



The Role, Status and Financing of CCS as a Mitigation Option in the United States

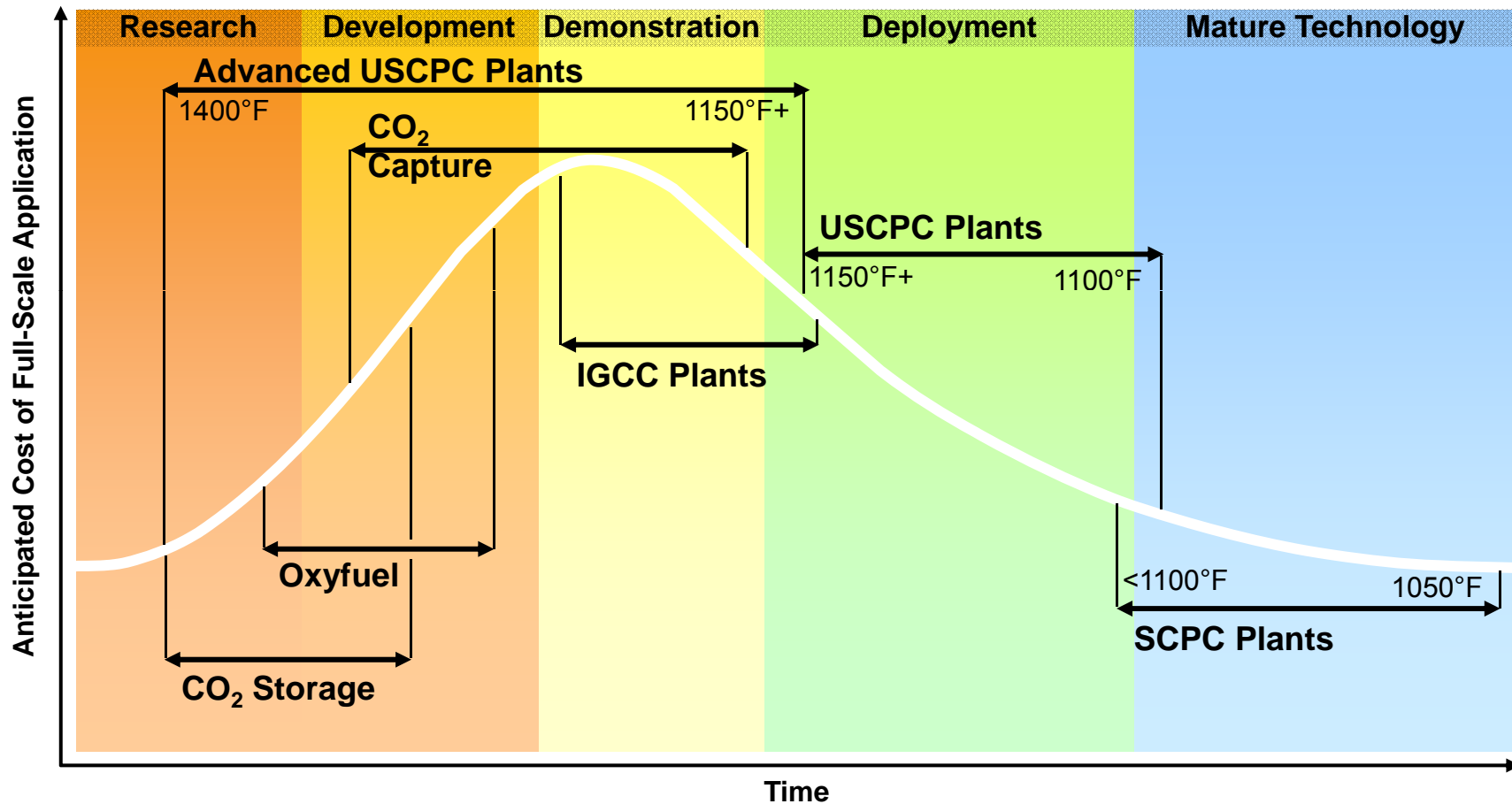
2nd Expert Meeting on Financing CCS Projects

May 28, 2008

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Senior Program Manager



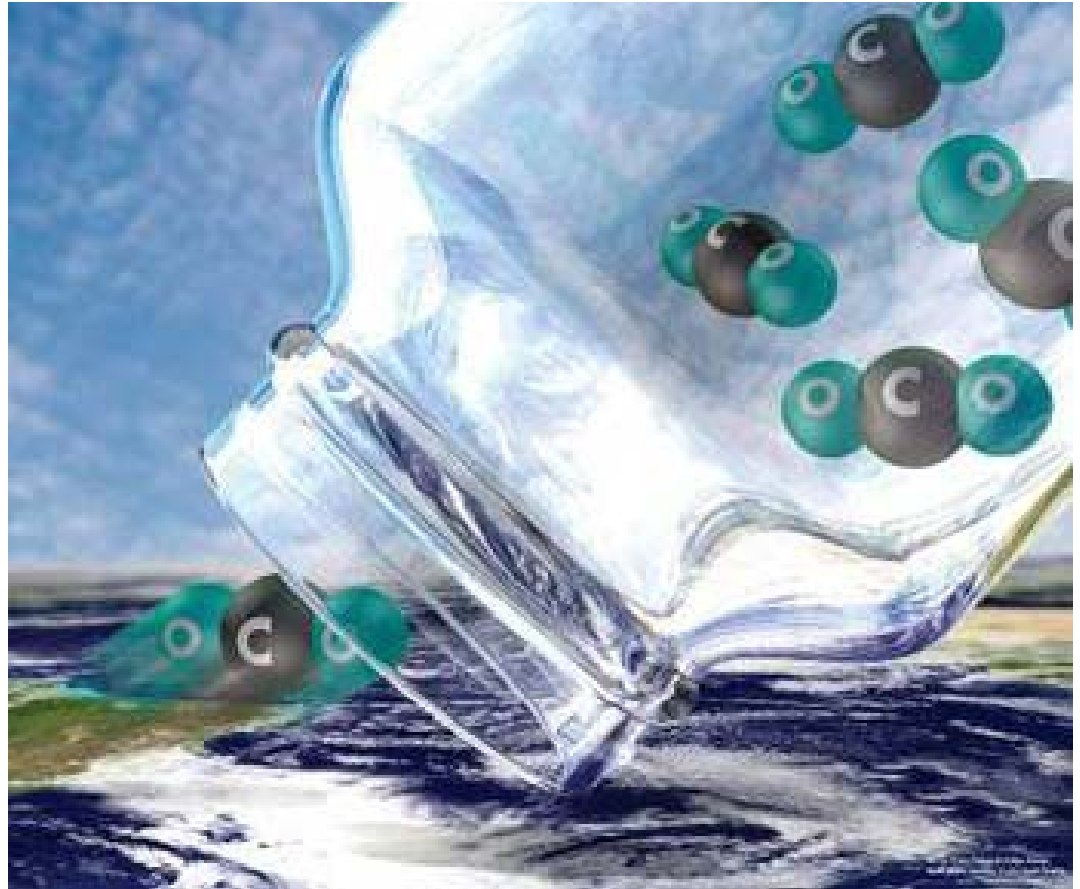
The “Mountain of Death” for New Technology Who is Going to Pay for Early Deployment?



