Carbon Sequestration Leadership Forum

CSLF-P-2009-24
11 September 2009

www.cslforum.org

POLICY GROUP

Framework of Risks and Rewards for Commercial Deployment of Projects with CCS

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FRAMEWORK OF RISKS AND REWARDS FOR COMMERCIAL DEPLOYMENT OF PROJECTS WITH CCS

Note by the Secretariat

Background

At the meeting of the Financing CCS Task on 28 June 2009 in San Francisco, there was agreement that the Task Force should prepare a "Framework of Risks and Rewards for Commercial Deployment of Projects with CCS", to be written by Andrew Paterson and Maria-Dubravka Pineda. The abstract and executive summary of the report is presented in this document. The full report will be available in the near future.

Action Requested

The Policy Group is asked to consider and approve the CSLF Financing CCS Task Force's preliminary report and scoping proposal on "Framework of Risks and Rewards for Commercial Deployment of Projects with CCS."

Framework of Risks and Rewards for Commercial Deployment of Projects with CCS

Andrew Paterson, Senior Advisor, CCS Alliance
Maria-Dubravka Pineda, Energy Security Forum, UCLA

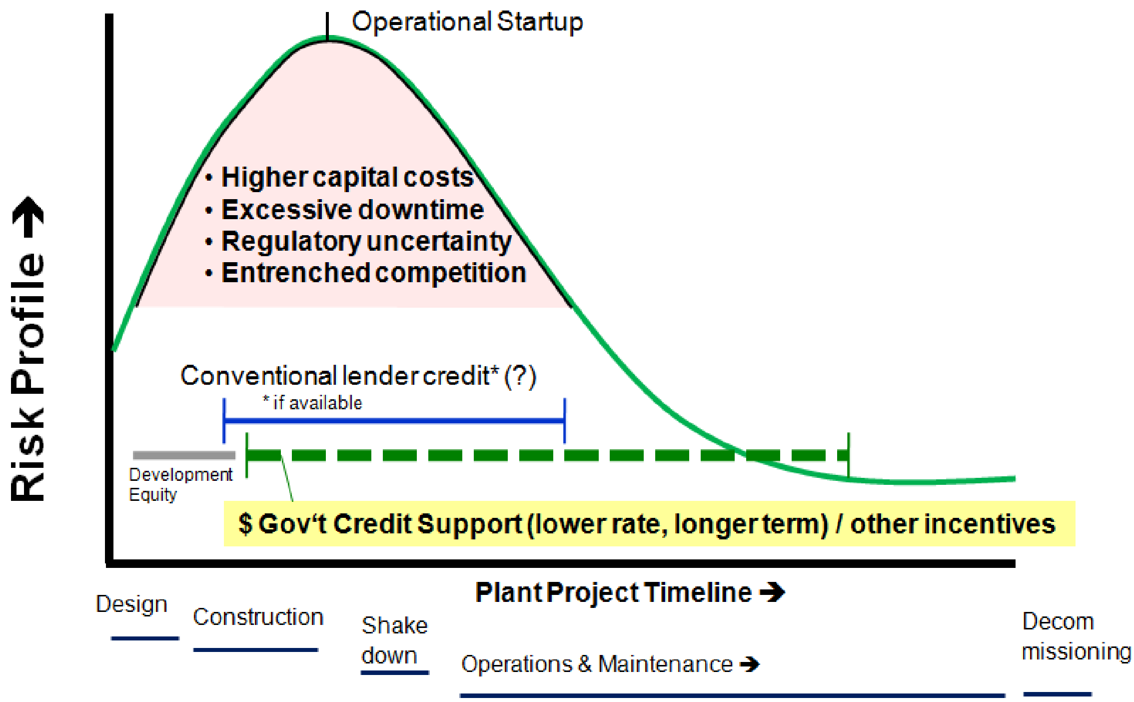
Abstract: Risk-based Energy Policy for Commercial Deployment of CCS

Traditional energy policy approaches focus on funding R&D to address market cost competitiveness or rely on federal mandates to force certain sustainable options. Too often these approaches are too costly for the public sector to sustain fiscally, and they also fail to address critical early risks, such as "first mover" technology risks, excess downtime and regulatory uncertainty, plus market factors, such as volatile prices and credit constraints, that create barriers to investment in innovative technologies. Carbon capture and storage (CCS) is not currently economic, especially in the face of low gas prices, and it is not "bankable" – it faces risks that lenders cannot resolve. Large-scale commercial projects with CCS cannot raise the debt required without fully dealing with the technical, regulatory, and market uncertainties involved. But, modernizing our energy infrastructure to affordably broaden access and reliability with environmental progress entails a huge investment. Curbing energy demand alone is not feasible, or even the primary path forward for civilization.

The "merchant energy collapse" in 2001-2002 among U.S. independent power producers dramatized clear market failings – even in a well-established market like North America – resulting in marked price volatility and painfully higher electricity bills for consumers, while several power providers filed for bankruptcy. More recently, severe fossil fuel price volatility in 2008, combined with an extended private market credit crisis has further aggravated the difficulty in financing large, "first-of-a-kind" energy projects, especially those with additional burdens such as regulatory uncertainties related to CCS.

A straight-forward project finance-based framework can enable policy-makers and government agency program managers to optimize incentives for a variety of clean and sustainable and energy sources, including the use of coal or petroleum coke with CCS. Rather than being "risk holders of last resort", public sector agencies at the federal or local level can become *informed negotiators* of risk and incentives, or "rewards", to best encourage investment and more innovative technology and industrial options. The importance of this effort is amplified by Asia building new units to *meet rising demand*, while the European Union (E.U.) and North America weigh a large wave of investment (greater than US$1 trillion per decade, according to the IEA) to replace an aging, inefficient fossil fleet *to reduce high carbon emission baseload*. Lenders and bondholders, with public sector financial assistance, will provide the bulk of this financing, rather than venture capital.

For first of a kind systems, the risk profile is elevated in the construction and shakeout phases so the incentives or rewards must be tailored to the risk profile to promote commercial investment and deployment of projects with CCS.



Proposed Scope of Work for CSLF leading up to G8 in 2010 (short version)
To provide updated input for policy-makers CSLF can uniquely convene and gather important perspectives to addressing the critical risks that could lead to broader deployment of CCS in several regions across several different physical and economic landscapes for CCS.

- 2009 2H: Plan & Scoping for Risk Map Study with explication of options for incentives (or "rewards")
- 2010 1H: Roundtables with key stakeholders and investors to exchange perspectives on risks and mitigation and rewards
- 2010 1H: Evaluation of Policy Options and Incentives for Risk Mitigation to promote investment in projects with CCS
- 2010 2H: Policy Recommendations, Outbriefs to G8 in July 2010 and subsequent forums

Framework of Risks and Rewards for Commercial Deployment of Projects with CCS

Executive Summary and Recommendations

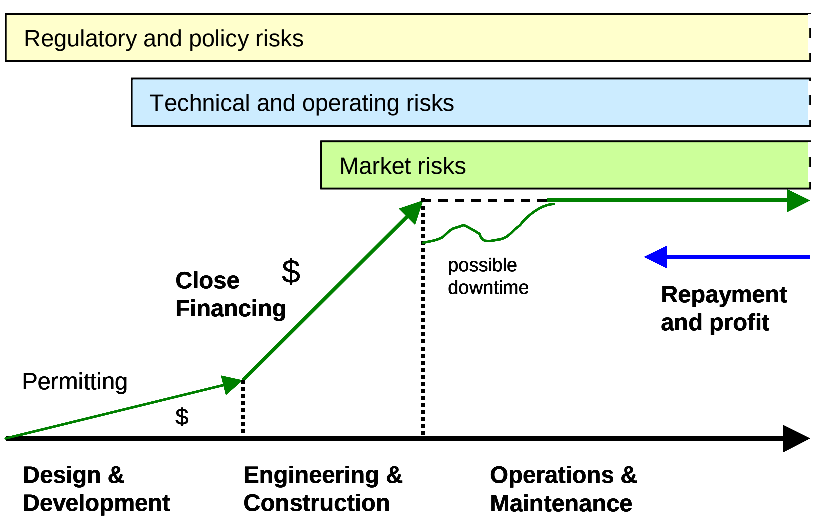
1. A risk map for commercial projects with CCS: technical, regulatory, market risks

