

# Carbon Capture and Storage: A Technology Solution for Continued Coal Use in a Carbon Constrained World

Congressional Briefing  
May 22, 2008  
562 Dirksen Senate Office Building



ELECTRIC POWER  
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# What Are Current CO<sub>2</sub> Capture and Storage Technology Costs?

**Congressional Staff Briefing**

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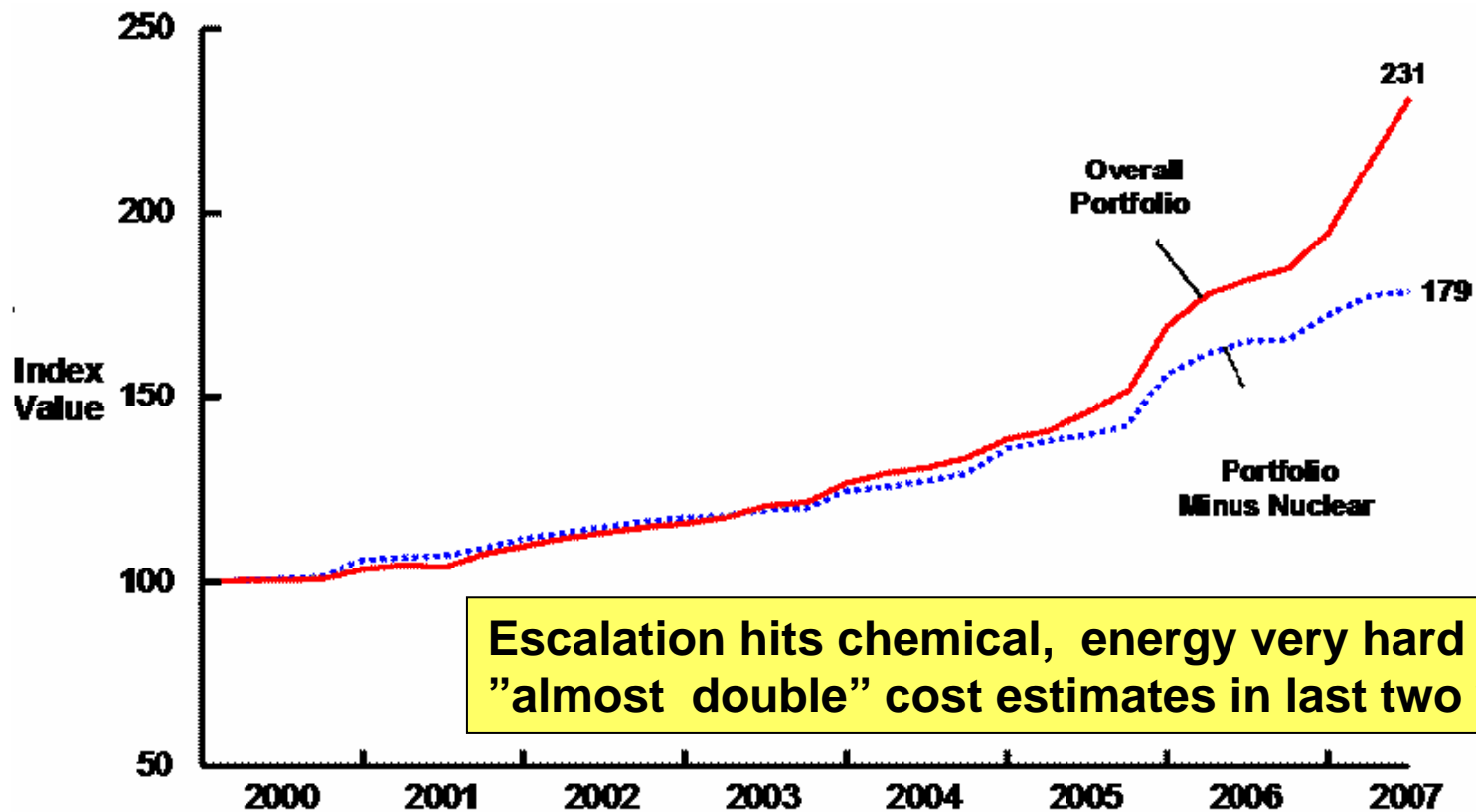
# Background On Cost

- EPRI has redone capital cost and O&M estimates for Integrated Gasification Combined Cycle with Capture of CO<sub>2</sub> (IGCC/CCS) and Pulverized Fuel with CCS (PC/CCS)
- Huge escalation in past few years – world competition
- Options are needed
- New Federal , Private RD&D should reduce costs and improve efficiency
- Accelerated EPRI / industry funding for projects both supporting DOE projects and separate RD&D.

