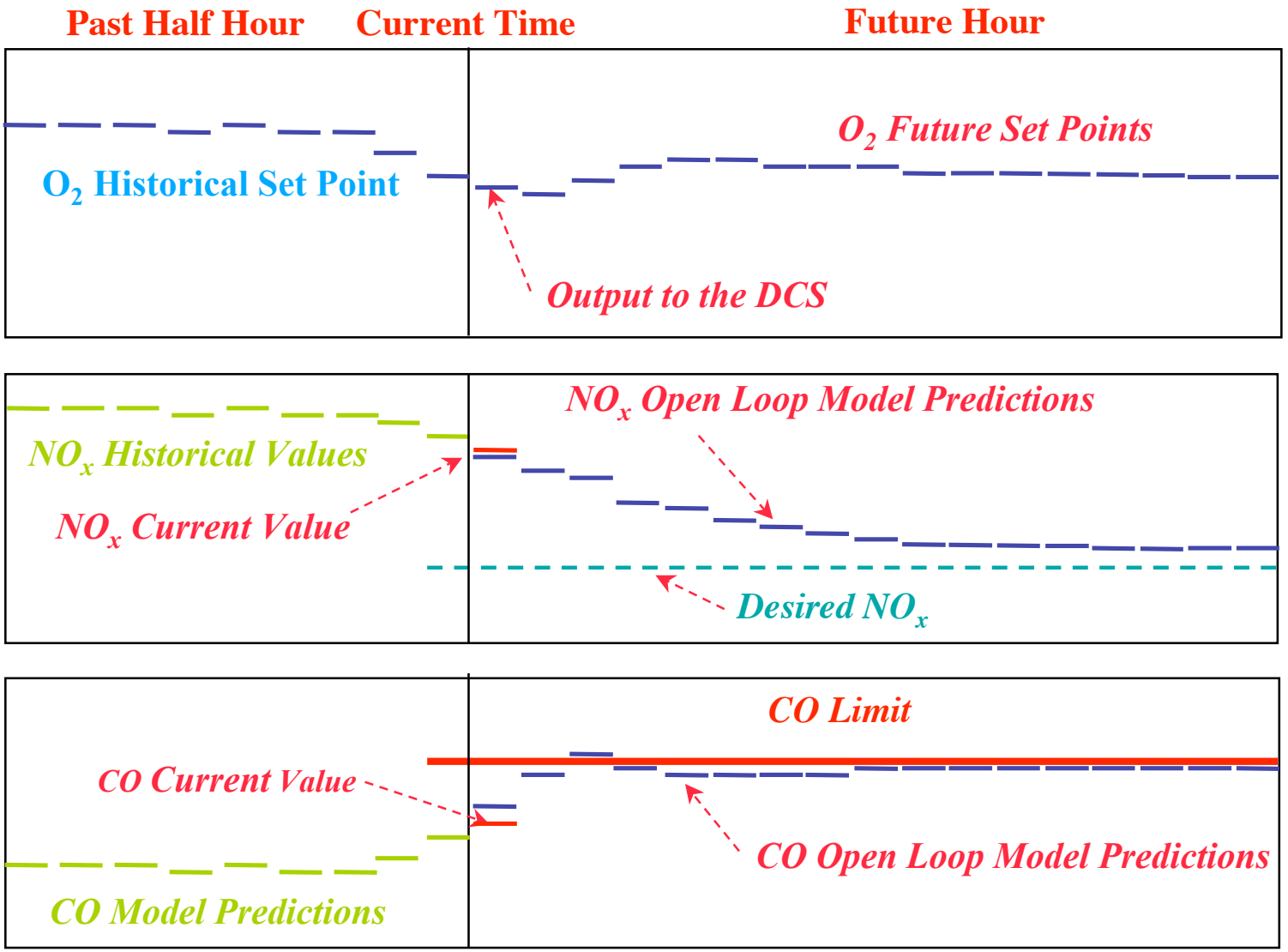
Deely Integration Project

- CombustionOpt: multiple year successful track record.
- First site where MPC was integrated with neural net.
- Achieving 0.12 and 0.13 lbs/mmbtu vs. goal of 0.08 lb/mmbtu.
- Motivations for adding Zolo*BOSS.*
  - New Spruce unit created additional NO_x pressure.
  - Increased coal costs.
  - Innovative culture.
  - Commitment to continuous improvement.
  - Recognition that in-furnace combustion data would provide additional performance gains.
  - Provide justification to install individual fuel air damper controls.

