

CCS Alliance for Risk-based Policy

in collaboration with Hunton & Williams

Commercial Risk Analysis for Deployment of CCS
Factors Affecting Financing for Early Plants

*Briefing for Second Session of the UNECE Ad Hoc Group of Experts on
Cleaner Electricity Production from Coal and Other Fossil Fuels*

http://www.unece.org/energy/se/docs/clep_ahge2.html

UNECE Meeting
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Presented by:

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Opening Quotes: Consensus to Move on CCS

"The vast majority of new power stations in China and India will be coal-fired; not "may be coal-fired – will be. So, developing carbon capture and storage technology is not optional, it is literally of the essence."

Former UK Labour Prime Minister Tony Blair, Speaking in Tokyo ahead of the 2008 G8 Summit (June 2008)
for *Breaking the Climate Deadlock: A Global Deal for a Low Carbon Future* (Sir Nicolas Stern)

"Carbon capture and storage (CCS) for coal-fired power plants is a critical technology if we are to achieve our environmental goals while continuing to use our abundant domestic coal resources. However, CCS storage capacity is not available everywhere, and the technology itself is not fully developed and ready for deployment. We believe CCS ultimately will prove to be one of the least-cost ways to reduce CO₂, and we are actively involved in projects to advance the research."

Jim Rogers, President – Duke Energy, June 28, 2007 from Testimony to Senate Environment & Public Works
http://epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=96b0a903-32fc-47f8-9a36-b4ddd9805e2b

"We believe CCS can stimulate faster policy action and help fill the gap between what we need to do and what we have committed to do. ...Using CO₂ from coal plants for domestic EOR has three advantages: 1) it reduces oil imports and our trade deficit; 2) using old oil wells reduces the environmental burden of drilling new wells; and 3) oil or gas wells are a better place to put CO₂ than into the atmosphere."

David Hawkins, NRDC at Gasification Technologies Conference, Oct. 2007

Overview for Commercial Risk Analysis

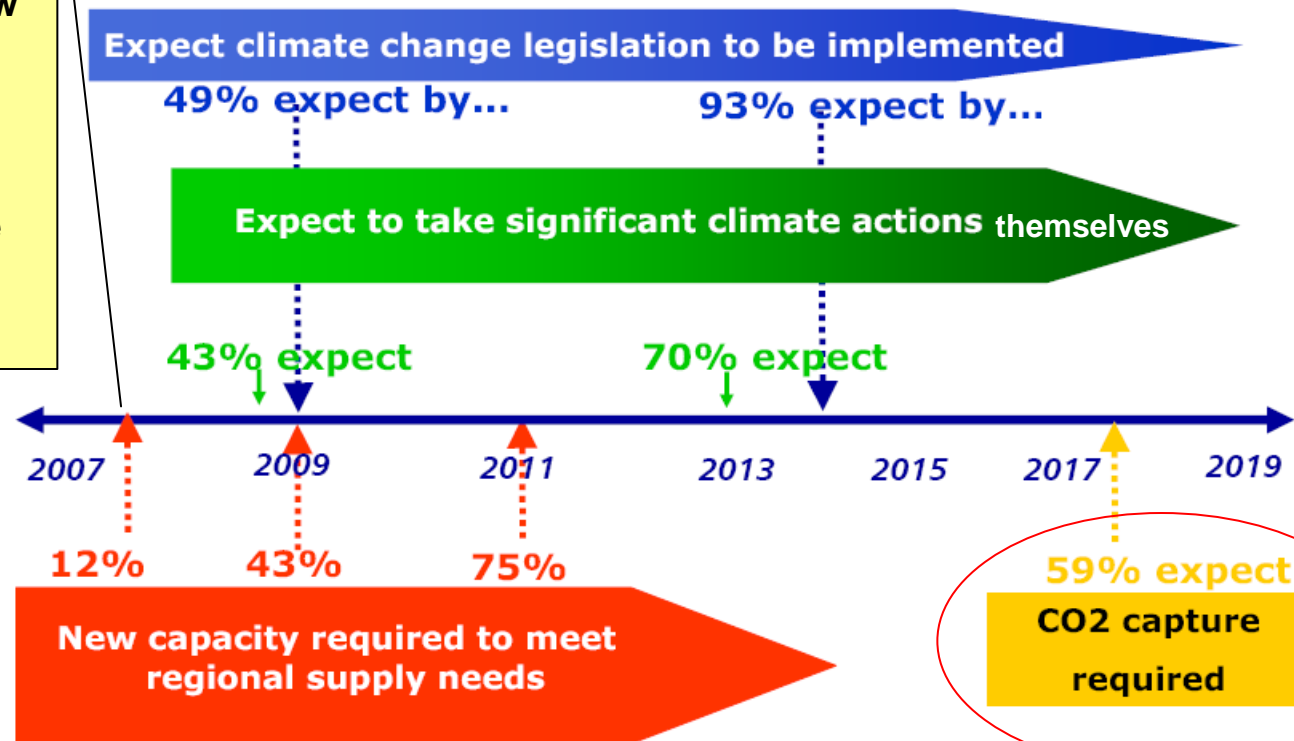
- A. The Market and U.S. Policy Landscape for CCS**
- B. Risk Analysis Frames Deployment Challenge:
*Financing First Plants***
 - No Financing = no new plants with CCS
 - Financing for baseload power must tap the bond market
 - Addressing critical risks is the path to enabling financing
- C. Approach & Methodology / Participants**
- D. Commercial Risk Rating Results**

Outlook on U.S. Carbon Policy Timing: Survey of Utility Execs (2007)



Will new capacity have to be built before climate actions are in place?

Challenge: New capacity is needed before federal legislation is expected to be resolved and litigated.



Source: Survey by GF Energy of Utility Executives in North America, April 2007

Lehman Brothers Roundtable at NARUC (Nov. 2007), with 40 bond funds

Bond Market Roundtable on Electricity & CCS

Critical risks for baseload power discussed with bond market



Roundtable participants: Doug Cortez, formerly with Fluor Engineering; Dan Ford, Lehman Brothers; Jim Hempstead, Moody's; Sandy Hochstetter, Arkansas Electric Coop; Lindene Patton, Zurich America; Barbara Tyran, EPRI; Klaus Lambeck, Ohio Public Utilities Commission staff; Mike Smith, Southern States Energy Board; Julie Jorgensen, Excelsior Energy; Faith Klaus, Lehman Brothers. With 32 bond fund managers.

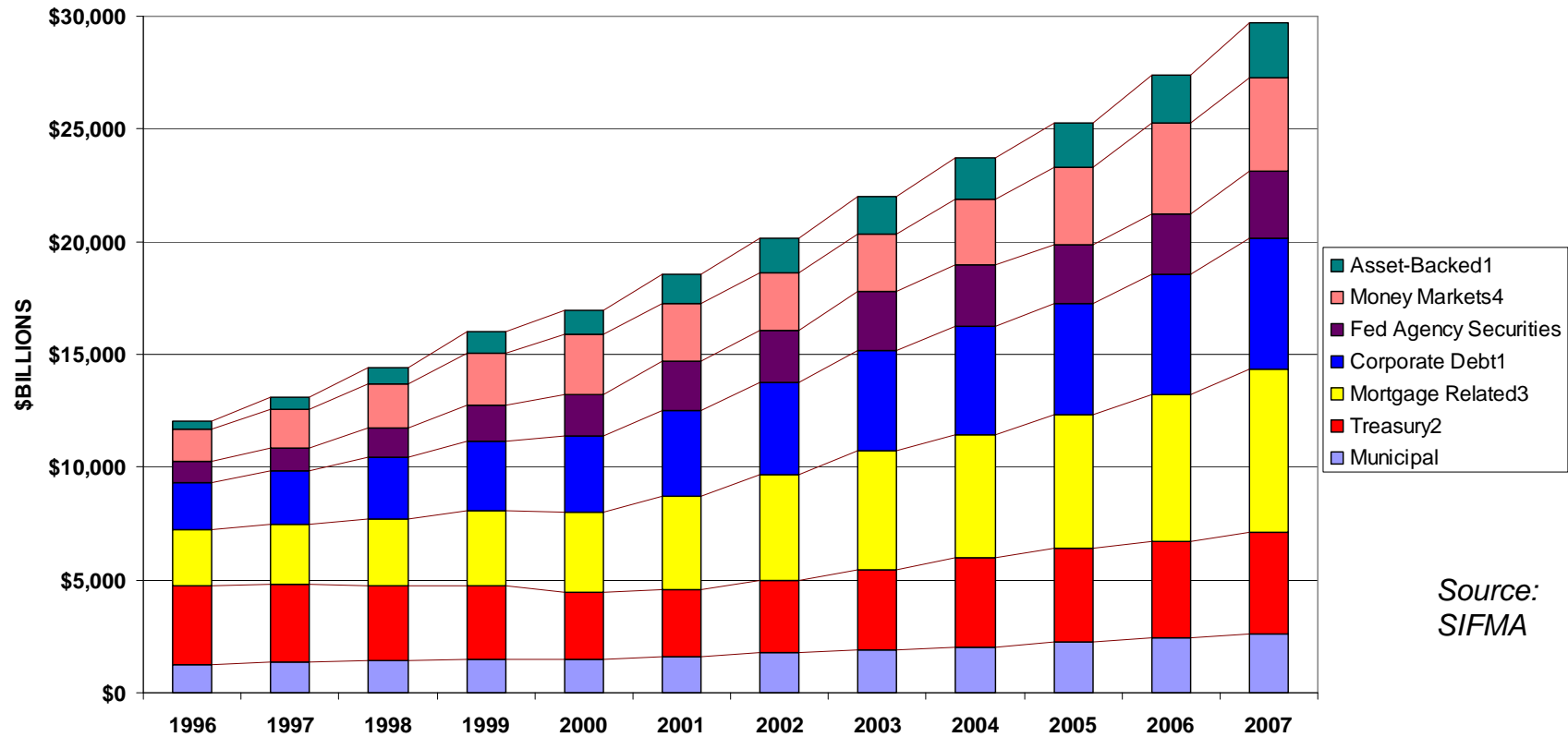
Moderator: Andrew Paterson, CCS Alliance (Econergy)

How big is the U.S. Bond Market (1996 – 2007) ?

U.S. Bond Market: Big Enough at \$30 Trillion

Energy infrastructure is financed in bond market, which sees \$6-7T a year in new bond issuance, about \$80-100B for power providers.

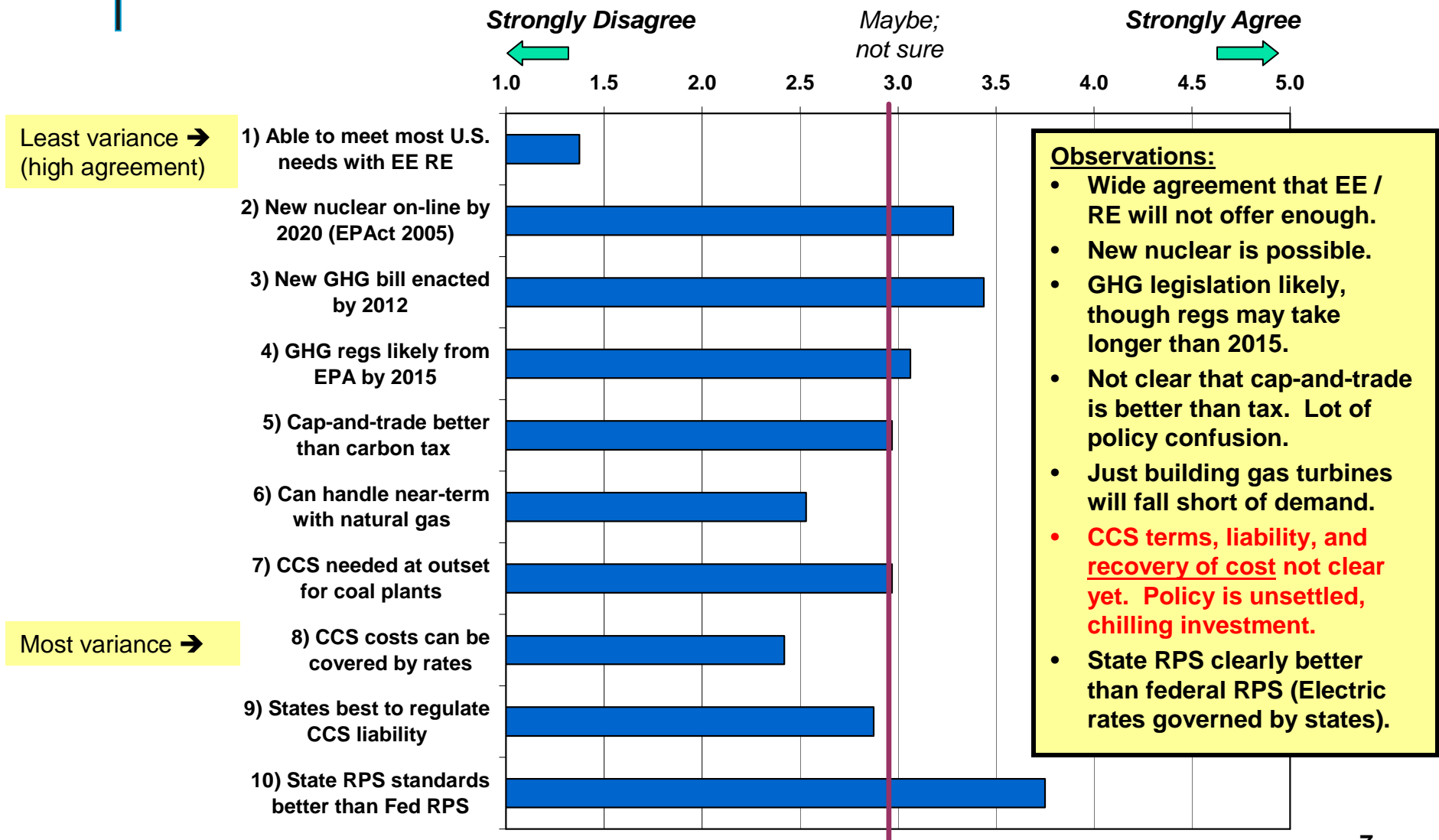
U.S. Bond Market Debt Levels (Market Size)



