

BUILDING A WORLD OF DIFFERENCE®



**BLACK & VEATCH**



# Existing Generation -- the Forgotten Asset in the Fight to Reduce Greenhouse Gases?

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# About My Co-Author



VGB

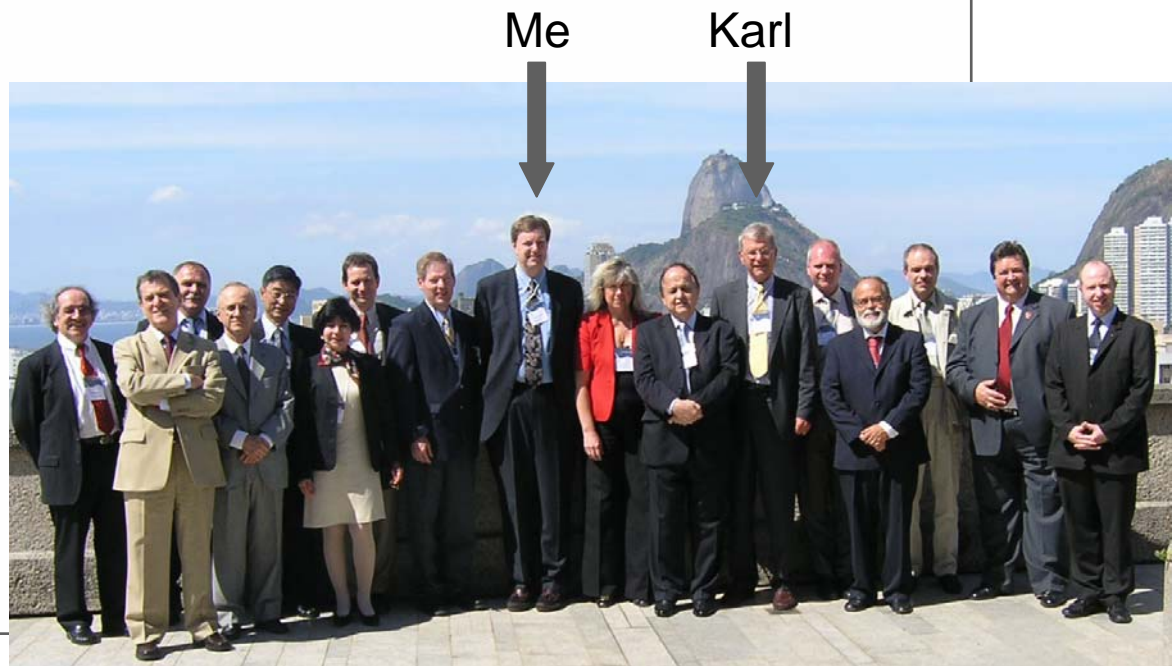
Karl Theis, Executive Director

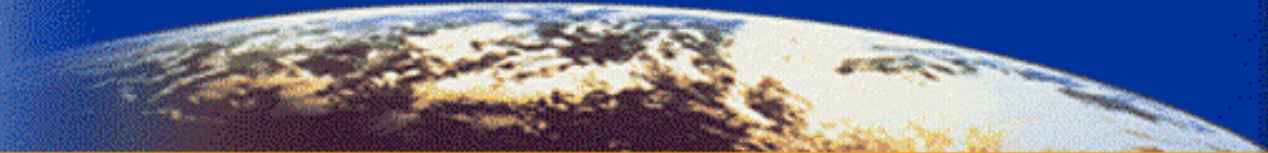


**COMPETENCE FOR AN ENVIRONMENT COMPATIBLE AND EFFICIENT GENERATION OF ELECTRICITY AND HEAT**

- Platform for all issues of power generation
- European network of experts
- Managing the communication process
- Knowledge management
- Lobby work on an european level

- Nuclear Power Plants
- Fossil-fired Power Plants
- Renewables/Distributed Generation
- Environmental Protection, Safety at Work and Chemistry





## Intro to World Energy Council's Performance of Generating Plant (PGP) Committee

- Promotes the international exchange of data and information on generating plant performance to facilitate the most effective use of generation assets and energy resources worldwide.
- Collects extensive performance and availability data world wide.
- Current focus includes research and analysis of the factors determining the performance of generating plant and wider deployment of the recommendations and methodologies for improvement of power plant performance/availability/emissions developed or identified by the Committee.

## Basic Premise

- Worldwide, sustainability of energy requires that we still leverage existing carbon-based assets within base energy production strategies
  - Limitations of alternative energy sources must be recognized
  - Lack of mechanism to substantially reduce demand or energy-use intensity
- Therefore, the associated challenge is to reduce the carbon footprint by improving environmental performance, efficiency, and reliability.
  - Retire/Replace Existing Coal Generation with “Clean” Plants
  - Improve CO<sub>2</sub> Emissions Signature from Existing Plants

# Three “Buckets” of Interest

1



Existing  
Generation

2



Near-Term  
“New Build”