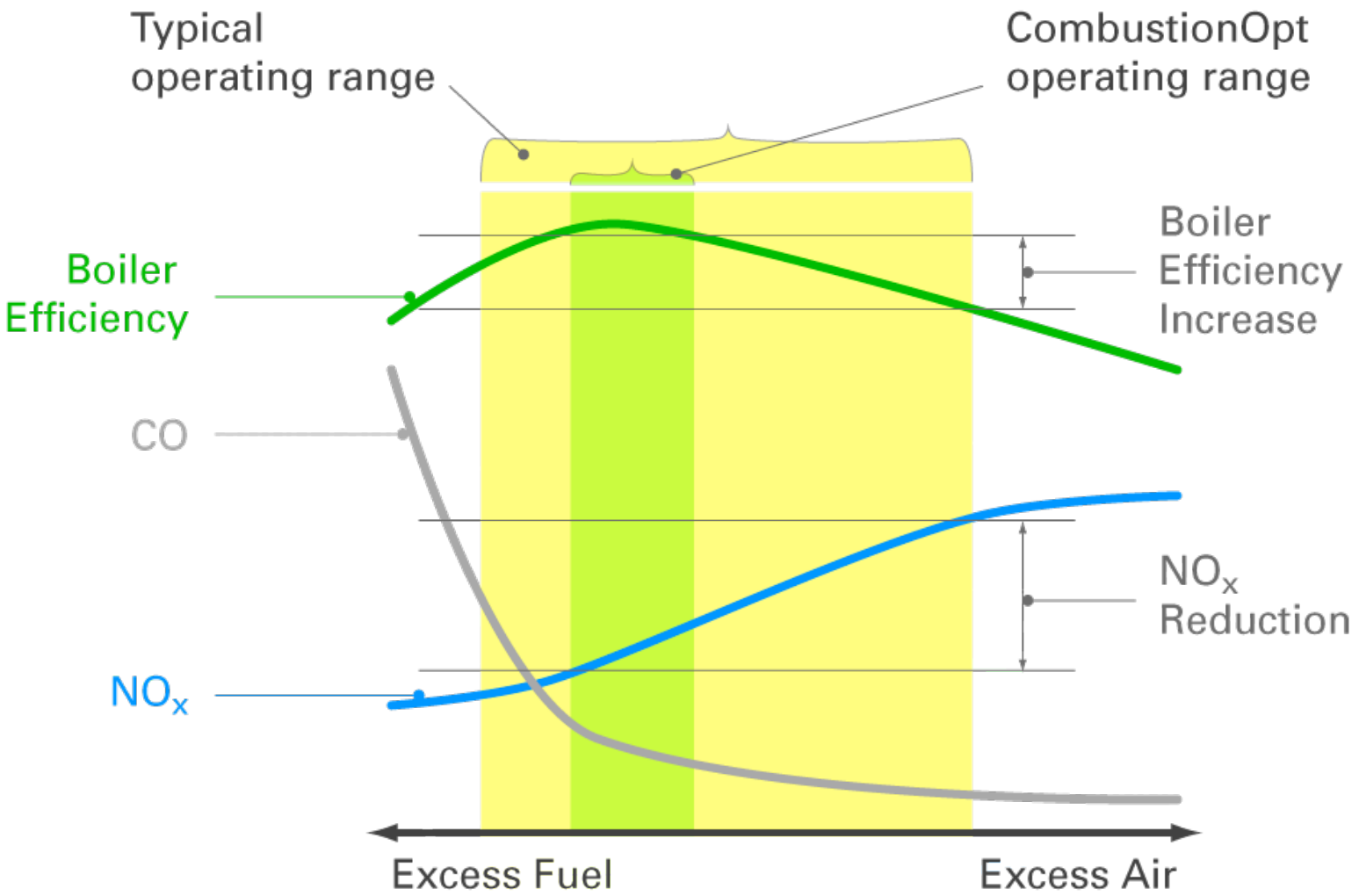
NeuCo CombustionOpt

- Provides real-time optimization and advanced control.
- Utilizes 3 types of models:
  - Model Predictive Control (MPC).
  - Neural networks with online learning.
  - Engineering calculations.
- Key goals for Deely.
  - Minimize NO_x.
  - Maintain steam temperatures (average and side/side split).
  - Minimize sprays to reduce heat rate.
  - Avoid plant constraints (high CO, damper positions, mill limits, etc.).