Source:
SIFMA

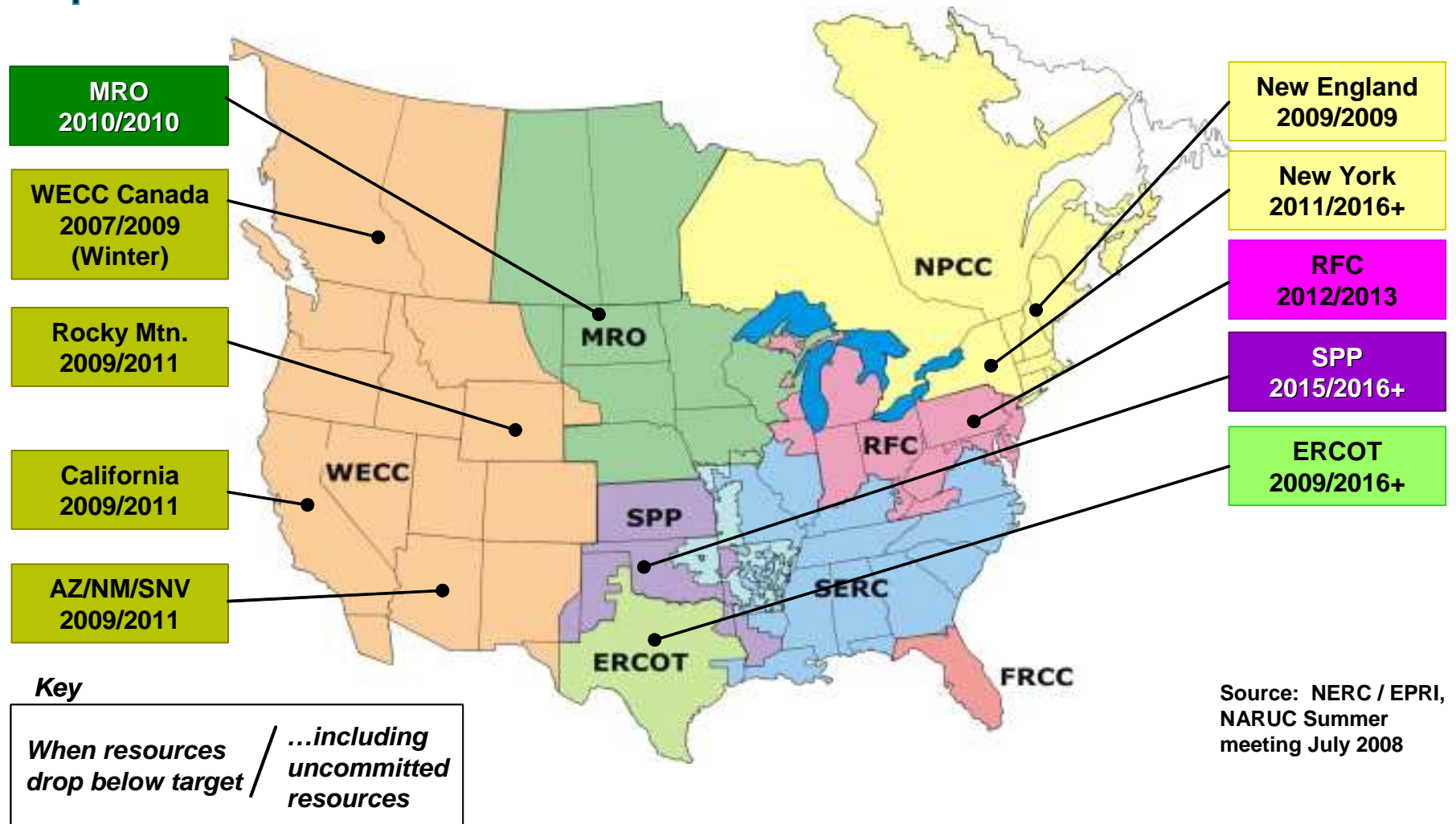
Bond Fund Viewpoints (32 responses; > \$2 Trillion under management)

Bond Market on Energy Policy (Lehman Roundtable at NARUC, Nov 2007)



2007 NERC Reliability Study

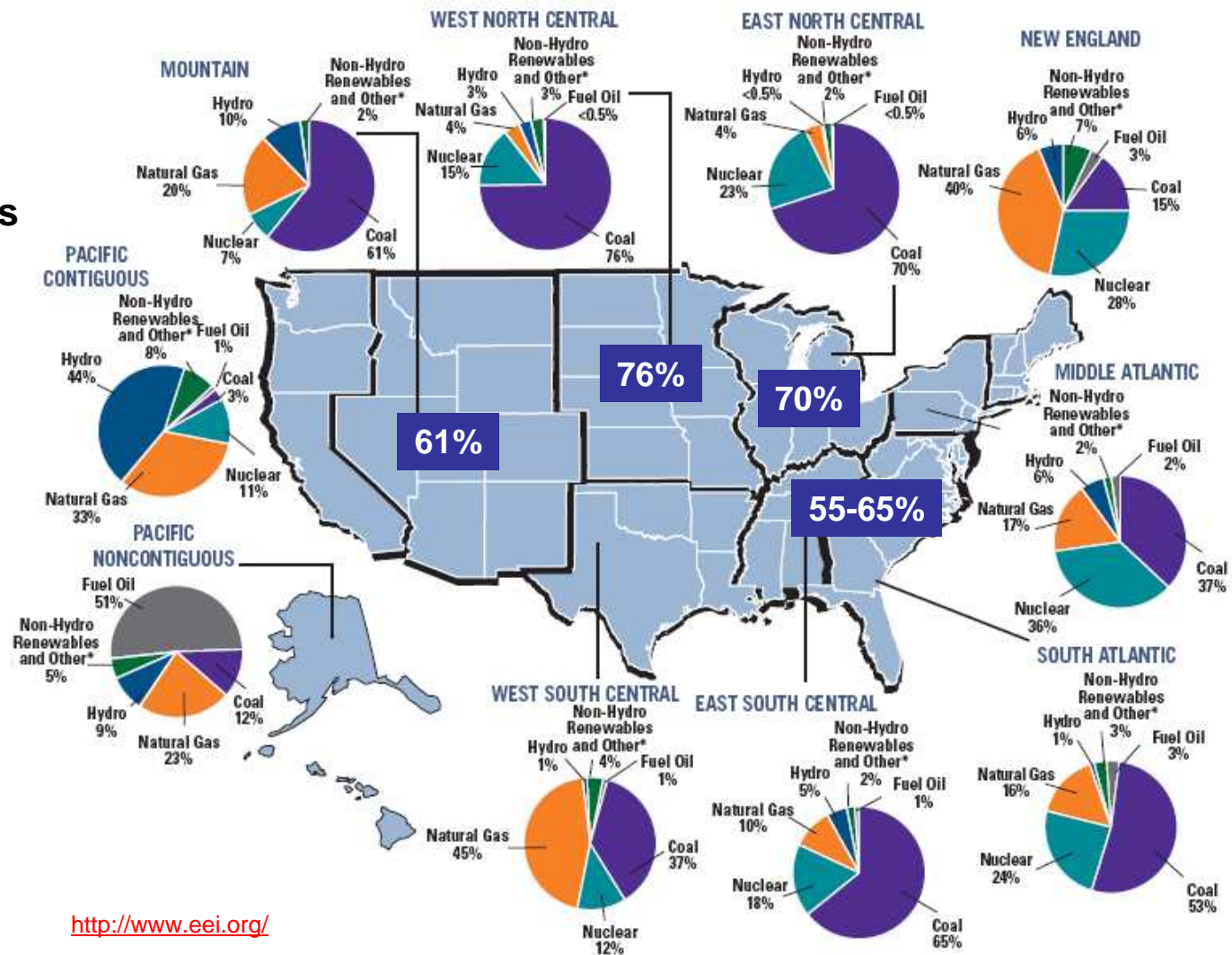
Big Driver: U.S. Reserve Margins are Declining



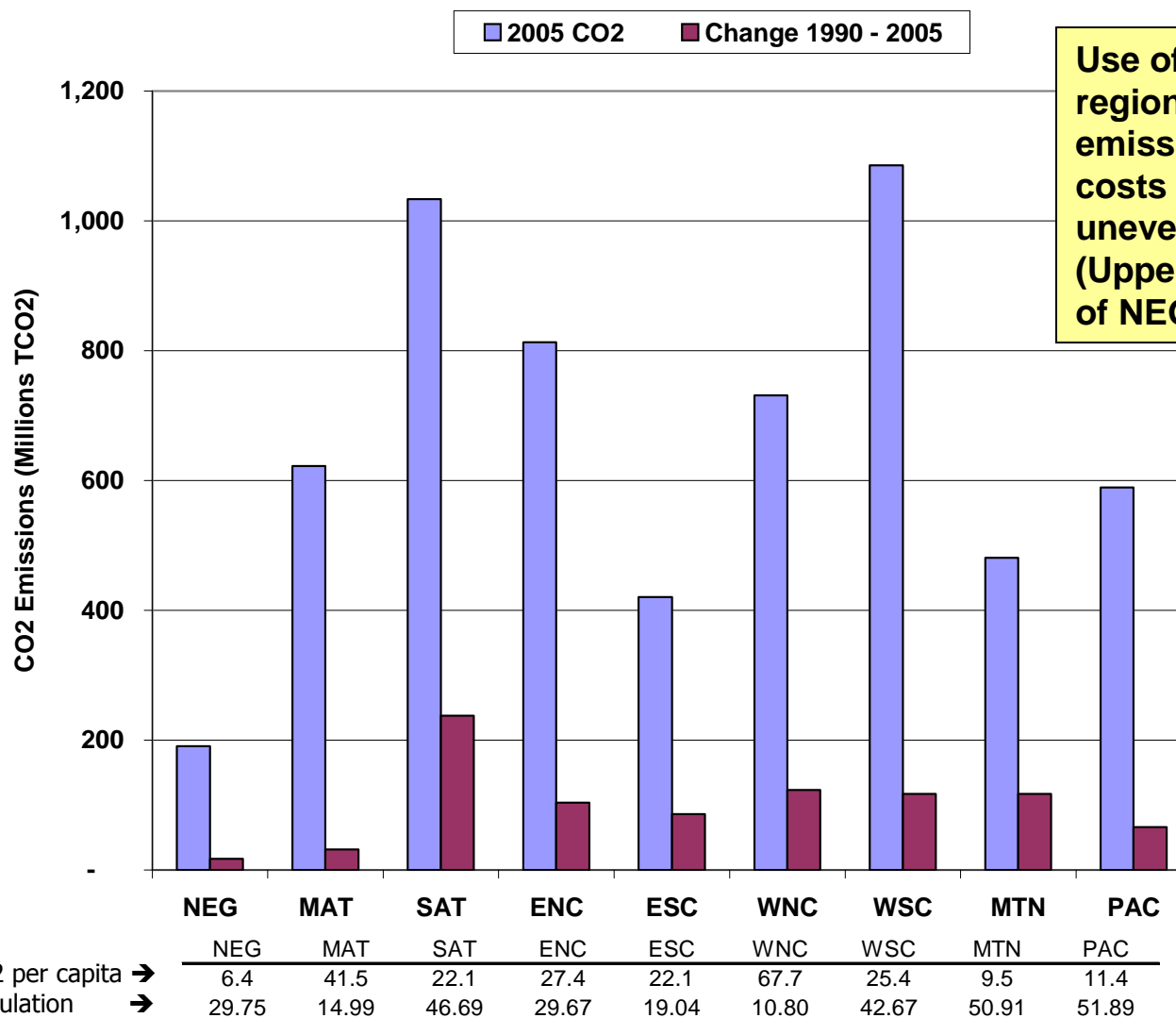
Differing Electricity Mix by U.S. Region (EEI), 2005

National averages mask very sharp regional differences on GHGs and electricity fuel sources.