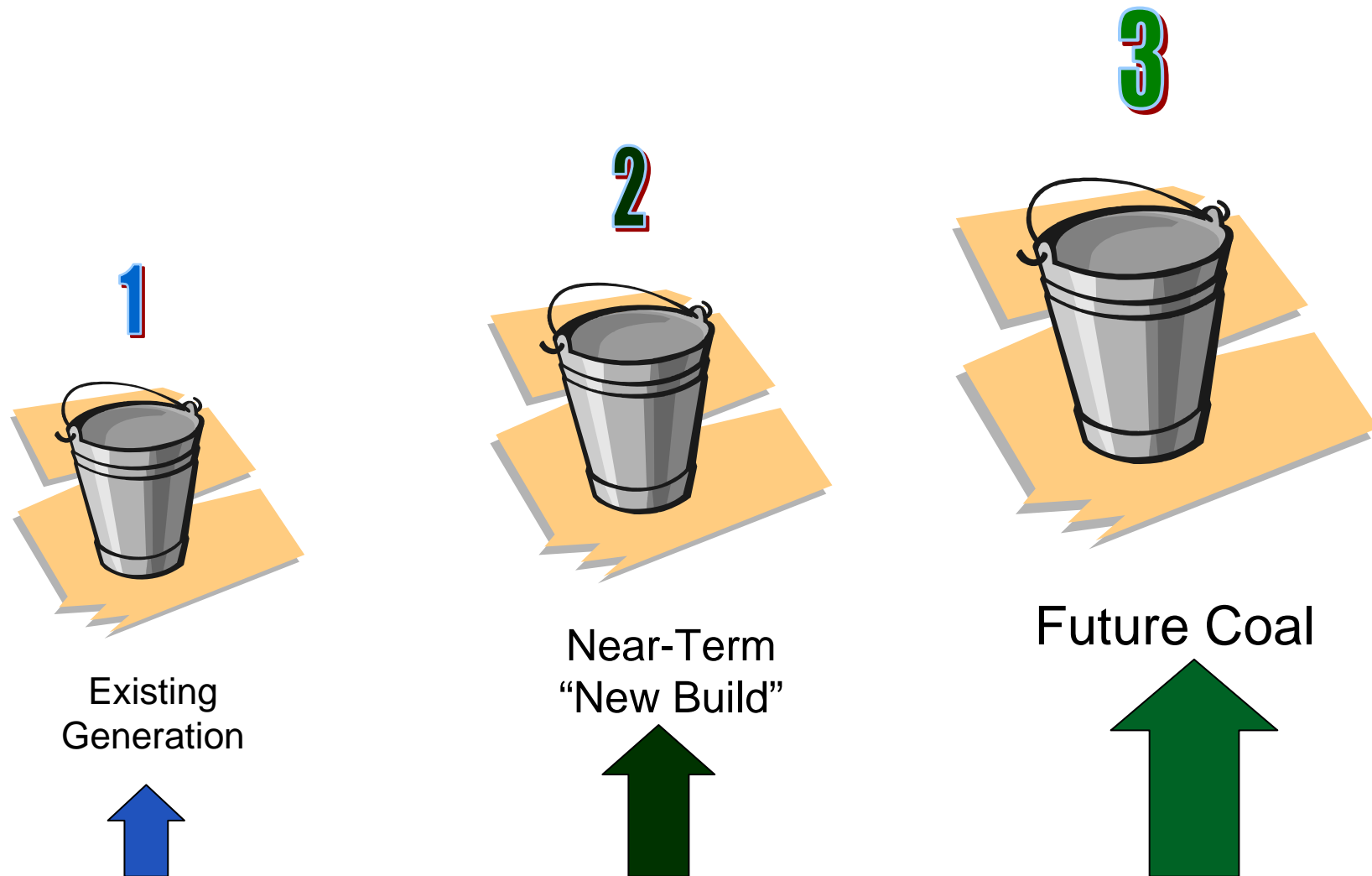
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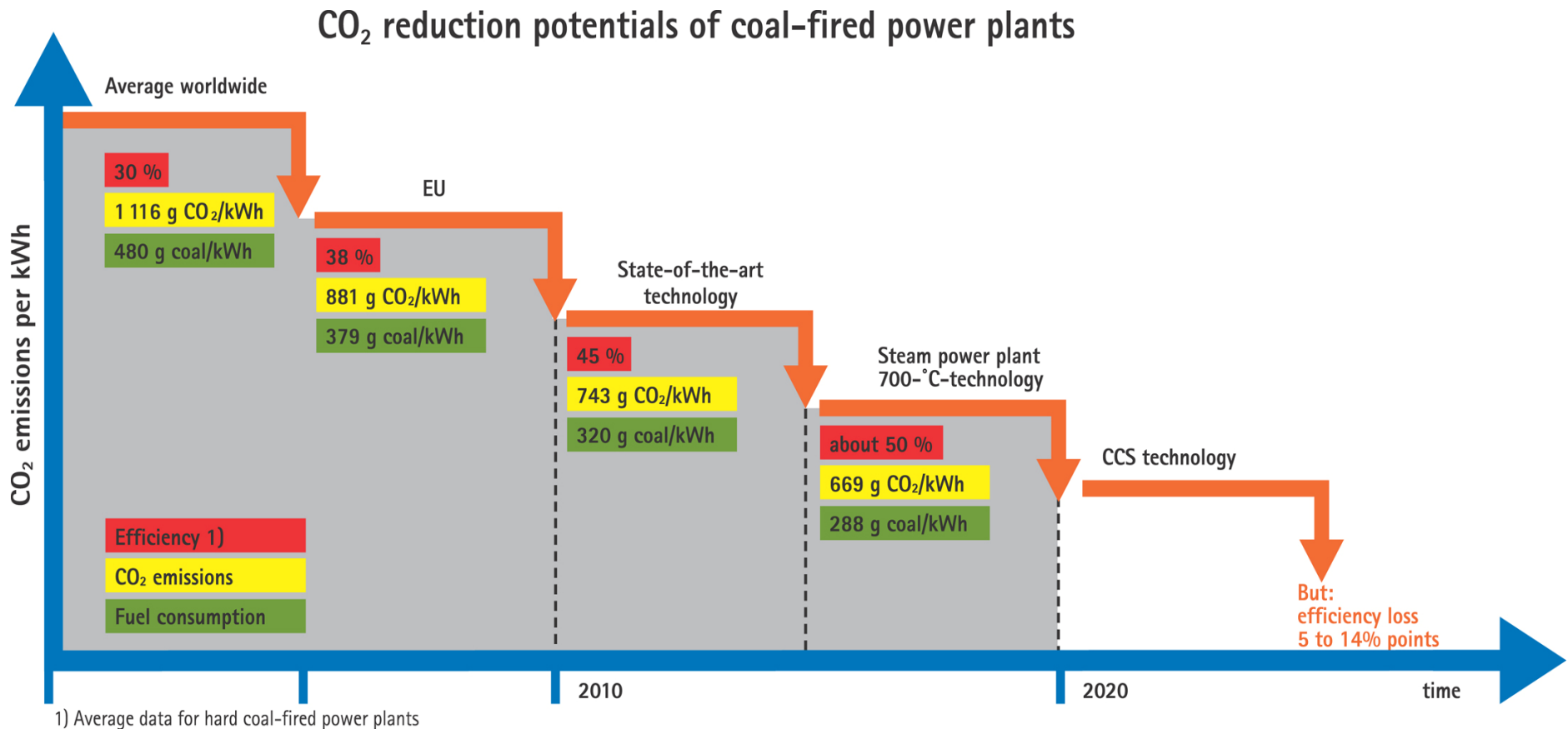
Future Coal

