



Carbon Capture and Storage Projects and the Bond Market

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Canada House, Carbon Capture and Storage
Workshop

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Introduction

- What is the IEA Clean Coal Centre?
- CCS projects and the future energy infrastructure costs
- What are bonds?
- Are bond markets considering CCS projects
- Future options
- Conclusions



Organisation



Organisation for Economic Cooperation and Development



International Energy Agency



Implementing Agreements (40)

Fuel cells, Motor fuels, Solar, Biofuels, Energy conservation, Wind power etc



IEA Clean Coal Centre



IEA Greenhouse Gas R&D Programme





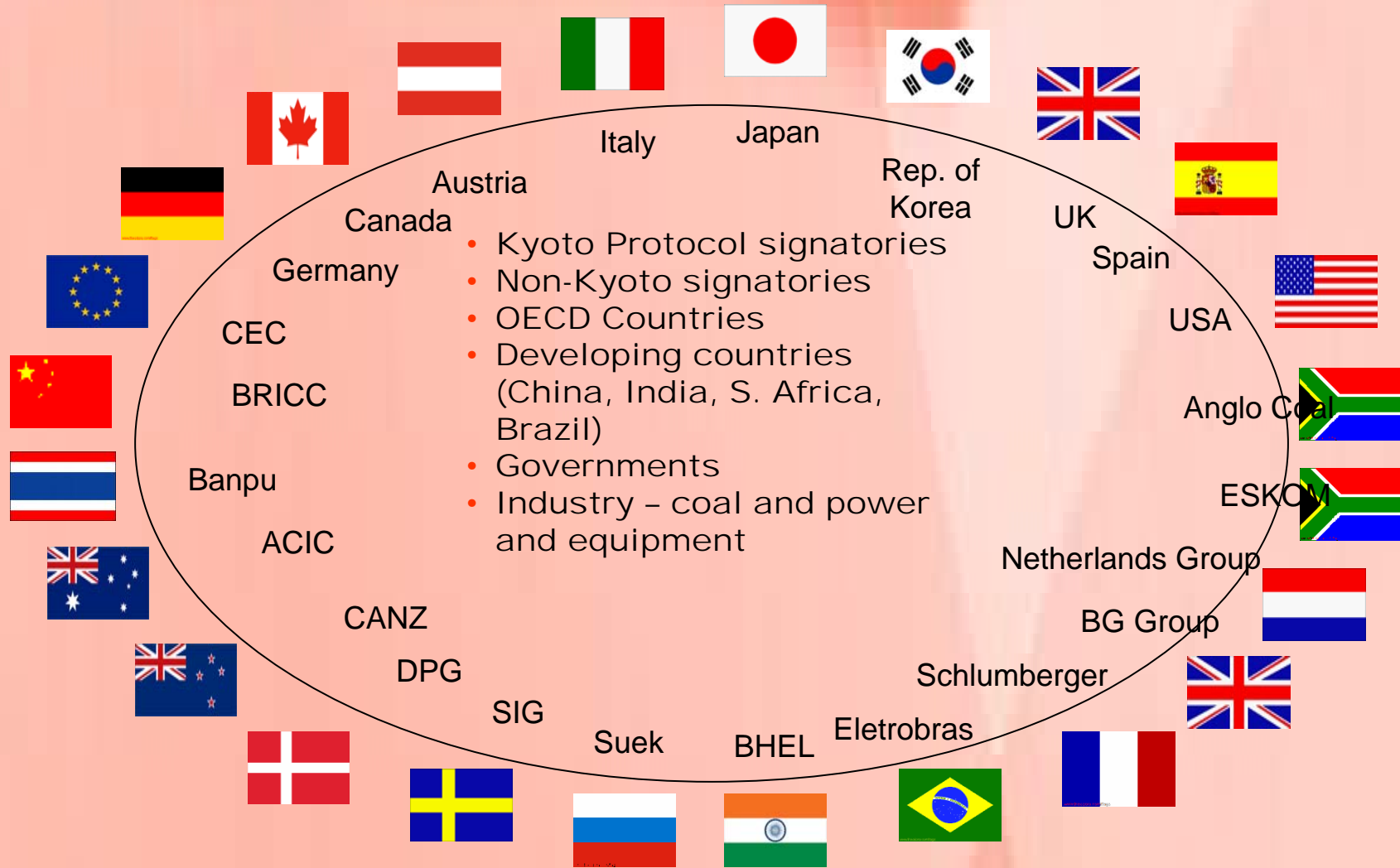
Mission Statement

IEA CCC will provide a source of *unbiased* information on sustainable use of coal world-wide. Services will be delivered to governments and industry through

- direct advice,
- review reports,
- facilitation of R & D and
- provision of networks



MEMBERS



- Kyoto Protocol signatories
- Non-Kyoto signatories
- OECD Countries
- Developing countries (China, India, S. Africa, Brazil)
- Governments
- Industry - coal and power and equipment



IEA CCC Current Situation

Non-Profit making organisation supported mainly by members subscriptions

Annual turnover around £1.8m (US \$ 3.6m)

Staff – 25

Members – 24 members inc those in process

Special Reports – 14 -16 every year

Technical focus – coal fired power and environment

- Co-firing
- Greenhouse towards zero emissions

Databases, Abstracts

Expert Advice

Ad hoc consulting for members



The Good News

- Different CCS projects are underway or planned globally

However ...