The Risk Rating Framework

The project risk framework is not another form of "R&D roadmap" (or wish list) or rating of technical priorities; it is not an environmental risk assessment. Nor is it a delineation of barriers, per se, though it can deepen an understanding of barriers to wider commercial deployment of CCS with energy and power projects. Instead, it is based on a straight-forward assessment of business risks in several dimensions based on the investment decision to finance and build a plant – in essence, a "Business Case". Industrial and power infrastructure with CCS will be financed primarily with debt and government subsidies, not by venture equity capital, which forces a *credit risk investment* framework, similar to that used in government loan guarantee programs. Both public sector and private sector perspectives are essential in evaluating risks with debt financing as *both* public and private sectors are needed to *fully* manage the critical technical, regulatory, and market risks. Unless the critical risks are *comprehensively and systematically*, not partially, addressed investment in commercial projects with CCS will continue to be unattractive, particularly in the wake of the credit crisis and continuing constraints in project financing.

Regardless of the country, a project finance risk framework sees business risks vary based on specific project and site features, and shift over the project timeline of the design, construction, permitting, operation, and stewardship of CO_2 emissions and CCS related to an energy project. Risks over the commercial project timeline are separated into three basic categories: A) system technology and operations, B) regulatory and policy, and C) market risks for revenues and finance. All these risks must be addressed to complete project financing.

Diagram of Risks and Project Finance Timeline



SOURCE: "Risk-based Energy Policy: A Framework for Financing Clean Energy", presented at World Energy Congress in Rome, 2007 by Dr. Maria Dubravka Pineda, Andrew Paterson.

A) **Technical risks:** System technology risks are those associated with construction and performance of the energy conversion system whether for power, fuels or energy production, using coal, pet-coke, and possibly blended biomass feedstocks. The engineering of various subsystems – such as feedstock processing, gas handling, combustion or gasification, power or energy linkages and cleanup and waste handling – all bear on the performance of the system and nature of the risks faced by owner / operators, as well as the local community and operating workforce. Excessive downtime, gas excursions, feedstock constraints, and accidents are examples of technical risks, which either increase expenses or reduce revenues (via downtime), or both, thereby threatening the investment capital return (or "rewards") and life of the project.

B) **Regulatory or policy risks** are those usually external to the project which have to do with permitting of its operations, waste streams, and effluents, as well as the outlook for public sector subsidies or risk assumption for events beyond the scope of any private operator to handle, such as long-term liability for CO_2 leakage after injection is halted. The larger regulatory landscape requiring carbon capture is also paramount to justify the additional risks and capital costs.

C) **Market risks:** Plants with CCS would face a number of market-based risks associated with long-term demand, specific off-take volume and pricing, financing rates, feedstock supply, labor availability, and other commercial market activities associated with consumption and investment.

Based on prior work a number of structured interviews and risk ratings were conducted with primary, frontline actors involved in design, building, financing, operating and permitting plants with CCS.

Observations from interviews with frontline actors in 2008

- "First mover" risks are prohibitive for owner utilities, bondholders, or state utility commissions; and engineering firms cannot economically offer enough warranty (or "wrap") to cover risks.
- Enhanced oil and gas recovery is not readily available in all regions, or demand for CO_2 is not adequate to absorb costs and volumes needed for CCS from power plants.
- Regulatory uncertainties in North America pose "show stopper" risks for deployment of CCS. Carbon emission legislation and EPA regulatory rules on CCS are not defined, and uncertainties must be resolved over the term of debt, not just during the period of construction.
- In North America, lack of clarity on CCS liability, after a proposed stewardship period, threatens financing, and is, perhaps, a "showstopper", meaning it is one risk that can stop an entire category of projects. In the E.U. directive on CCS, it appears the respective state takes on this liability.
- State regulations are not clear enough yet to resolve CCS cost and liability issues either in the United States.
- Capital costs have run up since 2005, and costs are still up for projects worldwide, despite the credit crisis of 2008. Higher capital costs for equipment, construction, piping, cement, and engineering make projects burdened with CCS uncompetitive without subsidies, so investors cannot recover capital costs with a return geared to the risks faced on such first of kind projects.
- Developers expect that CCS equipment will work, and do not see CO_2 transport as a major issue because such logistics would be planned before investment; nor do they

see a CCS site failure as likely with effective site characterization, again, before investment in plant construction. Elevated capital cost for CCS, rather than variable costs (fuel, labor, etc.), is the key barrier,

- Subsidies are needed to overcome higher costs, but that is not enough because critical risks must also be addressed, not just elevated costs. (Subsidies could be funded, perhaps, via user levies on coal or fossil feedstocks, as proposed in Section 114 of the U.S. House of Representatives climate bill HR 2454, for example).
- Lower natural gas prices, below $5 per million Btu in North America, will pose significant competitive problems for coal-based, capital-intensive projects. Gas prices in the E.U. are pegged more to global oil prices, so the perceived risk varies.
- A tightening of U.S. regulations related to water resources does not currently appear to pose much of a risk, though uncertainty remains about applicability of RCRA and Superfund to CCS.
- Increases in coal prices or interest rates were not rated high risks, nor were labor issues because there is time to address these issues before they become major problems.

Addressing Critical Risks to Financing Plants with CCS

As noted above, the risks then that must be addressed for financing commercial deployment of CCS with public and private sector engagement include:

A) Technical Risks

- **Capital Cost:** Carbon capture – whether via pre-combustion gasification, or via post-combustion processes (with or without oxyfuel) will have a higher capital cost (greater than 20-40% higher) in comparison to traditional pulverized coal (PC) combustion units for early plants. Since the cost of debt financing usually is less costly than equity (i.e., carries a lower rate of return), a more leveraged debt-equity structure could help on this issue by reducing overall capital costs, and government credit support (e.g., loan guarantees) could make a difference.
- **System Reliability:** The chance that plants with CCS will experience excessive downtime or reliability problems due to technical complexities of the capture system still poses a challenge. Buyers generally believe that there will be an extended "shake-out" period – as much as 2-3 years – to optimize operations with CCS. It is expected that site characterization and CO_2 transport logistics would be certified well before much investment is made, muting the impact of that risk. The U.S. Department of Energy (DOE) has funded several early stage projects to advance the field, and both the E.U. and United States are looking to subsidize early commercial scale systems in the near future.

B) Regulatory and Policy Risks

- **Regulatory Uncertainties and State Permits for Plants:** Skepticism also remains high about whether state and federal policies will bring such an advantage to plants for "carbon capture" or emission avoidance soon enough to influence choices about investment. Not enough consensus has emerged in the U.S. Congress to resolve sharp regional differences over the value of capturing CO_2 emissions relative to the greater costs of power or industrial projects with CCS. The U.S. Environmental Protection Agency (EPA) has proposed rules for underground injection, but those rules will not be finalized until after 2011. DOE has funded numerous CCS demonstrations through its seven regional partnerships with U.S. states to help resolve some of the technical geological uncertainties. The E.U. is also funding demonstration projects.