← Time to Commercialize  
New CO<sub>2</sub> Technology →

# Current Level of Interest Varies



# New CO<sub>2</sub> Technology Will Not Be Commercialized Over Night → Efficiency Improvement Offers Near-Term Benefits



Source: VGB

# Near-Term: Technology Exists to Address CO<sub>2</sub> Through Efficiency

2



Ready for use: Modern coal-fired and gas-fired power plant technology

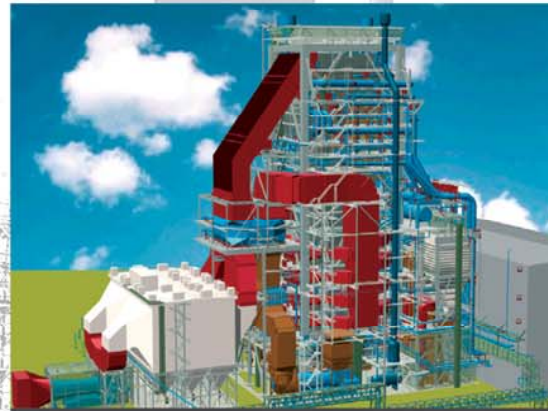
Lignite



BoA Niederaußem

> 43 %

Hard coal



Reference power plant NRW

46 %

Gas



CCGT Köln-Niehl

> 58 %

Source: VGB

## Example German Project

**1,100 MW unit  
Construction  
starts in 2007**

**1992: 42 %  
2005: 46 %**

**CO<sub>2</sub> Reduction  
- 9 %**

**Hard coal fired  
Steam Power Plant**

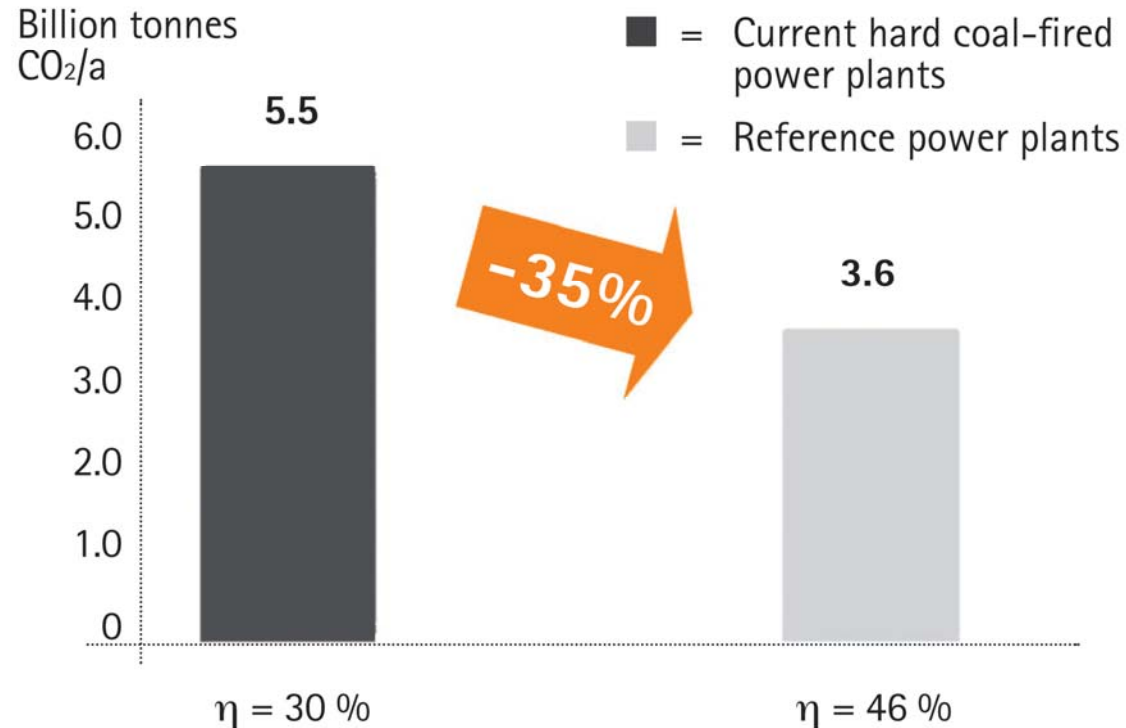


**Datteln 4, Germany**  
(commissioning: 2011)

Source: VGB

## Although it would be attractive to “replace” as many existing coal plant with “new” plant ...

Worldwide replacement of existing hard coal-fired power plants by modern reference power plants