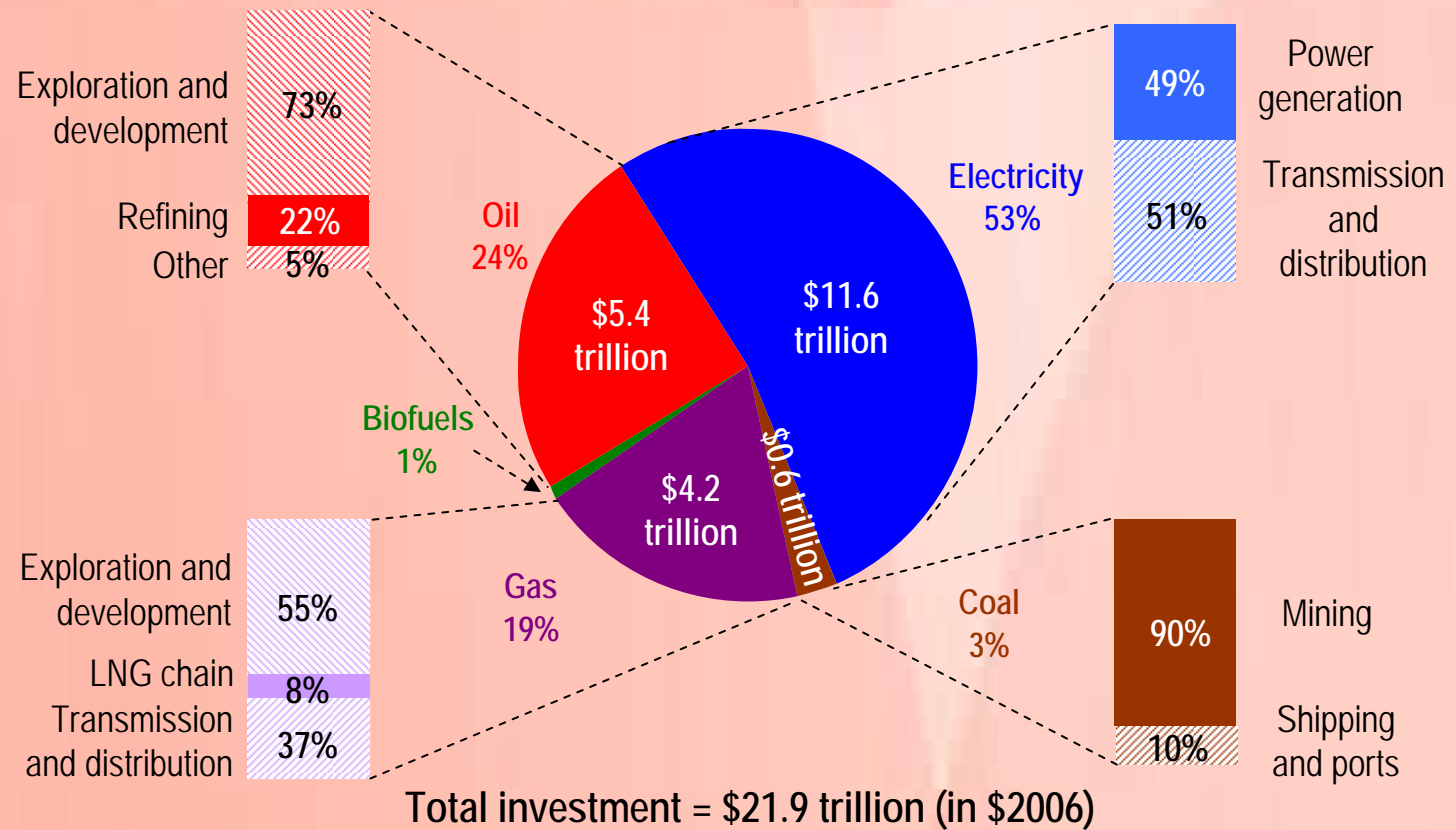
- Few coal-fired power plant projects are funded at large-scale
- A lot of uncertainty about full funding for proposed large projects
- UK has announced short list for its CCS tender
- USA redesigning Futuregen

Source: MIT, 2008

Project Name	Location	Feedstock	Size MW	Capture Process	CO2 Fate	Start-up
Total Lacq	France	Oil	35	Oxy	Seq	2008
Vattenfall Oxyfuel	Germany	Coal	30/300/1000	Oxy	Undecided	2008
AEP Alstom Mountaineer	USA	Coal	30	Post	Seq	2008
Callide-A Oxy Fuel	Australia	Coal	30	Oxy	Seq	2009
GreenGen	China	Coal	250/800	Pre	Seq	2009
Williston	USA	Coal	450	Post	EOR	2009-15
NZEC	China	Coal	Undecided	Undecided	Seq	2010
E.ON Killingholme	UK	Coal	450	Pre	Seq	2011
AEP Alstom Northeastern	USA	Coal	200	Post	EOR	2011
Sargas Husnes	Norway	Coal	400	Post	EOR	2011
Scottish& So Ferrybridge	UK	Coal	500	Post	Seq	2011-2012
Naturkraft Kårstø	Norway	Gas	420	Post	Undecided	2011-2012
ZeroGen	Australia	Coal	100	Pre	Seq	2012
WA Parish	USA	Coal	125	Post	EOR	2012
Coastal Energy	UK	Coal/Petcoke	800	Pre	EOR	2012
UAE Project	UAE	Gas	420	Pre	EOR	2012
Appalachian Power	USA	Coal	629	Pre	Undecided	2012
Wallula Energy	USA	Coal	600-700	Pre	Seq	2013
RWE npower Tilbury	UK	Coal	1600	Post	Seq	2013
Tenaska	USA	Coal	600	Post	EOR	2014
BP Rio Tinto Kwinana	Australia	Coal	500	Pre	Seq	2014
UK CCS project	UK	Coal	300-400	Post	Seq	2014
Statoil Mongstad	Norway	Gas	630 CHP	Post	Seq	2014
RWE Zero CO2	Germany	Coal	450	Pre	Seq	2015
Monash Energy	Australia	Coal	60 k bpd	Pre	Seq	2016
Powerfuel Hatfield	UK	Coal	900	Pre	EOR	Undecided
ZENG Worsham-Steed	USA	Gas	70	Oxy	EOR	Undecided
Polygen Project	Canada	Coal/Petcoke	300	Pre	Undecided	Undecided
ZENG Risavika	Norway	Gas	50-70	Oxy	Undecided	Undecided
E.ON Karlshamn	Sweden	Oil	5	Post	Undecided	Undecided