# IHS/CERA Power Capital Costs Index

*“North American Power Construction Costs Rise 27% in 12 Months”*

*“Continuing Cost Pressures Likely to Bring Delays and Postponements”*

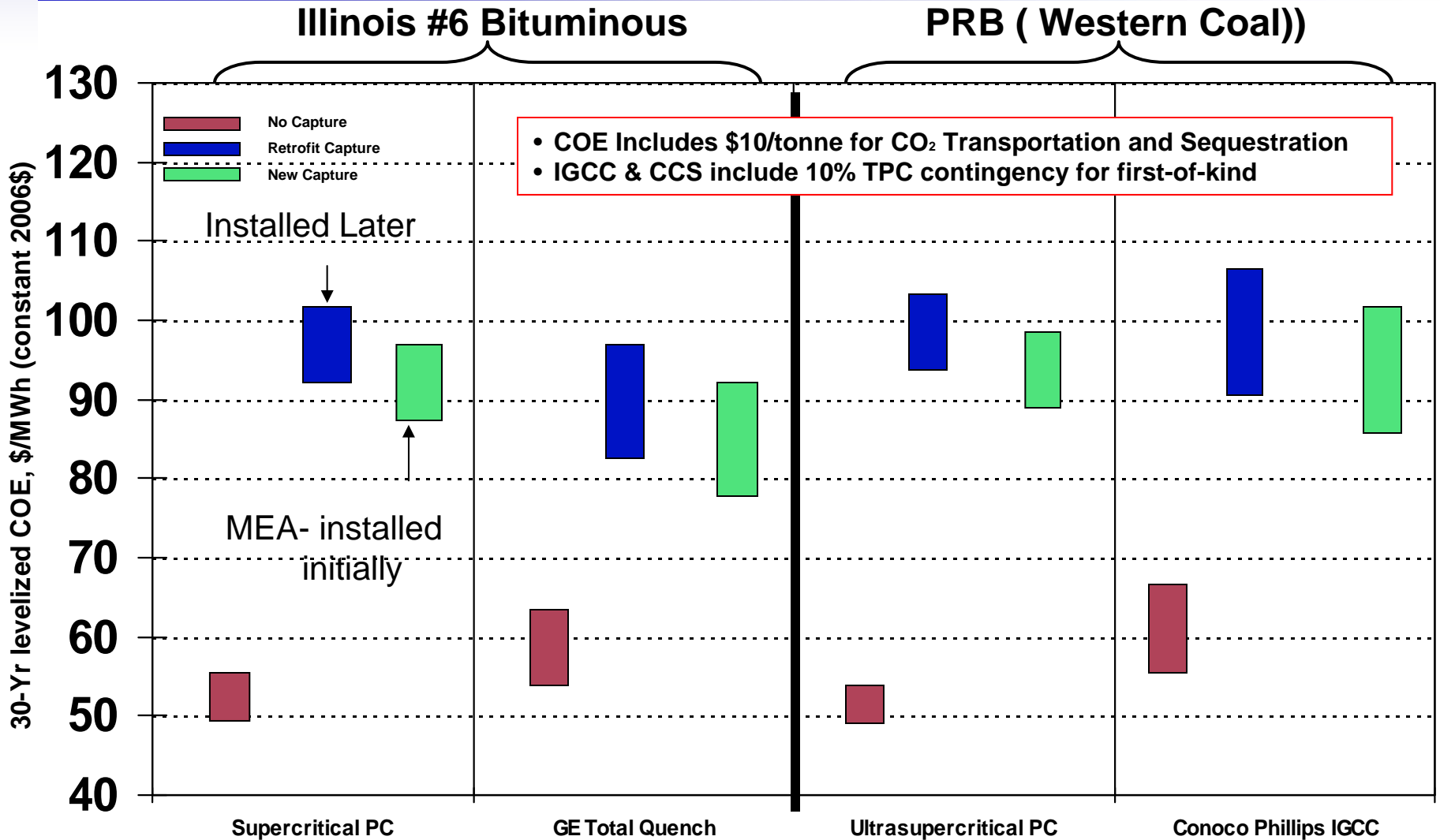


Source: IHS/CERA Press Release 2/14/08

# Capital Cost Estimates in Press Announcements and Submissions to PUCs in 2007–08—All costs are higher, more than would be predicted from indices (e.g., CEPCI)

Owner	Name/Location	Net MW	Technology/ Coal	Estimate Date	Reported Capital \$ Million	Reported Capital \$/kW	Notes/Status
AEP/ Swepco	Hempstead, AK	600	SCPC/PRB	Dec. 2006	1680	2800	CPCN issued
Southern Co.	Kemper County, MS	560	Air IGCC/ Lignite	Dec. 2006	1800	3000	FEED in progress
Duke	Cliffside, NC	800	SCPC/ Bit	May 2007	2400	3000	Permitted
Duke	Edwardsport, IN	630	IGCC/ Bit	May 2008	2350 In Service	3730	Permitted
AEP	Mountaineer, WV	630	IGCC/Bit	June 2007	2230	3545	Permit in Review
Tampa Electric	Polk County, FL	630	IGCC/Bit	July 2007	1613 (all \$?) 2013 Serv	2554/ 3185	Shelved; now NGCC
Sunflower	Holcomb, KS	2 x 700	SCPC/PRB	Sept. 2007	3600	2572	Permit denied
Am. Muni. Power	Meigs County, OH	1000	SCPC/Bit & PRB	Jan. 2008	2900/3300	2900/3300	
Tenaska	Sweetwater County, TX	600	SCPC + CCS/PRB	Feb. 2008	3000	5000	