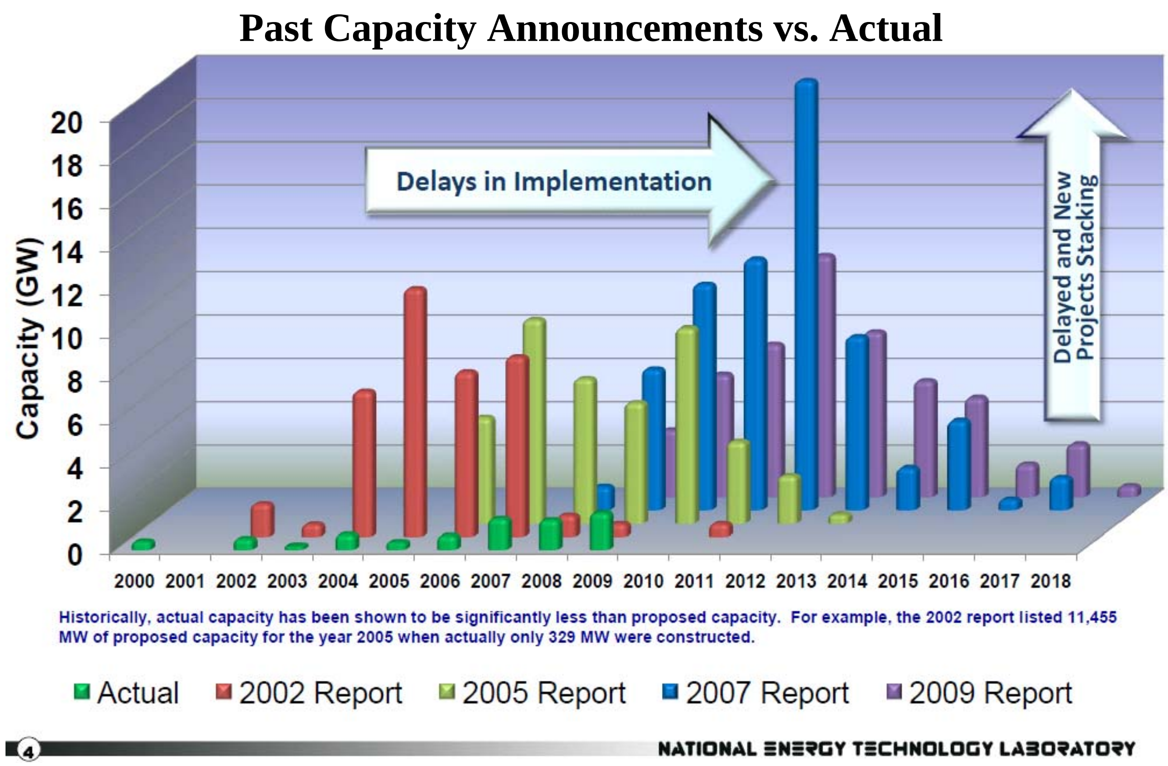
- **Climate Change Provisions**: While the U.S. House of Representatives passed the American Clean Energy and Security Act (ACES; HR 2454) by a narrow margin, passage in the U.S. Senate during 2009 faces challenges, largely rooted in regional differences and dependencies on fossil fuels. The U.S. Energy Policy Act of 2005 provided no mandates for curbing carbon emissions, though Title XVII offers loan guarantees for projects which reduce greenhouse gas (GHG) emissions and which employ "innovative technologies". A sharp difference exists between regions in North America: New England states have organized a carbon trading regime (RGGI); while, many public officials in Southeast states at this time value affordable electricity and manufacturing cost advantages ahead of addressing carbon capture since it involves substantial additional costs. Canada ratified the Kyoto Protocol, as did Mexico; but as a developing country, Mexico does not face a GHG reduction timeline. Even without concrete timelines and policies from the UNFCCC Copenhagen Summit in December 2009, progress can still be made by expanding incentives and risk-sharing within the major regions.
- **Tradeoffs:** Different actors in the CCS value chain view risks differently. Interviews with key actors on CCS issues since 2006 turned up an interesting "trichotomy": (1) utilities tended to see less risk in state permitting issues, perhaps because they understand the process in great depth and devote permanent resources to managing it; on the other hand, Independent Power producers (IPPs) – who lack the same regional presence that utilities command – appeared to rate state permitting issues higher as a risk area; (2) meanwhile, IPPs expressed stronger confidence in the engineering of gasification and CCS systems, rating the technical risks lower than utilities did; and, (3) technology vendors of gasification and CCS systems tended to rate financing risks much higher than utilities or energy companies did, most likely because utilities with a strong balance sheet have established access to capital and debt at lower rates. Technology system vendors and engineering firms, by contrast, are typically thinly capitalized with working capital stretched across numerous projects.

C) Market Risks

Industrial or power plants with CCS are weighed in the supply market against competing plants using typically natural gas feedstocks; therefore, natural gas prices directly impact market economics of such plants. Likewise, the availability of debt financing in capital markets is crucial for these capital intensive plants, and the credit crisis raises the costs of financing such plants. There is uniform agreement that coal prices are less volatile than oil and gas prices, despite last spring's price run up, and because much longer term contracts (e.g., 20 years) are available from mining companies that are not available with oil and gas, where prices are much more volatile.

Study Background: Project delays indicate unresolved critical risks, uncertain rewards

Each quarter, DOE's National Energy Technology Laboratory (NETL) in Pittsburgh tracks progress and delays on U.S. coal powered projects. With economic recession in 2001-2002 and market volatilities and cost rises, combined with regulatory uncertainties and the deep disruption in credit markets, dozens of announced projects have been delayed or cancelled in North America by utilities and independent developers. The extended economic recession since 2007 has also reduced prospects for long-term electricity demand growth with consumption actually declining in 2008 and 2009 by 2-3%.