Coal provides half of U.S. electricity, but much more in certain regions.



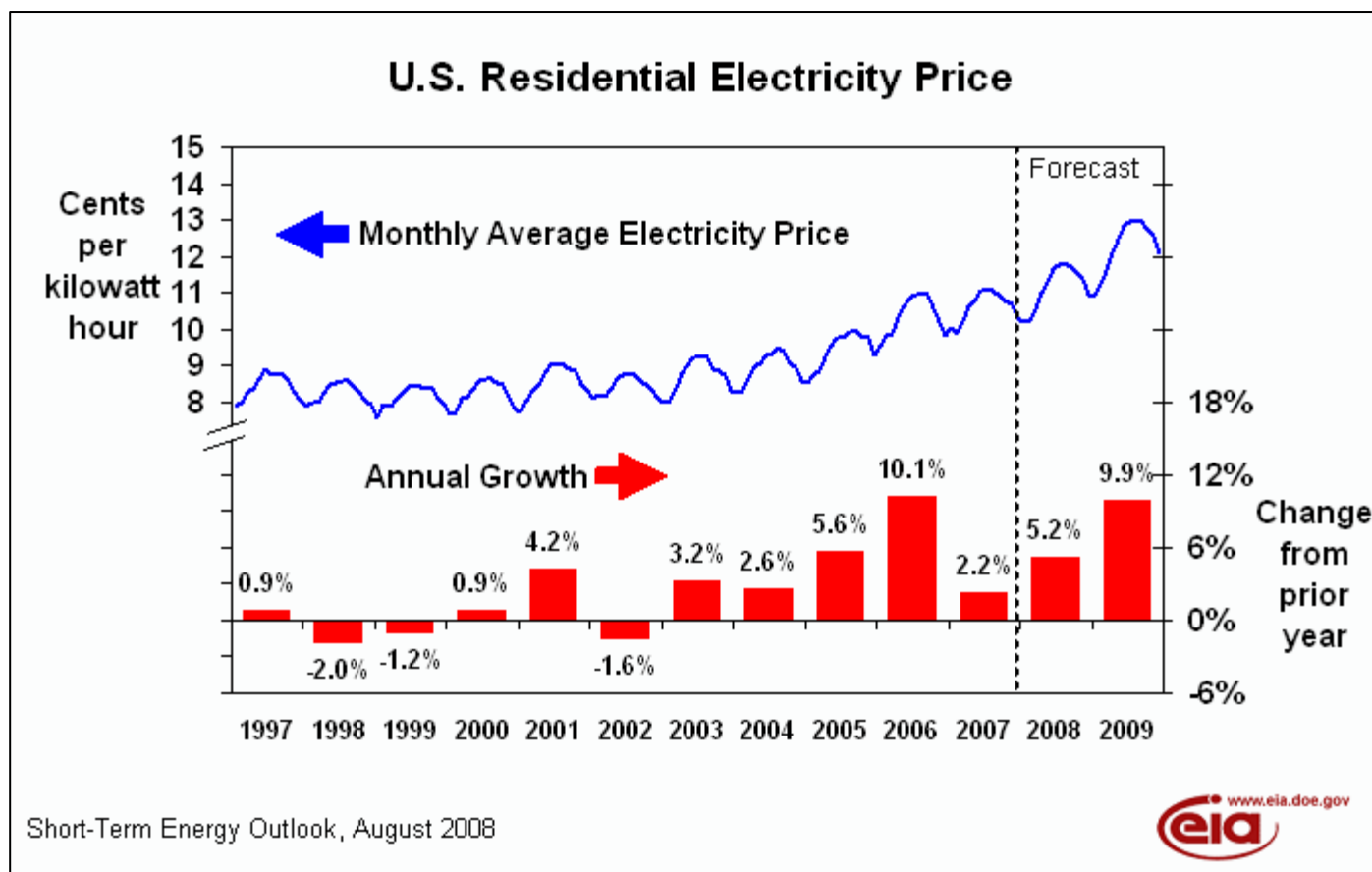
CO2 Emissions Vary Widely by Census Region... like Europe



Use of coal is very uneven regionally, as are CO2 emissions per capita, so costs and risks fall unevenly. CO2 in WNC (Upper Plains) is 10x that of NEG (New England).

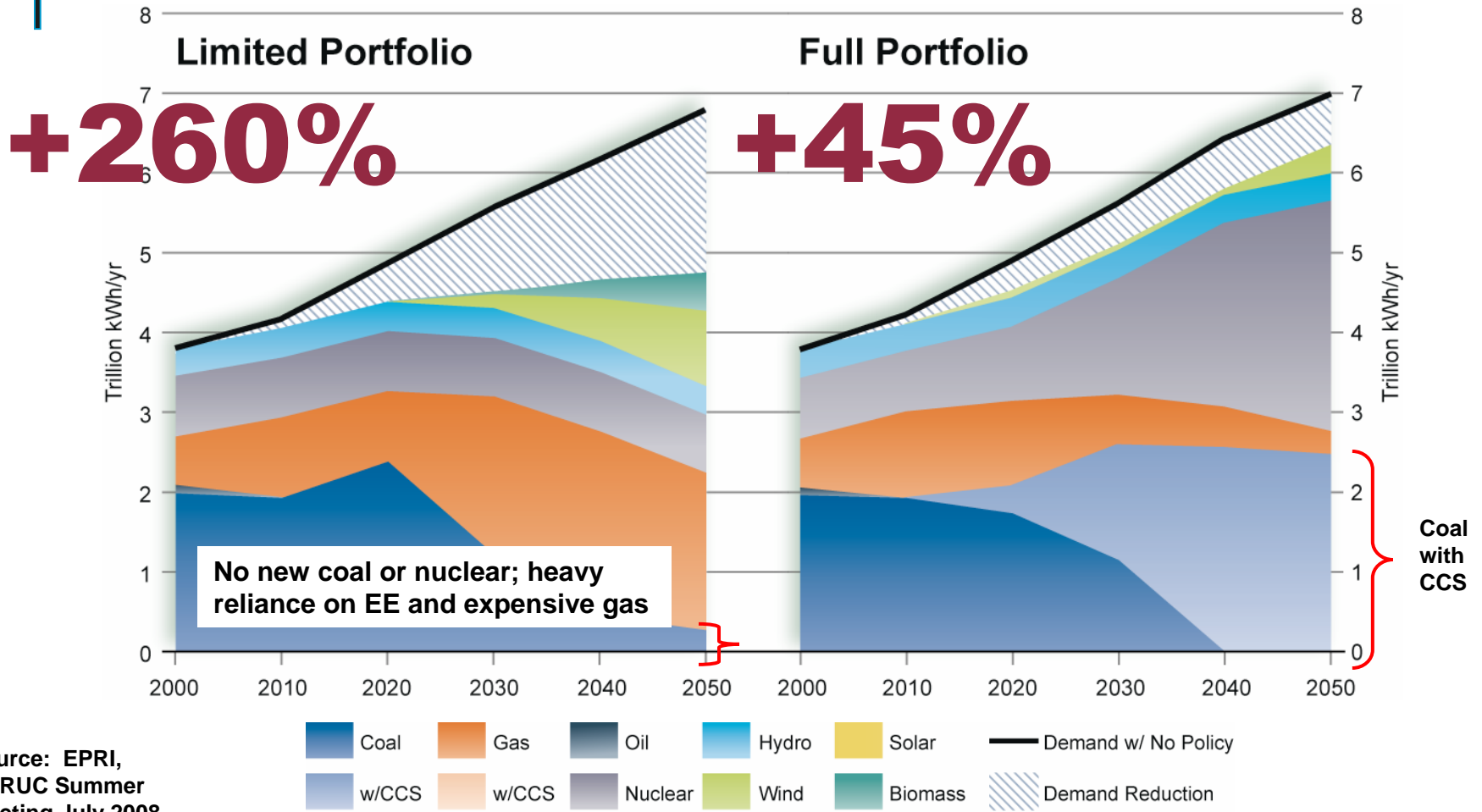
Market Factors: EIA outlook on U.S. Electric Prices

Rising electricity prices puts pressure on fuel source decisions, but also creates a higher ceiling to recover new capital investment. Higher natural gas prices are moving electricity prices higher at the margin.



EPRI Outlook to 2050 (July 2008)

Impact on Electricity Prices of Full vs. Limited options

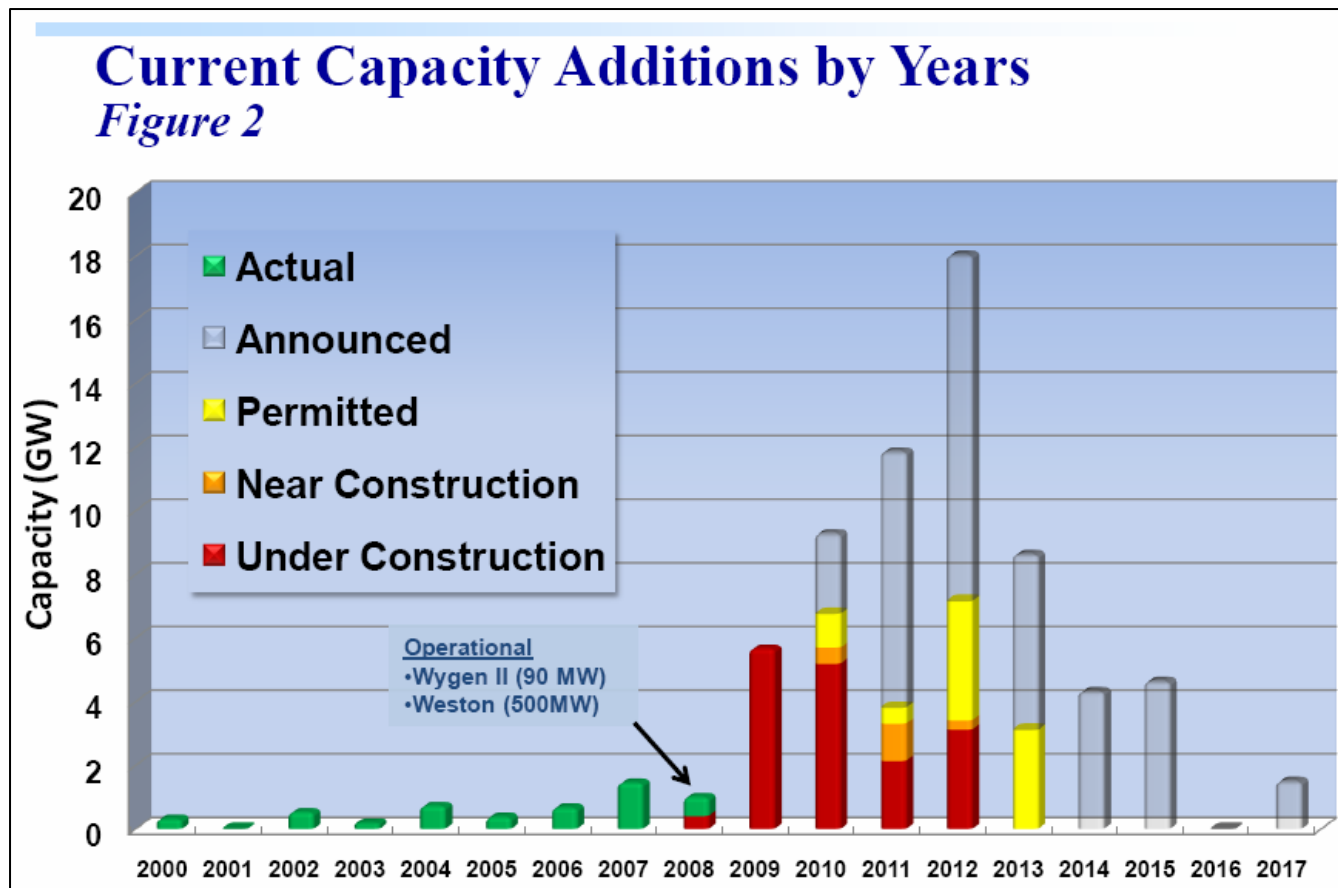


Source: EPRI, NARUC Summer meeting July 2008

*Economy-wide CO₂ emissions capped at 2010 levels until 2020 and then reduced at 3%/yr

NETL: U.S. Coal Plant Additions... none with CCS

Current coal-fired projects in development reflect the potential for a surge in growth, but questions exist as to whether this is achievable. The 3,079 MW of new added capacity installed in the last three and a half years (800 MW per year) is only 11% of the 27,218 MW of progressing plants that are proposed to be operational by 2012.