Policy Trend in U.S.: Increasing recognition that we need explicit strategies for funding research, development, demonstration and early deployment

Topics

- CCS Cost
- Financing CCS
 - Lieberman-Warner
 - CO₂ Price
 - Incentives
- Demo Activities
- Concluding Thoughts



Part I: CCS Cost



Pleasant Prairie Chilled Ammonia, Post-Combustion Capture Demo
Dedicated in February 2008; Late 2007 photo, courtesy of Alstom

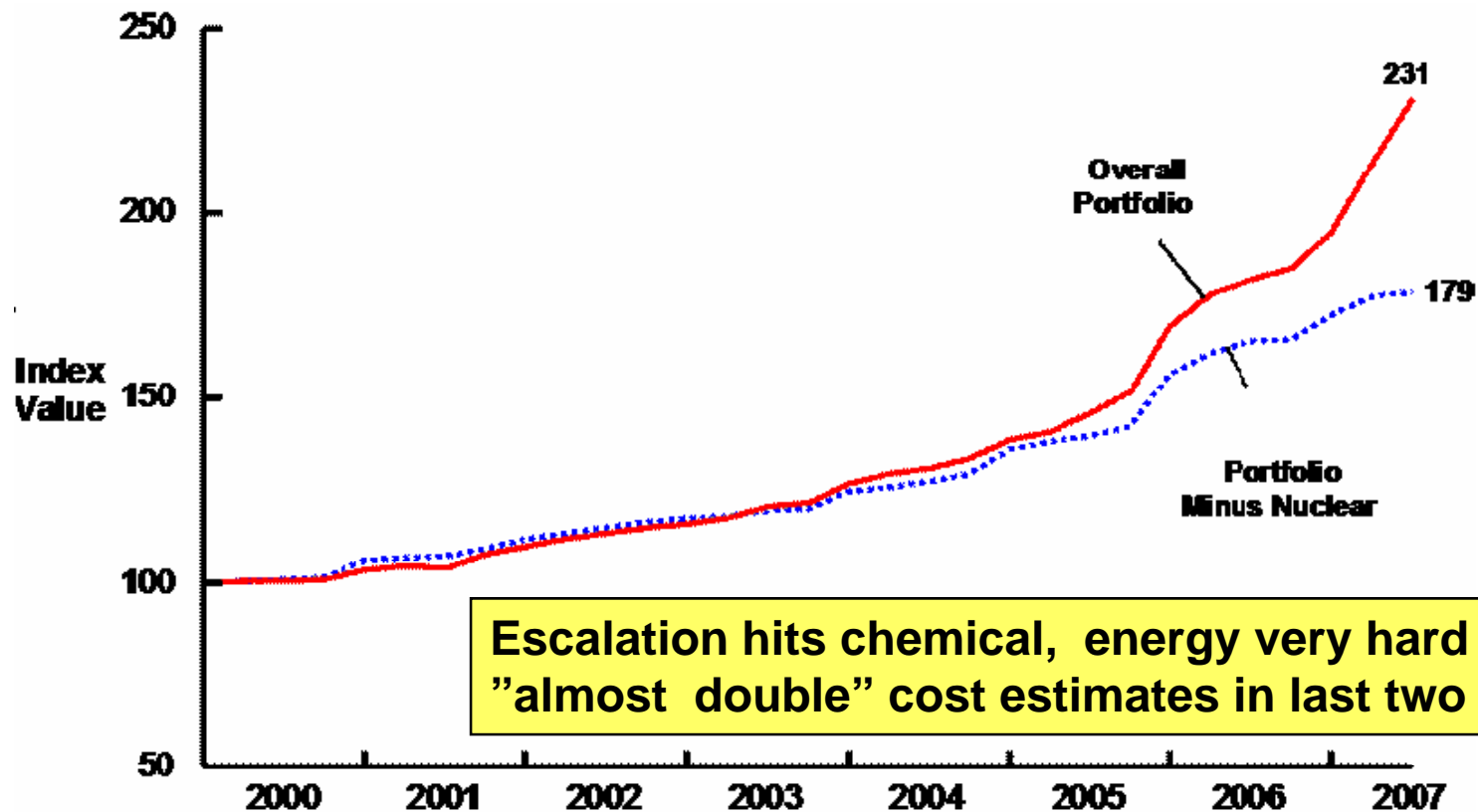


Capital Cost Estimates in Press Announcements and Submissions to PUCs in 2007–08—All costs are higher, more than would be predicted from indices (e.g., CEPCI)

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	

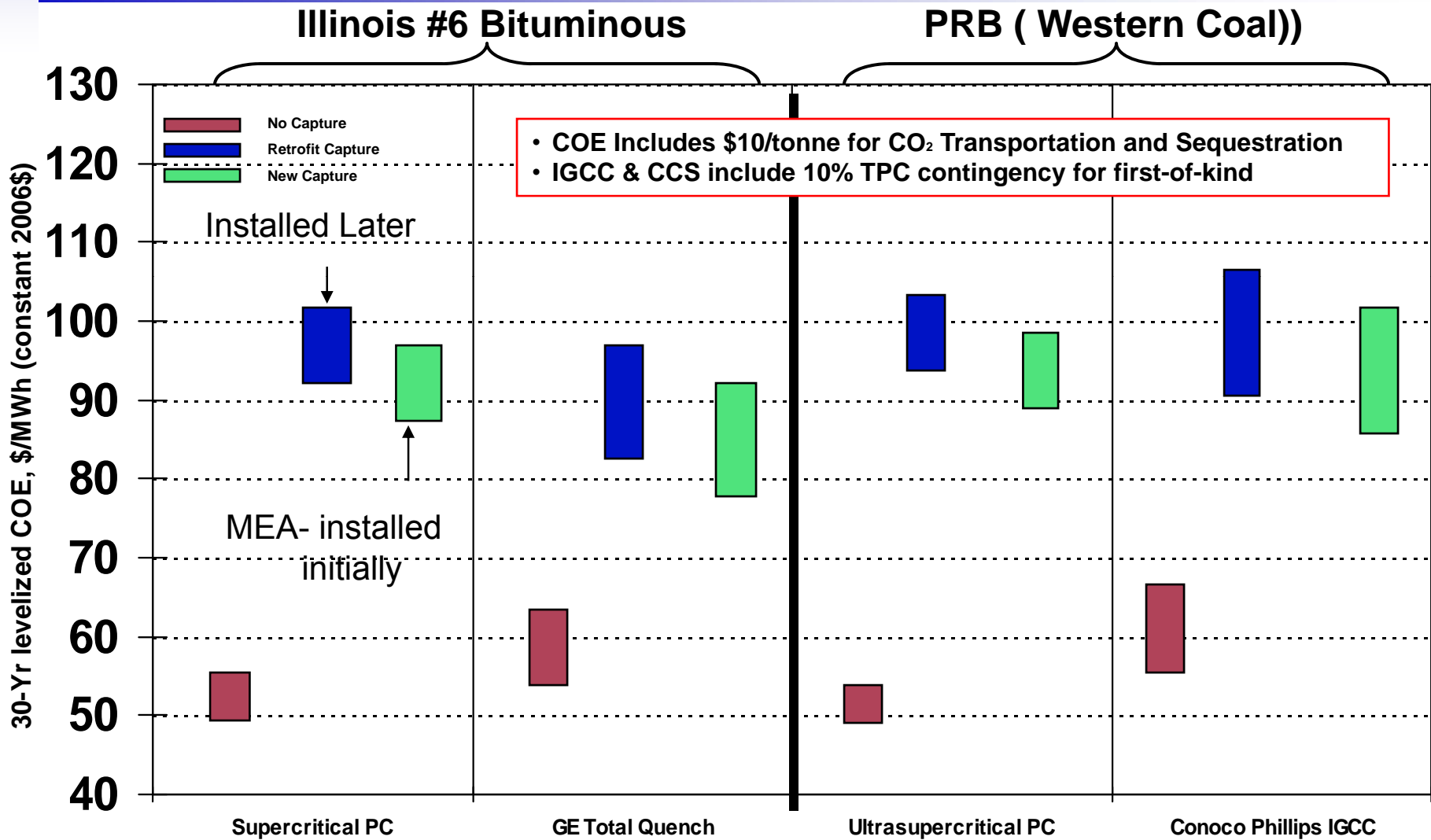
Energy Technology Costs Are Highly Uncertain: Are Today's Costs a New "Plateau" or a "Bubble"?