# With Current Technology CO<sub>2</sub> Capture Costly; No Clear Winners in Current Designs

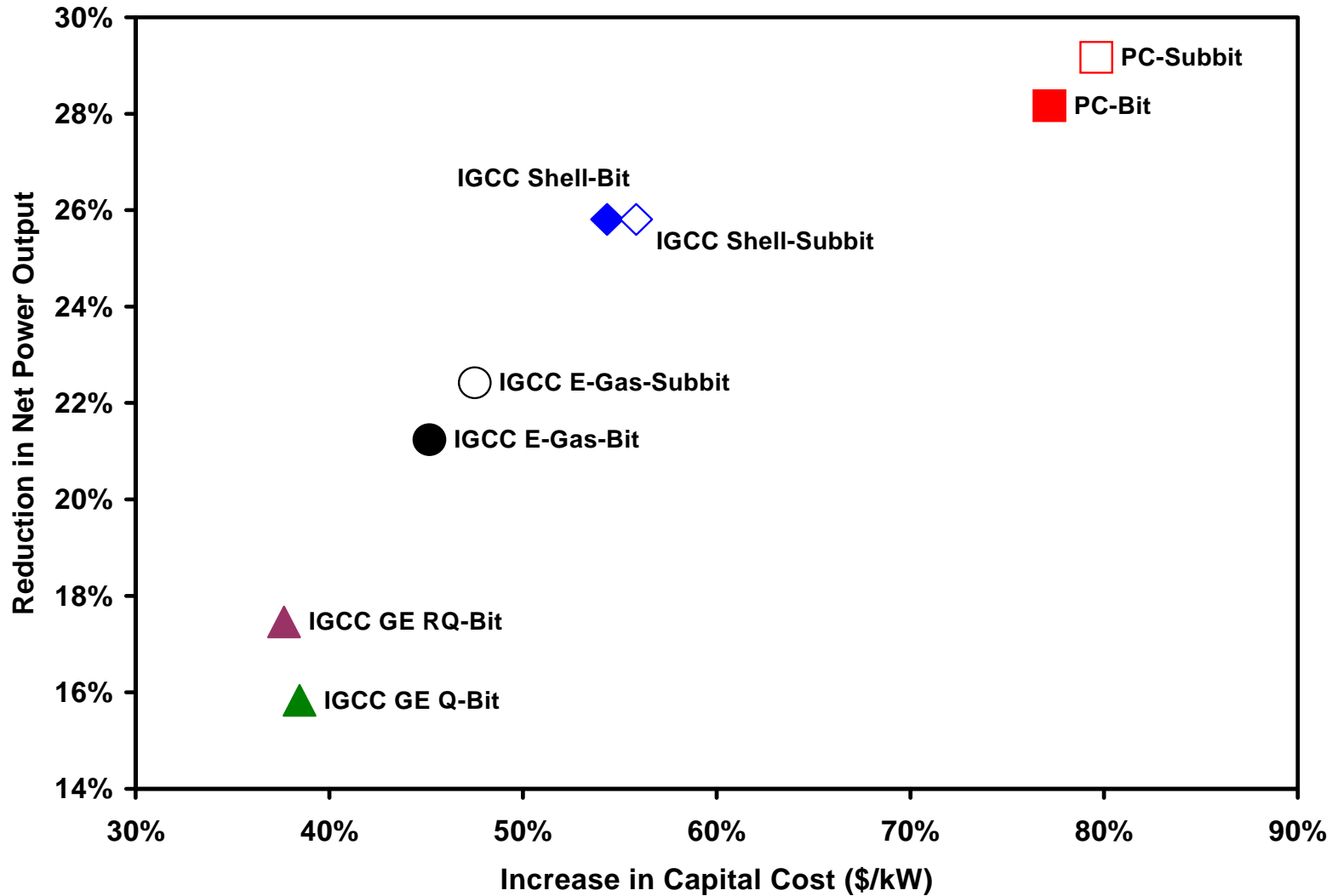


# CO<sub>2</sub> Capture Can Be Done Today, But....

- As last slides shows It would **increase** the **cost** of electric power from coal **significantly and there are no clear winners for all coals**
- EPRI's current estimates
  - Cost of power from a pulverized coal plant with post-combustion capture would be **60-80% higher**
  - Cost of power from an IGCC with pre-combustion capture would be **40-50% higher** (but IGCCs start out with a higher cost, so won't necessarily be cheapest option with CCS)
  - Cost of oxy-combustion more difficult to estimate with certainty at this stage of development but overall cost of power probably similar to PC + post combustion capture
- Luckily, EPRI also estimates that **with a concerted RD&D effort, the cost impact of CCS should decrease dramatically**