Risk Rating Results for CCS Deployment

- Risk ratings frame the challenge: financing
- Approach & Methodology / Participants
- Risk ratings: Highs and Lows
- Summary Observations & Path Forward

The severity of risk is gauged within **a time horizon** for the **likelihood** an event occurs times the **impact** (detriment) to the project (e.g., on assets and cash flows) for various risks:

Within a Time Horizon

Probability x Impact = Severity of Risk

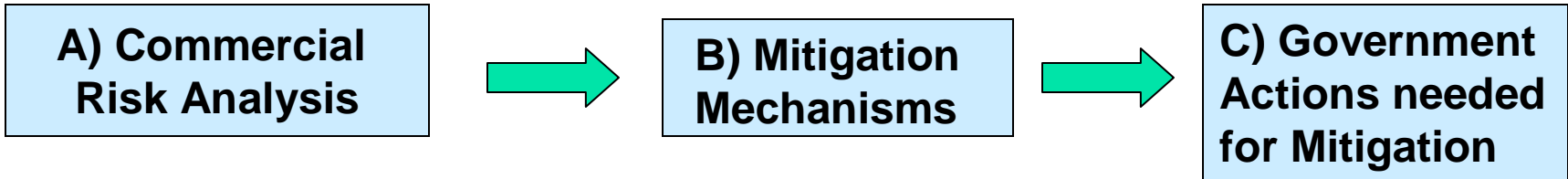
CCS Alliance for Risk-based Policy

For Deployment of Coal-based Projects with CCS

Risks → Mitigation Approaches → Actions Needed

CCS Alliance Scope:

- I) Risk Study for CCS Deployment (coal power plants or energy projects with CCS)
- II) Legal research on critical issues, risks and formulation of mitigation options



Risk Type

- 1) Tech-CCS
- 2) Reg-CCS
- 3) ...
- 4) ...

Key Risks

- Capital cost with CCS too high
- State rules on CCS not clear

Analysis based on Interviews of key actors:

- Utilities
- Energy Companies
- Technology & System Vendors
- Engineering Firms / EPC Contractors
- Federal Agency Officials
- State Officials (permitting, resources)
- Investment Sources / Banks

Government

- Loan guarantees
- Grants (by DOE, etc.)
- Tax subsidies
- Injection regulations
- Permitting approaches
- Carbon emission rules
- Federal “Energy Bank”
- LT purchase contracts

Industry / Investors

- Insurance / bonding
- Engineering backups
- Long-term contracts
- Site review, feasibility
- Collateral, backup supply

C) Government Actions needed for Mitigation

(Match actions with mechanisms)

Near-term / Long-term

- Appropriations
- Legislation
- Tax bill
- Regulation
- Agency action
- Executive order
- Reserves (e.g., SPRO)
- Others

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A) Commercial Risk Analysis

Risk Type

- 1) Tech-CCS
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- 3) ...
- 4) ...

Key Risks

Capital cost with CCS too high
State rules on CCS not clear

Analysis based on Interviews of key actors:
(results of Risk Study)

Category	(#) Specific Risk	25 point scale Rated Severity	Relative Value
30 Respondents			
ALL (34 Risks)			
Overall Average		10.2	Average
Tech - CCS	7. Capital costs for carbon capture equipment (>50% capture) impair financing of a new plant.	17.1	High
Policy - CCS	18. National policies lack sufficient incentives (loans, tax measures) for first-of-a-kind plants.	16.2	High
Policy - CCS	13. Uncertainty about EPA carbon emission regulations and CCS hampers permitting on new plant.	15.9	High
Policy - CCS	19. National policies (e.g., tax credits) lack sufficient incentives for sequestration of carbon.	15.6	High
Policy - CCS	17. Regional, state policies fail to provide sufficient clarity about CCS requirements and liability.	15.2	High
Policy - CCS	15. Value of (eventual) carbon emission allowances does not adequately cover costs of CCS.	13.9	Above Avg.
Market-CCS	31. EPA regulations on underground injection of CO2 and liability fail to offer clarity for financing.	13.4	Above Avg.
Market-CCS	34. Prospect of liability for long-term leakage of CO2 from CCS threatens new plant financing.	13.3	Above Avg.
Market	28. Financing of new plant proves difficult (e.g., debt tenors too short, more equity required).	13.3	Above Avg.
Market-CCS	33. Revenues from the sale of CO2 (e.g., for EOR) are not adequate to cover costs of CCS.	12.9	Above Avg.
Policy - CCS	16. Regional, state policies fail to provide sufficient incentives to support plant economics with CCS.	12.9	Above Avg.
Market-CCS	27. Market rates or state PUC approved rates do not offer sufficient recovery of CCS costs.	12.8	Above Avg.
Market	23. Current conventional coal plants are allowed to run longer, curbing demand for new plants.	9.7	Average
Tech - CCS	9. The site for CCS could suffer a significant technical failure and more than minor leakage occurs.	7.3	Below Avg.
Tech - CCS	11. Transportation of CO2 for CCS proves difficult logistically (e.g., transit path too long).	7.0	Below Avg.
Market-CCS	32. Transport costs of CO2 become more costly after new plant is operating, threatening run time.	6.1	Low
Market	24. Natural gas prices drift and stay lower (<\$4/MBtu), making the plant with CCS uncompetitive.	5.3	Low

B) Mitigation Mechanisms

Government

- Loan guarantees
- Grants (by DOE, etc.)
- Tax subsidies
- Injection regulations
- Permitting approaches
- Carbon emission rules
- Federal "Energy Bank"
- LT purchase contracts

Industry / Investors

- Insurance / bonding
- Engineering backups
- Long-term contracts
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C) Government Actions needed for Mitigation

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- Legislation
- Tax bill
- Regulation
- Agency action
- Executive order
- Reserves (e.g., SPRO)
- Others

Ratings completed in Spring 2008

Rating Respondents: Sophisticated on CCS Issues

Gasification Technologies Council

Conoco Phillips

GE

Siemens

Air Liquide

Chevron

Excelsior Energy

Warley Parsons

CH2M Hill

Burns & McDonnell

Potomac-Hudson Engineering

Oglethorpe Energy

Eastman Chemical

e3Gasification

ZeroGen (Australia)

Arkansas Electric Coop Corp.

National Rural Electric Coop Assoc.

Minnkota Power Coop

Pace Energy Consultants

IEA GHG R&D Programme (London)

Hensley Energy

EPRI

World Coal Institute (WCI)

ICO2N (Canada)

Natural Resources Defense Council

World Resources Institute

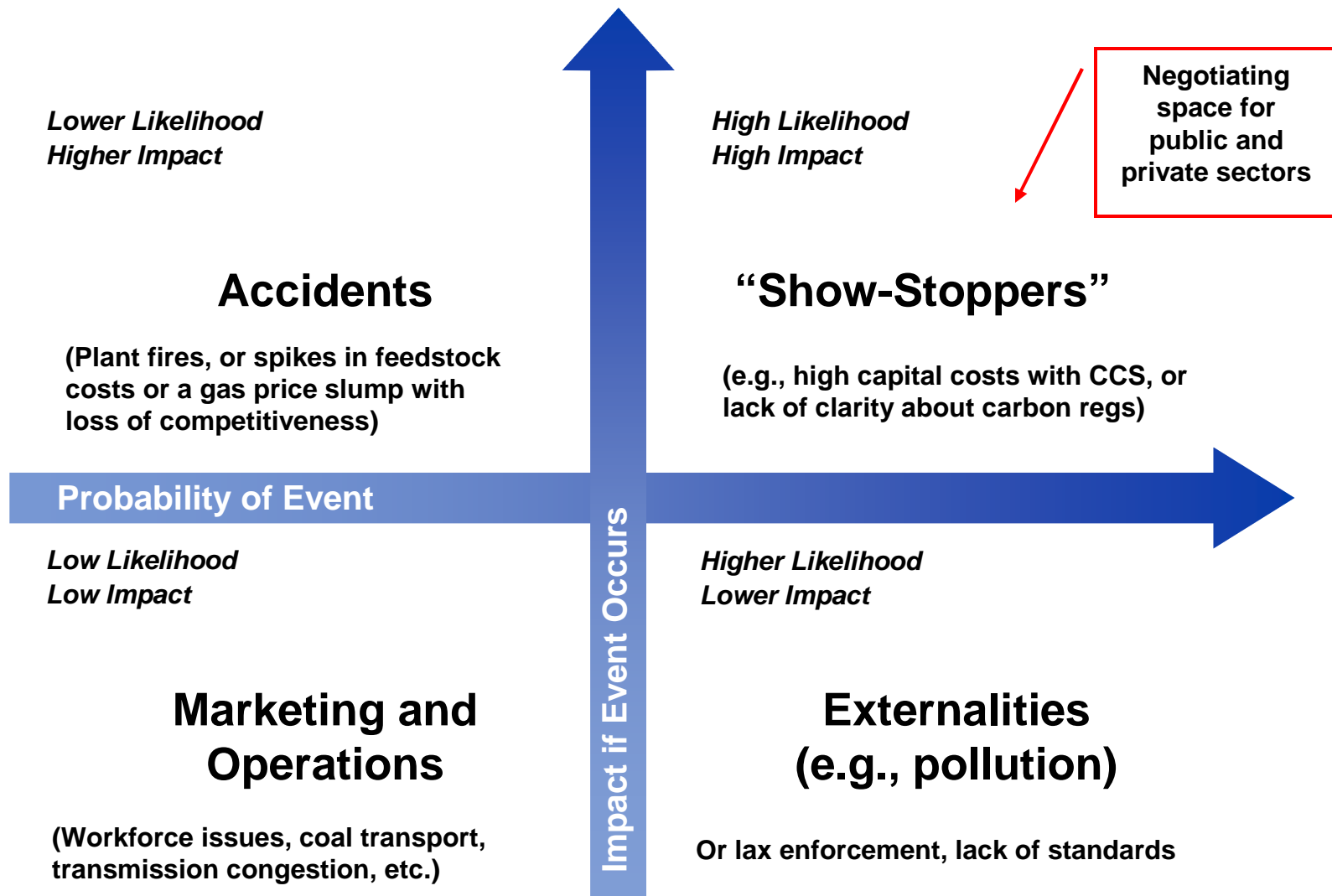
Imperial College of London

MIT

U.S. Dept. of Energy (Fossil Energy)