... It is clearly not in the cards

# Significant Opportunity to Reduce Emissions Through Performance Improvement

- The World Energy Council (WEC) and others have shown in past that there is significant opportunity to reduce baseline emissions and fuel consumption by:
  - Improvements to plant and transmission/distribution efficiencies.
  - Improvements to management practices
    - Reliability
    - Fuel Utilization
    - Efficiency
    - Capacity
  - Improvements can pay for themselves



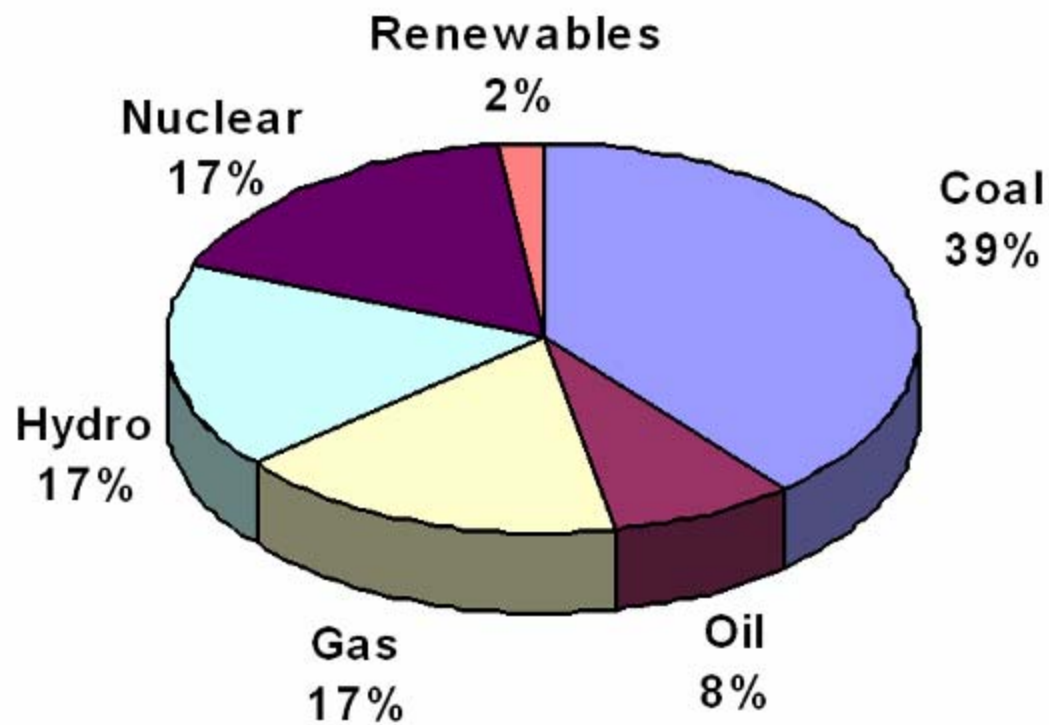
World Energy Council  
CONSEIL MONDIAL DE L'ENERGIE

## Worldwide Value of Performance Improvement

- **Economic**
  - **US\$80 Billion per Year**
- **Environmental**
  - **1 Billion Tonnes of CO<sub>2</sub>e Reduction per Year and Proportional Reductions of Other Emissions**