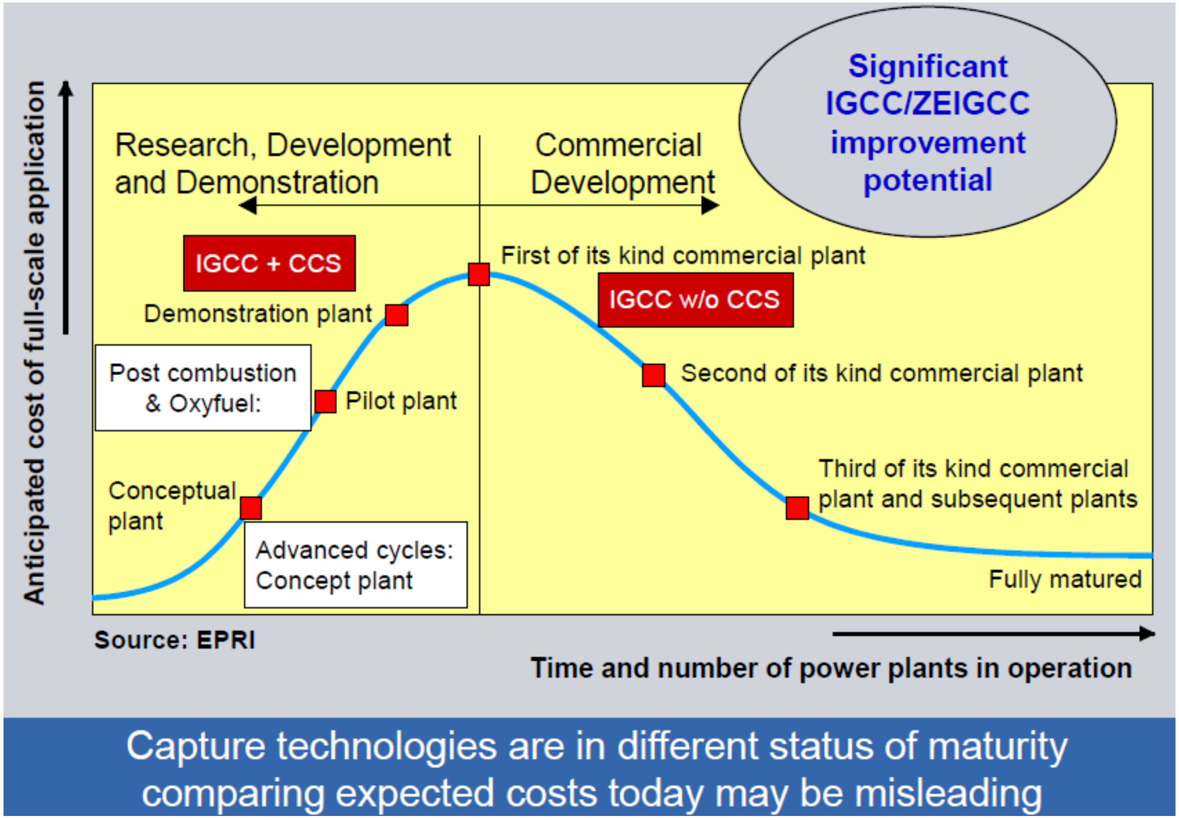


Nevertheless, a handful of coal-fired projects and gasification units are proceeding in North America with support of their state legislatures and commissions. Likewise, higher rates and the availability of deeper subsidies in the E.U., combined with realizations that renewable power is not providing the scope of reliable power first promised, is allowing some coal projects with CCS to move ahead. Even with a reduced outlook for electricity growth, an aging fossil fleet, including coal plants with more than 320 GW of capacity, needs to be replaced with units incorporating higher efficiency features and CCS. Some of these plants can employ gasification of coal and biomass for co-production of fuels and electricity with reduced life cycle carbon emissions, but rewards, i.e., higher returns on investment, for these benefits must be readily apparent at the time of investment, not down the road.

Additional technology development and deployment

With either gasification or with post-combustion, CCS poses serious challenges early and for first units. More technology development (funded by both the private and public sectors) is proceeding, albeit at a pace that varies by region. Widespread construction of gasification and combustion units in China is enabling vendors there to gain more experience with materials and engineered configurations.

There is fairly wide agreement that different technologies are at different maturities currently, which affects the level and kind of incentives or rewards, especially for “first movers”. First movers and their investors bear much more permitting, technology, and construction risk than followers, which justifies government subsidies:



Source: Siemens, EPRI (European Gasification Conference, March 2009)

Government funding and risk-sharing is clearly very important early on with technologies and first plants, and can be scaled down over time within a project after operational certainty and with more installations. This tailoring of incentives, or "rewards", with weighting early and to first movers allows government agencies to stretch limited budgets farther.

For more than two decades, DOE has funded research and development in clean coal power systems. And, four gasification power plants were built for power generation in the United States, all with significant co-funding from DOE. The Great Plains plant provides nearly three million tons a year now for enhanced oil recovery in the Canadian Weyburn field.

U.S. Clean Coal Demonstration Facilities Built

Year Start	Plant	U.S. State	Owner / Gasifier	Size (MWe)	Cost (US Mil)	Comment, Status
1984	Great Plains (DOE loan)	ND	Dakota Gasification (makes syngas)	900	$1,900 (all)	Refinanced; Still working
1996	Wabash (DOE funding)	IN	Cinergy / Global (E-Gas, Conoco)	262	$438 ($219)	High sulfur capture; Still operating
1997	Polk (DOE funding)	FL	Tampa Electric (Texaco)	250	$303 ($150)	High availability, (>90%)
1998	Piñon Pine (DOE funding)	NV	Sierra Pacific (KRW)	100	$336 ($168)	Faltered; tried to show fuel flexibility

Source: DOE / NETL

Each of the plants was built to demonstrate advances in technology first and reach commercial success, secondarily, as well as to provide owners valuable operating performance experience for future orders.

The Gasification Technologies Council tracks construction and operation of gasification units worldwide (data as of 2007):

Country	No. of gasifiers	MWth	Eq MWe for IGCC	MWe for electricity	Primary application
World Active Total	385	54,600	24,400	5,470	Chemicals, Elec.
World Planned Total	32	16,800	7,600	5,230	Electricity
Combined Total	417	71,400	32,000	10,700	
Active Projects					
South Africa	105	12,407	5,618	0	Fuel, Chemicals
U.S.	51	8,248	3,796	1,156	Chemicals, Power
Germany	46	6,974	3,087	282	Chemicals, Fuels
China	53	5,882	2,594	0	Ammonia, fuels
Italy	12	3,652	1,622	1,485	Electricity
India	27	3,225	1,430	60	Ammonia
Spain	5	2,785	1,240	1,224	Electricity
France	8	1,597	712	568	Electricity
Czech Republic	32	1,396	620	350	Power, Methanol
Japan	14	1,389	600	343	Power, Chemicals
Brazil	3	550	246	0	Ammonia
Australia	3	130	62	2	Syngas
Total Active	359	48,235	21,627	5,470	

Source: www.gasification.org

The experience with gasification in the petrochemical industry is thought by some in the power sector to bring value to the commercialization of coal gasification which would allow for better carbon management of coal resources with less environmental degradation, and avoid import of more natural gas. With large current account deficits (above 5% of GDP for U.S. in 2007), reducing energy imports is a rising national priority in several countries. Reduced demand for natural gas would, in turn, help reduce price volatility for chemical makers and other industrial users of natural gas domestically.

Implications for Policy

As commercial deployment of plants and systems with CCS stands on the brink of early full-scale commercial use in North America, in the E.U. – and perhaps in China – moving from demonstration to commercial deployment will require addressing critical policy priorities and issues. The U.S. Energy Policy Act of 2005 (EPAct) offers tools to address them through public – private mechanisms. Moreover, the 2009 American Reinvestment and Recovery Act (ARRA, or the "Stimulus bill"), amplified the tools or "rewards" government could bring to financing plants with CCS at commercial scale. In particular, these tools can be used to overcome several specific market shortcomings, failures or "imperfections":

- **Free Riders and a "First Mover Penalty":** As evidenced by evaluation of risks, early buyers expect to pay higher capital costs for the first units, and face excessive downtime during an extended shakedown period. Subsequent plant owners will benefit from the manufacturing, construction, and shakedown learning curve effects, and then pay a lower price for systems that are more reliable with the benefit of that early experience. This reality results in a classic "economic free rider" problem, or "first mover penalty": Government financial incentives could help overcome these issues: first movers pay a penalty, while subsequent buyers are "free riders", who pay lower costs and suffer fewer delays on cash flow and return on investment (or "rewards").

- **Public Externalities of Innovation and Progress on GHGs:** No single owner or utility can capture the promise of broader social benefits of innovation, reduced emissions, and potential carbon capture. Utilities or industrial project owners will be local or regional entities, but the benefits from the first units will be national. Broader community benefits of reduced emissions warrant government involvement, as is seen with other energy sources, such as nuclear or renewable energy (e.g., via tax subsidies).
- **National Strategic Value with "Industrial Flexibility":** Co-production capabilities in the case of plants using gasification could offer flexible manufacture of fuels (e.g., shifting to production of clean diesel) during an oil import disruption or national emergency as seen with severe hurricanes. In 2009 the U.S. National Research Council (NRC) released a study in this regard: "Liquid Transportation Fuels from Coal and Biomass". According to the NRC, "If CO_2 produced in the conversion process is geologically stored, the greenhouse gas emissions of this combined fuel over its life cycle could be close to zero." This industrial production flexibility also creates a direct strategic national benefit in the form of a more resilient energy base, which no single company is structured to capture or bear the risks for. Government incentives are the best way to encourage and "monetize" this strategic value, say through stand by payments or subsidized capital costs. Because of huge domestic reserves of coal, gasification plants directly reduce imports of energy, and help mute volatility in natural gas markets by providing alternative supply to industrial gas users (e.g., chemical plants, steelworks, glass makers, fertilizer factories). This in turn, could reduce costs for fertilizer in the agriculture sector, as one example, while increased use of biomass in co-production would boost revenues.
- **Regulatory Bias on Electricity Rates:** In most regions and in many countries, public service commissions allow electricity generators to pass through marginal fuel cost price spikes to ratepayers, whereas, cost recovery of plant capital may be restricted or borne primarily by utility shareholders. Therefore, full cost recovery with investment return for large, capital-intensive plants face de facto biases in the regulatory structure, even if they may be unintentional. The resulting regulatory structure favors a short-term orientation of power companies combined with a bias against longer-term, high capital cost options for electricity generation with CCS, or nuclear units for that matter. This bias so distorts the market that at times, consumption actually rises with price, e.g., when all consumers need gas at the same time during severe hot or cold weather episodes (as observed in 2001 and 2002). Government support for capital investment is merited given these market distortions.

