Understanding risks associated with deployment of carbon capture and storage

Risk Analysis – Policy Issues

James Ekmann, Leonardo Technologies, Inc.

LTI

Risk Analysis - Policy Issues: Introduction

- “Climate change” is highly charged issue and responses to it are complex.
- A single project or a series of projects can be seen as more than a business venture.
  - Does a single project set a precedent for an industry?
- Policies and regulatory frameworks are offered partly in response to international concerns and potential global impacts but reflect domestic priorities.
  - Financial institutions respond to uncertainties and stockholder concerns
- Supra-national issues complicate decision-making by increasing uncertainties.
  - Wind projects with or without the PTC (in the U.S.) vs. CCS
- How does one factor policy-driven uncertainty into decision-making at the project level?

LTI

The World is a Complex System

“Climate change is 500 million times more complicated than any other environmental problem we have faced.” – Daniel Esty

What is risk?

- IPCC 4th Assessment Working Group III[1] report (TAR Chapters 2 and 3) discussed risks associated with developing and implementing climate mitigation strategies. Authors acknowledged that there are knowledge gaps to be addressed.

- Frank Knight[2] offered widely recognized definition of risk: "To preserve the distinction… between the measurable uncertainty and an unmeasurable one we may use the term 'risk' to designate the former and the term 'uncertainty' for the latter".

- Risk is understood to require both uncertainty and exposure – possible consequences. Glyn Holton[2] supplied a more general definition of risk that might apply to almost any action with the two essential components: exposure and uncertainty: "Risk…is exposure to a proposition of which one is uncertain."

- **Risk is partly in the eye of the beholder particularly when dealing in situations where there is balance between subjective elements and objective elements. Development of long-term strategies for dealing climate change may be just such a case.**

[1] IPCC 4th Assessment, WG III TAR, Chapters 2 and 3 (2007)
[2] Knight, Frank H. 1921."Risk, Uncertainty, and Profit", Hart, Schaffner, and Marx (NY) as quoted in Holton, Glyn A. 2004. "Defining Risk", Financial Analysis Journal, Vol. 60,No. 6 (Nov/Dec 2004)

LTI

Strategies for dealing with climate change: Mitigation and Adaptation

- Assessing risk in the context of climate change requires one to be specific about who is facing the risk (exposure) and how that person (or institution) understands and assesses risk.

- Risks faced by human societies (and nature) include unmeasurable uncertainties. Concern over "dangerous" impacts or "irreversible" change is often used to oppose particular technologies or actions. But there is no objective standard for assessing future impacts so assessments deal in probabilities and relative uncertainties.

- Recommendations to "protect" may not address cost/benefit analysis. How much change can be tolerated or managed through adaptation?

- As we move "down" the scale of complexity, scope (nation vs. a single site) and time, uncertainties and exposures become more measurable & better understood even if still not quantifiable.

- Ultimately, uncertainties and degrees of exposure create a cumulative sense of risk. Whether we address the problem globally, within a single country, at some smaller scale, these different "risks" impact which strategies we pursue.

LTI

Why is this important?

- We are acting at a great distance – costs to mitigate and adapt are likely to be incurred before full impact of climate changes are noted. Not knowing how quickly or how slowly these impacts arise and can be assessed makes calculating cost/benefit ratios difficult.
- Estimates of aggregate net economic costs of damages from climate change (i.e., the social cost of carbon (SCC)) are expressed in terms of future net benefits and of costs that are discounted to the present.
- Estimates of benefits – such as lower energy bills due to conservation and introduction of more efficient generating technologies – are speculative.
- Calculated (modeled) costs and benefits are often more sensitive to parameters such as discount rate and timing of regulations than to costs of individual technologies or actions.
- Estimated costs assume universal emissions trading, transparent markets, and low transaction costs.
- Let's spend a minute looking at estimates of mitigation costs.