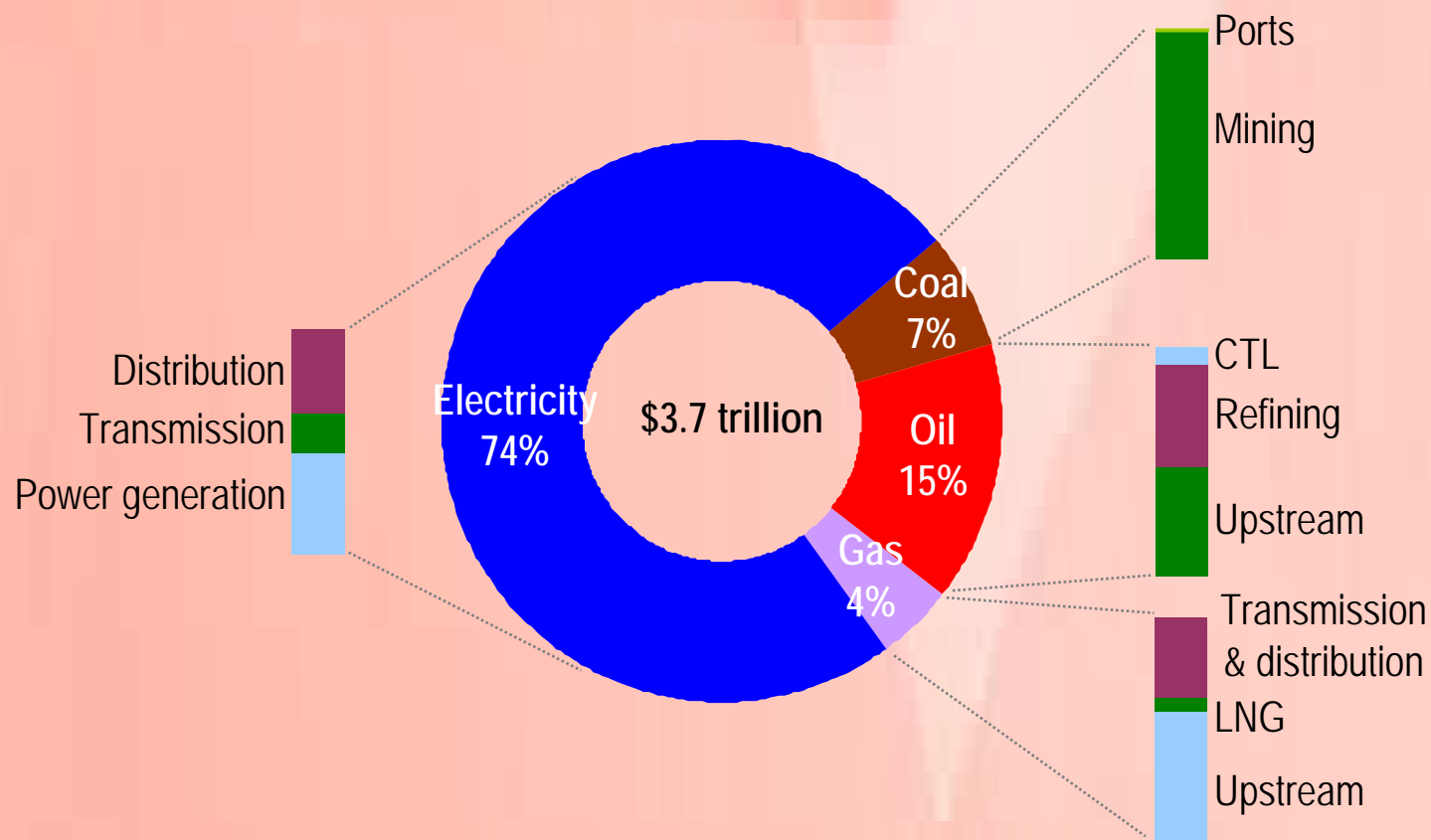


Reference Scenario: Cumulative Investment in Energy-Supply Infrastructure, 2006-2030





Reference Scenario: Cumulative Energy-Supply Investment in China, 2006-2030



China needs to invest \$3.7 trillion in energy supply infrastructure – three-quarters of which for the electricity sector



Some Options for Funding CCS

- Expand traditional “technology policy” options (tax credits, subsidies, etc.)
- Set new regulations requiring CCS (e.g., generator CO₂ performance standards) (as in California CO₂ stds) and which the EU is also proposing
- Establish a CCS Trust Fund with fees used to pay full added cost of early CCS projects (proposed here; under consideration by Congress and EPA) (Source, Rubin, 2008)
- Utilise the bond market



WHAT IS A BOND?