Federal financial support, such as that provided via the E.U. Emission Trading Scheme, and in EPAct 2005 and in ARRA 2009, can help overcome externalities and biases where public benefits and national strategic value merit the use of public resources. A project finance framework indicates with considerable clarity the business issues to which such public resources might best be directed. Moreover, several of the remedies involve tapping the superior cost of borrowing capital, which the federal government garners via treasury financing or via tax incentives for targeted technologies.

Conclusions about the Landscape for Risk Study

- While there are "CCS demonstration projects" there are no commercial "CCS projects"; there are only energy or power or industrial projects with CCS, typically for enhanced oil recovery (EOR).
- CCS is not economic in most countries because capturing the CO_2 gas stream creates inefficiencies, so subsidies will be needed for first plants to cover "early mover" risks.
- Due to their inherent large size (i.e., greater than US$1 billion), industrial and power projects with CCS will be financed with debt, rather than with venture capital.
- Utility bond holders require *certainty* on CCS liability with no indefinite, long-term exposure after injection and short-term stewardship to verify CCS stability. Private owners and insurance could manage *finite* first losses; states may want to share in risk assumption to encourage plants and encourage local coal use with economic development.
- Dependence on coal-based electricity for high reliability, baseload power remains substantial in some U.S. regions, and in several OECD countries, as well as in China, India, and Russia. Hence, CCS is vital for progress on carbon emissions.
- The current pace of electricity demand and interest in constraints on carbon emissions require that advanced coal plants be built to replace an aging coal fleet, now with over 300 GW of capacity in the United States. None of the 1,100 coal-fueled plants in the United States are fitted for CCS.
- Some mechanisms for rewarding pioneers or "first movers" are in place, depending on the country, but legislation in several countries is needed to resolve uncertainties to enable financing. Without financing, and additional rewards for facing elevated early risks, no commercial-scale projects with CCS will be deployed.
- The volatility of natural gas prices (which are pegged to oil prices in some areas like the E.U.) where gas prices dip below US$5 chills investment in large capital assets, such as power projects or gasification facilities with CCS.
- Grants and tax credits are easy rewards for industry to ask for, but can be difficult for legislatures to fully fund. Levies on fossil fuels could be used, targeted at projects with CCS (e.g., Section 114 of the U.S. Waxman – Markey bill).
- Policies which reduce uncertainties, such as loan guarantees, or dispatch preference, can help stretch limited government funds across more projects in more regions.

2. Policy options and recommendations to promote project finance with CCS

Policy options and mechanisms already exist, but do not offer enough subsidy or risk coverage to enable broad deployment of industrial and power projects with CCS because plants are not being built. Mechanisms or "rewards" can generally be sorted into two categories: those that address elevated costs with CCS, and those that address critical risks:

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

- **Federal Grants:** Traditional federal funding provided by appropriations and procurement (limited availability).
- **Investment tax credits / Accelerated depreciation:** Capital subsidies partially available under Section 48A&B. More helpful with early funding while risk is highest vs. later as with production tax credits.
- **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 public utility commissions (PUCs) require pass-through to rate payers. Too often these tax credits fail to offset early construction risks.
- **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, e.g., availability of EOR or low-cost feedstocks.

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

- **Loans or Guarantees:** Loan guarantees for first-of-a-kind plants improve capital structure by reducing equity and interest rates. Federal loans are much less costly to federal budget than tax benefits because they are repaid.
- **Federal Off-take Contract:** A federal off-take agreement (e.g., for fuels or power) can boost credit standing, provide revenue boost, even if just as a standby payment for CCS.
- **State Rate Regulation:** Conventional power rate regulation is preferred by lenders because it insulates the plant from market volatility on revenues, enhancing debt financing.
- **Dispatch Preference:** States 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., CO_2 injection).
- **Offsets and Liability Transfer:** To address "long-term, indefinite" liability for CO_2 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 because that cost cannot be quantified.

Risk-based mechanisms in a project finance oriented approach offer the advantage of reducing federal budget impact, covering more projects.

CSLF Study Proposal:
Evaluation of Commercial Risks for Deployment of CCS

The project risk framework is not another form of "R&D roadmap" (or wish list) or rating of technical priorities; it is not an environmental risk assessment. Nor is it a delineation of barriers, per se, though it can deepen an understanding of barriers to wider commercial deployment of CCS with energy and power projects. Instead, it is based on a straight-forward assessment of business risks in several dimensions based on the investment decision to finance and build a plant. Energy infrastructure with CCS will be financed primarily with debt and government subsidies, not by venture equity capital. Hence, this forces a credit risk investment framework. Both public sector and private sector perspectives are essential in evaluating risks with debt financing as *both* public and private sectors are needed to *fully* manage the critical technical, regulatory, and market risks. Unless the critical risks are fully addressed investment in commercial projects with CCS will continue to be unattractive, particularly in the wake of the credit crisis and continuing constraints in project financing.

A project finance framework sees business risks vary based on specific project and site features, and shift over the project timeline of the design, construction, permitting, operation, and stewardship of CO_2 emissions and CCS related to an energy project. Risks over the commercial project timeline are separated into three basic categories: A) system technology and operations, B) regulatory and policy, and C) market risks for revenues and finance.

Without financing CCS cannot be deployed on commercial scale energy projects, as CCS is not economic itself; it can only be utilized with a power or fossil energy project that is economic.

Objectives of the CSLF Commercial Deployment Risk and Incentives Study

1. Build on prior work at CSLF, the Electric Power Research Institute (EPRI), the IEA Greenhouse Gas R&D Programme (IEA GHG), the IEA Clean Coal Centre, and agencies of the member countries of CSLF.
2. Update the analysis of critical barriers, focused on critical commercial risks, policies and *inadequate* incentives or rewards, which are failing to foster investment in energy and power projects with CCS.
3. Utilize CSLF Incentives Registry to identify and further refine policies which mitigate critical risks for projects with CCS.
4. Engage the financial community and a range of investors (private equity, lenders, insurance groups, etc.) to refine policies for addressing critical risks with CCS that hinder financing.
5. Deepen the CSLF Project Database and develop project case studies or more detailed evaluations of projects which aid in formulating and applying policies accelerate the deployment of CCS. The database can also be a source of "at stake" key actors (owners, engineering firms, permitting agencies) to interview on risks and barriers and mitigation approaches.
6. Track progress on projects with CCS as they seek financing and move ahead, and evaluate critical success factors or unresolved risks and barriers.

Proposed Scope of Work for CSLF leading up to G8 in 2010 (short version)

To provide updated input for policy-makers CSLF can uniquely convene and gather important perspectives to addressing the critical risks that could lead to broader deployment of CCS in several regions across several different physical and economic landscapes for CCS.

- 2009 2H: Plan & Scoping for Risk Map Study.
- 2010 1H: Roundtables with key stakeholders and investors to exchange perspectives on risks and mitigation and rewards.
- 2010 1H: Evaluation of Policy Options and Incentives for Risk Mitigation to promote investment in projects with CCS.
- 2010 2H: Policy Recommendations, Outbriefs to G8 in July 2010 and subsequent forums.