Model Predictive Control (MPC)



CombustionOpt Optimization

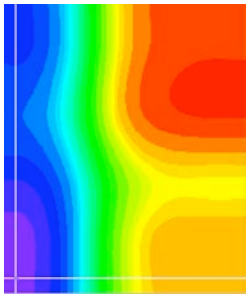


Zolo*BOSS* In-Furnace Sensor

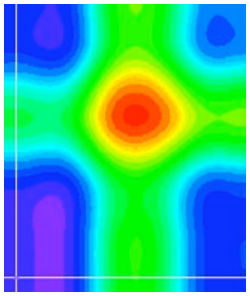
- Measures and maps multiple constituents directly in the furnace.
  - Real time measurements of:
  - Temperature.
  - Oxygen.
  - CO.
  - Water vapor.
- Tunable Diode Laser Absorption Spectroscopy
  - Scans a laser in wavelength across the constituent absorption line.
  - Compares light absorbed by the constituent to light that traversed the boiler.
  - No calibration required.

Zolo*BOSS* Data

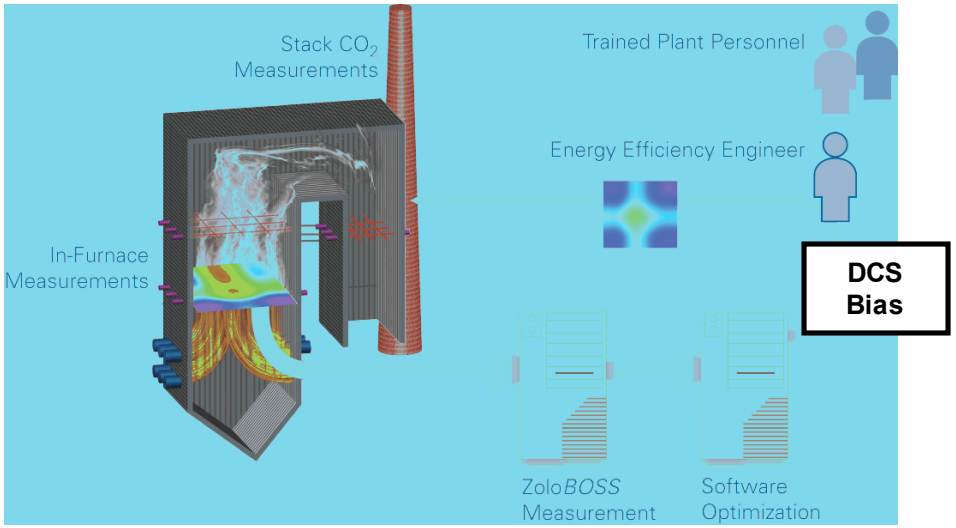
Tomograph: two dimensional representation of constituent level.