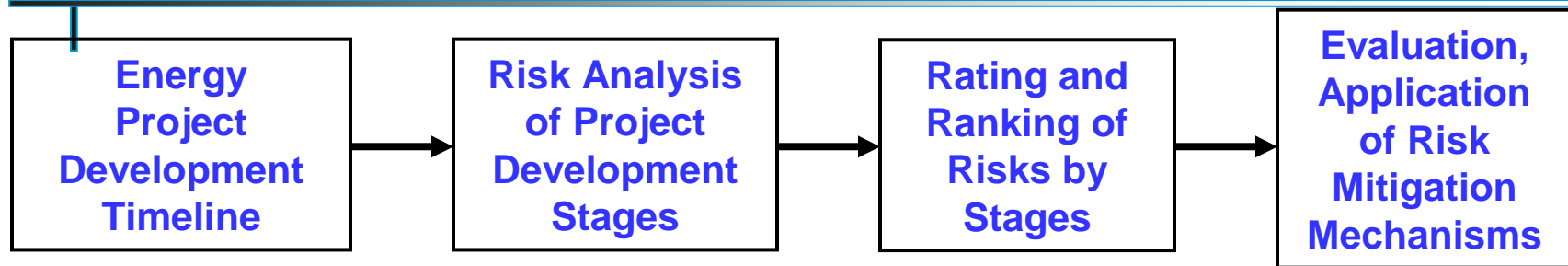
New Energy Finance

Plot of Risks: Probability vs. Impact Reveals Nature



For Deployment of Coal-based Projects with CCS

Approach to Commercial Risk Framework

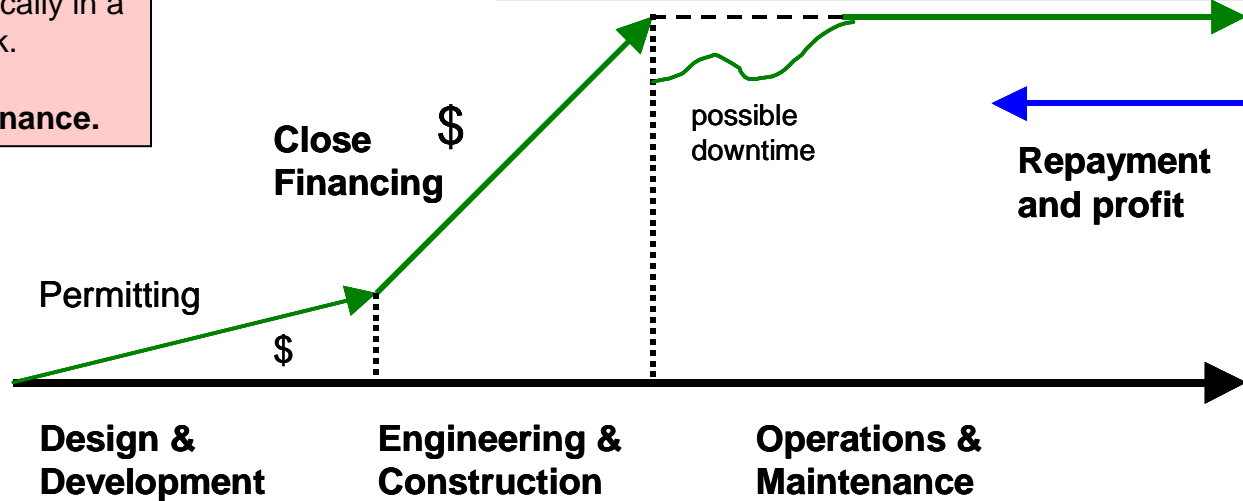


Regulatory and policy risks

Technical and operating risks

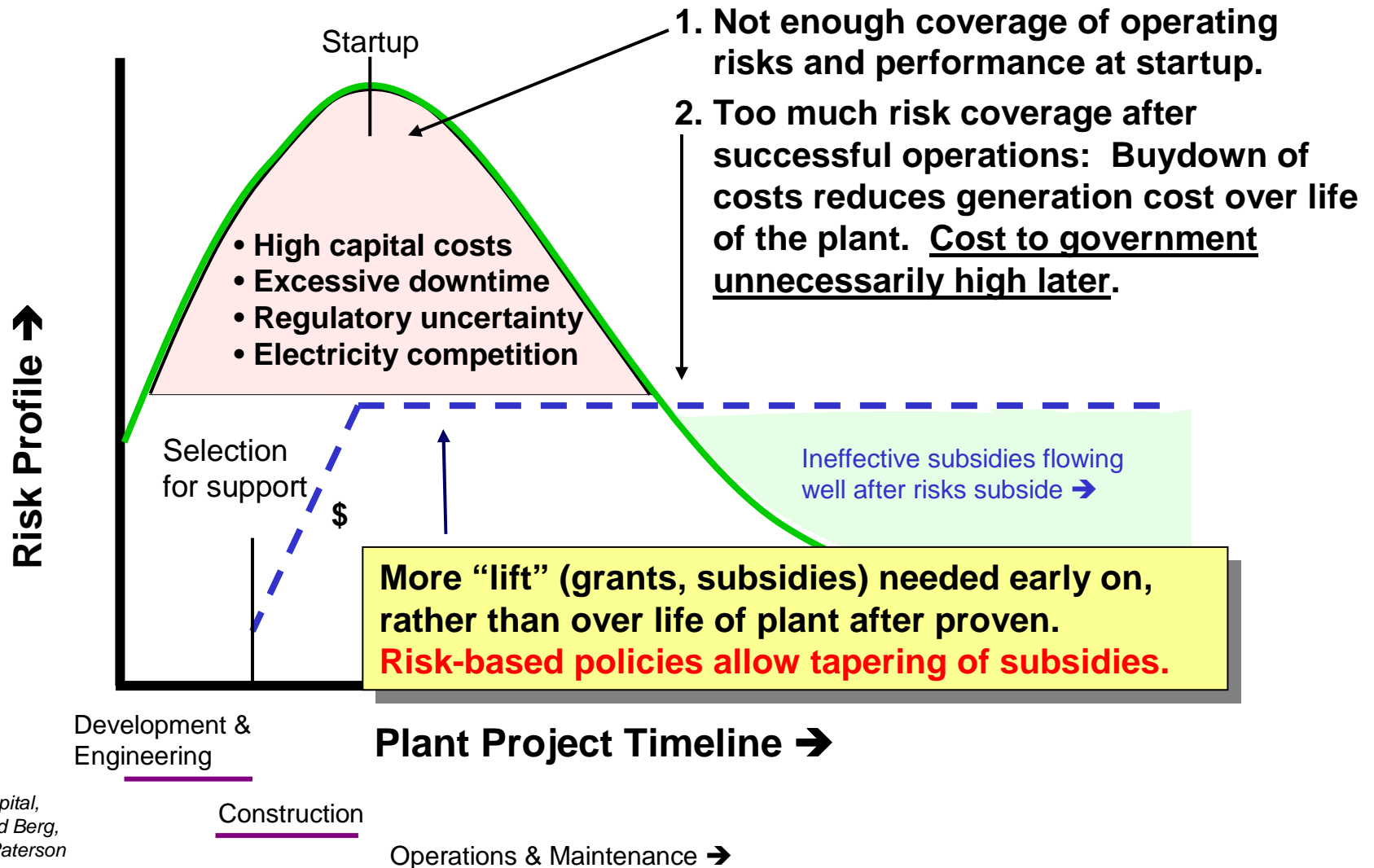
Market risks

Coal projects with CCS cannot complete financing without a comprehensive commercial risk analysis by creditors, typically in a project finance framework.
Deployment = project finance.



Source:
Scully
Capital

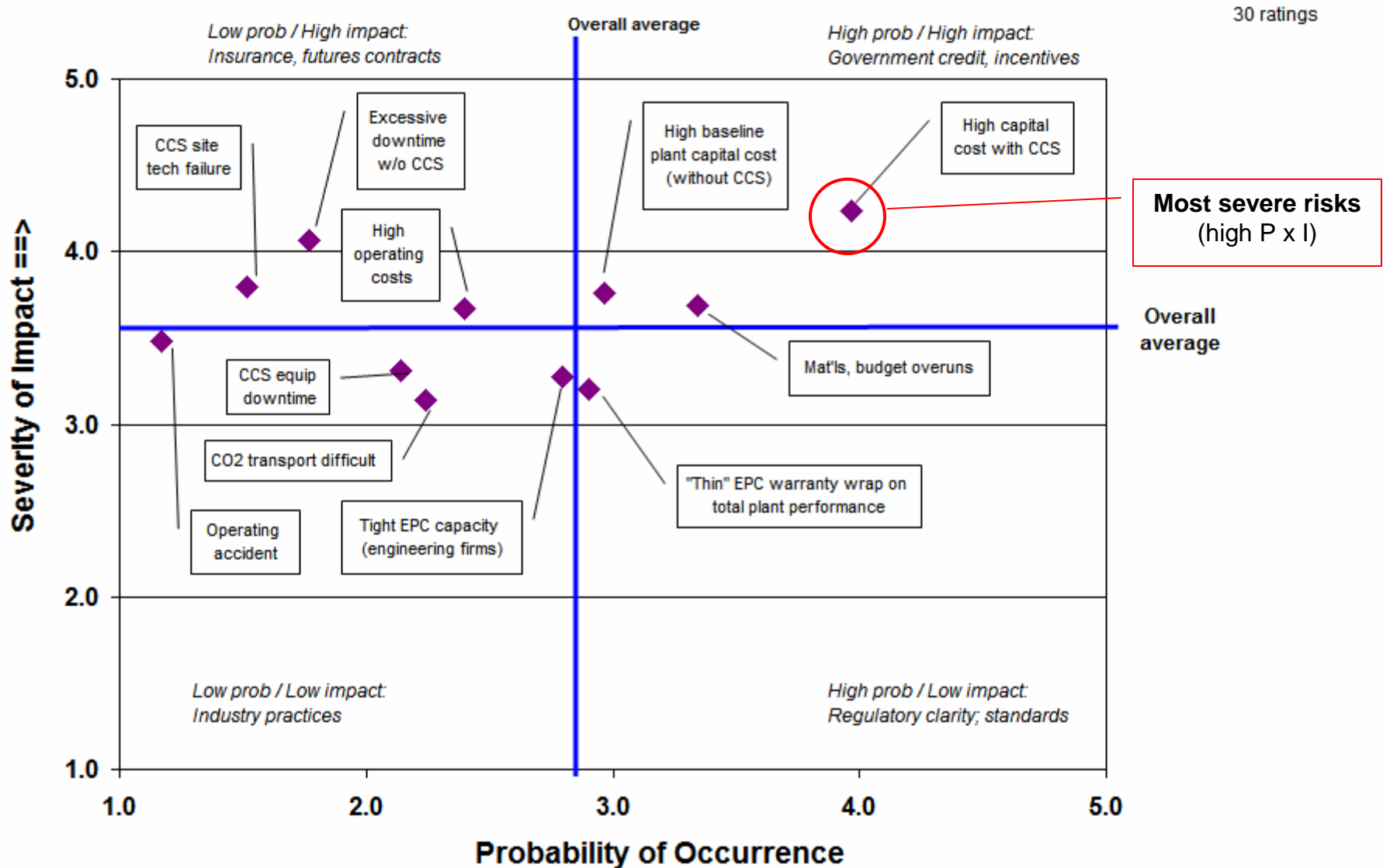
First of a Kind Systems: High Risk Early



Source:
Scully Capital,
also David Berg,
Andrew Paterson

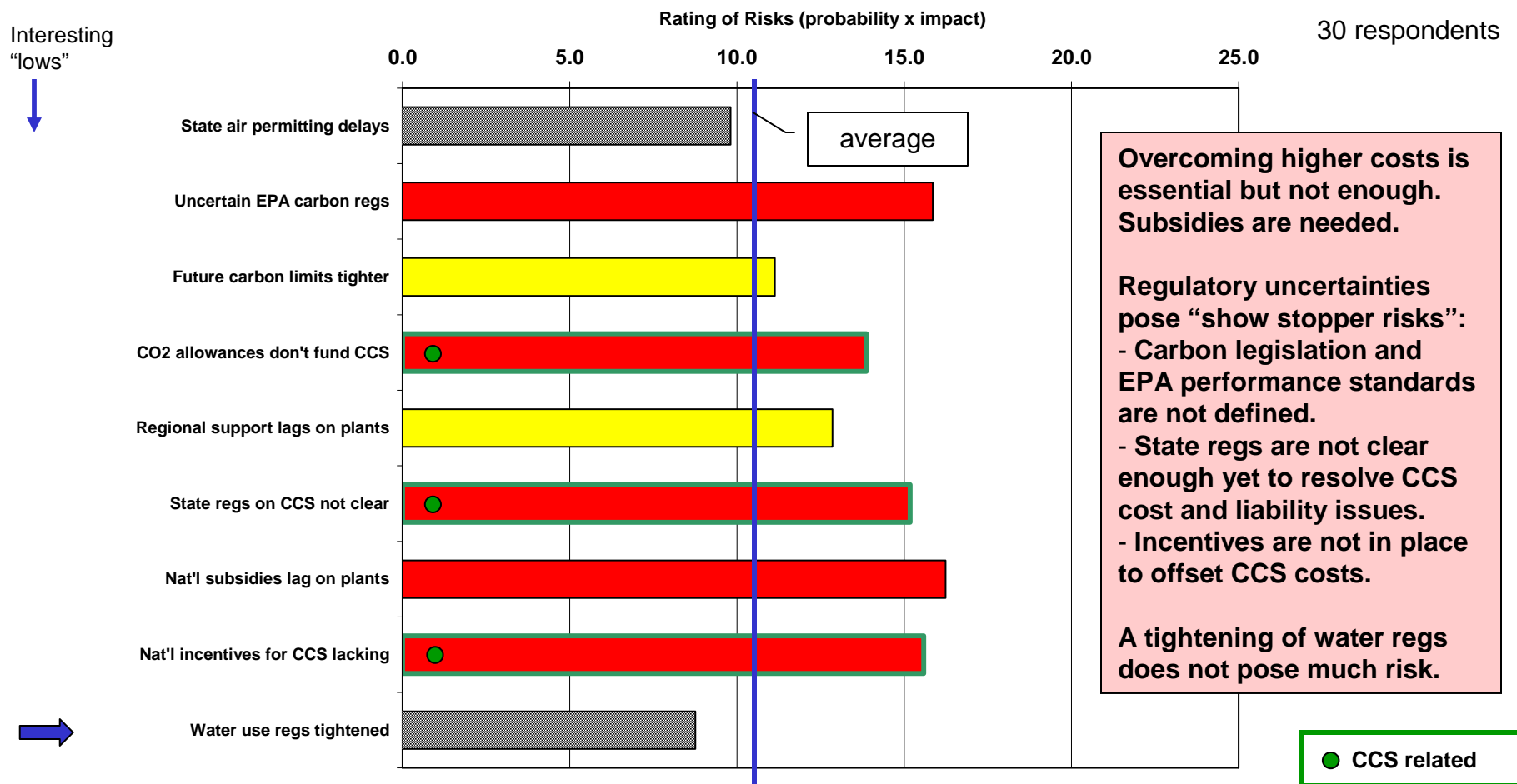
For Deployment of Coal-based Projects with CCS