"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

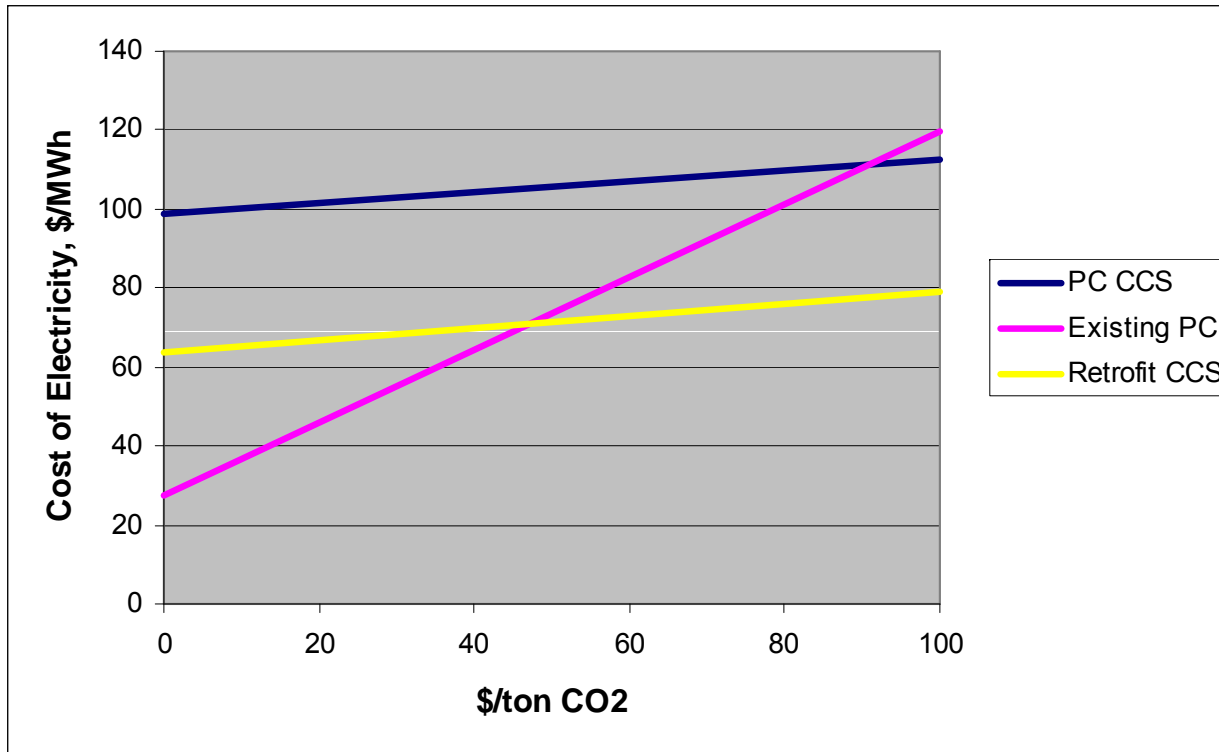
With Current Technology CO₂ Capture Costly; No Clear Winners in Current Designs



CCS Retrofit May Be Attractive for Some Plants ...

Cost of New PC w/ CCS versus Retrofit of Existing PC

(COE analysis, March 2008 Cost Estimates from G. Booras)