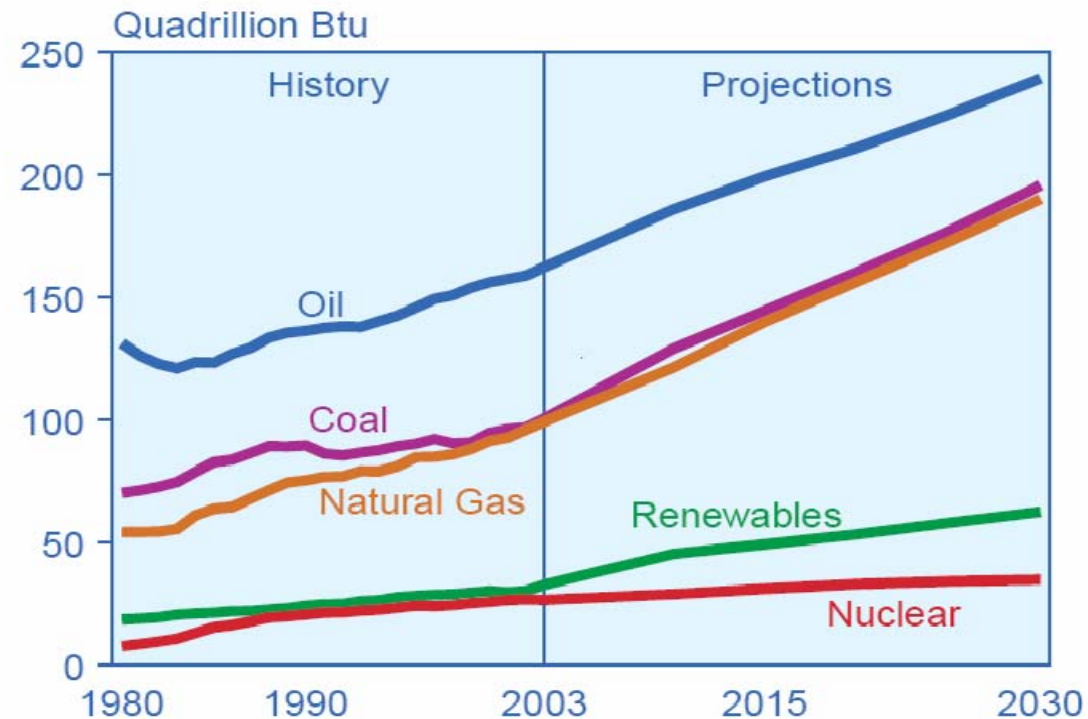


# World Electricity Production



# Coal Continues to Play A Major Role

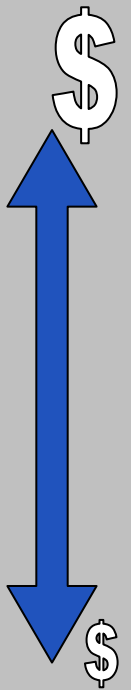
World Marketed Energy Use by Energy Type, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

## Its an Economics Problem

- CO<sub>2</sub> Reduction Technologies Exist but are very costly
  - Capital
  - Impact on plant efficiency
  - Impact on footprint of the plant
- Given limited capital investment in ESI – where do the \$\$ ultimately get spent?
  - New generation with carbon capture/sequestration
  - New transmission
  - Incremental improvements to conventional plant (e.g., advanced supercritical)
  - Retrofits to existing generation
  - Performance Improvements for existing generation



## It's a Multi-pollutant problem

- CO<sub>2</sub> gets the most attention today but is only one of the key pollutants of interest/concern to public welfare
- Regional coal sources will have different issues/value propositions. In most cases, "good" coals for CO<sub>2</sub> are not good for NO<sub>x</sub>, SO<sub>2</sub>, etc.
- Different regulations/restrictions are being placed on emissions across Electricity Supply Industry.
- Evolving regulations such as Hg can impact fuel mix as well.
- Coal is not uniform - in terms of performance, reliability, capacity risk, emissions, and economics.

## Costs for CO<sub>2</sub> Capture are Significant

- Additional equipment
  - CO<sub>2</sub> removal
  - CO<sub>2</sub> compression
  - CO<sub>2</sub> piping to sequestration site
- Energy penalty (12 – 40 percent depending on generation and capture technology)
- Solvent replacement (primarily amine processes)



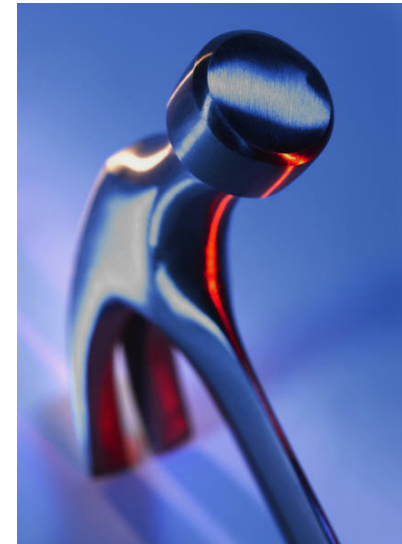
## Other Considerations

- With CO<sub>2</sub> capture, emissions of other regulated pollutants (SO<sub>2</sub>, NO<sub>x</sub>, particulates, etc.) will increase due to makeup power generation to replace power lost to energy penalty