Coal with CCS TECHNICAL Risks: Probability vs. Impact



Risk Ratings: REGULATORY / POLICY

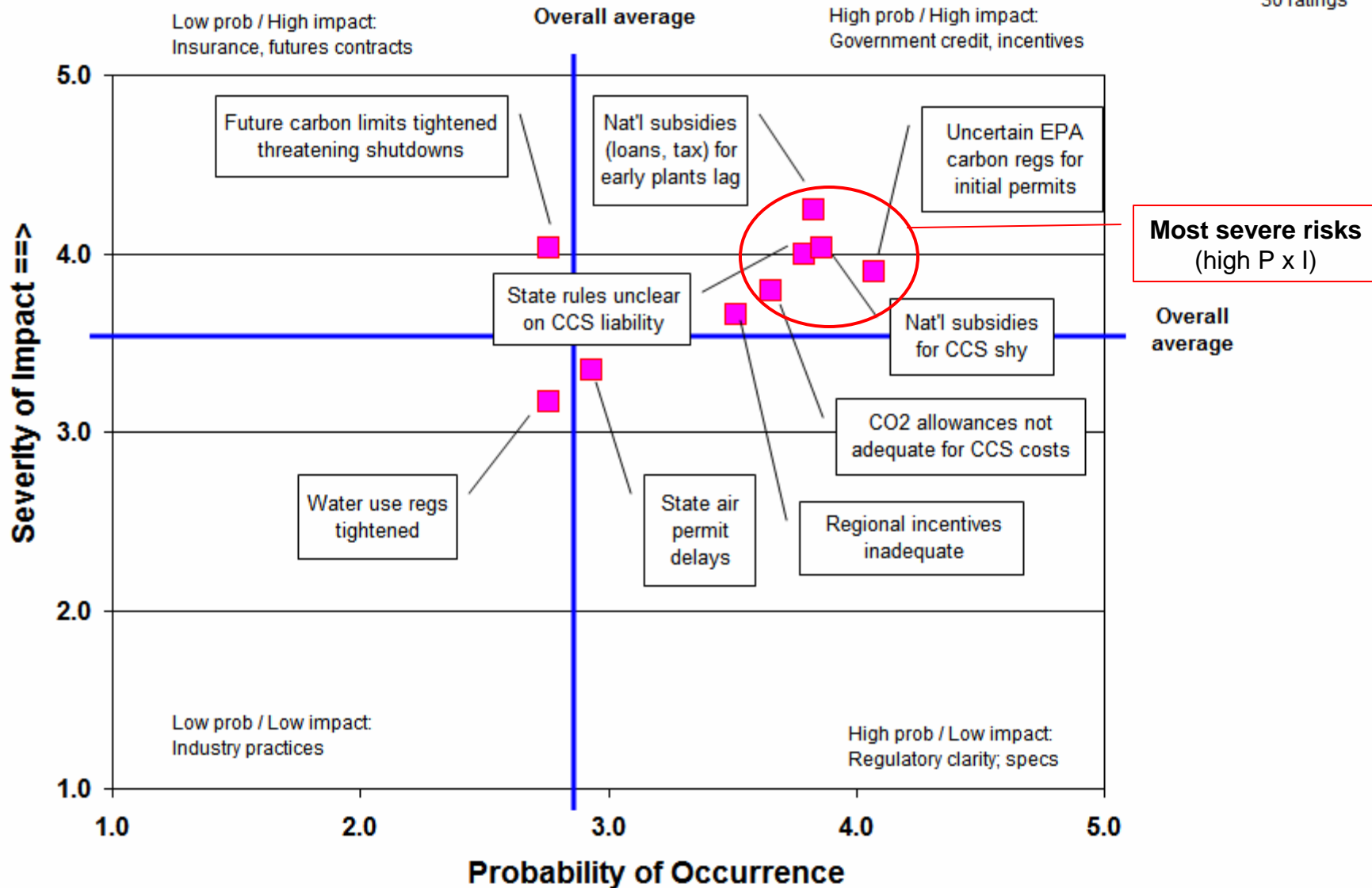
Regulatory uncertainties (federal + state) about CCS costs and liability threaten financing.



For Deployment of Coal-based Projects with CCS

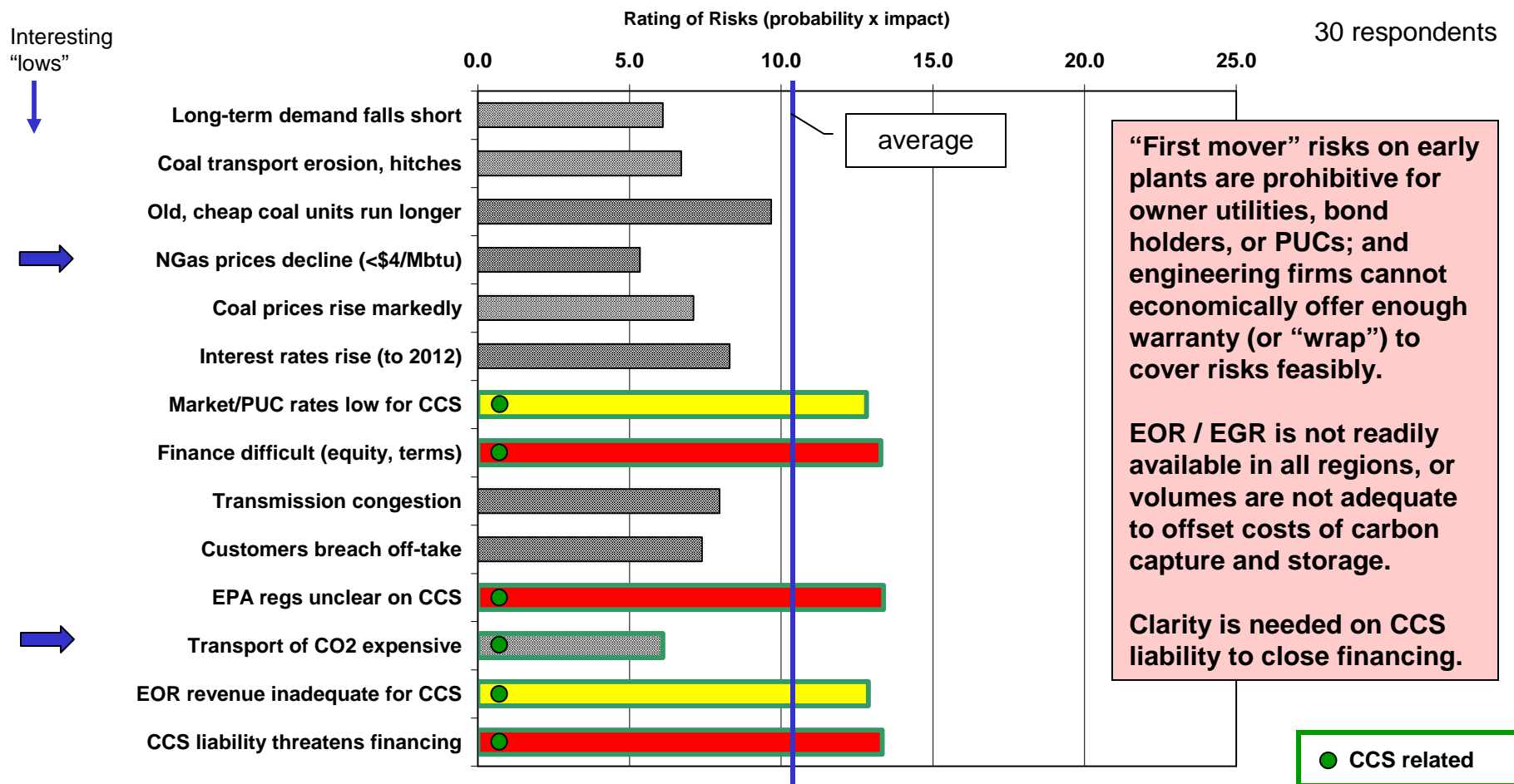
Coal with CCS POLICY Risks: Probability vs. Impact

30 ratings



Risk Ratings: MARKET

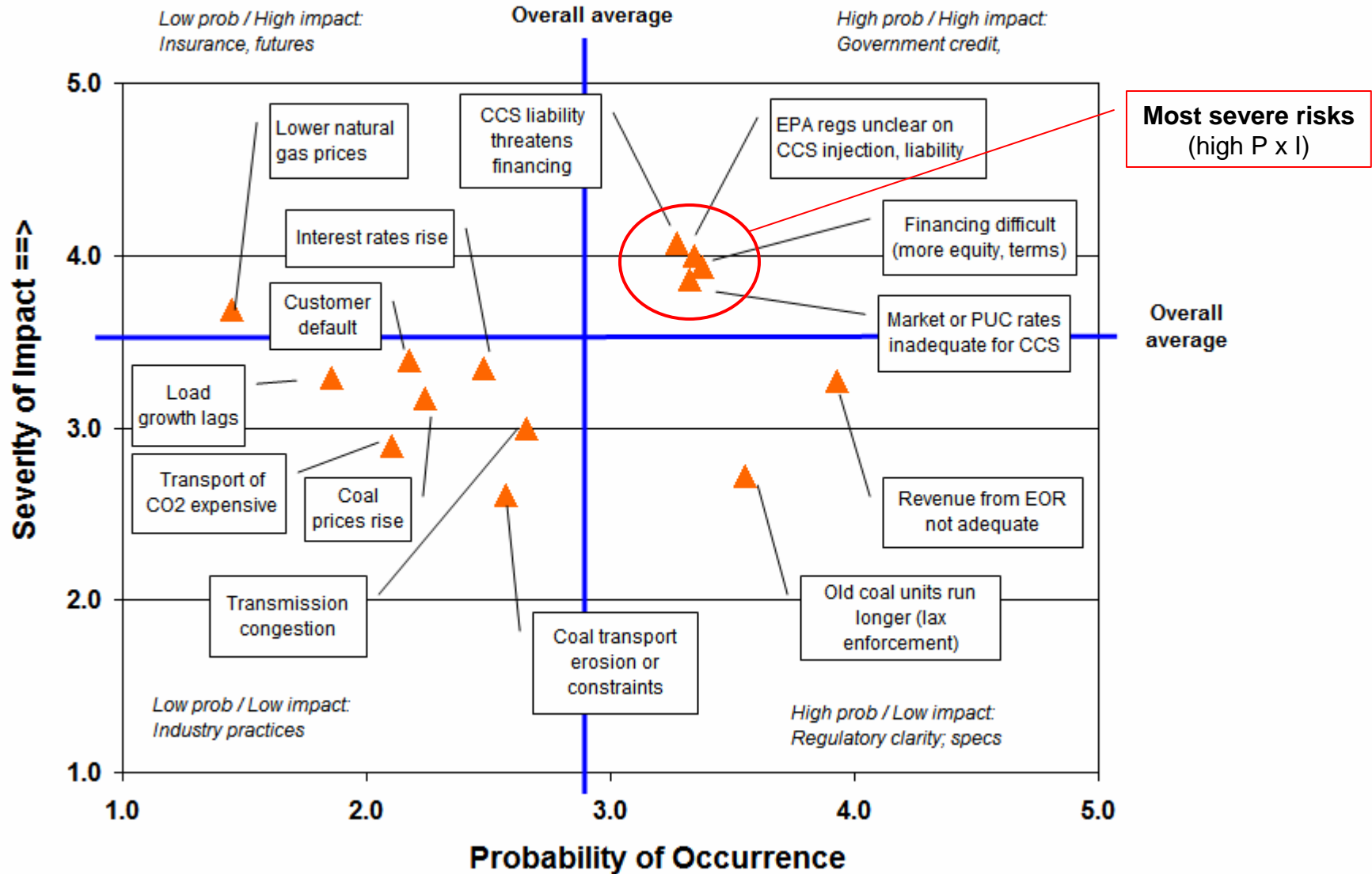
Lack of subsidies and uncertainty about liability for CCS make financing very difficult.



For Deployment of Coal-based Projects with CCS

Coal with CCS MARKET Risks: Probability vs. Impact

30 ratings



Risk Ratings on CCS – Observations

- **Capital costs have run up since 2005, but costs are up for projects worldwide.**
- **Respondents expect that CCS equipment will work, and do not see CO2 transport as a major issue, nor do they see a CCS site failure as likely. CAPITAL COST for the plant with CCS is the key barrier, not variable costs.**
- **Subsidies are needed to overcome higher costs, but that is not enough.**
(Subsidies could be paid for by injection fees on CO2, or user levies on coal)
- **Regulatory uncertainties pose “show stopper” risks for deployment of CCS:**
 - Carbon emission legislation and EPA regulatory rules on CCS are not defined.
 - State regulations are not clear enough yet to resolve CCS cost and liability issues.
 - Incentives (tax credits, loans, allowances) are not in place to offset higher CCS costs.
 - A tightening of water regulations does not pose much of a risk currently.
- **“First mover” risks are prohibitive for owner utilities, bondholders, or PUCs; and engineering firms cannot economically offer enough warranty (or “wrap”) to cover risks. Few owners want to finance early CCS demos and plants.**
- **EOR is not readily available in all regions, or demand is not adequate to absorb costs and volumes needed for carbon capture and storage from power plants.**
- **Clarity is needed on CCS liability to close financing – perhaps a “showstopper”.**
- **Increases in coal prices or interest rates were not rated high risks.**
- **Lower NGas prices (<\$5) would pose competitive problems; not seen as likely.**

Mechanisms for Mitigation of Critical Risks

Risk-based mechanisms entail less federal budget impact, covering more projects.