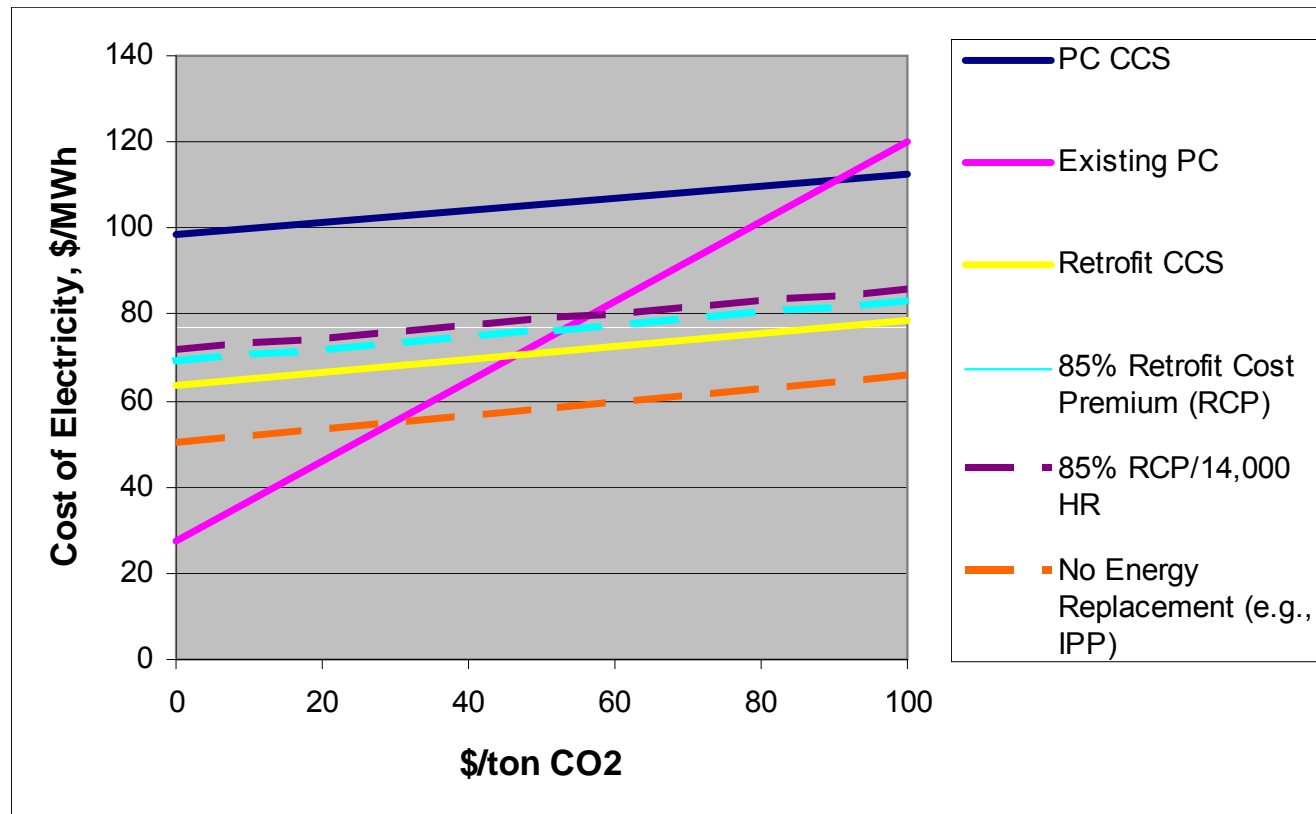


Analysis assumes:

- Retrofit MEA process in 2012
- 35% retrofit cost premium
- Replace capacity lost to retrofit w/ new PC w/ CCS

Plant	New PC w/ CCS	Existing PC	Retrofit CCS
MW	425	600	425
\$/kW	4000	0	940 * 1.35
Btu/kWh	11,300	9,500	12,500

CCS Cost Sensitivity Analyses (dashed lines)



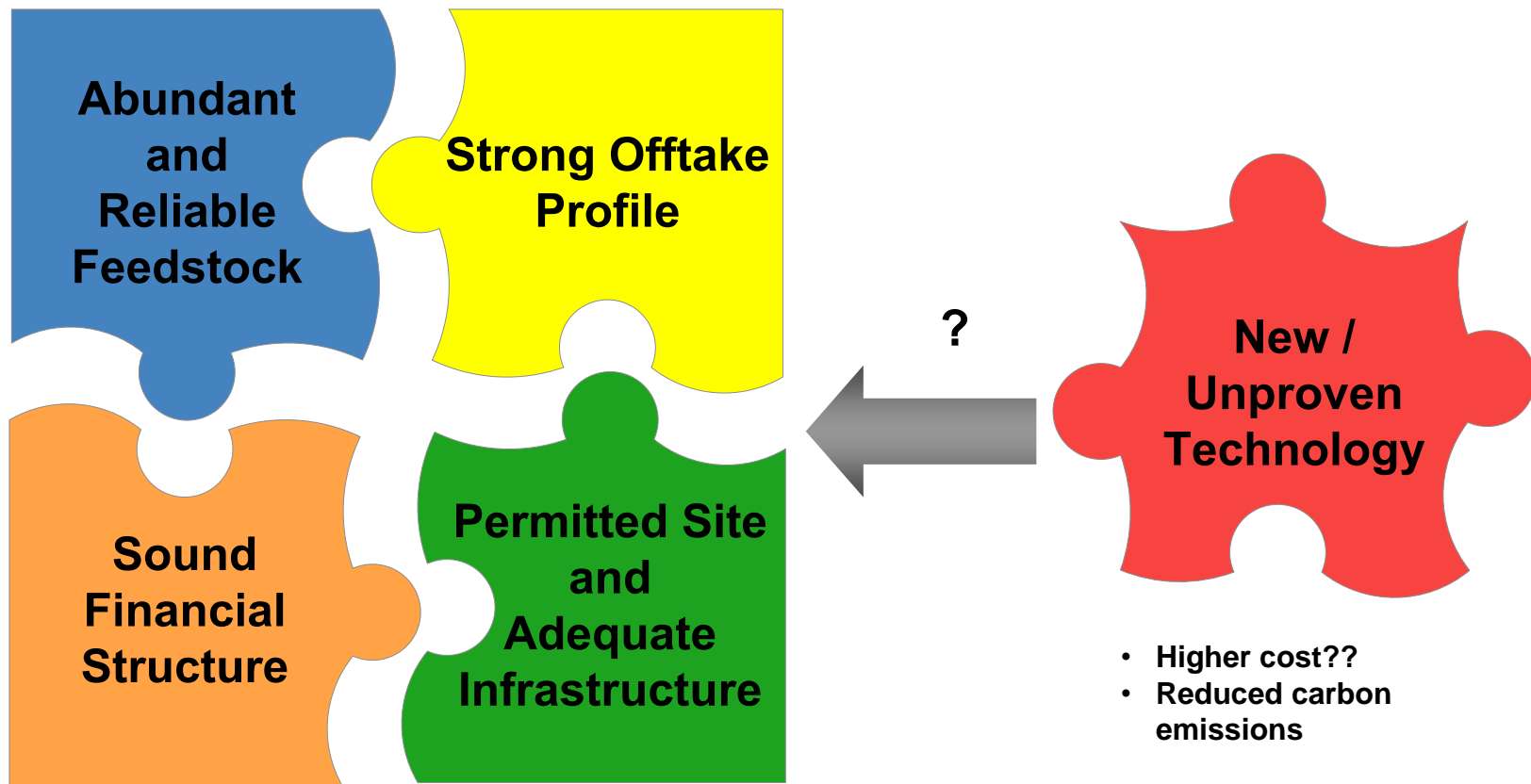
- COE is relatively insensitive to significant capital cost and heat rate retrofit penalties
- Energy replacement cost is a significant fraction of retrofit cost. Some companies may not consider this cost (e.g., IPP).

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

- Space
 - Where is there 6 acres near an operating 500 MW plant?
 - Have areas near stack been used for FGD, SCR retrofit?
- Steam
 - Where do you get half the steam currently used in the low pressure turbine (e.g., for an amine regenerator)?
- Energy
 - How do you make up the lost power?
- Cost
 - SO₂ Scrubbers retrofits were 1.2-1.8x as expensive as on new units
- Transport and Storage
 - How do you transport the CO₂ offsite in populated areas