Unbalanced 

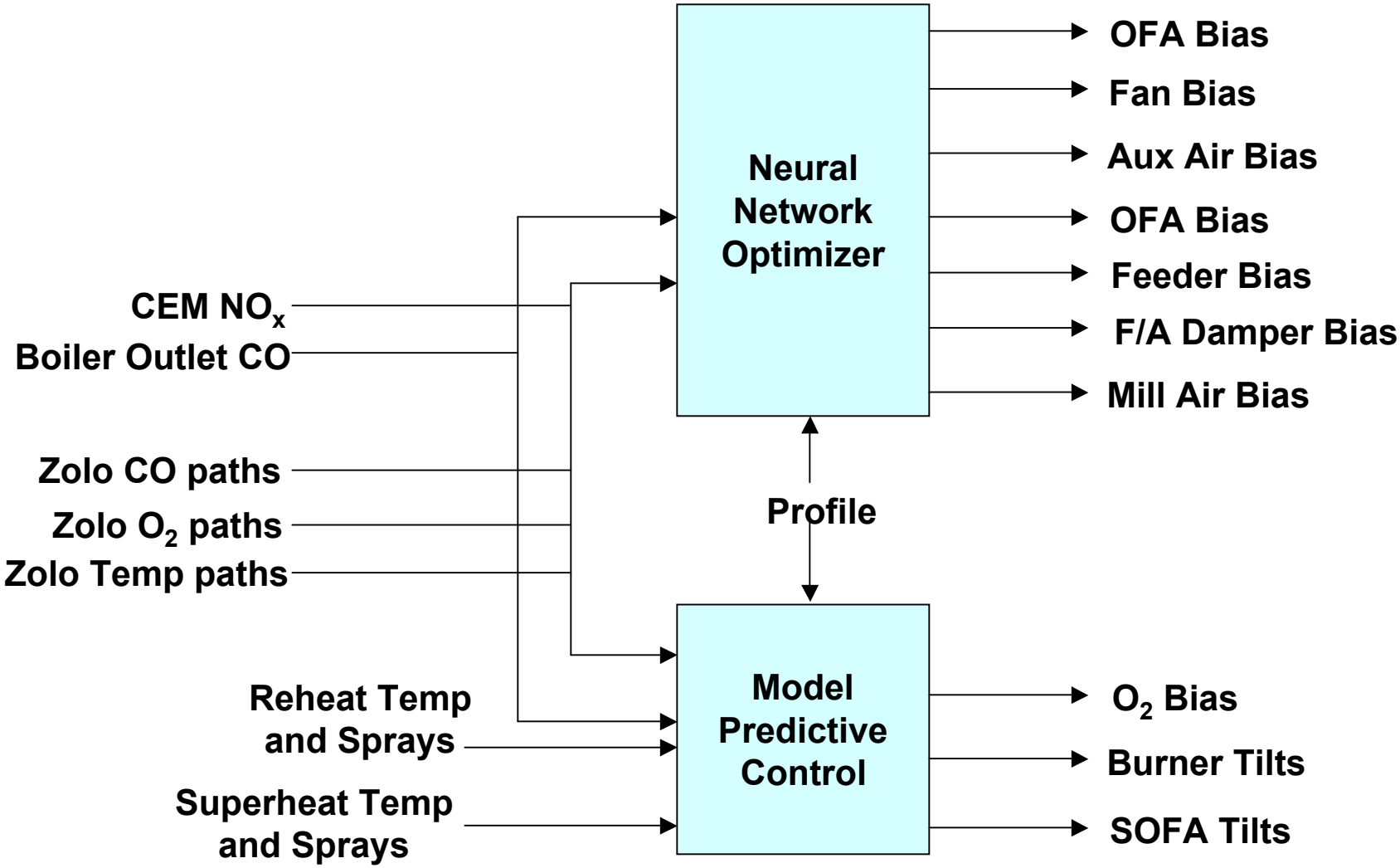
Plus in-furnace data and optimization

= Balanced 

Zolo*BOSS* Data > NeuCo CombustionOpt > DCS bias > Controls



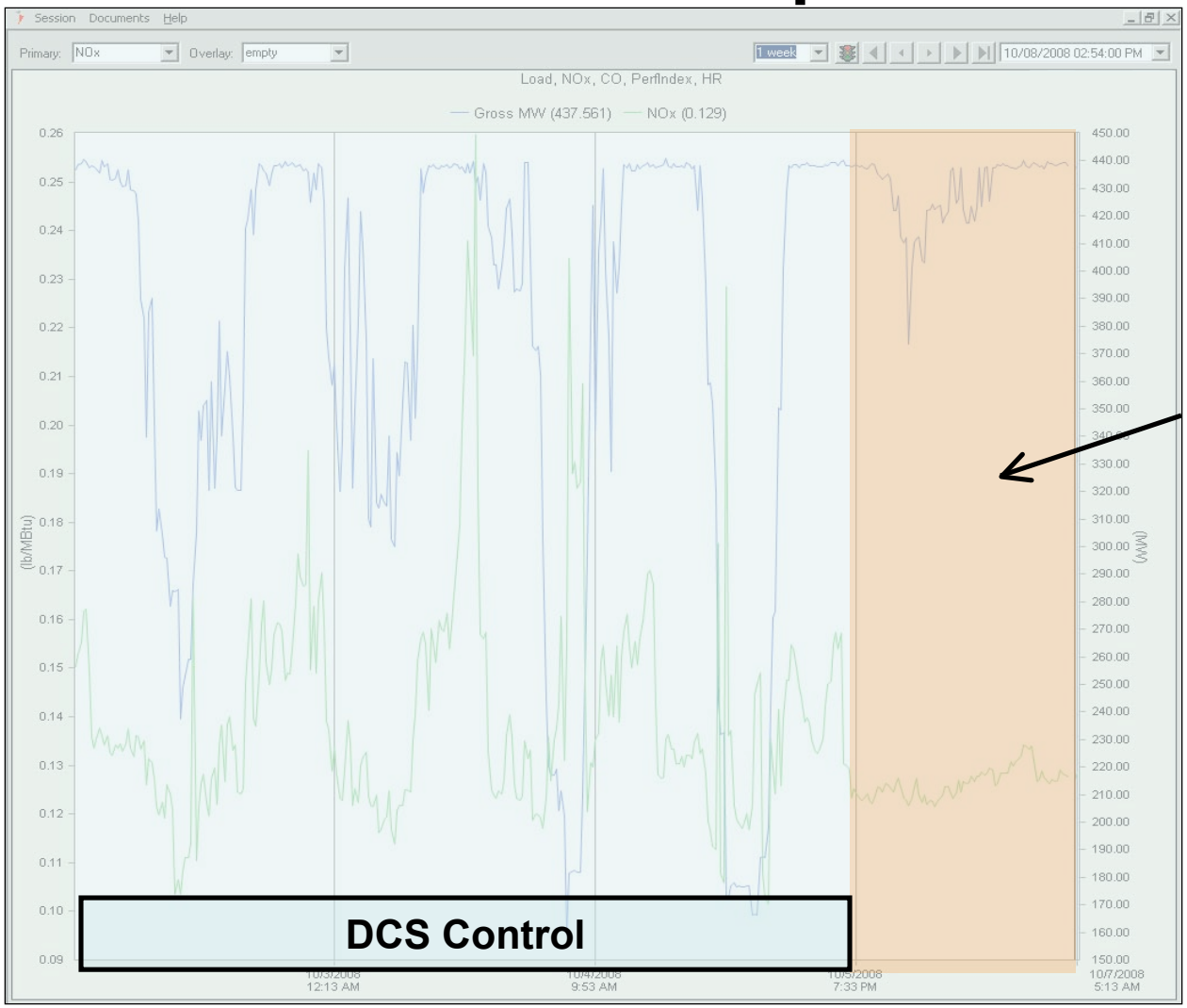
CombustionOpt with Zolo*BOSS* at Deely 1



Initial Findings

- Zolo*BOSS* data validated against:
  - Manual test results.
  - CPSE observations.
- CombustionOpt model validation:
  - Models accurately predict actual in-furnace values.
  - Control bias changes control and manipulate actual in-furnace values.
- CombustionOpt able to:
  - Minimize CO and O_2 deviations within furnace.
  - Use spatial resolution to better control NO_x.

DCS Control vs.
NeuCo CombustionOpt with Zolo*BOSS* Control



CombustionOpt engaged using Zolo*BOSS* signals to manage NO_x.

Challenges Overcome

- Zolo*BOSS* window breakage.
  - Thermal shock (fixed with longer sight tubes).
  - Shotgun pellets during deslagging (fixed with simple plug).
- Data communications failures (fixed).
- NERC Security Requirements (continuing challenge).
- Inadvertent removal of system from closed-loop operation (fixed).
- Demand following load, including shutdown (fixed).
- Unit out of service (fixed).

How we did it:

- Strong plant champion.
- Total commitment by CPSE, NeuCo and Zolo Technologies.
- Great communication.
- Support of plant management and technical staff.
- Prompt and continuing attention.

First Results

- On vs. Off test:
  - CombustionOpt & Zolo*BOSS* enabled vs. DCS control.
- Conditions:
  - Small load variations for both “On” and “Off” states.
  - Constant coal quality.
  - No other changed operating conditions.
- Measured unit performance objectives.
  - NO_x.
  - CO.
  - Efficiency (using PerfIndex).