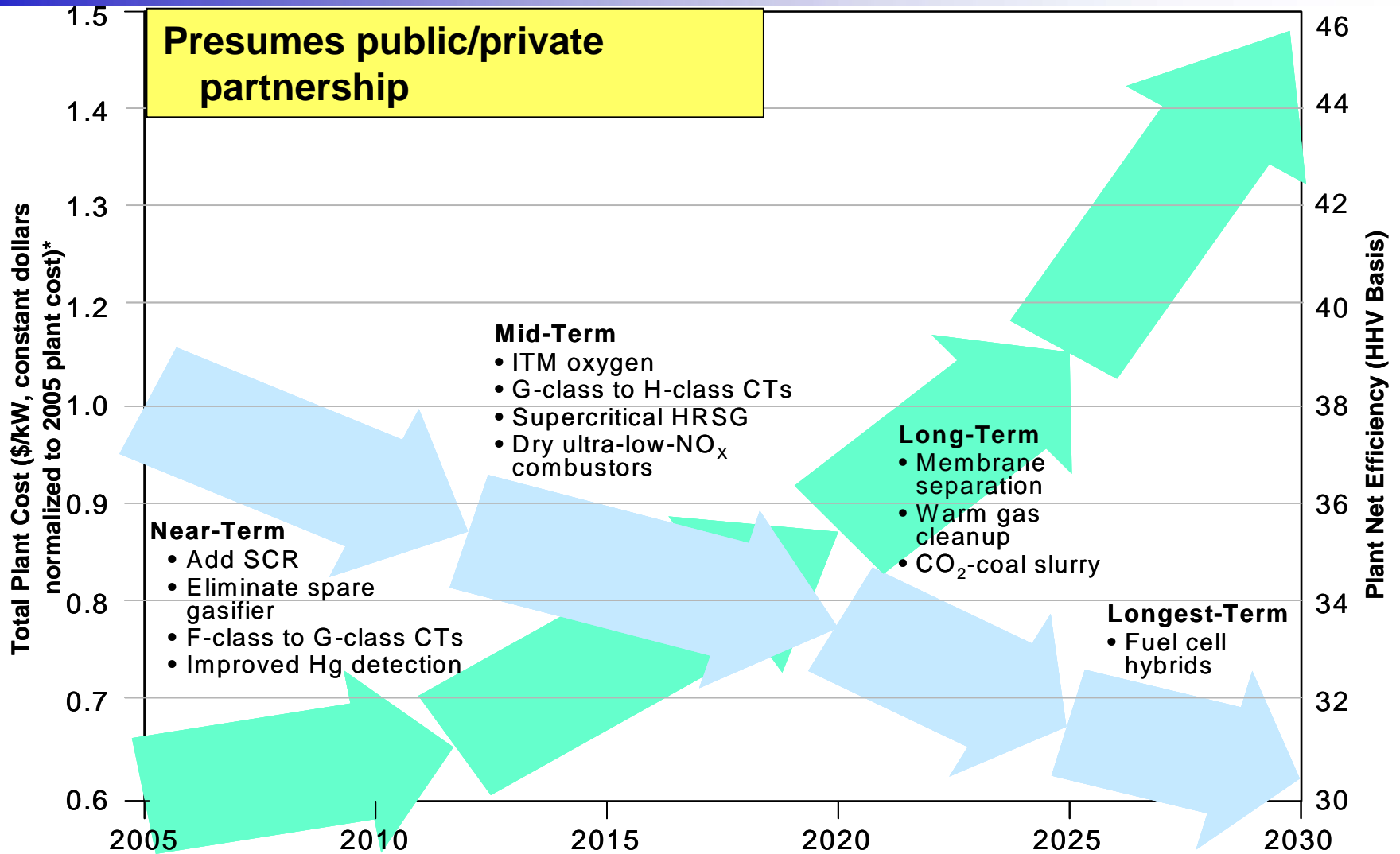
# Cost & Performance Penalties for CO<sub>2</sub> Capture

(based on retrofit of existing PC or IGCC plant – today's technology)