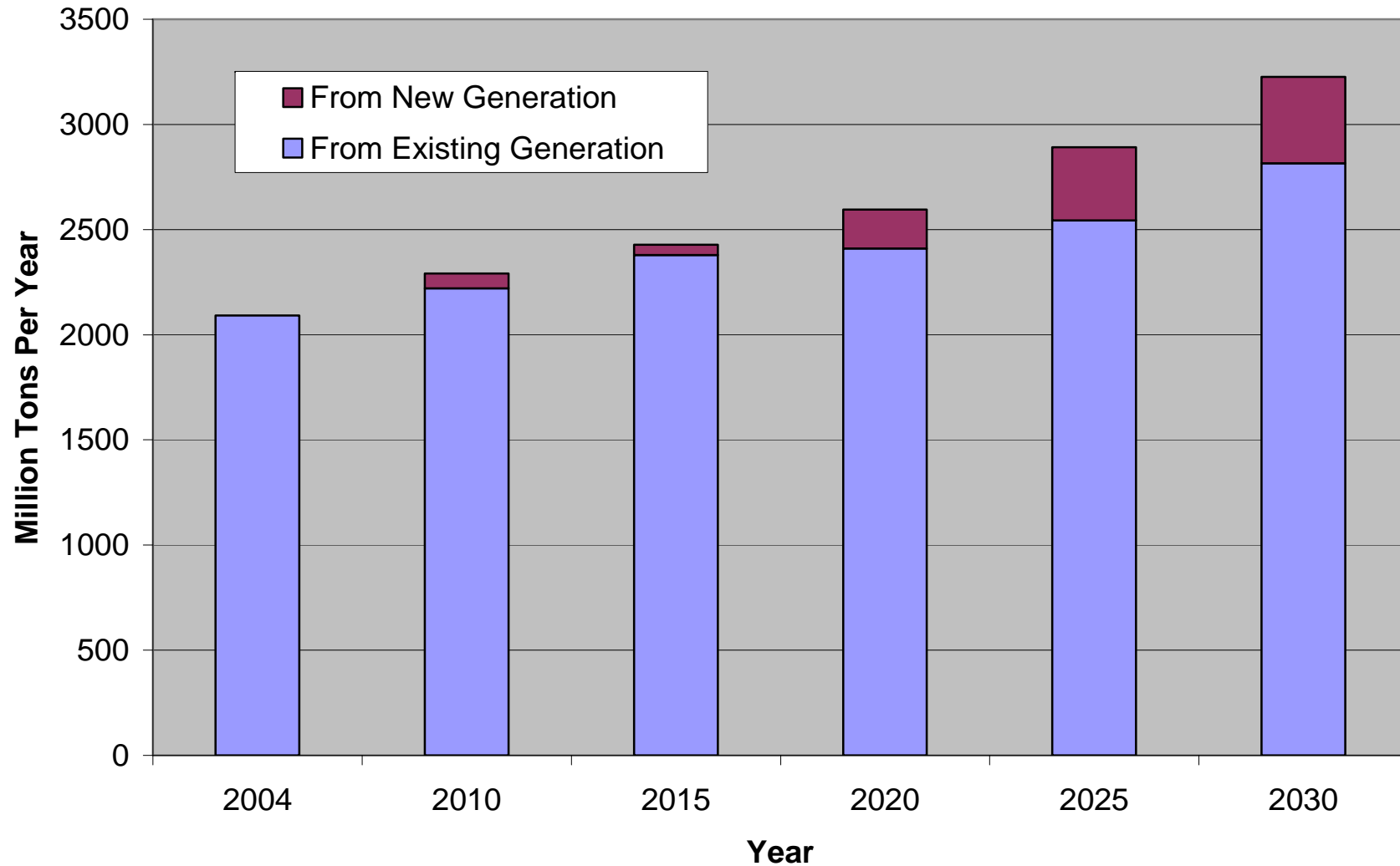


## For generation, the CO<sub>2</sub> Challenge

- Recognize the inherent “capacity” for CO<sub>2</sub> reductions within the existing coal-fired generation fleet
- Leverage tools and technologies that help:
  - Raise plant efficiencies and lower emissions
  - Address aging equipment, aging workforce, greater fuel variability, all within a capital scarce environment.



## US CO<sub>2</sub> Production from Power Generation



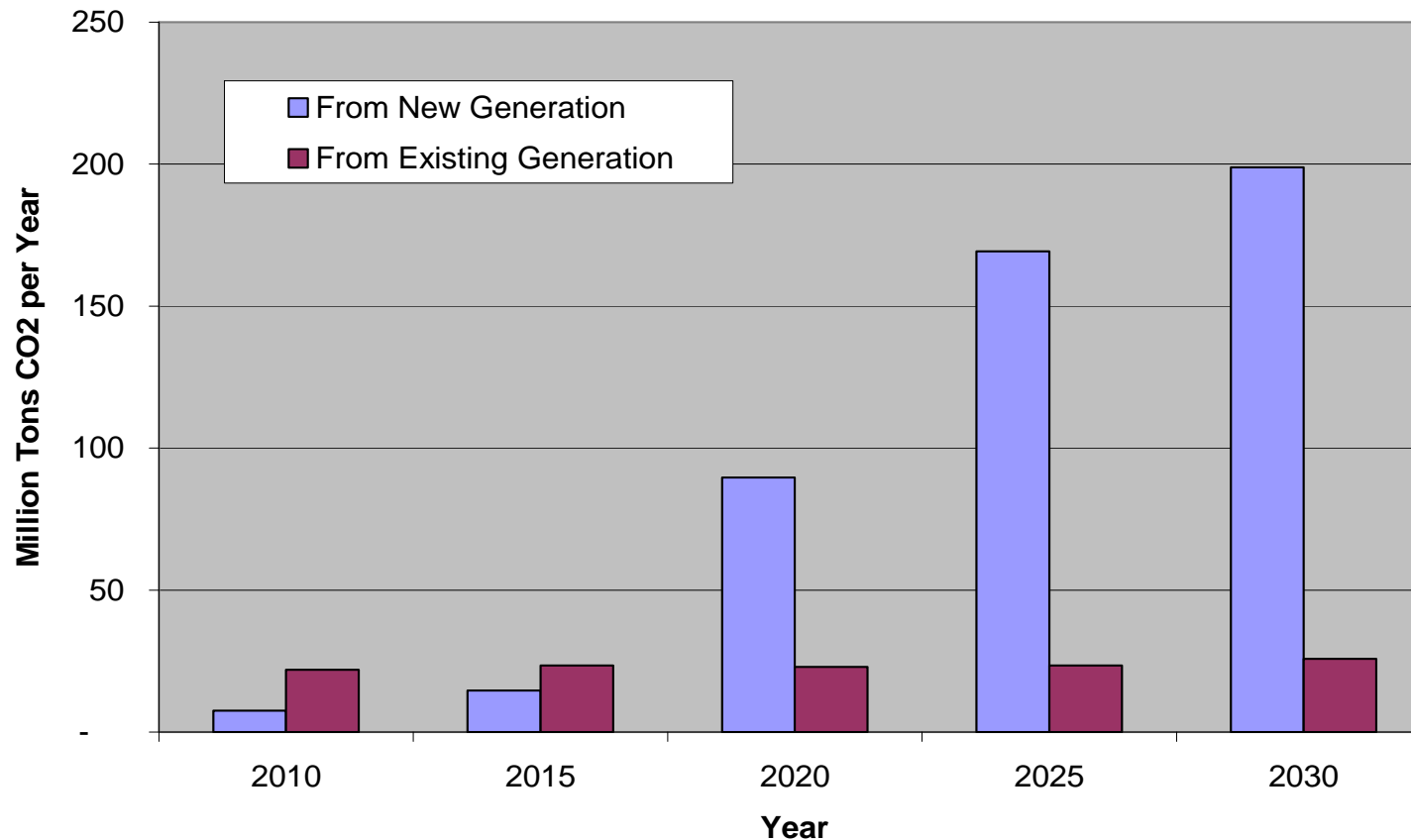
Reference: US EIA International Energy Outlook