Part II: Financing CCS

Project Financing Elements



Source: Scully Capital

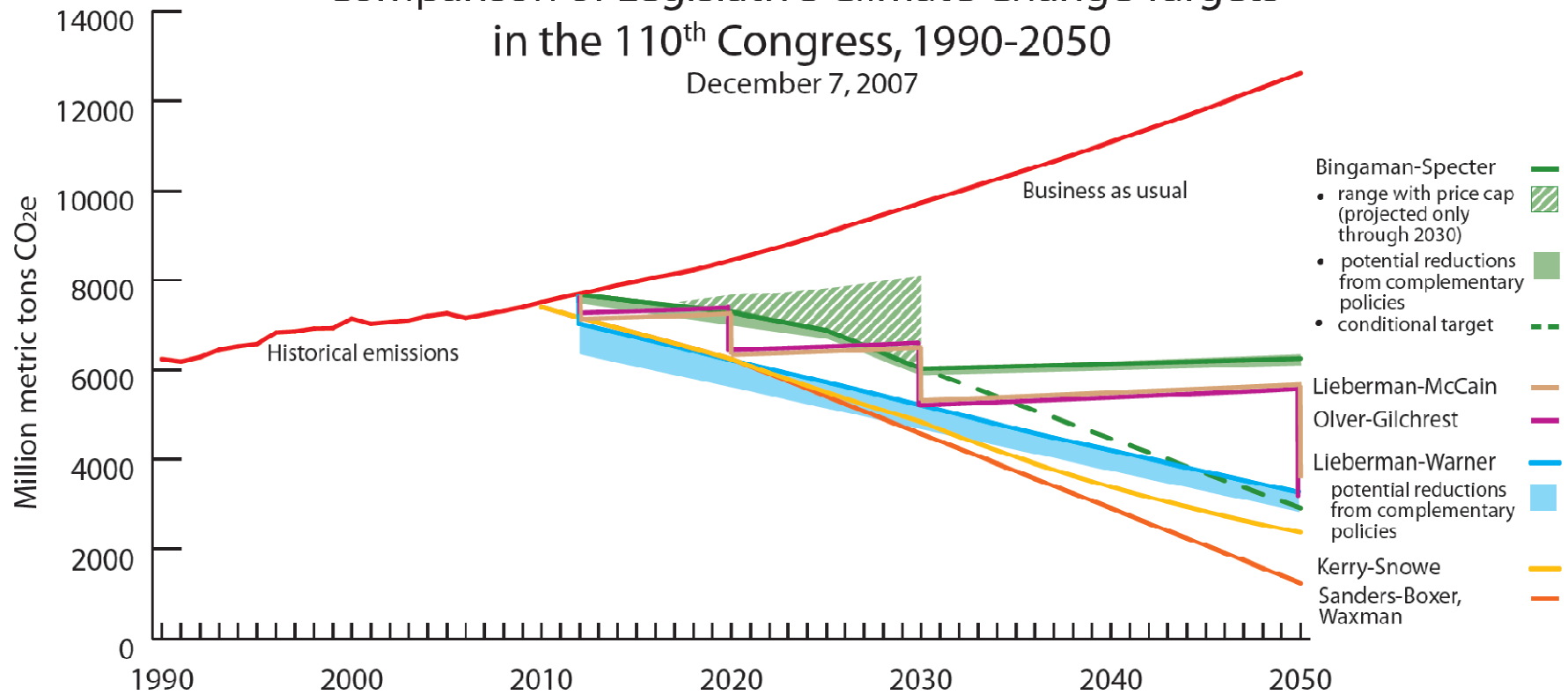
Sources of Funding/Economic Incentives

Funding Commercial-scale Projects will Likely Require a Combination of:

- Carbon price
- Carbon Tax/Allowance Proceeds
 - Lieberman-Warner R&D and Bonus Allowances
- Utility funding
- Federal funding
- State Incentives
 - E.g., Indiana – expedited processing, extra 3% rate of return on equity, incentives for Indiana fuels for gasification, CWIP for environmental investments
- Venture investment
- Risk Sharing Funds

U.S. Climate Policy Proposals Focus on Cutting Emissions Significantly Below Historic Levels

Comparison of Legislative Climate Change Targets
in the 110th Congress, 1990-2050
December 7, 2007



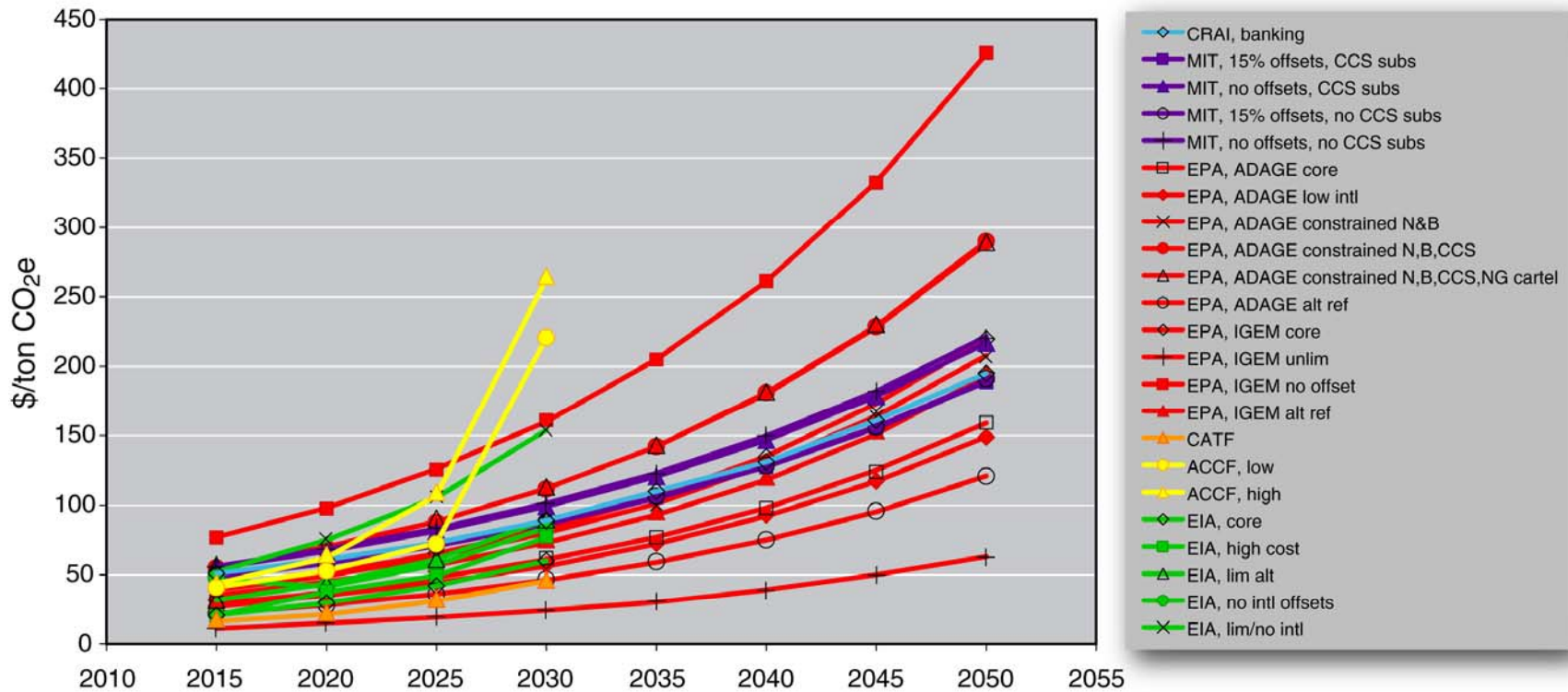
 WORLD RESOURCES INSTITUTE

For a full discussion of underlying methodology, assumptions and references, please see <http://www.wri.org/usclimatetargets>. WRI does not endorse any of these bills. This analysis is intended to fairly and accurately compare explicit carbon caps in Congressional climate proposals and uses underlying data that may differ from other analyses. Data post-2030 may be derived from extrapolation of EIA projections.