STUDY OUTLINE

A. Executive Summary and Recommendations
   1. Risk "map for commercial projects with CCS: technical, regulatory, market risks
   2. Policy options, "rewards" and recommendations for financing projects with CCS.

B. Brief Overview of Current Commercial Deployment Landscape: Technology and Markets
   1. Electricity in EIA forecasts for coal-based electricity and overall market demand to 2030
   2. State of Capture Technology and CCS (DOE sources, PNNL, NETL, EU)
   3. Technical risks associated with CCS (WRI Guidelines, NETL sources, Stanford)
   4. Current Status of Projects with CCS worldwide (electricity, fuels, chemicals)
   5. Update on debt financing markets for energy projects after the credit crisis
   6. CSLF documents and the CCS Projects Database (with EPRI)
   7. Progress in the EU, North America, elsewhere on CCS demonstrations (DOE partnerships)

C. Regulatory Issues affect risks for Projects with CCS
   1. Policy summary in major coal using economies: USA, EU, China, India, Japan, Russia
      [Top 5 coal consuming countries use 70%+ of world coal production]
   2. EU CCS directive and regulatory regime
   3. U.S. regulatory uncertainty rooted in multiple conflicting statutes
      a. U.S. EPA Rulemaking on CO2 injection under the Safe Drinking Water Act
      b. Exposure to RCRA and CERCLA for underground storage as regulatory risks
      c. Unclarified regulation of carbon emissions under Clean Air Act (Mass. v. EPA)
   4. Uncertainty about timeline and terms for carbon emission legislation in U.S. Congress
   5. Uncertainty about a post-2012 international carbon emission regime affects value of CCS

D. A Risk Framework to optimize policy options for commercial deployment of CCS
   1. Project finance framework to address technical, regulatory, and market risks
   2. Overview of the CSLF Incentives Registry
   3. Assessing "likelihood" versus "impact" of risks for energy projects for stakeholders
      Nature of likelihood and severity of impact determines mitigation approaches
   4. Evaluation of severity of risks and identification of "showstopper risks" or barriers
   5. Risk management approaches from mapping the risks: policies in place; policies needed

E. Risk Mitigation: Conclusions and Recommendations (policy options)

F. References (other exhibits, prior studies and related work)

SAMPLE REFERENCES

European Commission proposal for a Directive on the geological storage of carbon dioxide
http://ec.europa.eu/environment/climat/ccs/eccp1_en.htm

The Future of Coal: securing electricity supply and clean coal technology
http://www.cbi.org.uk/pdf/20081222-CBI-The-future-of-coal.pdf

BERR: Towards Carbon Capture and Storage: Government Response to Consultation
http://www.berr.gov.uk/files/file51115.pdf (April 2009)

9th European Gasification Conference, March 2009
An overview of EPRI's activities in IGCC and CCS: Jack Parkes, EPRI
http://www.icheme.org/gasification2009/presentations.htm

EPRI Prism / MERGE Analysis Update 2009
http://mydocs.epri.com/docs/public/000000000001019563.pdf

DOE Regional Sequestration Partnerships
http://fossil.energy.gov/sequestration/partnerships/index.html

NETL Studies

EU Studies

IEA briefings

CCS Alliance (www.ccsalliance.net)

“Risk-based Energy Policy: A Framework for Financing Clean Energy”, presented at World Energy Congress in Rome, 2007 by Dr. Maria Dubravka Pineda, Andrew Paterson.
http://www.hunton.com/Resources/Sites/general.aspx?id=622

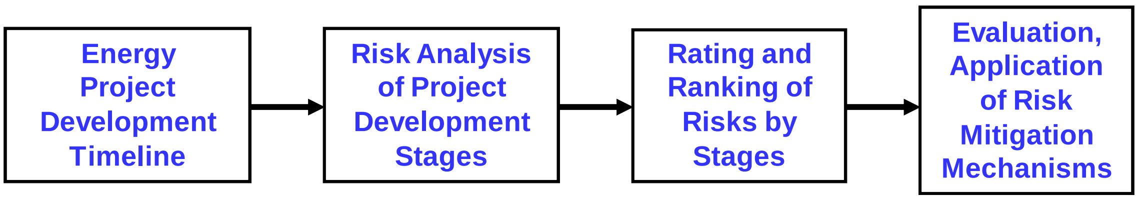
DOE Report: “The Business Case for Coal Gasification with Co-Production: An Analysis of the Business Risks, Potential Incentives, and Financial Prospects, with and without Carbon Sequestration” (December 2007)
http://www.climatevision.gov/pdfs/Co-Production_Report.pdf

“Liquid Transportation Fuels from Coal and Biomass: Technological Status, Costs, and Environmental Impacts”, National Research Council (May 2009)
http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12620

EXAMPLE STUDY OUTCOME

The CCS Alliance conducted a risk study during the spring months of 2008 with the help of the IEA GHG R&D Program and the World Coal Institute.

<u>Project Approach</u>



The risk probabilities and severity of impact were each rated on a five-point scale using a timeframe from now until 2012 or 2015, depending on the policy-making horizon, as follows:

1 = Very low probability or impact
2 = Low probability and minor impact
3 = Moderate impact or probability
4 = Significant probability or substantial impact
5 = High likelihood or within view already, and project-threatening level of impact

Risk ratings were completed by 30 industry executives, government officials, and a few NGOs, who were asked to rate 34 business risks in three broad categories: technical, regulatory, and market risks. This parallels similar ratings conducted in 2004 and 2005 in studies performed for DOE with the cooperation of EPRI.

Highest rated risks of 34 questions (30 U.S. respondents) from Spring 2008:

		Risk Ratings (2008) for	P	I	P x I = S
Q #	Risk Type	**Commercial Projects with CCS**	**Probability**	**Impact**	**Severity**
			5 pt. max	**5 pt. max**	**25 pt. max**
7	Tech - CCS	Capital costs with CCS run too high	4.0	4.2	**16.8**
18	Reg / Policy	Federal subsidies lag on first plants	3.9	4.2	**16.4**
13	Reg - CCS	Uncertain carbon regulations, EPA rules	4.1	3.9	**15.9**
19	Reg - CCS	Federal incentives for CCS lacking	3.9	4.0	**15.5**
17	Reg - CCS	State regulations on CCS not clear	3.8	4.0	**15.2**
15	Reg – CCS	CO2 allowances don't cover CCS costs	3.6	3.8	**13.7**
28	Market	Finance difficult (equity required, terms)	3.4	3.9	**13.4**
31	Market-CCS	EPA regulations on CCS hinder financing	3.3	4.0	**13.3**
16	Reg / Policy	Regional support lags for new plants	3.6	3.6	**13.0**
34	Market-CCS	CCS liability threatens financing	3.2	4.0	**12.9**
27	Market-CCS	Market or/PUC rates too low for CCS	3.3	3.9	**12.7**
33	Market-CCS	EOR revenue inadequate for CCS	3.9	3.2	**12.6**
4	Technical	High cost of materials hurts viability	3.3	3.7	**12.3**
1	Technical	Capital cost (no CCS) too high	3.0	3.8	11.1
14	Reg - CCS	Future carbon regulations are tightened	2.8	3.9	11.0
		Overall Average	**2.8**	**3.5**	**10.1**

Commercial deployment of power or energy projects with CCS must fully address a range of technical, regulatory, and market risks to complete financing. By systematically mapping the critical risks against the mechanisms available, additional regulatory or policy options can be developed and financings can be completed. These risks are typically mapped against the mechanisms for mitigation outline above.