## Relative Benefits

- CO<sub>2</sub> mitigation benefits from ***New Generation*** is equal to combined value of heat rate impact and CO<sub>2</sub> capture rate
  - Large Impact at Plant
  - Lesser Impact at National Level due to small contribution of new coal in overall generation mix
- CO<sub>2</sub> mitigation benefits from ***Existing Generation*** is equal to CO<sub>2</sub> reductions achieved either through CO<sub>2</sub> scrubbing or performance/efficiency improvements
  - Plant-level improvements may be modest without scrubbing
  - Large population of plants bolsters opportunity value

# Comparison of Benefits (US Case)

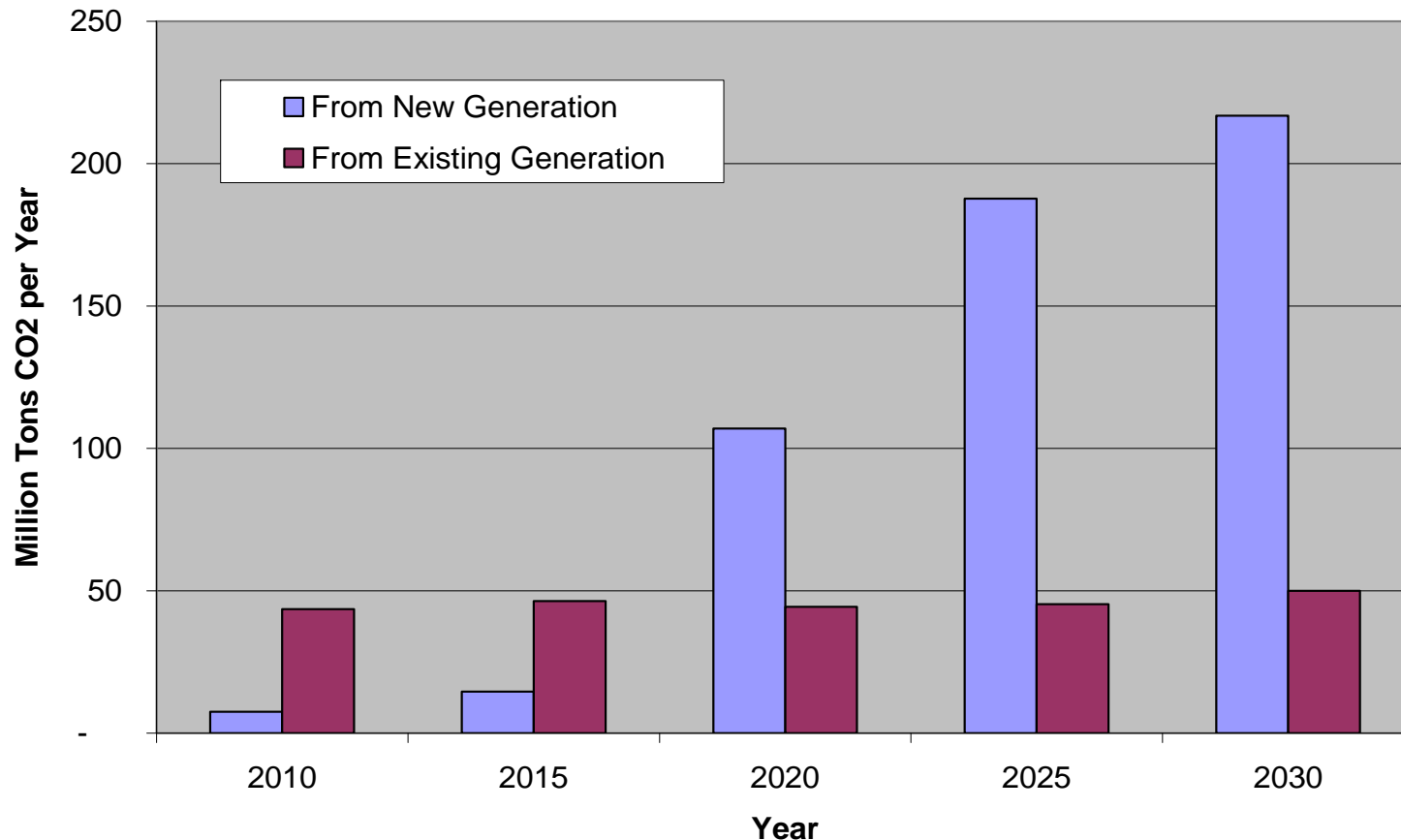
## CO<sub>2</sub> Reduction "Benefits"



Assumptions include modest retirements, no CO<sub>2</sub> controls on existing plants, 1% performance improvement, and 50% capture for new generation by 2030