LTI

Cost to stabilize atmospheric levels of GHG's[1]

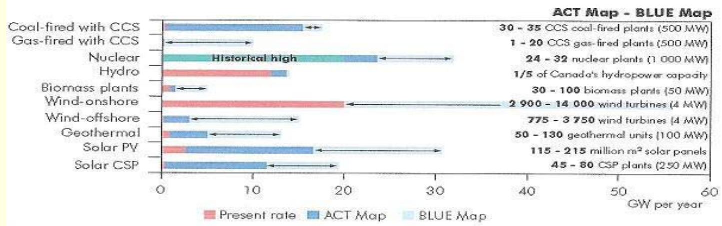
- Estimated costs for mitigation depend on targets chosen as the desired equilibrium concentration of CO2 in the atmosphere; on the target year in which a stable level will be realized; and on other policy-based issues. Most analyses seek a "solution" wherein achieving the stabilization goal is likely to have some "manageable cost".
- Energy Technology Perspectives 2008 report looked at technology investments needed to reach IPCC "targets": either the 2.0 – 2.4 ^{0}C target; or a concentration somewhere between the atmospheric levels associated with temperature rises between 2.4and 3.2 ^{0}C. The authors described measures needed to reach the lower target as the Blue scenarios and those needed for the less restrictive emissions scenario as the ACT scenarios.
- The study argues that annual costs could be substantial for the next 40 years and the deeper and earlier the cuts are made, the more expensive they will be. Whether "savings" would offset those costs is not clear. Earlier economic studies have suggested that a strategy based on managing costs through a combination of prioritized mitigation actions and adaptation might be less costly.
- Recent G8 statements seem to recognize that there is no easy nor cheap fix and that different nations may need to follow different paths consistent with their stage of development and particular circumstances.

1. Energy Technology Perspective 2008: In support of the G8 action plan; Scenarios and Strategies to 2050, OECD/IEA (2008)

LTI

Cost to stabilize atmospheric levels of GHG's[1]

➢For the ACT scenarios, emissions peak between 2020 and 2030. The MAP scenario implies adoption of a wide range of technologies with marginal costs up to $50 (U.S.) per metric ton of CO2 saved. This scenario translates into **additional[2]** investments in the energy sector of approximately $17 trillion (U.S.) between now and 2050.



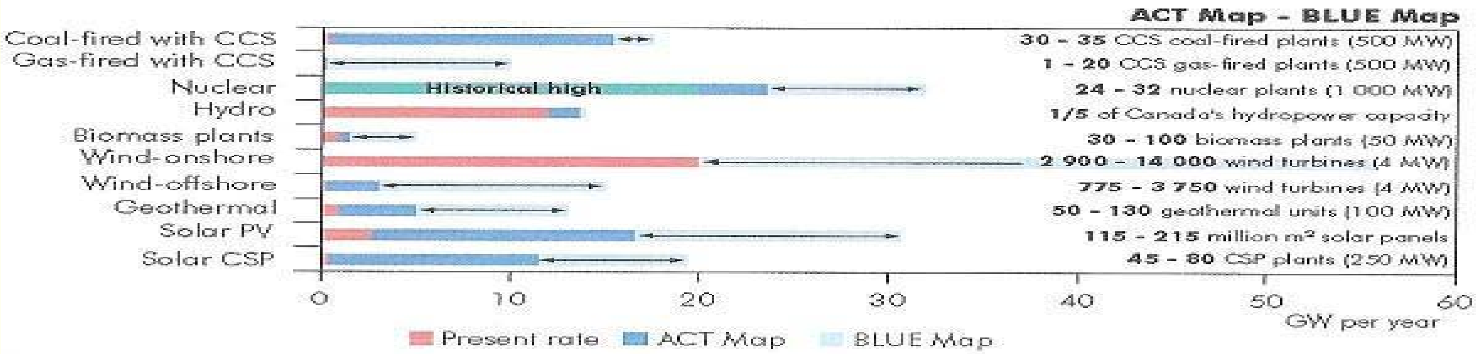
Additional investment in the electricity sector in the ACT and BLUE Map scenarions compared to the assumed baseline

➢The Blue scenarios reduce emissions by between 50% and 85% of 2005 levels by 2050. Costs for the MAP version of these scenarios are much higher, but less certain. Under the most optimistic assumption, the Blue MAP scenario would necessitate deployment of all technologies that would cost as much as $200 (U.S.) per metric ton of CO2 saved. Additional investment required to achieve the technology transition envisioned in the Blue MAP scenario is approximately $45 trillion (U.S.) over the period up to 2050.