Matrix of Critical Barriers or Risks with CCS vs. Incentive Mechanisms
(existing and needed)

It should be noted that risks vary somewhat by major regions. For example, the E.U. has issued a CCS directive which more clearly allocates stewardship and coverage of CCS liability than is currently promulgated in the U.S. Similarly, the E.U. lacks a RCRA and Superfund regulatory regime which poses more of a challenge in the U.S. Electric prices in North America are also generally half that seen in the E.U. or Asia, particularly in regions more dependent on old coal units. Still, capital costs for equipment are elevated worldwide because engineering firms and key component suppliers operate globally.

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.)					
	A) Subsidies					
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
	B) Risk Assumption / Transfer					
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)					
	A) Subsidies					
State	Additional collateral or Revolving funds	X				XX
Federal	Carbon allowances (traded with cap)	XX	XXX	XX		XXX
	B) Risk Assumption / Transfer					
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				

Also, the E.U. Emission Trading Scheme makes available a source of continent-wide funding for subsidies that is lacking in North America.

Through this risk-based process, government policy-makers and agencies can negotiate and provide more precise financial support and rewards for commercial deployment of CCS. This allows federal and state governments to stretch scarce fiscal budgets across more projects and more effectively.

Targeted Questionnaire Participants

The Delphi Method pioneered by Rand Corporation uses a structured questionnaire process for collecting and distilling knowledge from a group of experts. Questionnaire responses are supplemented with controlled opinion feedback (Adler and Ziglio, 1996). A Delphi structured interview method targeted at leading actors offers a useful communications approach among experts for facilitating the formation of a group judgment and discerning effective policy options. This approach is particularly valuable in dealing with a new, technologically based phenomenon for which prior history is limited and data points are few or so old as to be of limited utility.

Questionnaire issues were developed based on discussions with leading actors in the value chain of energy project development. Respondents rate risks once for probability and once for severity of impact in the event of occurrence for a given time horizon, e.g. through 2012 or 2015.

Category of participant	***Firms / Organizations***
1.Vendors & Tech firms	GE, ConocoPhillips, Praxair, Air Liquide
2.Engineering contractors (EPCs)	Bechtel, Fluor, Parsons, B&M, Alstom
3.Utilities (regulated, merchants, hybrids)	AEP, Cinergy, Duke, TVA , EPRI, RWE
4.Independent power co's (IPPs)	Excelsior, Baard, Tondu, TriGen , TECO
5.Public Power & Co-ops	APPA coal group, NRECA, E.ON
6.Government agencies	DOE, EPA, NETL, EU entities
7.Public Utility Commissions	NARUC + OH, IL, IN, PA; EU boards
8.State / Local Agencies (Comm; Devel)	NASEO + Coal boards, RDAs
9.Fuel / Coal / Chemical companies	CONSOL, Eastman, Peabody, Rio Tinto
10.Financial (Banks, Funds, Insurance)	CSFB, JP Morgan, SwissRe, Deutsche Bank
11.Rating agencies	S&P, Fitch, Moody's
12.Transmission entities (TransCos)	PJM, MISO, EU grid agencies
13."Pragmatic" NGOs (vs. "ideologues")	NRDC, CATF, WRI, Env. Defense

EXAMPLE RISK QUESTIONNAIRE STUDY INSTRUMENT

Please rate each of the following risk areas from 1 to 5 in BOTH Column A *and* in Column B:

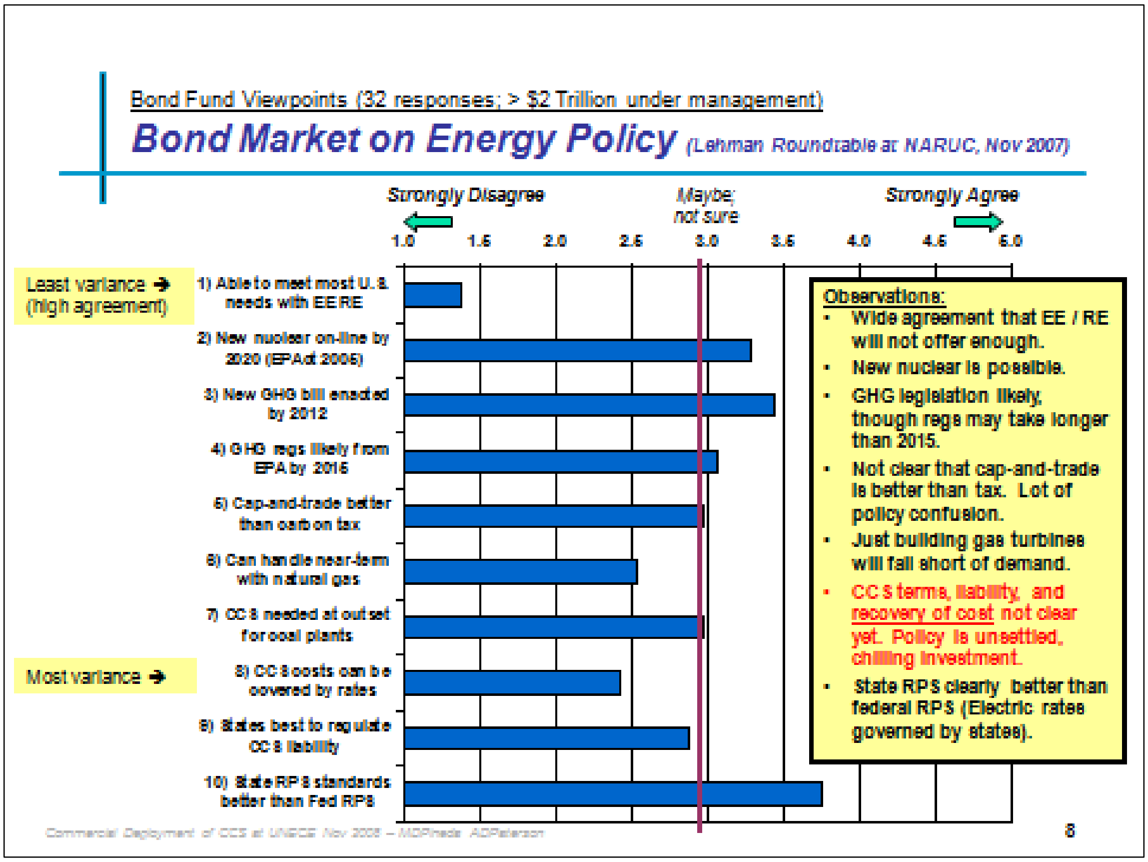
<u>Column A</u>* = *Probability: *Likelihood that the risk will occur or be realized (1 to 5)*
High probability/High impact (5)= Very likely or poses very serious impact on a commercial project.
<u>Column B</u>* = *Impact: *Impact of consequences if risk event occurs (1 to 5)*
Low probability/Low impact (1) = Low probability (or is being addressed); or low impact if it occurs.

For example, a particular risk could be viewed as a very low probability event (1), but pose a severe impact if it occurred (5); or have both a high likelihood (5) and a very high consequence or impact (5).