Elements of Lieberman-Warner Climate Security Act of 2007

- Economy-wide Coverage – about 87% of 2005 emissions
 - Downstream on coal (units > 5,000 tons/yr)
 - Upstream on oil, gas, F-gases, N₂O
- Cap-and-trade system
 - 22.5% auction phasing to 69.5% by 2030
 - Permits/auction revenues designated for a wide array of uses
- Permits to support CCS development and deployment
 - CCS Technology Fund – 1% of permits auctioned (120 days after enactment through 2022) to “kick-start” CCS
 - Goal: Rapid deployment of 5-10 commercial scale electric generation plants with CCS
 - Bonus Allowance Account – 3-4% of permits 2015-2030, 1% of permits from 2031-2050.
 - Goal: Provide bonus permits to qualifying CCS plants – maximum of 2 bonus permits annually, declining over time

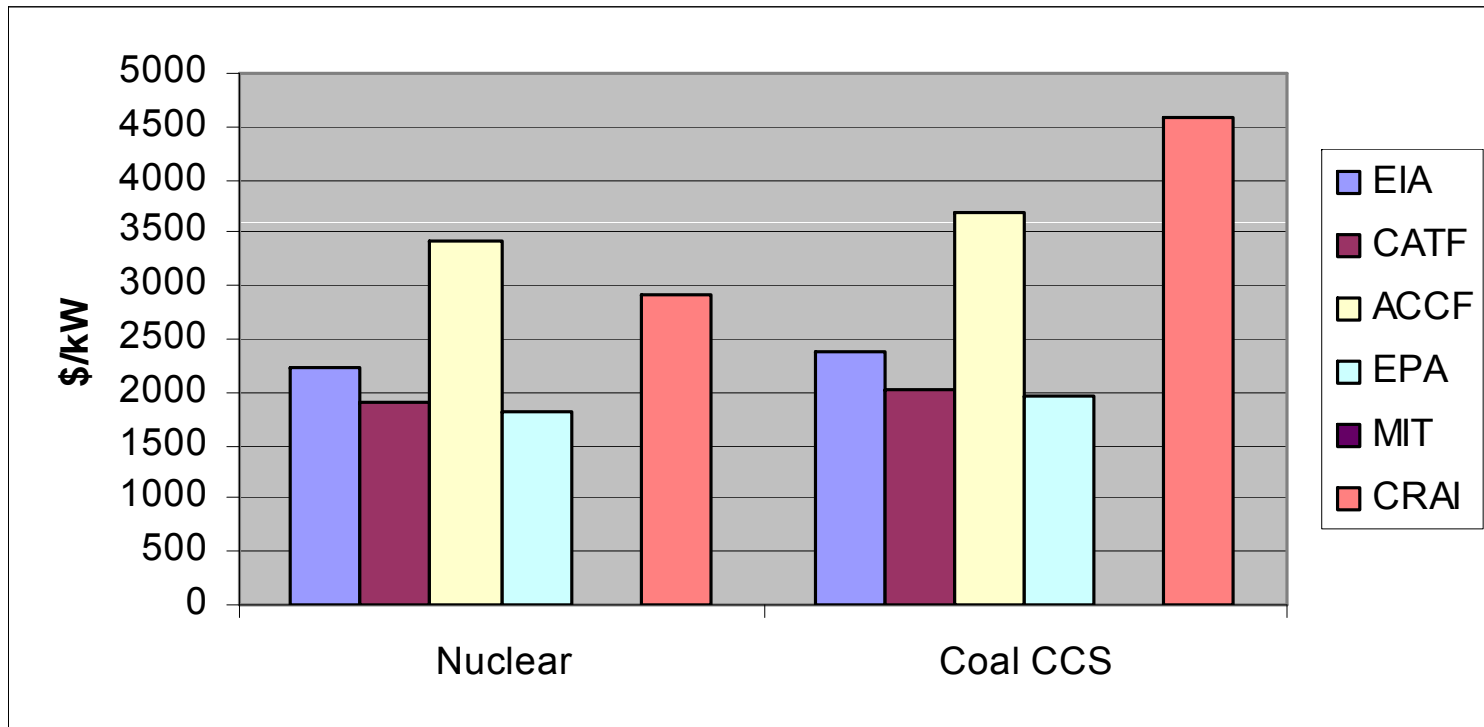
And the Cost of Lieberman-Warner 2007 (L-W) is



For more information on L-W Cost Estimates, see www.epri.com

Reported and Guesstimated Technology Cost Estimates for L-W Analyses

Overnight Capital Cost (2008\$/kW)