Mechanisms provide A) a subsidy or B) risk assumption:

A. Traditional “Cost-based” Mechanisms: Subsidies for higher cost technologies early

- 1. Federal Grants** (e.g., DOE CCPI program)
- 2. Investment tax credits / Accelerated depreciation**
- 3. Unit tax credits** (e.g., production tax credits, or CCS tax credits)
- 4. Rate subsidies** (allowances or feed-in tariffs)

B. Progressive “Risk-based” Mechanisms: Negotiated between public – private sector actors

- 1. Loans or guarantees** (under Energy Policy Act 2005)
- 2. Federal off-take contract / Capacity payments**
- 3. State rate regulation** (available in about half the states)
- 4. Dispatch preference**
- 5. Offsets and Liability transfer**

Mechanisms for Mitigation of Critical Risks

Mechanisms and incentives tend to take A) some form of subsidy or B) risk assumption:

A. Traditional “Cost-based” Mechanisms: Subsidies for higher cost technologies early

- 1. Federal Grants:** traditional federal funding provided by appropriations and procurement (limited availability).
- 2. Investment tax credits / Accelerated depreciation:** capital subsidies partially available under Section 48A&B. More helpful with early funding while risk is highest versus later production tax credits.
- 3. Unit tax credits** (e.g., production tax credits, or CCS tax credits): Ensures that technology works before tax subsidy is provided, but does not shoulder much risk, which is borne early by plant owners. Can only be utilized to the degree income is earned. Many PUCs require pass through to rate payers.
- 4. Rate subsidies (allowances or feed-in tariffs):** Similar to production tax credits, but comes in as revenue rather than tax benefit. Can be tailored better than federal tax credits to regional and local attributes.

B. Progressive “Risk-based” Mechanisms: Negotiated between public – private sector actors

- 1. Loans or guarantees:** Under EPAAct 2005, DOE offers loan guarantees for first-of-a-kind plants. Improves capital structure by reducing equity and interest rates. Much less costly to federal budget than tax benefits.
- 2. Federal off-take contract:** Federal off-take agreement can boost credit standing, provide revenue boost.
- 3. State rate regulation:** Conventional rate regulation is preferred by lenders; enhances debt financing.
- 4. Dispatch preference:** State could also grant dispatch preference to a baseload unit, but this would not cover technical downtime (repairs) or shutdowns for regulatory compliance issues (e.g., CO2 injection).
- 5. Offsets and Liability transfer:** To address “long-term, indefinite” liability for CO2 leakage, carbon offsets could be purchased, and a liability transfer could be negotiated between plant owners, states, insurers, and federal agencies. No cost subsidy truly addresses indefinite long-term liability.

Risk-based mechanisms may trigger less federal budget impact, covering more projects.

For Deployment of Coal-based Projects with CCS

Risks vs. Mechanisms for Mitigation (X = helps cover risk)

Existing Mechanisms do NOT adequately mitigate critical risks. Subsidies are not enough.

Increasing Risk Coverage

Lead Actor	Mechanisms (vs. Critical Risks)	High Capital Costs with CCS	Uncertainty on Carbon Emission Cap & Regs	Unclear rules on CCS Injection	Lack of clarity on long-term CCS Liability	Electric prices (or rates set) too low for CCS costs	
	Level of Risk ==>	High	High	High	High / Med	High / Med	
	Existing Mechanisms (U.S.)						
	<i>A) Subsidies</i>						
Federal	Federal grants (DOE)	XXX				XX	
Federal	Investment tax credits (capital subsidy)	XX				X	
Federal	Unit tax credits (operating subsidy)	XX				X	
State	State grants (e.g., for engineering)	XX		X		X	
	<i>B) Risk Assumption / Transfer</i>						
Federal	Federal Loan Guarantee	XXX	XX		X	XX	
State	Rate-basing or Dispatch Preference	XXX	XXX	XX		XX	
Industry	Stockpiles; Backup supplies or systems	XX					
	Level of Risk Covered	Covered	Exposed	Exposed	Showstopper!	Adequate	
	Action Needed (e.g., legislation)						
	<i>A) Subsidies</i>						
State	Additional collateral or Revolving funds	X				XX	
Federal	Carbon allowances (traded with cap)	XX	XXX	XX		XXX	
	<i>B) Risk Assumption / Transfer</i>						
Federal	Clear regulations on carbon emissions		XXX				
State	Clear rules on CCS and LT Liability			XXX	XXX	X	
Industry	Insurance and Carbon Offsets			X	X		
Federal	Federal off-take contract or feed-in	XXX	XXX	X		XX	
Industry	EPC Turnkey "wrap" or warranties		X				
	Level of Risk Covered	Covered	Adequate	Adequate	Negotiable	Adequate	
		XXX = most coverage; XX = moderate coverage; X = a little coverage					

For Deployment of Coal-based Projects with CCS

Risks → Mitigation Approaches → Actions Needed

Q#	Highest Risks	Comment	Outlook / Actions Needed
7	Capital costs with CCS high	Capital costs remain a major threat for first units. Engineering backlog is global. Revolving credit could assist "FEED".	DOE LGs and some tax credits are in place. Appropriations and a tax bill are needed for subsidies.
18	Nat'l subsidies lag on plants	DOE Loan Guarantees and some tax credits (Sec. 48 ITCs) are in place.	Appropriations, and a tax bill are needed from Congress
13	Uncertain EPA carbon regs	Uncertainty about EPA regs on CCS injection and GHG curbs remain.	EPA UIC draft regs are out for comment. GHG legislation is much farther away.
19	Nat'l incentives for CCS lacking	CCS is not economic; subsidies are essential, especially for first plants.	Demos of CCS must move ahead. DOE regional partnerships are useful.
17	State regs on CCS not clear	Sites for CCS will likely span multiple states, requiring cooperation.	"Fossil supply" states will likely take the lead on CCS policy as with EOR.
15	CO2 allowances don't cover CCS costs	Uncertainty about CO2 policy breeds a lack of confidence in allowances.	Carbon legislation must spell out allowances for CCS explicitly.
31	Lack of clarity in EPA regs on CCS hinder finance	Lenders need clarity on CCS rules. Regulated rates with CCS could help.	State rules on CCS would promote financing if long-term, no residual liability.
34	CCS liability threatens financing	Lack of resolution for "post-injection" liability on leakage freezes capital.	State rules help, but federal backing long-term would provide more resolution.
28	Finance difficult (more equity, short tenors)	Financing difficulties are symptomatic of other risks not being resolved.	State rules on CCS enable progress, and federal backing would help.
33	EOR revenue inadequate for CCS	With oil above \$70, EOR is a financial boon, but volumes needed are low.	Federal assistance may be needed for CO2 pipelines and permitting.
16	Regional support lags on plants	States need to be engaged with Congress in designing approaches.	Risk-sharing between states and federal agencies is important.
27	Market/PUC rates low for CCS	Higher capital costs and economic losses with CCS give PUCs heartburn because of "rate shocks" to consumers.	Higher natural gas prices keep coal in play; but PUCs need to pass through federal subsidies for CCS.

CCS Alliance

Summary Points for CCS Deployment

- CCS is not economic and subsidies will be needed for first plants.
- Some tools are in place, but legislation is needed to resolve uncertainties. Financing is key: No financing = no CCS deployment.
- Utility bond holders require certainty on CCS liability with no indefinite, long-term exposure after injection. Private owners and insurance could manage first losses, states may want to share risks to encourage plants.
- With dependence on coal-based electricity for 12 hrs a day, more in some U.S. regions, CCS is vital for progress on carbon emissions.
- The current pace of electricity demand and the rise and volatility of natural gas prices require that advanced coal plants be built now.
- Grants and tax credits are easy for industry to ask for, but are difficult for Congress to fully fund. Levies on coal may be needed; but those funds would need to be sequestered for coal projects.
- Risk-based policies (such as loan guarantees, or dispatch preference) can help stretch limited government funds across more projects.
- If risks are addressed through a mix of policies and demos, early plants could be built with CCS to demonstrate feasibility.

Path Forward: Risk Mitigation Mechanisms

Financing

Offset
costs

- Establish extent of private insurance capacity on CCS risks
- Utilize loan guarantees and tax credits to offset CCS costs
- Develop financial mechanisms and carbon offsets for risk transfer

Regulations and State Actions

Clarify
rules

- Track EPA UIC (underground injection) regulations for resolution of CCS liability issues
- Monitor state actions on CCS characterization and GHG rules
- Work with state PUCs willing to support plants with CCS in rates

Federal Legislation

Address
LT liability

- Garner financing for CCS demonstrations (e.g., fossil fuel charge)
- Utilize results of CCS demonstrations to refine risk assessments
- Follow legislation on carbon emissions, allowances and incentives for reductions, including ultimate liability for CCS

END / MOVING AHEAD

Perspective – CCS: MAKING IT HAPPEN (EU Roundtable)

“CCS is necessary if we are serious about fighting climate change. It is not about pumping taxpayers’ money into energy companies’ pockets. I wish we could move to a carbon-free society without CCS, but [this] is not possible, so we should be serious about it.”

By 2020, all power plants could be forced to be capture-ready with CCS and by 2025, and there could be regulation on the average amount of CO₂ per kW/h that installations would be allowed to emit.

“I have some difficulty with regulation because we still do not know the real costs of CCS. To have regulation, we need to have at least some idea of the costs. For that, we need demonstration projects and for the technology to be tested on a broader scale.”

Andris Piebalgs, EU Commissioner for Energy, May 2008

http://www.friendsofeurope.org/Portals/6/Documents/Reports/2008-05-27_CCS_Report_for_web.pdf





Background Material & Analysis

Critical Legislative and Regulatory Efforts Underway

- **EPA UIC Draft Rule for CO₂ Injection (released for comment in July)**
- **EPA response to Mass. v. EPA: CO₂ regulation under Clean Air Act**
- **Review of rulings after suspension of CAIR and Mercury Rule**
- **New Source Reviews (U.S. EPA)**
- **Carbon emission legislation in 2009-2010 (various proposals)**
- **State carbon emission legislation now (CA, WA, New England...)**
- **Ongoing EOR / EGR permitting (concentrated in Gulf Coast)**
- **Permits for CCS demonstration projects (regional partnerships)**
- **International deliberations on GHG limits which could bear on U.S.**
- **Credit agency reviews of GHG impact of energy investments (S&P, Fitch, Moody's, major banks)**

CCS Alliance

In Collaboration with Hunton & Williams

“Enabling CCS: Policy Options for Remedies and Risk Mitigation”

Preamble / Objective:

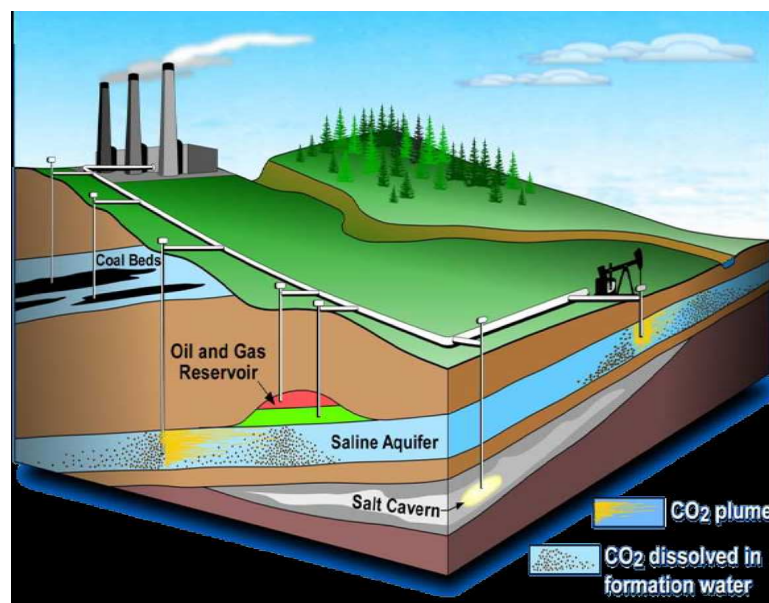
Phase I of the work scope for the CCS Alliance systematically identified the key risks and legal and policy challenges to consider *investing* in deployment of CCS. This work incorporated efforts elsewhere, such as by industry and energy groups, and regional partnerships and the IOGCC.