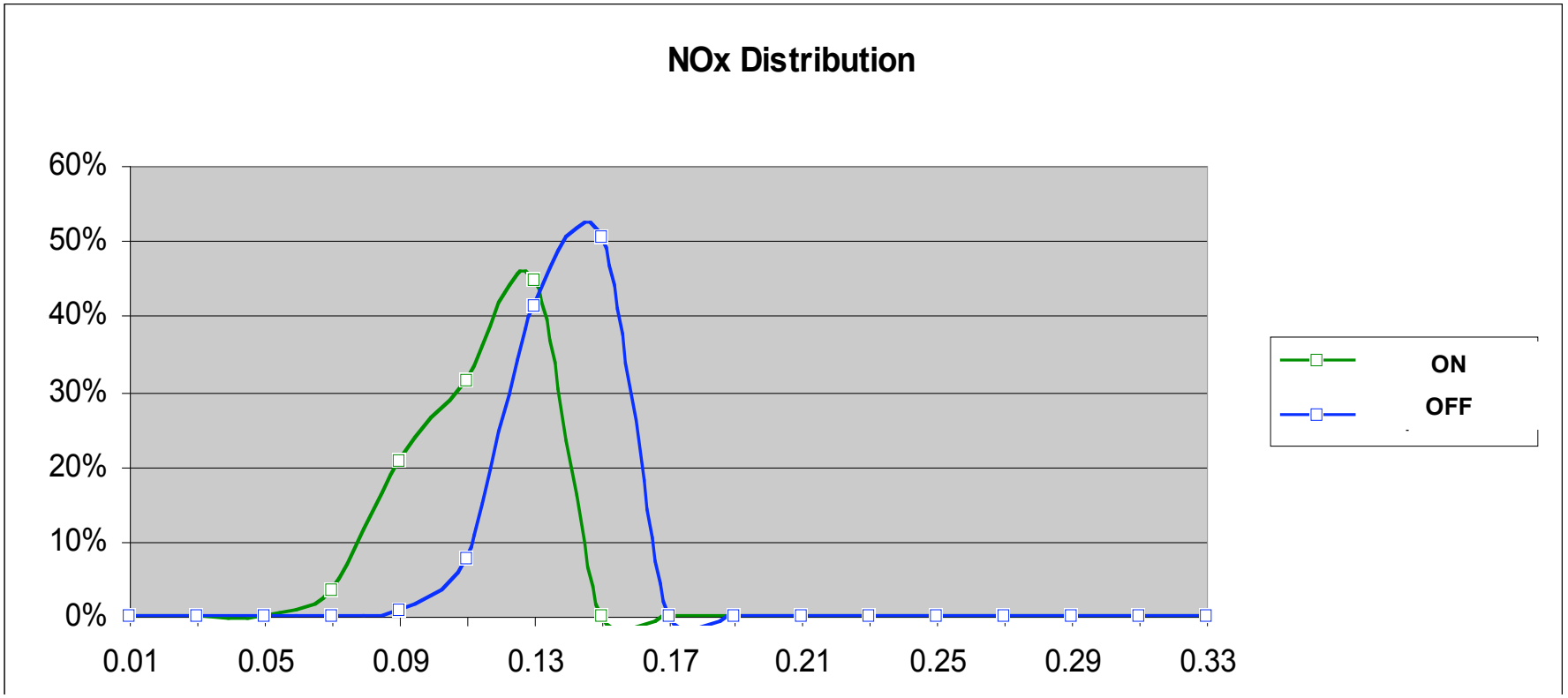
PerfIndex Fuel Efficiency Calculation

- Broader than boiler efficiency.
- Captures net heat rate components affected by combustion optimization.
  - Boiler efficiency.
  - Steam temperatures (RH & SH).
  - Attemperation sprays (RH & SH).
  - Auxiliary power (fan loading, mill amps, etc.).
- Expressed in same units (Btu/kWh) as heat rate.
- Extensively validated over years and across boilers.