- A bond is a debt security or debt instrument, similar to an I.O.U. When you purchase a bond, you are lending money to a government, municipality, corporation or other entity which you agree to repay over a defined amount of time
- Bonds issued by a company or corporation are taxable
- Bonds issued by state or regional governments, municipalities do not normally pay tax



Structure of a bond

- The issuer or person who purchases the bond
- Principal amount
- Specified interest rate; paid to the issuer yearly (also known as the coupon)
- Date of maturity or when the bond finishes



Variables that Effect Value

- Tax status
- Price
- Interest rate
- Redemption Features
- Credit Quality
- Yield
- Maturity



MATURITY

Bonds vary in their terms from 4 years
Where they are known as short term

Medium-term notes/bonds which have a
maturity of between 5-12 years

Lastly, there are long-term bonds which
can have maturities of 12 plus years



CREDIT RATINGS

- Several agencies undertake in-depth analysis of a bond issuer's financial conditions and the backing behind the bond and then assign ratings. Essentially the higher the rating the lesser the risk, usually AAA rating mean the bonds are Government backed

Credit Risk	Credit Ratings		
	Moody's	Poor's	Fitch
Prime	Aaa	AAA	AAA
Excellent	Aa	AA	AA
Upper Medium	A	A	A
Lower Medium	Baa	BBB	BBB
Speculative	Ba	BB	BB
Very Speculative	B, Caa	B, CCC, CC	B, CCC, CC, C
Default	Ca, C	D	DDD, DD, D



INTEREST RATES

- **FIXED:** Stays same until maturity; ie: buy a \$1000 bond with 7% fixed interest rate and you will receive \$70 every year until maturity and at maturity you will receive the \$1000 back.
- **FLOATING:** reflected and adjusted to current market rates.
- **PAYABLE AT MATURITY:** receive no payments until maturity and then you receive principal plus the total interest earned compounded semi-annually at the initial interest rate.



YIELD

- Yield is the return you actually earn on the bond--based on the price you paid and the interest payment you receive

Two Types of Yields:

Current Yield: annual return on the dollar amount paid for the bond and is derived by dividing the bond's interest payment by its purchase price

Yield To Maturity: total return you will receive by holding the bond until it matures or is called.



TAXABLE STATUS

- Several bonds have special tax advantages. In the USA there is no state or local income tax on the interest from U.S. Treasury bonds
- There is no federal income tax on the interest from most municipal bonds



TYPES OF BONDS

Municipal: issued to raise money for Infrastructure projects such as hospitals and highways

Corporate: debt obligations issued by private and public corporations

Convertible Bonds: can be exchanged for other securities



TYPES OF BONDS

- High-Yield / Junk Bonds
 - Speculative Grade Bonds
 - Rated below Baa by Moody's or BBB at S&P
 - The more the risk the higher the yield
- Asset-Backed Bonds
 - Securitized by a financial asset, such as property