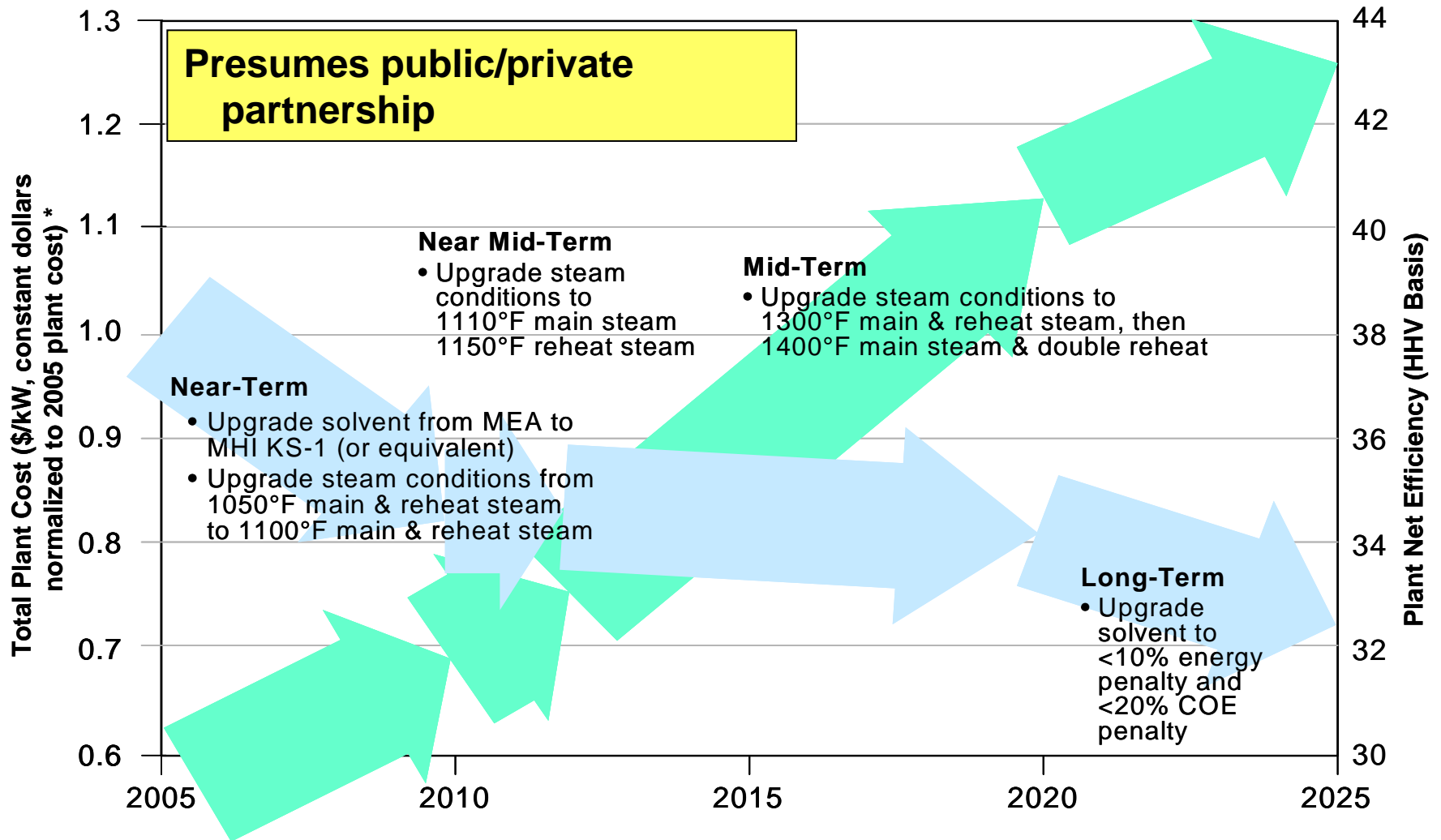




# EPRI Estimates of the Benefits and Timing of RD&D in Gasification of Coal

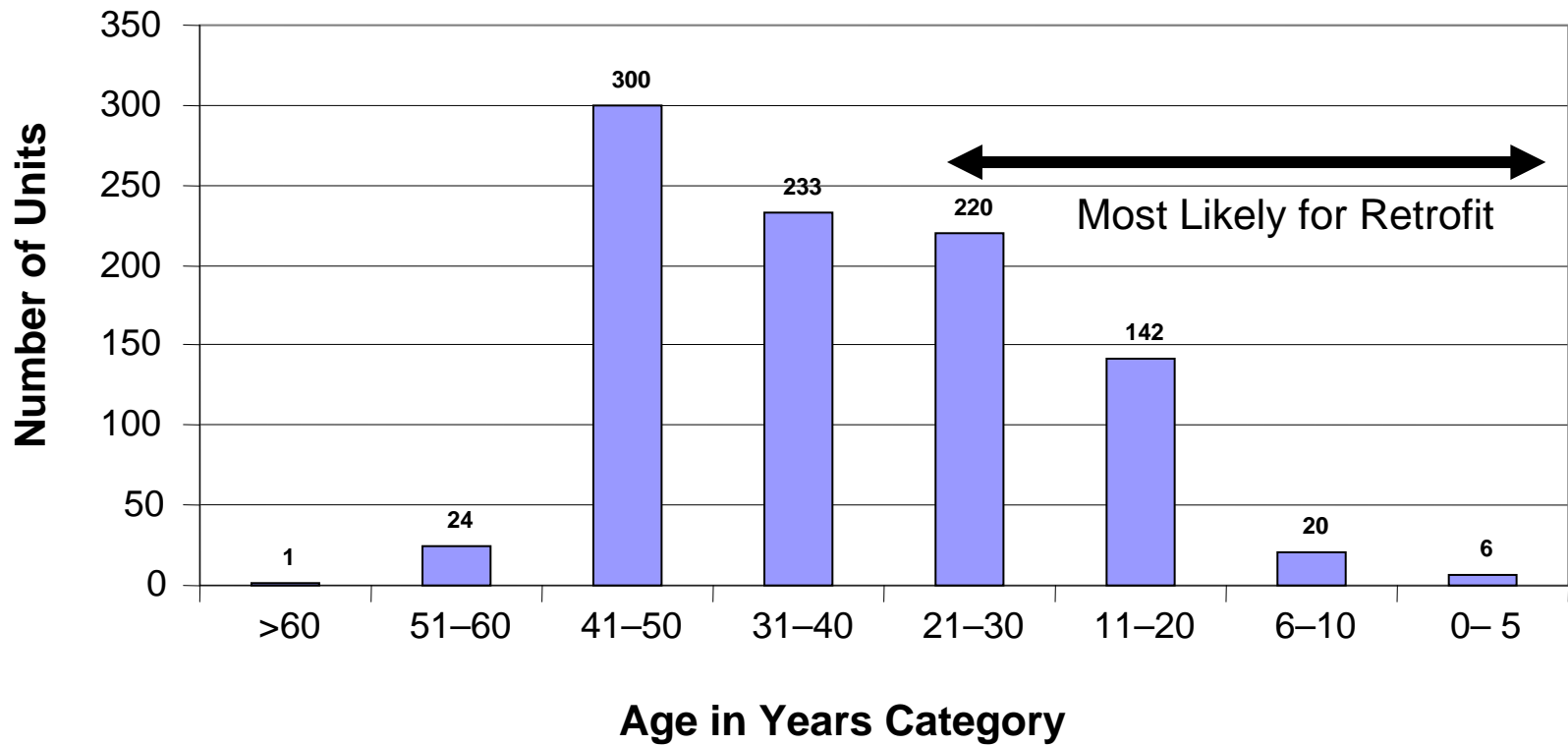


# EPRI Estimates of the Benefits and Timing of RD&D in Combustion



# What Could be Retrofit? U.S. Coal Plant Age

## U.S. Coal Power Unit Distribution



# What if your new “conventional” plant may need CO<sub>2</sub> capture later in its life?

- There are some things you should do differently:
  - Add space
  - Ensure access to suitable geologic storage site
  - Make plant as efficient as practical – higher efficiency means less CO<sub>2</sub> to capture and compress
  - Design emissions controls to either achieve ultra-low SO<sub>x</sub> and NO<sub>x</sub> emissions today, or be readily upgradeable
  - For solvent-based systems, design steam turbine to accommodate very large extraction of low pressure steam for regeneration