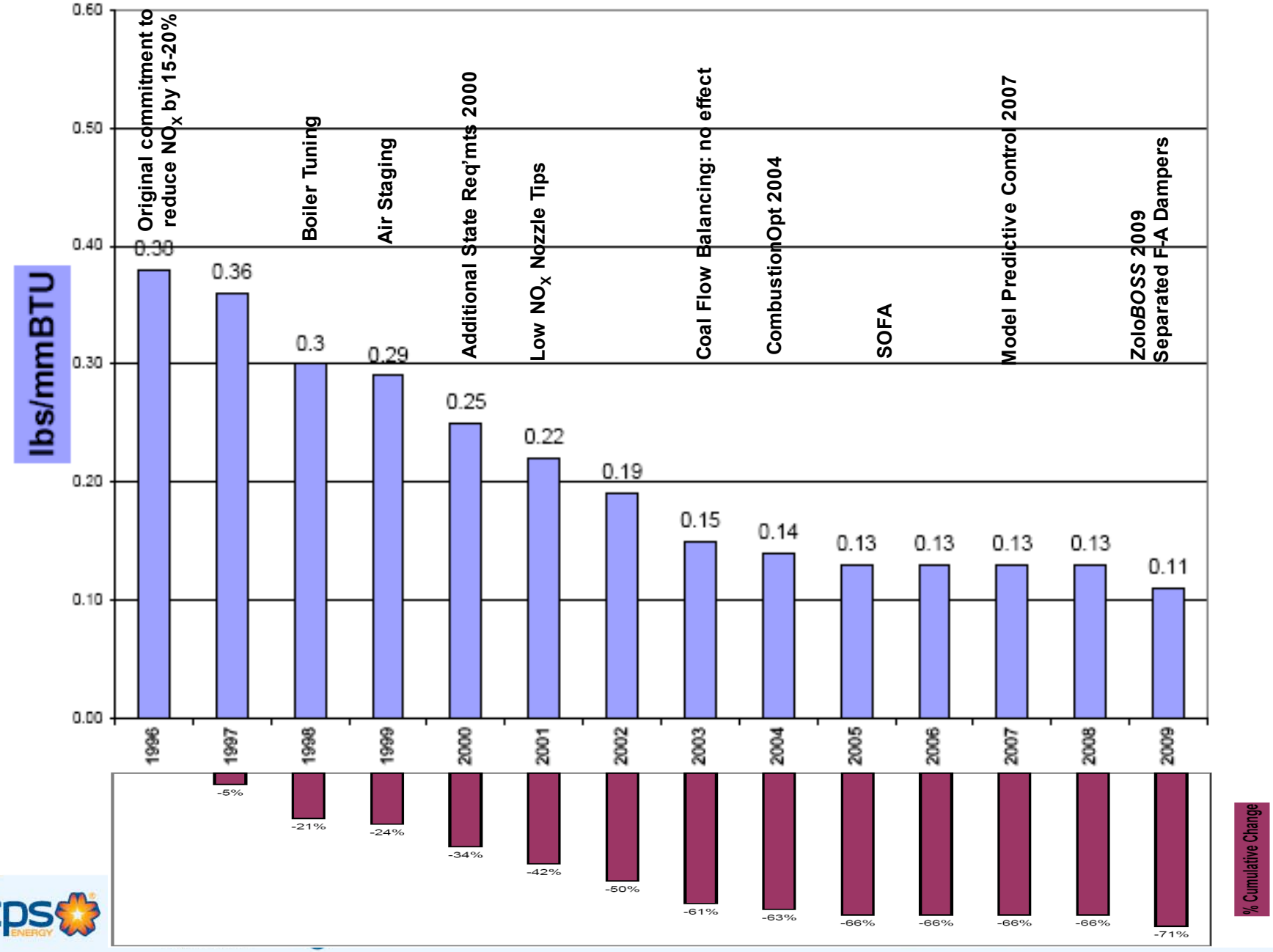
First Results

Performance Parameter	OFF	ON	CHANGE
NO_X lbs/mmBTU at stack	0.138	0.112	-19%
CO PPM at stack	8	52 (within limit)	44 ppm
O_2% in back pass	2.7	2.3	-14.6%
PerfIndex (Fuel Efficiency Index)	776	772	-0.6%
MW Load	Full	Full	Minor fluctuations

NO_x Distribution: On vs. Off



NO_X Reduction at Deely



Next Steps

- Continue to improve Zolo*BOSS* based combustion models.
- Add remaining fuel air damper elevations to models.
- Further optimize unit for:
  - NO_x.
  - Heat Rate.
- Quantify sustained benefits.

Zolo*BOSS* ordered for Deely 2

- Given:
  - Challenges with Deely 1 that were overcome by a strong team effort.
  - Long term commitment by all parties.
  - History of reliable operation.
  - Favorable furnace performance results.
  - Deely 2 has proven track record with CombustionOpt.
- Second Zolo*BOSS* will be installed summer 2009.

Conclusions

- CombustionOpt + Zolo*BOSS* provide substantial NO_x and fuel efficiency benefits.
  - Builds upon years of CombustionOpt usage.
  - Zolo*BOSS* adds valuable real time in-furnace information to models.
- NO_x reduced 19%.
- PerfIndex improved 0.6%.
- CO maintained under limit.
- Fuel efficiency benefits translate to substantial CO_2 benefits.