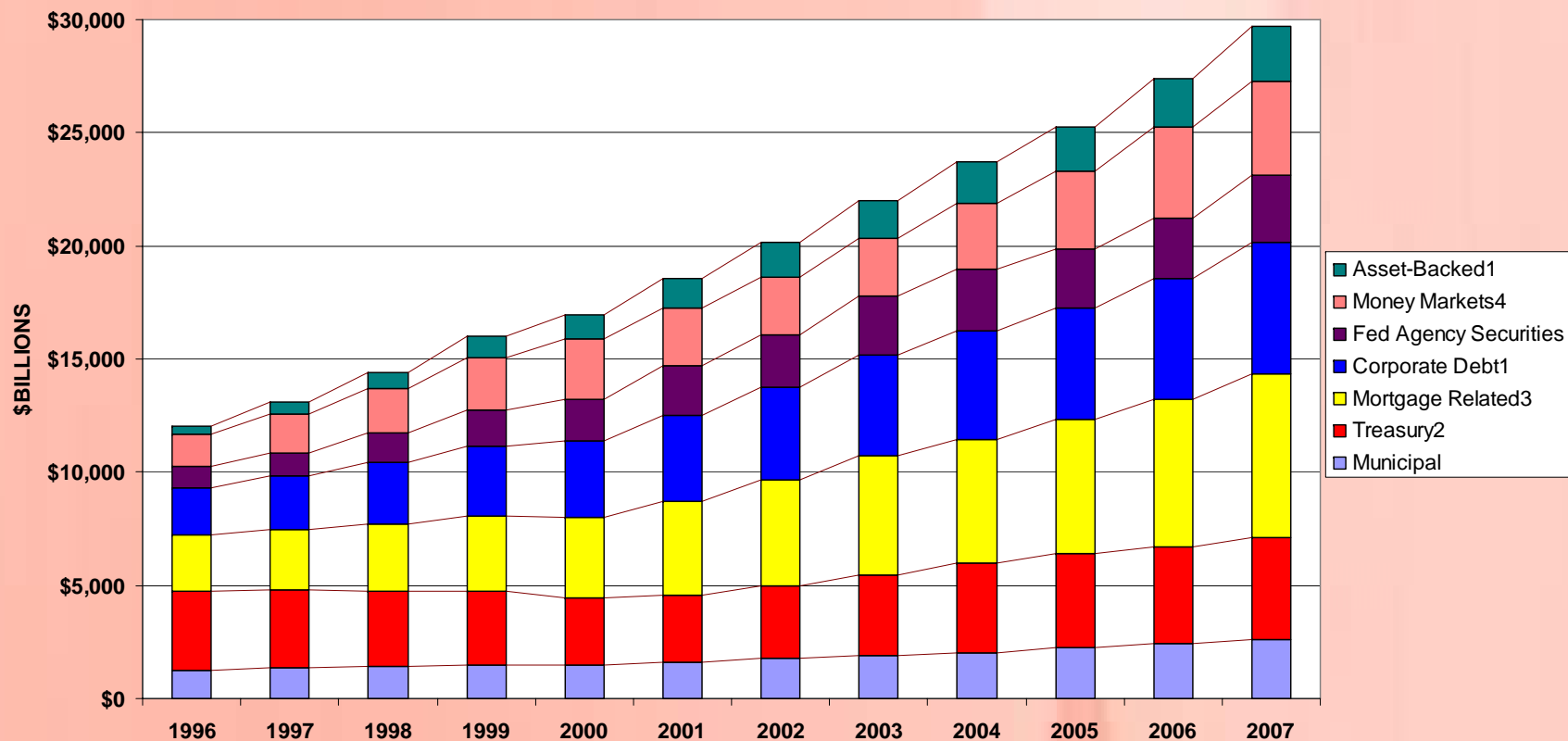


How big is the U.S. Bond Market (1996 – 2007) ?

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

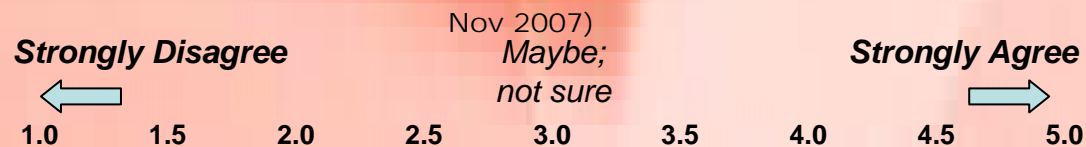
Energy infrastructure is financed in bond market, which sees \$6-7T a year in new bond issuance, about \$80-100B for power providers.

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





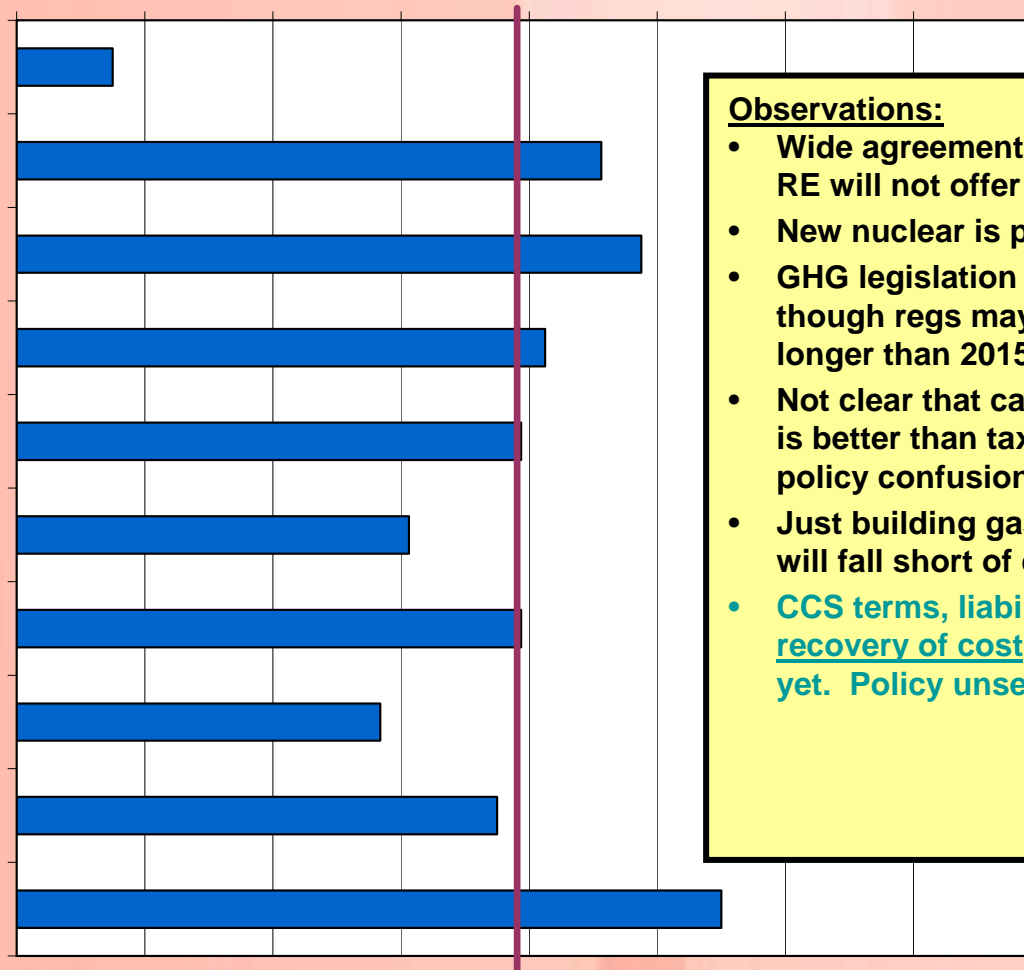
Bond Fund Viewpoints (32 responses; > \$2 Trillion under management)
 Bond Market on Energy Policy (Lehman Roundtable at NARUC,



Least variance →
 (high agreement)

- 1) Able to meet most U.S. needs with EE RE
- 2) New nuclear on-line by 2020 (EPAAct 2005)
- 3) New GHG bill enacted by 2012
- 4) GHG regs likely from EPA by 2015
- 5) Cap-and-trade better than carbon tax
- 6) Can handle near-term with natural gas
- 7) CCS needed at outset for coal plants
- 8) CCS costs can be covered by rates
- 9) States best to regulate CCS liability
- 10) State RPS standards better than Fed RPS

Most variance →



Observations:

- Wide agreement that EE / RE will not offer enough.
- New nuclear is possible.
- GHG legislation likely, though regs may take longer than 2015.
- Not clear that cap-and-trade is better than tax. Lot of policy confusion.
- Just building gas turbines will fall short of demand.
- CCS terms, liability, and recovery of cost not clear yet. Policy unsettled.