1. Energy Technology Perspective 2008: In support of the G8 action plan; Scenarios and Strategies to 2050, OECD/IEA (2008)

2. Beyond earlier estimates of ~ $20 trillion (U.S.) between the present and 2030.

Back-up version of Figure



Additional investment in the electricity sector in the ACT and BLUE Map scenarions compared to the assumed baseline

Recent analysis for the IPCC suggests that CCS is an important option in the mid-term and as we seek deep reductions.

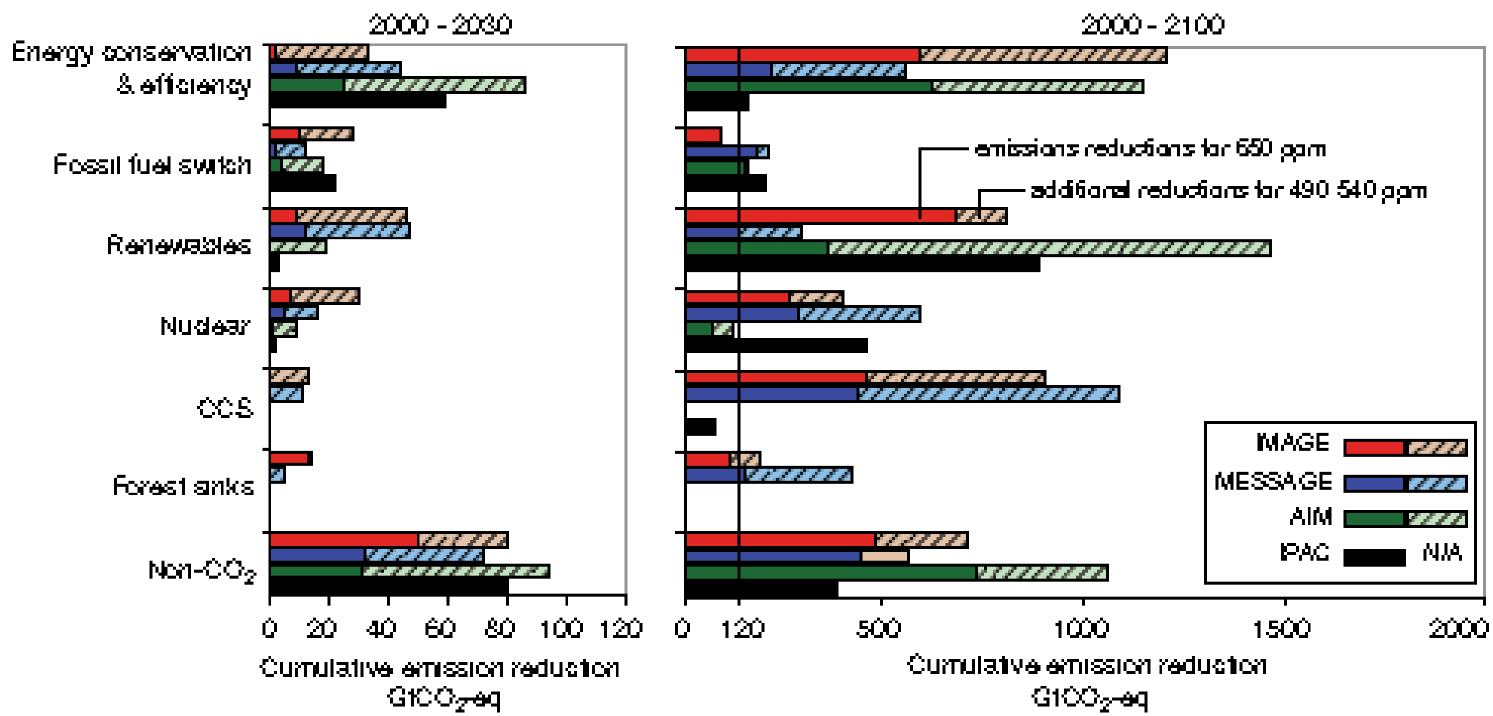


Figure SPM 9: Cumulative emissions reductions for alternative mitigation measures for 2000 to 2030 (left-hand panel) and for 2000-2100 (right-hand panel). The figure shows illustrative scenarios from four models (AIM, IMAGE, IPAC and MESSAGE) aiming at the stabilization at 490-540 ppm CO_2-eq and levels of 650 ppm CO_2-eq, respectively. Dark bars denote reductions for a target of 650 ppm CO_2-eq and light bars the additional reductions to achieve 490-540 ppm CO_2-eq. Note that some models do not consider mitigation through forest sink enhancement (AIM and IPAC) or CCS (AIM) and that the share of low-carbon energy options in total energy supply is also determined by inclusion of these options in the baseline. CCS includes carbon capture and storage from biomass. Forest sinks include reducing emissions from deforestation. [Figure 3.23]

IPCC 4th Assessment Report, Summary for Policy Makers and TAR's for Working Groups III

LTI

What makes CCS special? CCS projects engender risks from technical and non-technical issues.

- Climate change may be one of the most complex problems that human societies have ever addressed even though it is not about "everything".
- Implementation of one project or a complete mitigation "portfolio" requires assessing point of view of various actors with a stake in climate change.
- Interests of general population, of governments and of non-governmental organizations in developing "solutions" to climate change differ from those of project performers or investors.
- Investors are seeking an acceptable return on investment perhaps while encouraging outcomes consistent with social goals – and this is becoming increasingly important.
- Project performers seek to build a project with the specific intent of "profitably" producing and selling power.
- Interests of those charged with protecting public health and welfare or with ensuring public receives fair value from those providing essential services to the public (electricity, water, natural gas, telecommunications) differ from these other groups.
- Collective actions of the various interest groups do impact investments and this impact partly determines investment risk.

LTI

Impact of policy on project risk