# Retrofit Issues for Post Combustion Capture (e.g., for Existing Coal Plants)

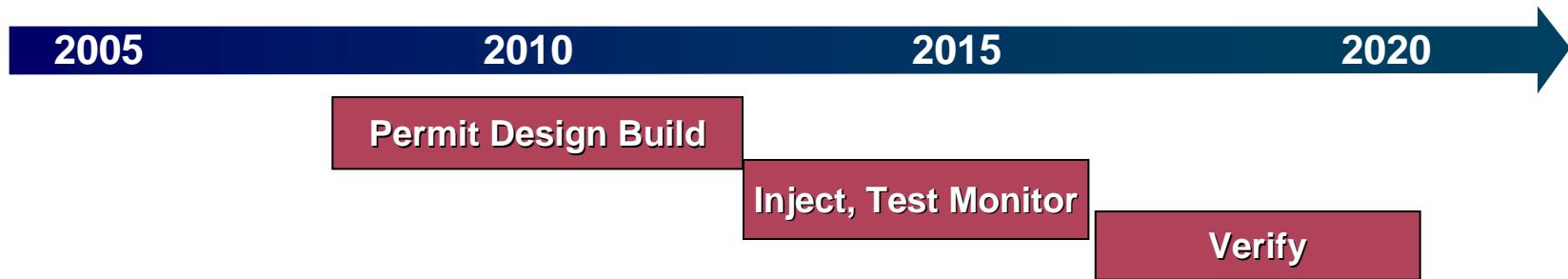
- Space, steam , energy and cost
- Need ~ 6 acres near an operating 500 MW plant
- Have all areas near stack been used for FGD , SCR retrofit?
- May need half the steam used for a low pressure turbine (e.g., for an amine)?
- Concerns about how to make up the lost power.
- Cost to retrofit ?(SO<sub>2</sub> Scrubbers for existing plants were 1.2-1.8x as expensive as on new units)
- Transport – existing or new pipelines
- Where does the CO<sub>2</sub> go for storage/sequestration? (storage varies)

# Difficulty in Going Immediately to 90% Capture

## - Experience, Integration , Risk

- No one in the world has run IGCC with Capture of CO<sub>2</sub> in an integrated manner
- No one has operated full-scale modules of post-combustion treatment or oxyfuel commercially
- Designs will be very stringent and have novel components or large scale-ups to provide 90% Capture
  - IGCC/CCS (e.g. Hydrogen Turbines)
  - PC CCS (e.g., large modules / untested designs on coal),
  - Oxyfuel cant do “partial”, must scale up significantly
  - Need to learn by doing and get large-scale integrated capture and storage on and in the ground quickly, but may need to start with lower capture percentages

# Need to Start Now - Timeline for Full-Scale Demonstration of CO<sub>2</sub> Capture and Storage



- **Learn by permitting, operating, and monitoring**
  - Full scale
  - Complete system
- **Goals**
  - **Capture cost, energy << today**
  - Transportation guidelines adopted
  - Storage rules, legal issues, public acceptance settled



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# Technical Potential for Future CO<sub>2</sub> Emissions Reductions

**Congressional Staff Briefing**

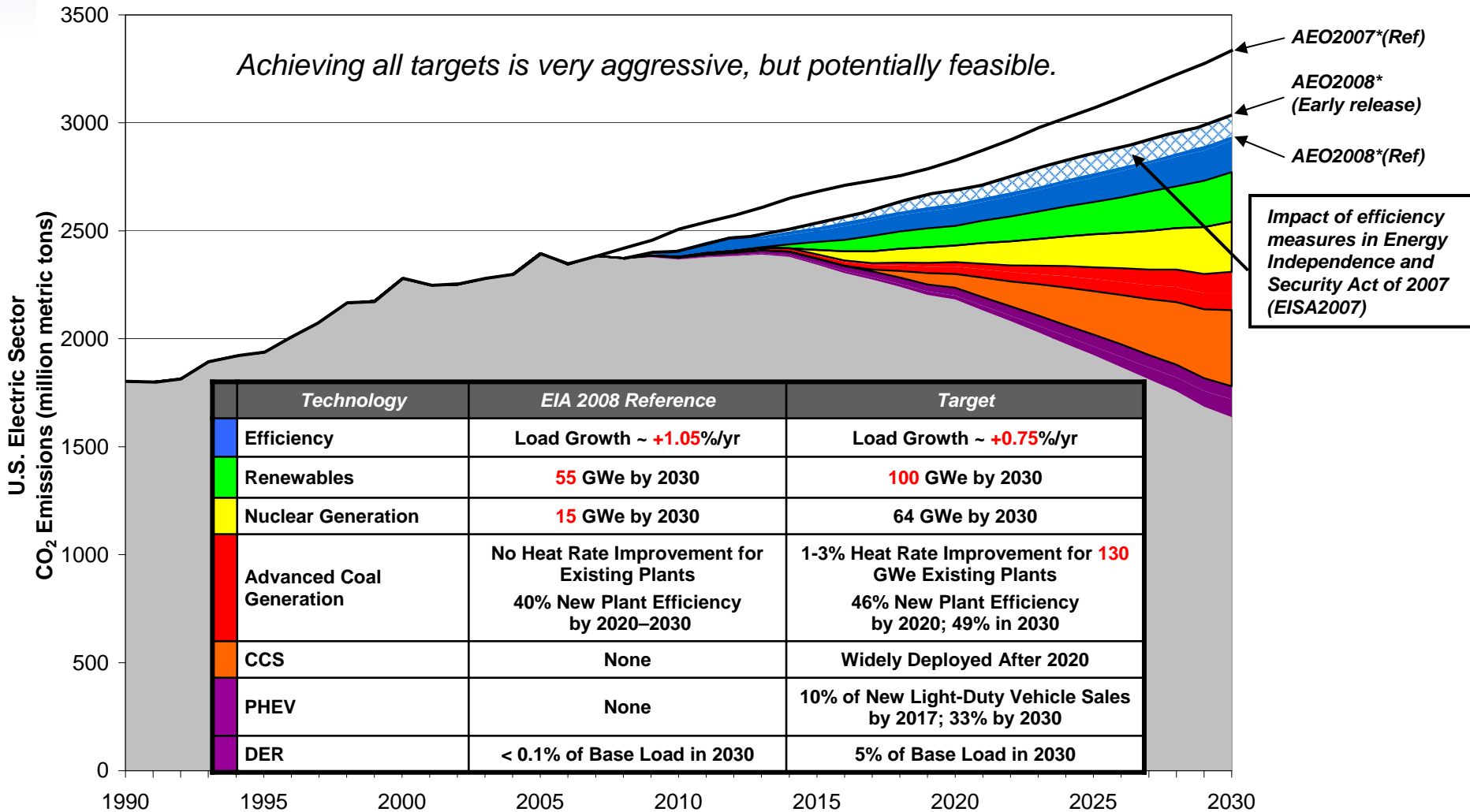
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# 2008 Prism...Technical Potential for CO<sub>2</sub> Reductions