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

A) Risk Analysis

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:
(results of Risk Study)

Q #	Q Type	Risk Ratings for Coal Gen with CCS	2008		Total (11)
			Probability	Impact	Rating
7	Tech - CCS	Capital costs on CCS high	4.3	4.3	18.3
17	Reg - CCS	State regs on CCS not clear	4.3	4.3	18.3
13	Reg - CCS	Uncertain EPA carbon regs	4.3	4.2	17.9
19	Reg - CCS	Nat'l incentives for CCS lacking	4.4	4.1	17.9
18	Reg	Nat'l subsidies lag on plants	4.1	4.0	16.4
15	Reg - CCS	CO2 allowances don't fund CCS	3.9	3.9	15.3
31	Mkt - CCS	EPA regs unclear on CCS	3.7	4.1	15.2
28	Mkt	Finance difficult (equity, terms)	3.5	4.1	14.5
34	Mkt - CCS	CCS liability threatens financing	3.4	4.2	14.1
27	Mkt - CCS	Market/PUC rates low for CCS	3.5	4.0	13.8
33	Mkt - CCS	EOR revenue inadequate for CCS	3.5	3.8	13.5
16	Reg	Regional support lags on plants	3.7	3.5	13.2
1	Tech	High capital cost (w/o CCS)	3.1	3.8	11.8
14	Reg - CCS	Future carbon limits tighter	2.8	4.2	11.8
4	Tech	High cost of basic materials	3.4	3.3	11.0
5	Tech	Constrained EPC capacity	3.2	3.3	10.4
12	Reg	State air permitting delays	2.9	3.5	10.0
10	Tech	"Thin" EPC system warranty	3.3	2.9	9.5
23	Mkt	Old, cheap coal units run longer	3.5	2.6	9.3
26	Mkt	Interest rates rise (to 2012)	2.5	3.6	8.9

B) Mitigation Mechanisms

Government

- Loan guarantees
- Grants (DOE, etc.)
- Tax subsidies
- Injection regulations
- Permitting approaches
- Carbon emission rules
- Federal "Energy Bank"
- Revolving loans

Industry / Investors

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

C) Government Actions needed for Mitigation

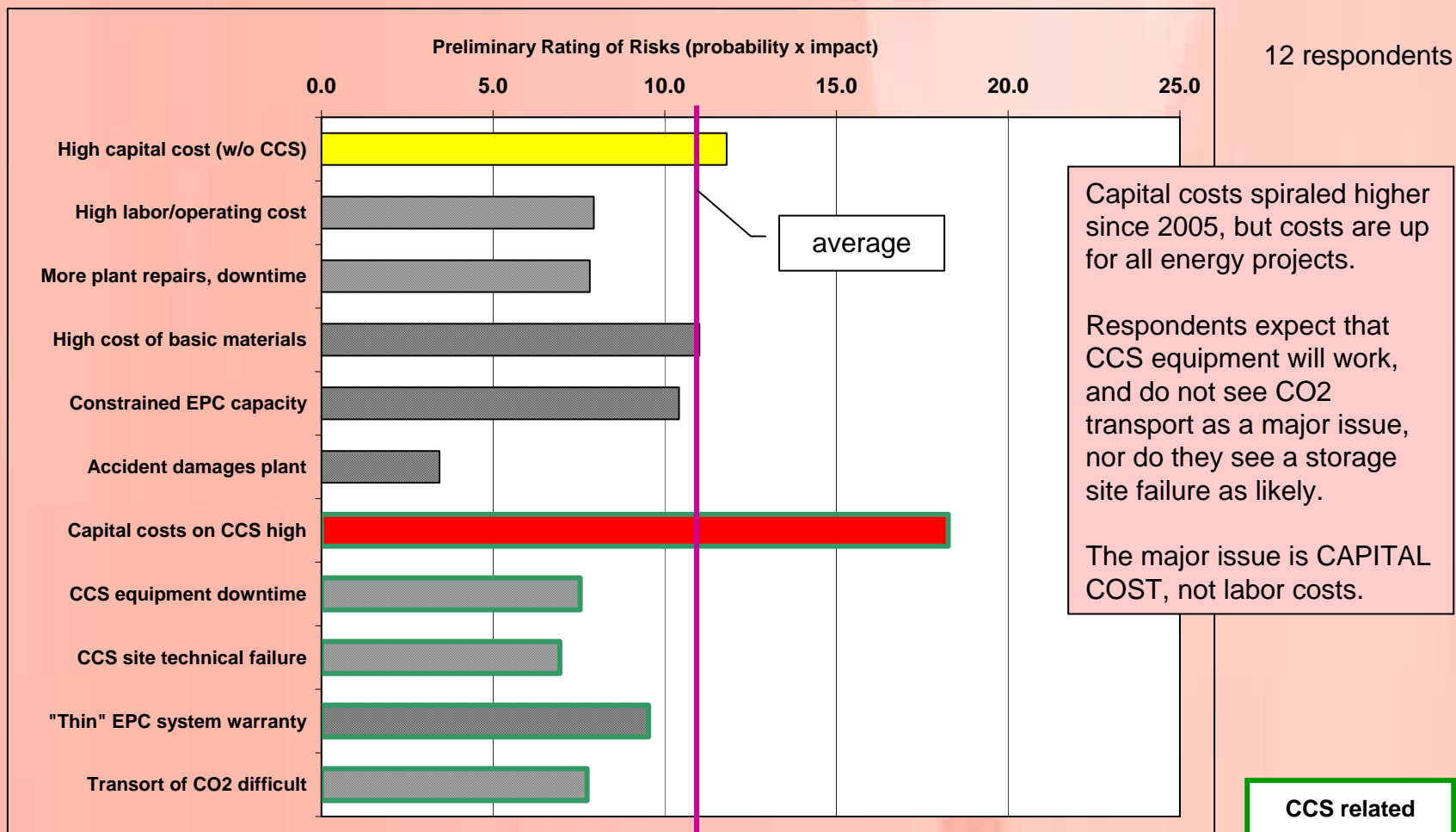
(Match actions with mechanisms)