Phase II builds on the identification and prioritization of those risks and policy and regulatory issues to assemble the legal and financial approaches to *enable* CCS.

Private investors, power and energy companies and communities considering CCS face clear “first mover” risks and costs that must be addressed by policy and legal measures, and financing incentives that address those critical risks.

Enabling CCS requires:

- Legislation and regulatory engagement
- Financial incentives and insurance mechanisms
- Private contractual and risk-sharing approaches
- Working with states on policy / regulatory issues



IPCC Overview of CCS Risks

The risks due to leakage from storage of CO₂ in geological reservoirs fall into two broad categories: global risks and local risks. Global risks involve the release of CO₂ that may contribute significantly to climate change if some fraction leaks from the storage formation to the atmosphere. In addition, if CO₂ leaks out of a storage formation, local hazards may exist for humans, ecosystems and groundwater. These are the local risks. With regard to global risks, based on observations and analysis of current CO₂ storage sites, natural systems, engineering systems and models, the fraction retained in appropriately selected and managed reservoirs is very likely to exceed 99% over 100 years, and is likely to exceed 99% over 1000 years. Similar fractions retained are likely for even longer periods of time, as the risk of leakage is expected to decrease over time as other mechanisms provide additional trapping.

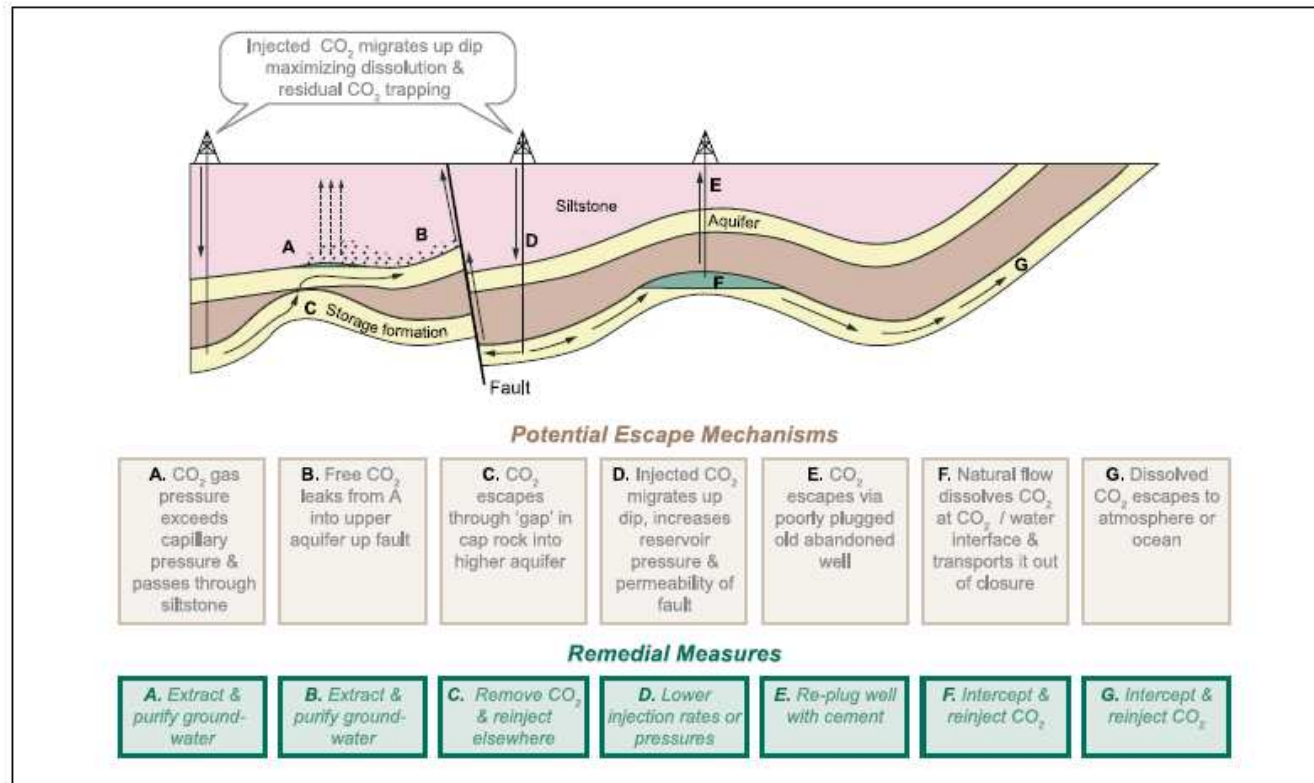


Figure TS.8. Potential leakage routes and remediation techniques for CO₂ injected into saline formations. The remediation technique would depend on the potential leakage routes identified in a reservoir (Courtesy CO₂CRC).

Mitigation Built on Science, Industrial Experience

A sound risk mitigation strategy can be built on scientific methodologies and industrial experience.



Geological Storage Safety and Security Pyramid

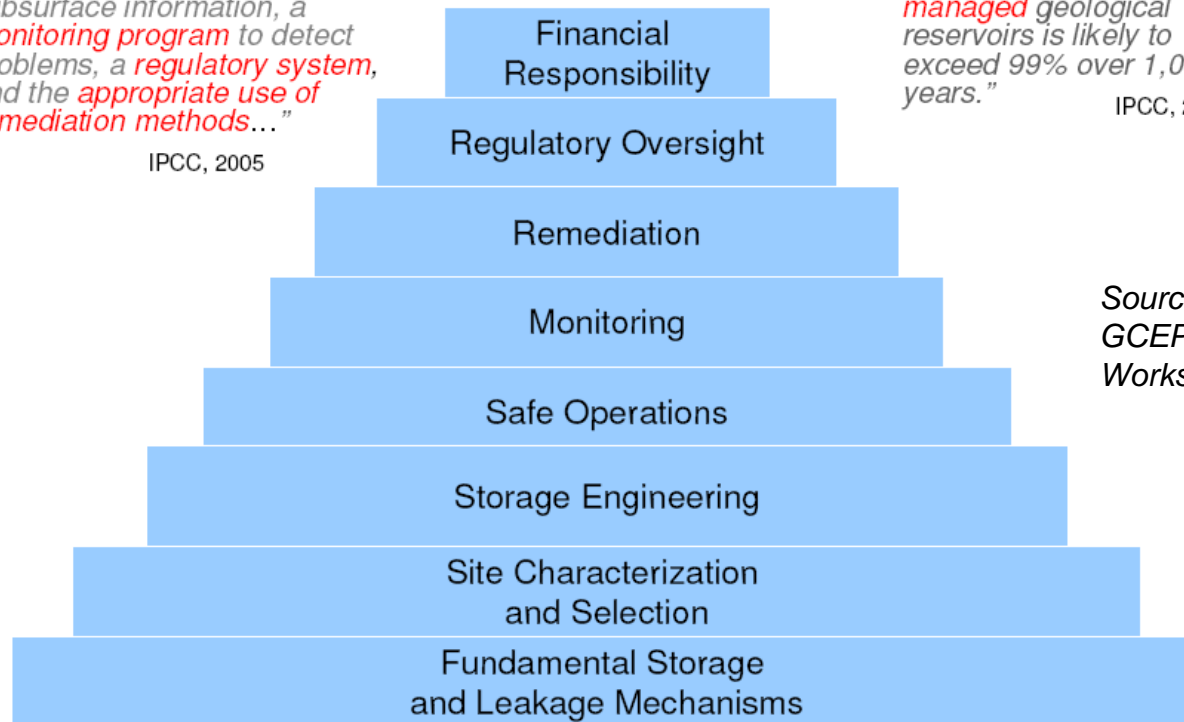


*“ With **appropriate site selection** informed by available subsurface information, a **monitoring program** to detect problems, a **regulatory system**, and the **appropriate use of remediation methods...**”*

IPCC, 2005

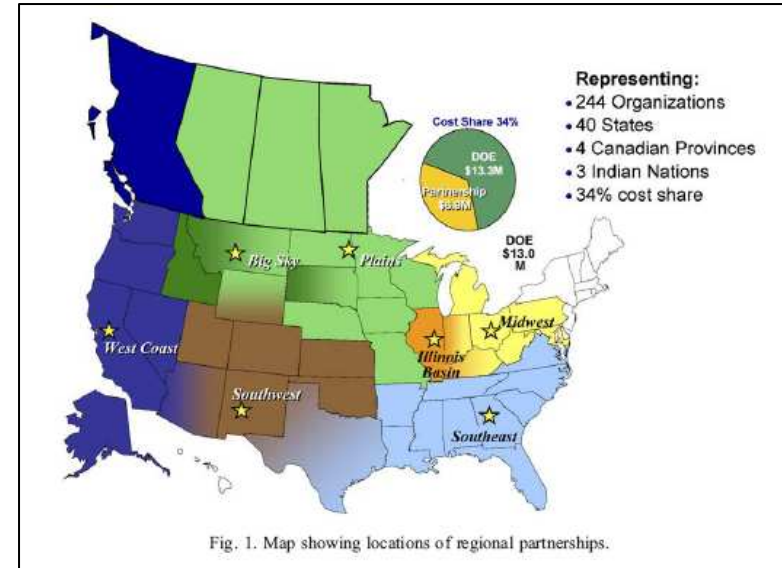
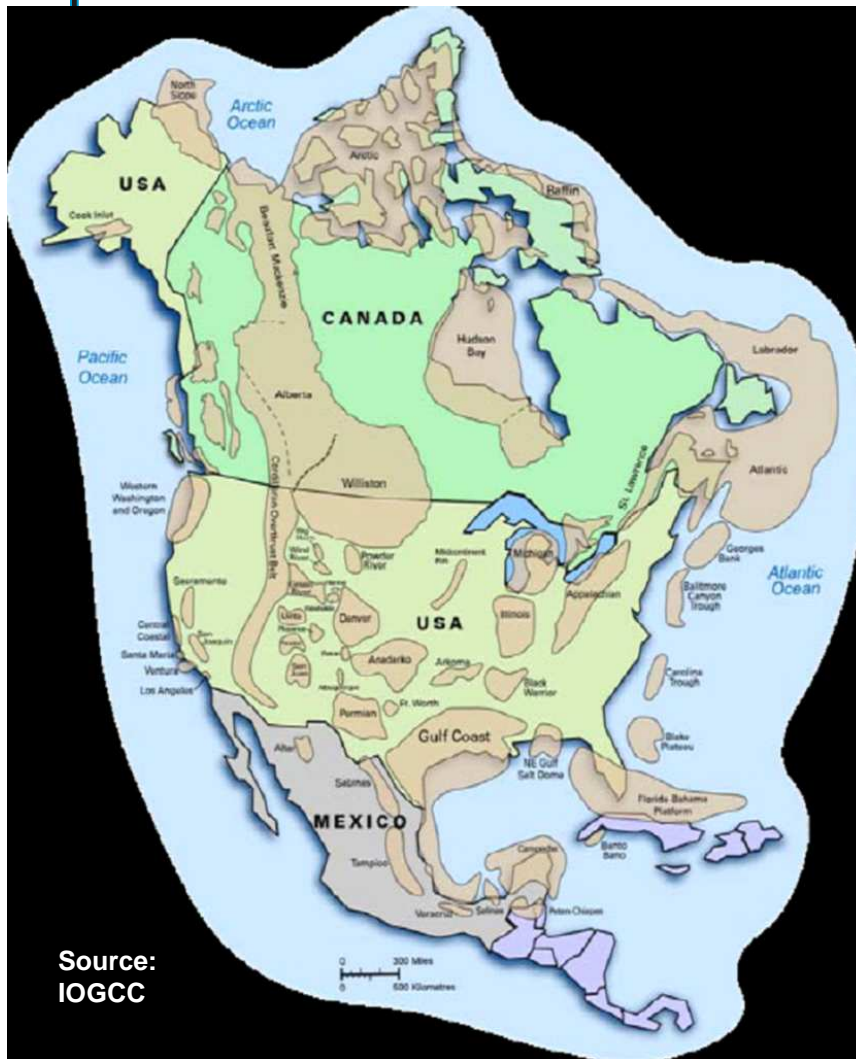
*“... the fraction retained in **appropriately selected and managed** geological reservoirs is likely to exceed 99% over 1,000 years.”*

IPCC, 2005



Source: Dr. Sally Benson, GCEP at Stanford, in WRI Workshop June 5, 2007

CCS Potential and Regional Partnerships



The seven regional partnerships selected by DOE are:

- Big Sky Carbon Sequestration Partnership (BSCSP)
- Midwest Geological Sequestration Consortium (MGSC)
- Midwest Regional Carbon Sequestration Partnership (MRCSP)
- Plains CO₂ Reduction Partnership (PCOR)
- Southeast Regional Carbon Sequestration Partnership (SECARB)
- Southwest Regional Partnership for Carbon Sequestration (SRPCS)
- West Coast Regional Carbon Sequestration Partnership (WESTCARB)