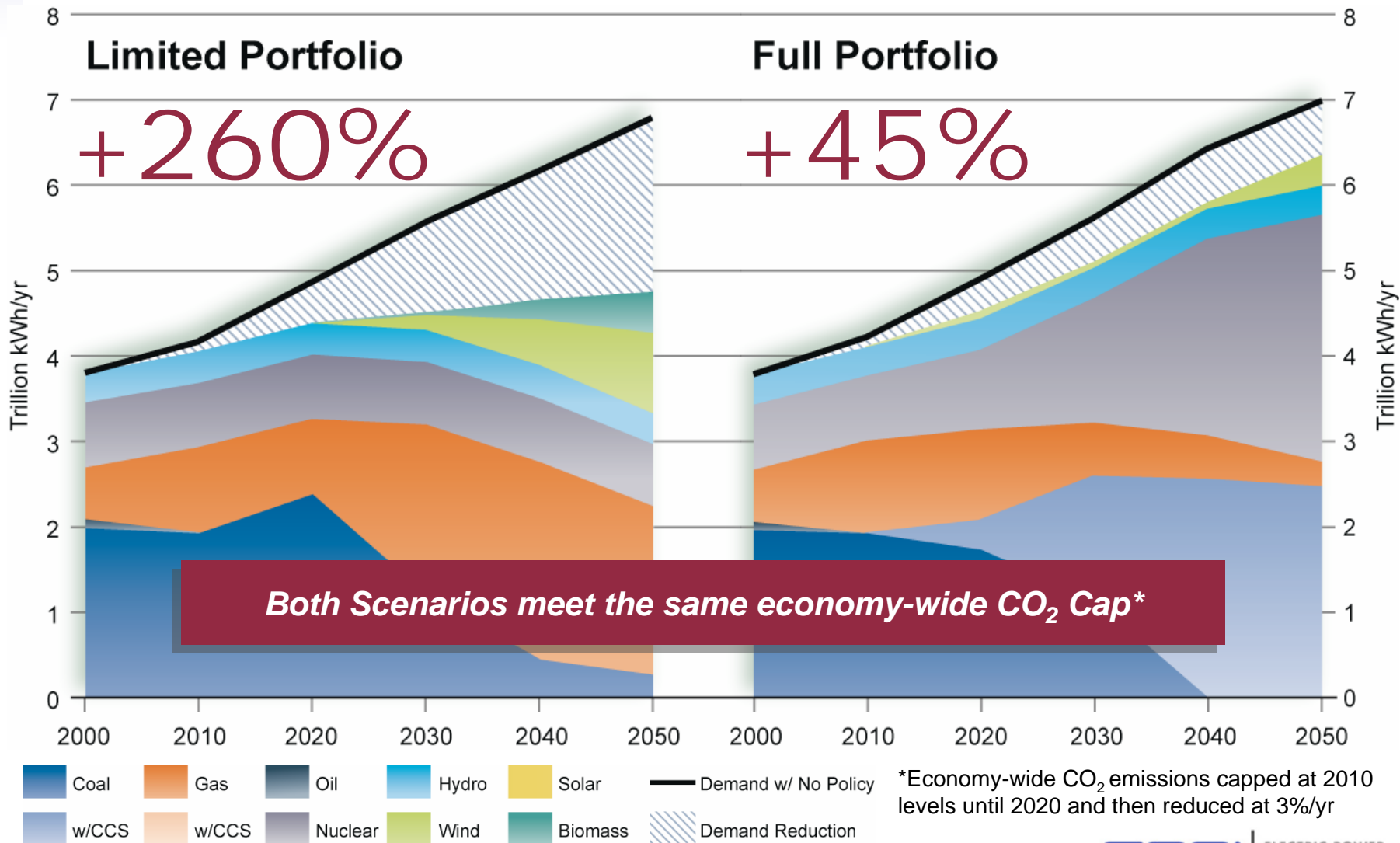


\*Energy Information Administration (EIA) Annual Energy Outlook (AEO)