Near-term / Long-term

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

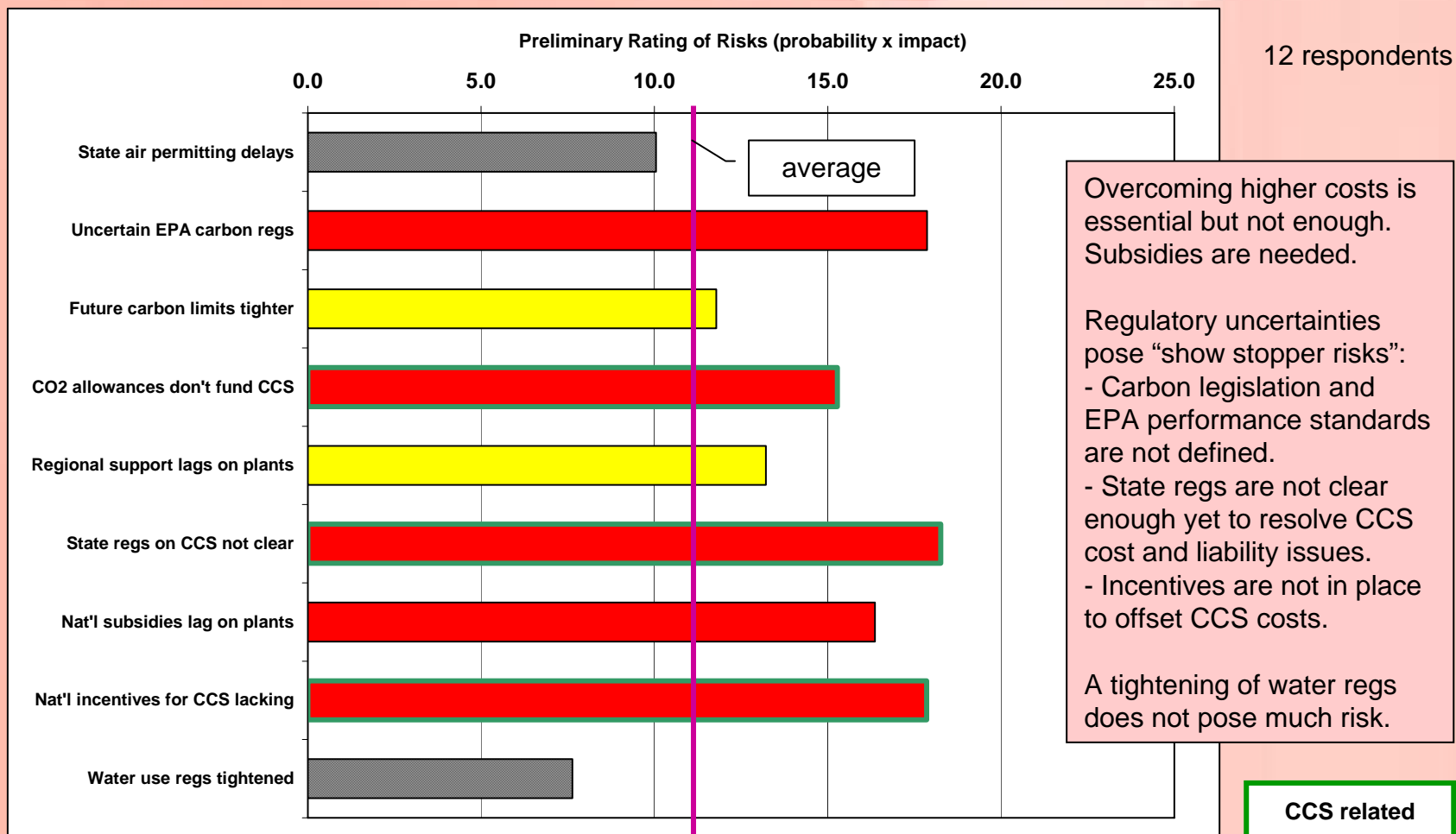
Risk Ratings: TECHNICAL

Deploying CCS creates a large drain on plant production, so capital costs run much higher.