# Comparison of Benefits (US Case)

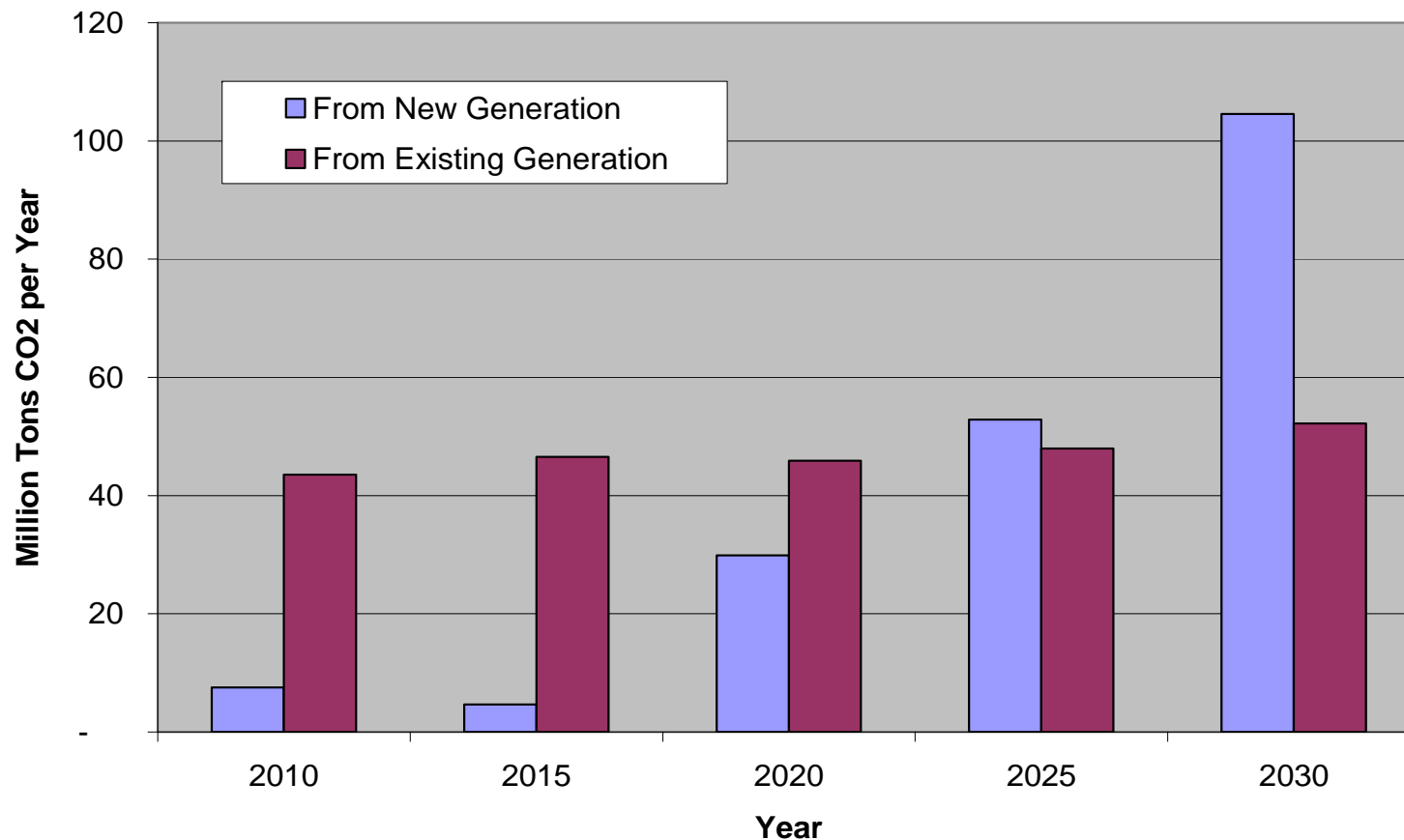
## CO<sub>2</sub> Reduction "Benefits"



Assumptions include more aggressive retirements, no CO<sub>2</sub> controls on existing plants, 2% performance improvement, and 50% capture for new generation by 2030

# Comparison of Benefits (US Case)

## CO<sub>2</sub> Reduction "Benefits"



Assumptions include modest retirements, no CO<sub>2</sub> controls on existing plants, 2% performance improvement, and 25% capture for new generation by 2030

## Existing Plants May Not Be Sexy But Are Not To Be Ignored

- “Relative” Benefit from CO<sub>2</sub> mitigation through performance improvement:
  - Can be greater in short-term than that realizable through new generation
  - Can remain a significant contributor through 2030 and beyond
  - Has dramatically better cost-to-results in terms of \$\$ investment required
  - Can be tied to other plant performance, reliability, and cost drivers.
  - Cycle modifications that improve heat rate can also improve capacity and/or other performance capabilities such as min. load/cycling, etc.

## A Shift in Focus is Needed

- Our WEC work suggests ...
  - Need to look beyond “current” points of emphasis – safety, skills development, sound O&M practices, reliability and more recently, commercial availability
  - More emphasis needed on efficiency/capacity issues and associated emissions
- Unique opportunity to employ innovative practices and proactive, diagnostic tools/processes to lower emissions
  - Performance Monitoring
  - Predictive maintenance tools
  - Large-Scale Plant Optimization
  - Plant advisory systems for Rapid identification/corrective action
  - Monitoring and Diagnostic centers
  - Performance/Emissions Dashboards - business focus linked to emissions and market metrics