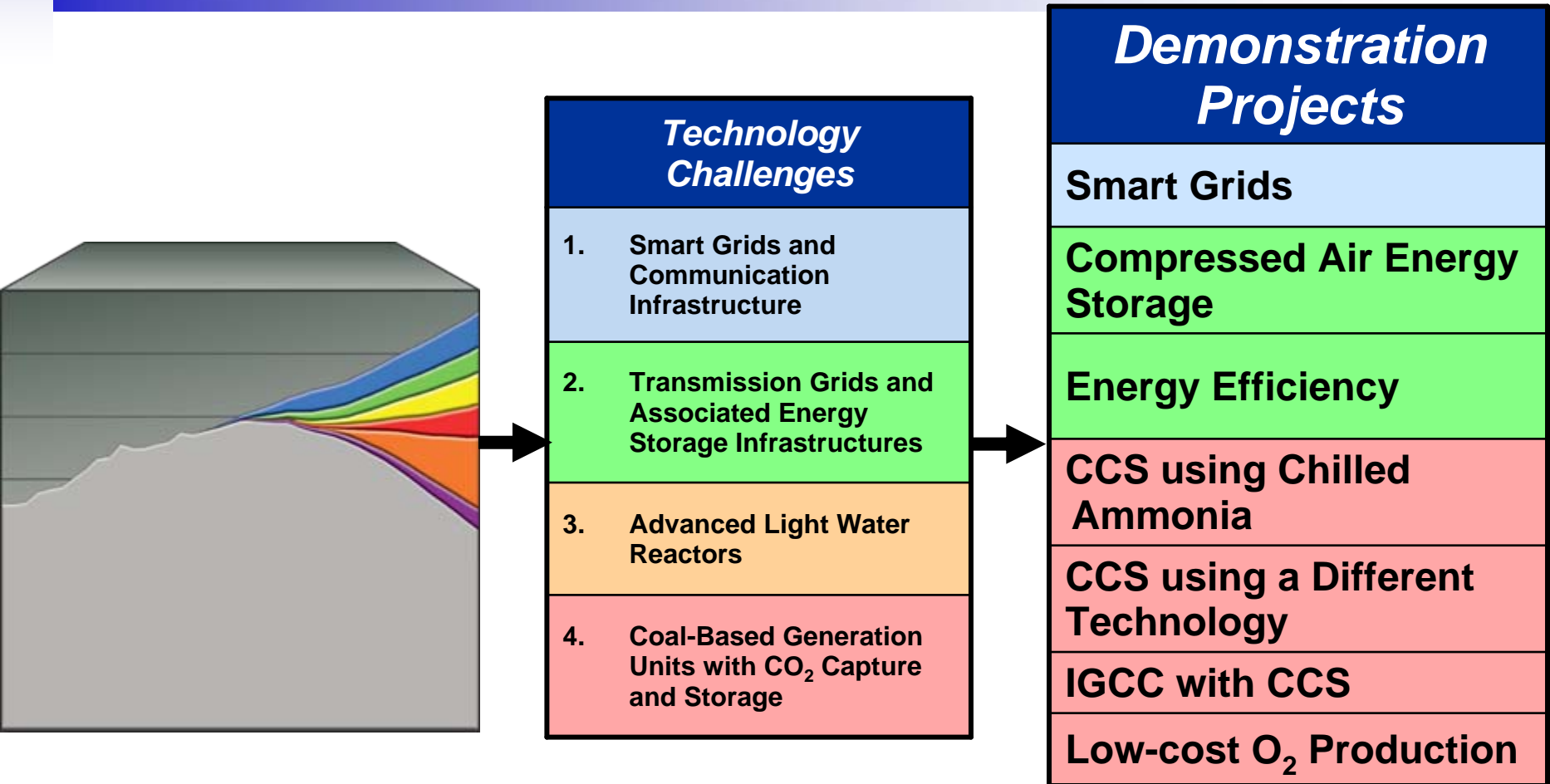
# Electricity Technology Scenarios

	Full Portfolio	Limited Portfolio
<b>Supply-Side</b>		
Carbon Capture and Storage (CCS)	Available	Unavailable
New Nuclear	Production Can Expand	Existing Production Levels ~100 GW
Renewables	Costs Decline	Costs Decline Slower
New Coal and Gas	Improvements	Improvements
<b>Demand-Side</b>		
Plug-in Hybrid Electric Vehicles (PHEV)	Available	Unavailable
End-Use Efficiency	Accelerated Improvements	Improvements

# Increase in Real Electricity Prices... 2000 to 2050



# EPRI - Industry Climate Demonstrations Now Gathering Funding



# Climate Technology Demonstration Projects

- **Post-Combustion CO2 Capture with Storage**
  - **CCS Using Chilled Ammonia CO2 Capture Solvent (AEP)**
  - **CCS Using Competing Post-Combustion CO2 Capture Technology (Southern Company/SSEB)**
- **Ion Transport Membrane (ITM) Oxygen Plant Scale-Up & Turbomachinery Integration (supporting DOE project)**
- **IGCC with Integrated CO2 Capture and Storage (CCS)**
- Energy Efficiency Demonstration – 6 Hyper efficient Technologies at five different locations
- Smart Grid Demonstration – Virtual Power Plant at about five different locations
- Compresses Air Storage Both Underground and Aboveground

Note - coal based projects are in **red**

Together...Shaping the Future of Electricity



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