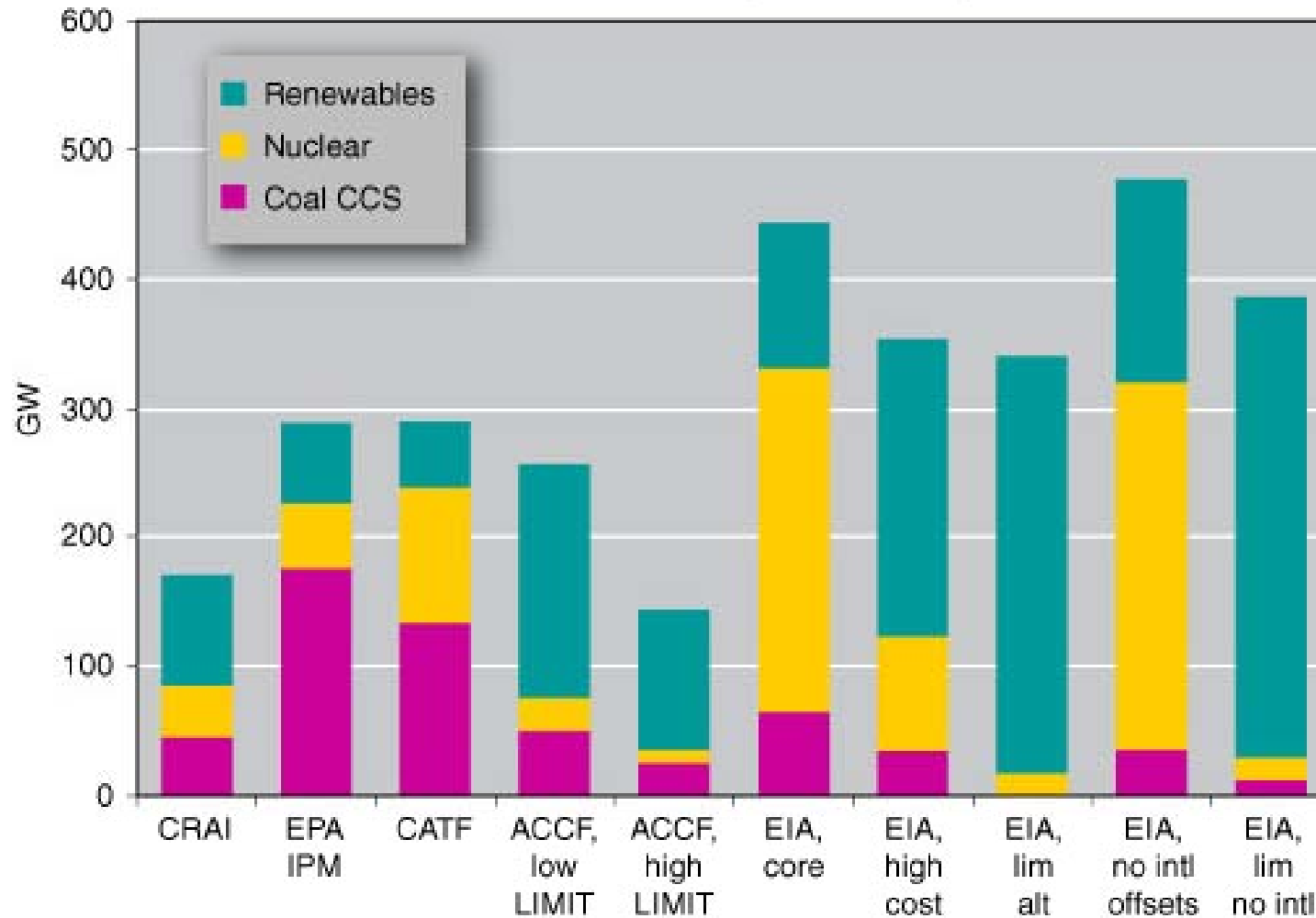
Caveats: Converted to 2008\$

CATF= AEO2007, EPA/IPM= AEO2005, CRAI= updated AEO2007

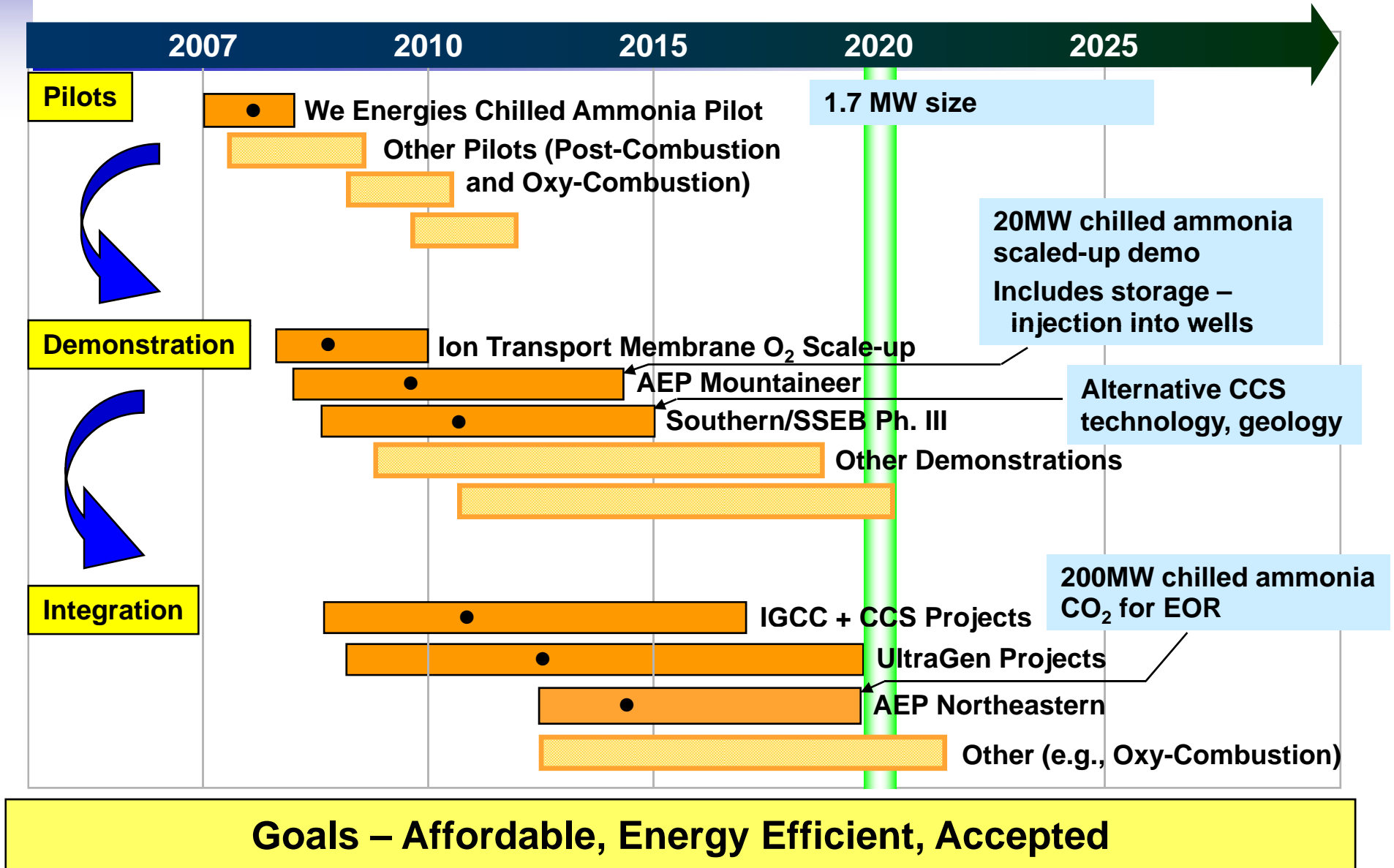
Some costs decline rapidly over time, e.g., CRAI Coal CCS to \$3203/kW by 2050

Cumulative Capacity Additions of Coal CCS, Nuclear and Renewables ... includes no CCS Retrofits