- Technology-neutral policy design is strongly preferred from economic and environmental perspectives. The role of government is to set social and political boundaries, leaving the market to innovate[1].
- Technology-specific policies are likely to remain important for two reasons:
- Price signals may emerge gradually, and take time to command investor confidence.
  - For some technologies, there may be a role for government support to bring new technologies to the point where carbon prices set by policy are sufficient to let the market take over.
  - Some technologies serve other public goods or political constituencies, and in such cases policy makers may wish to single them out.
- Climate policy risks[2] may be reduced compared to other risks if policy is set over a sufficiently long timescale into the future…Investment risk premiums are significantly lower when the price jump representing the policy uncertainty is shifted from only five years in the future out to 10 years to coincide with the planning cycle in the utility industry.
- Climate policy risks are more important for technology investments for which climate policy is a dominant economic driver, for example carbon capture and storage (CCS).

1. World Resources Institute, Scaling-up: Global Technology Deployment to Stabilize Emissions (2007)
2. Yang and Blyth, Climate Policy Uncertainty and Investment Risk, 144 pages, ISBN 978-92-64-03014-5, OECD (2007)

LTI

The "Carbon Principles"

- Major financial institutions developed a set of "Carbon Principles" to serve as guidelines for advisors and lenders to power companies in the United States to facilitate financing of new electric power generation.
- The lead firms (Citi, JPMorgan Chase and Morgan Stanley) worked in consultation with power companies (American Electric Power, CMS Energy, DTE Energy,NRG Energy, PSEG, Sempra and Southern Company) while the Environmental Defense and the Natural Resources Defense Council advised. Credit Suisse and CERES have since adopted these guidelines.
- They were created to provide a consistent approach among major lenders and advisors in evaluating climate change risks and opportunities in the U.S. electric power industry. An Enhanced Diligence Process was also developed to provide banks and their power industry clients with a consistent road map that could be used to reduce regulatory and financial risks associated with GHG emissions.
- The Carbon Principles are a common set of beliefs that a balanced portfolio approach is needed in the power industry to meet future needs including:
  - Energy Efficiency: The best way to limit CO2 emissions is to not produce them.
  - Renewable and low-carbon energy technologies.
  - Conventional or advanced generating facilities will be needed to meet demand, including power from natural gas, coal and nuclear technologies