Risk Ratings: REGULATORY

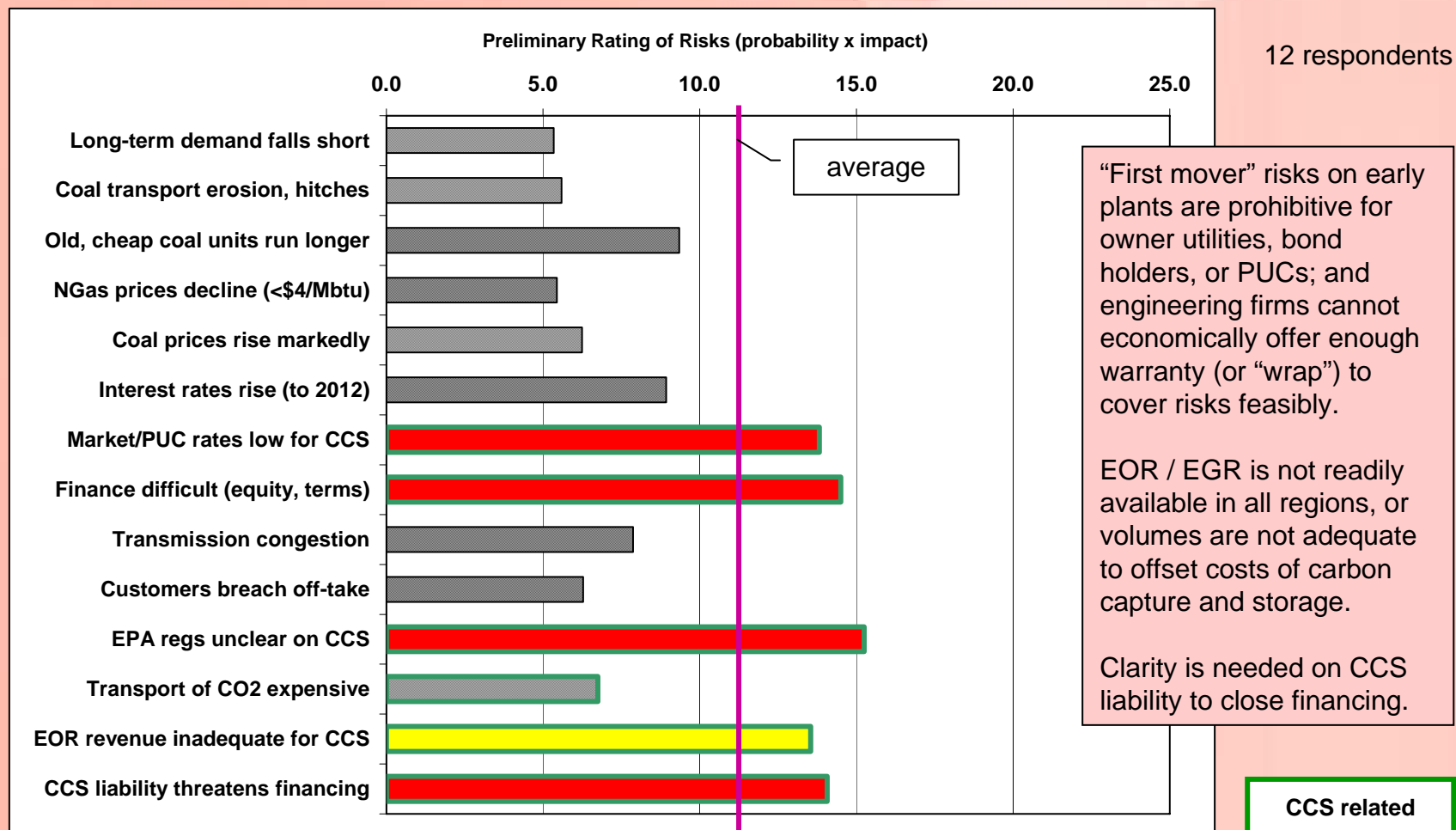
Regulatory uncertainties (federal + state) about CCS costs and liability threaten financing.





Risk Ratings: MARKET

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





For Deployment of Coal-based Projects with CCS

From interviews of key actors (owners, builders, financial entities, agencies, states) critical risks in three major areas are evaluated in a project finance credit analysis framework. Risks are rated (1 to 5) for both “likelihood” and “impact” if a risk event occurs. The product (25 point scale) provides a “severity” of risk for specific events affecting deployment with CCS.

		Preliminary (12 interviews)				
		Risk Ratings (2008) for Coal Gen with CCS		P	I	P x I = S
Q #	Q Type		Probability	Impact	Severity	
			5 pt. max	5 pt. max	25 pt. max	
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26	Mkt	Interest rates rise (to 2012)	2.5	3.6	8.9	
		Overall average	2.9	3.6	10.7	
		-- other risks (14) rated lower...				



Preliminary Risk Ratings on CCS

- 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 labor 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)



Preliminary Risk Ratings on CCS

- Regulatory uncertainties risk delay for CCS:
 - Internationally CCS legislation is not yet clearly defined about how to resolve CCS cost and liability issues.
 - Few incentives (tax credits, loans, allowances) are in place to offset CCS costs with the exception of the USA which just legislated a tax credit for every ton of CO₂ sequestered underground
- First mover risks are too high for owner utilities, bondholders and engineering firms to proceed with CCS projects
- EOR is not suitable for all regions and supply would outweigh demand in the long term for carbon capture and storage from power plants.



BOND BENEFITS AND PROBLEMS

Historically a high degree of safety with regular, scheduled and predictable payments, however In the bond and credit markets:

- subprime mortgages and mortgage backed bonds have collapsed,
- commercial paper (short-term IOUs) limited,
- Reluctance and very little interbank lending, and
- the entire global financial system came to the brink of what the IMF chief called "a systemic meltdown."
- Unlikely that the bond market can be used for CCS projects unless they are Government backed bonds

Conclusions

- Bond markets are one option, but the current state of world economic and financial markets make this unlikely unless a Government backed bond
- Other economic options also exist, such as carbon trading but the price would need to be high enough to incentivise CCS projects
- Currently CCS costs including transport and storage are around €35-70/tCO₂ costs could drop with technology development to €25/35/tCO₂
- The showstopper is without Government acceptance of long term liability and a regulatory environment that is viable CCS will not attract wide scale private investment



“All I’m saying is **NOW** is the time to develop the technology to deflect an asteroid”



THE END
THANK YOU FOR LISTENING

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