<u>RATING</u>		**<u>RISK CATEGORY</u> <u>"The likelihood and impact of…" (*YOUR* outlook thru 2012)</u>**
A	**B**	**TECHNOLOGY & OPERATIONS** (*system performance and cost*) – "Rate the risk that…"
__	__	1*. Power / product cost will be too high in market due to high capital costs (<u>even without CCS</u>).
__	__	2*. Power / product cost runs too high in market or to PUC due to high variable or operating costs.
__	__	3*. <u>Excessive</u> plant downtime will occur due to subsystem failures or technical problems (not CCS).
__	__	4*. Cost of basic materials (e.g., steel, cement, piping) runs higher, making new plant uneconomic.
__	__	5*. Contractor / vendor capacity is seriously constrained elevating plant construction risk, delays.
__	__	6*. Acute accidents occur, generating regulatory penalties or severely damaging a new plant.
		** Note: To more clearly evaluate technical risks, #1-6 are questions framed <u>without regard to CCS</u>.*
__	__	7. Higher capital costs for CCS equipment (with >50% capture) impair financing of a new plant.
__	__	8. Carbon capture equipment fails during operations, leading to excessive downtime and repairs.
__	__	9. The site for CCS suffers a significant technical failure and more than minor leakage occurs.
__	__	10. EPC/vendor performance "wrap" (warranty) is not adequate for new plant feasibility with CCS.
__	__	11. Transportation of CO_2 for CCS proves difficult logistically (e.g., transit path too long)
A	**B**	**REGULATORY & POLICY** (*governmental policy and liability*) – "Rate the risk that…"
__	__	12. State air permitting process substantially delays construction of coal plants even with CCS.
__	__	13. Uncertainty on <u>carbon emission</u> legislation (and EPA rules) hampers permitting on new plant.
__	__	14. Carbon emission regulations become even tighter *after* construction, leading to extra costs.
__	__	15. Value of (eventual) carbon emission allowances does not adequately cover costs of CCS.
__	__	16. Regional, state policies fail to provide sufficient incentives to subsidize higher costs of CCS.
__	__	17. Regional policies fail to provide sufficient clarity about CCS injection & long-term liability.
__	__	18. National incentives (ARRA: loans, tax offsets, grants) are not sufficient for first-of-a-kind plants.
__	__	19. National policies (e.g., CCS tax credits) do not provide enough incentive for higher CCS costs.
__	__	20. Water or aquifer regulations are tightened, *after siting*, hindering operations and future CCS.
A	**B**	**MARKET & FINANCE** (*dynamics of finance, demand and supply*) – "Rate the risk that…"
__	__	21. Long-term demand for power, and/or plant output fails to grow as forecast, reducing revenue.
__	__	22. Coal transport / rail constraints will be aggravated, raising delivered costs of coal over time.
__	__	23. Current conventional coal plants are allowed to run longer, curbing the need for new plants.
__	__	24. Natural gas prices stay lower to 2012 (<$6/MBtu), making coal plants with CCS uncompetitive.
__	__	25. Coal prices rise significantly (as in 2008), threatening competitiveness of plants vs. natural gas.
__	__	26. Interest rates rise sufficiently (2010-2012) to jeopardize financing or economics for new plant(s).
__	__	27. Market rates or state PUC approved rates do not offer sufficient recovery of higher capital costs.
__	__	28. Financing of new plants remains difficult (e.g., debt tenors too short; credit stays constrained).
__	__	29. Transmission congestion curbs plant revenues over time as grid upgrades lag load growth.
__	__	30. *Customers* of new plant suffer future financial strains and off-take commitments are breached.
__	__	31. EPA regulations on underground injection of CO_2 and liability fail to offer clarity for financing.
__	__	32. Transport costs of CO_2 become more costly *after* new plant is running, threatening economics.
__	__	33. Revenues from sale of CO_2 (e.g., for EOR) or tax credits do not cover costs of CCS enough.
__	__	34. Prospect of liability for long-term leakage of CO_2 from CCS threatens new plant financing.

EXAMPLE OF ROUNDTABLE OUTPUT

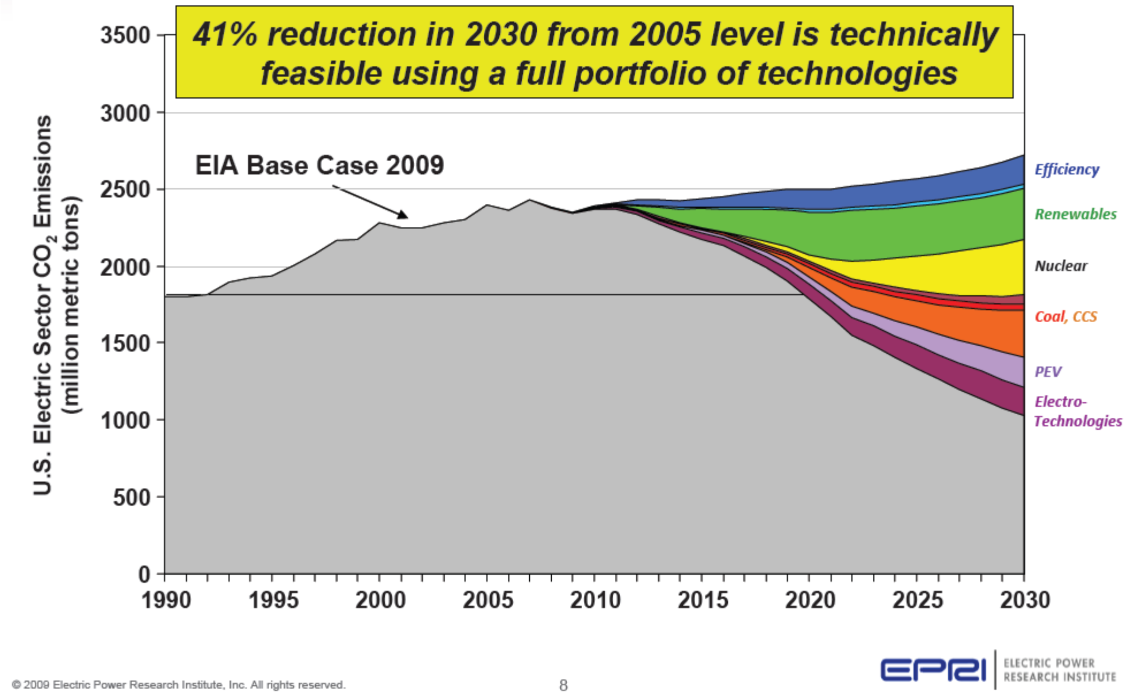
Since debt financing will provide the overwhelming majority of financing for large scale electricity infrastructure, a unique roundtable was held in November of 2007. In all, 32 bond fund managers were polled in a breakout roundtable with EPRI and Lehman Brothers (now Barclay's) linked to the annual NARUC (utility commissioners) meeting. There was wide agreement that energy efficiency and renewable energy alone would not provide adequate supply to meet future demand in North America. Moreover, policy incentives, liability coverage and uncertainties about carbon emission regulations were chilling investment.



This kind of interaction needs to be updated and can further guide the distribution of incentives, risk mitigation and rewards in energy policy related to CCS, particularly as it pertains to financing large capital investments.

EPRI "Full Portfolio" Electricity for carbon-constrained landscape (Summer 2009)

For the United States, the Electric Power Research Institute projects a positive role for CCS through 2030.



A "full portfolio" of energy technologies is needed to meet affordability and environmental goals. EPRI recently updated its aggressive technical scenario to include transmission and distribution efficiency and wider use of electricity in transportation and the economy:

	Technology	EIA AEO Base Case	EPRI Prism Target
	Efficiency	Load Growth ~ +0.95%/yr	8% Additional Consumption Reduction by 2030
	T&D Efficiency	None	20% Reduction in T&D Losses by 2030
	Renewables	60 GWe by 2030	135 GWe by 2030 (15% of generation)
	Nuclear	12.5 GWe New Build by 2030	No Retirements; 10 GWe New Build by 2020; 64 GWe New Build by 2030
	Fossil Efficiency	40% New Coal, 54% New NGCCs by 2030	+3% Efficiency for 75 GWe Existing Fleet 49% New Coal; 70% New NGCCs by 2030
	CCS	None	90% Capture for All New Coal + NGCC After 2020 Retrofits for 60 GWe Existing Fleet
	Electric Transportation	None	PHEVs by 2010; 40% New Vehicle Share by 2025 3x Current Non-Road Use by 2030
	Electro-technologies	None	Replace ~4.5% Direct Fossil Use by 2030