Cumulative Capacity Additions by 2030

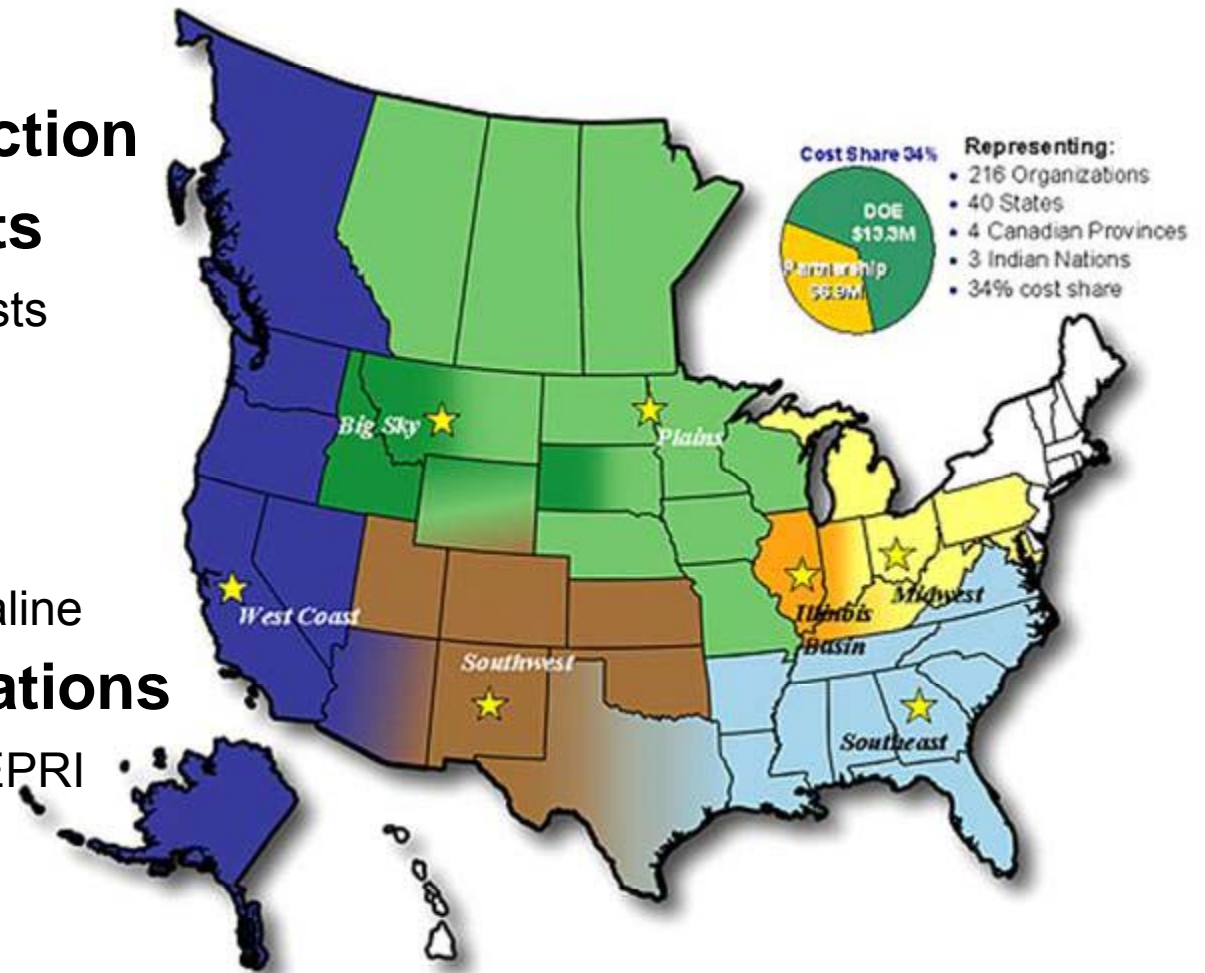


Part III: Demo Activities



DOE Regional Carbon Sequestration Partnerships

- **Phase 1: Data collection**
- **Phase 2: Small pilots**
 - 22 Geologic Injection Tests
 - 8 EOR/Saline
 - 6 Saline reservoirs
 - 8 ECBM/EGR
 - EPRI involved in three saline
- **Phase 3: Demonstrations**
 - Several possibilities for EPRI involvement



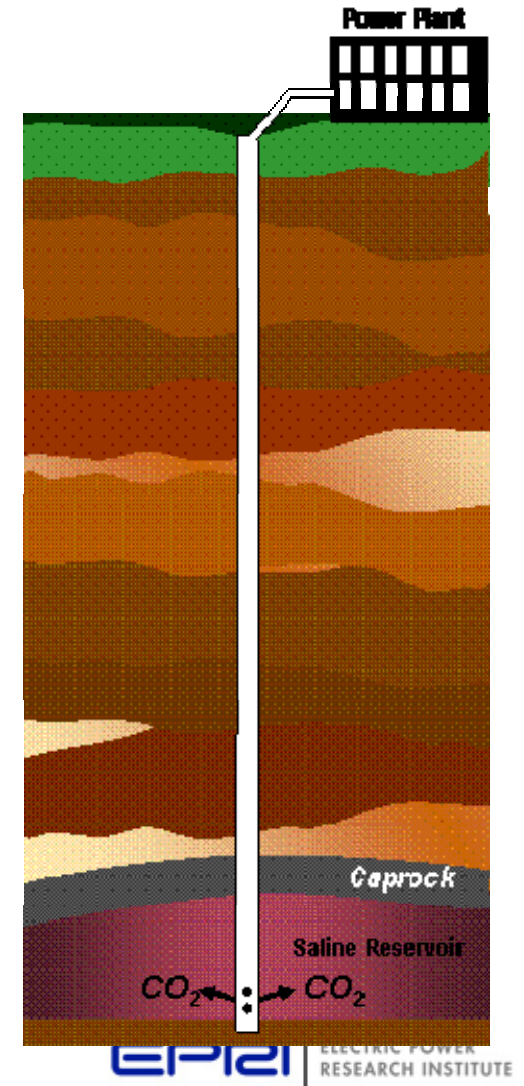
DOE Phase 3 Update

- **WESTCARB**

- Original focus on BP Carson project, changed to Clean Energy Systems (CES)
- 500k t/y for 4 years starting in 2010

- **SECARB**

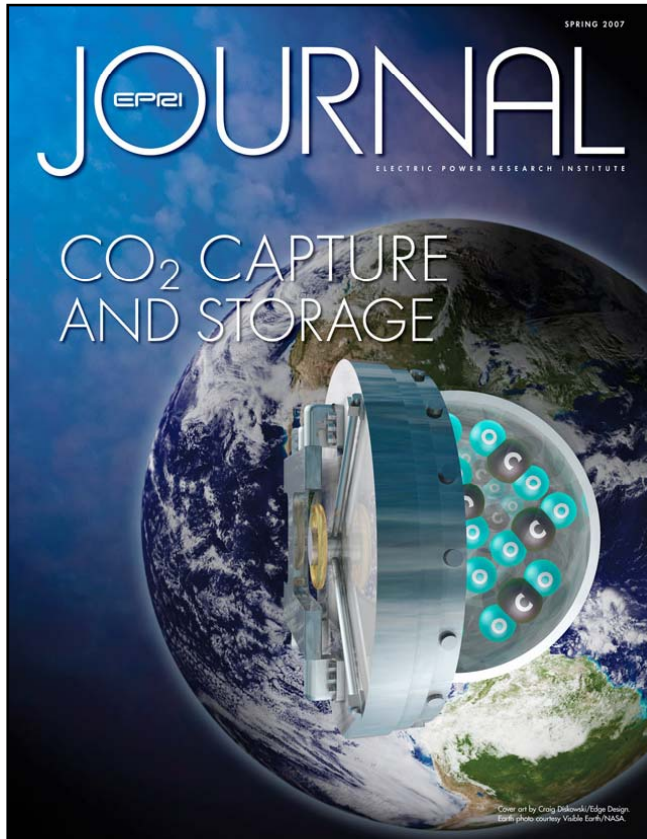
- Two part injection into same saline reservoir in two geologically separate locations
- Cranfield: Purchased CO₂ @ 1Mt/y for 1.5 y
- Another test: Inject 100-250 kt/y from a CO₂ capture pilot located at a Southern Company site



Concluding Thoughts

- CCS is a critically important technology to the U.S.
 - Large coal reserves
 - Large potential sequestration potential
- In the U.S., cost of coal with CCS (and other generation technologies) has ~doubled since 2000
 - CCS retrofit is being considered
- Lieberman-Warner could produce CO₂ price and incentives sufficient to spur CCS deployment, but need investment now for technology to be commercial by 2020

Questions?



See EPRI Journal Summer 2007 and
Recent Congressional Testimony

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