Enhanced Diligence Process

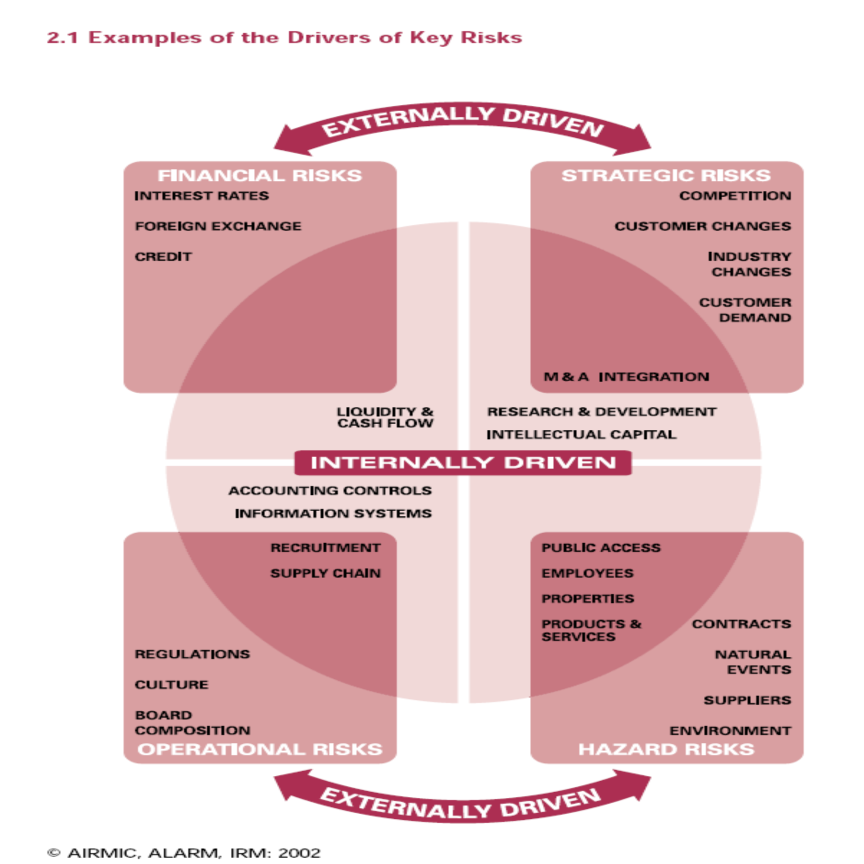
- An Enhanced Diligence Process is applied to assess the potential carbon - related risks of investments when a client has selected a coal- fired power plant as the best supply option for customers. It will be used to examine financings involving new fossil fuel generation to identify potential risks posed by the cost of CO_2 emissions and to address those risks. .

- Absence of federal action on climate change creates unknown financial risks for those building and financing new fossil fuel generation. The institutions that adopted the Principles recognize that federal CO_2 control legislation is being considered and is likely to be adopted during the service life of many new power plants. They believe that it is prudent to take concrete actions now to help developers, investors and financiers identify, analyze, reduce and mitigate climate risks.

- Emerging Practice and Guidance: Some emerging practices targeted at quantifying, reducing, and mitigating climate change - related risks include:

  - Use of a wide range of assumptions about timing, stringency, and structure of regulation, and the ability of the project owner to pass through or recover compliance costs. Absent clear policy on regulating CO_2, financial institutions and clients should use conservative base assumptions, including a auctioning of allowances.
  - Committing, at the corporate or project level, to reduce net GHG emissions within specific timetables or for new capacity, committing to not increase net emissions.
  - Implement energy efficiency measures or programs and develop or acquire low-GHG emitting generation that is as cost-effective as new fossil generation.
  - The institutions that adopt the Principles recognize that...geological storage could serve as a key method for mitigating CO_2 emissions...the Enhanced Diligence Process will evaluate the client's assessment of CO_2 capture, transport and storage options and view positively plans to maintain the option to use CCS..

Key drivers of risk[1]



A report issued by the Institute of Risk Management (IRM), the Association of Insurance and Risk Managers (AIRMIC) and ALARM, the National Forum for Risk Management in the Public Sector seeks to offer standards for risk assessment and risk management. This document lists a number of different types of risk, some of which can be understood and assessed as internal to the organization doing the evaluation of risk and others that are primarily external or outside the control of the organization assessing the risk incumbent to a particular decision.

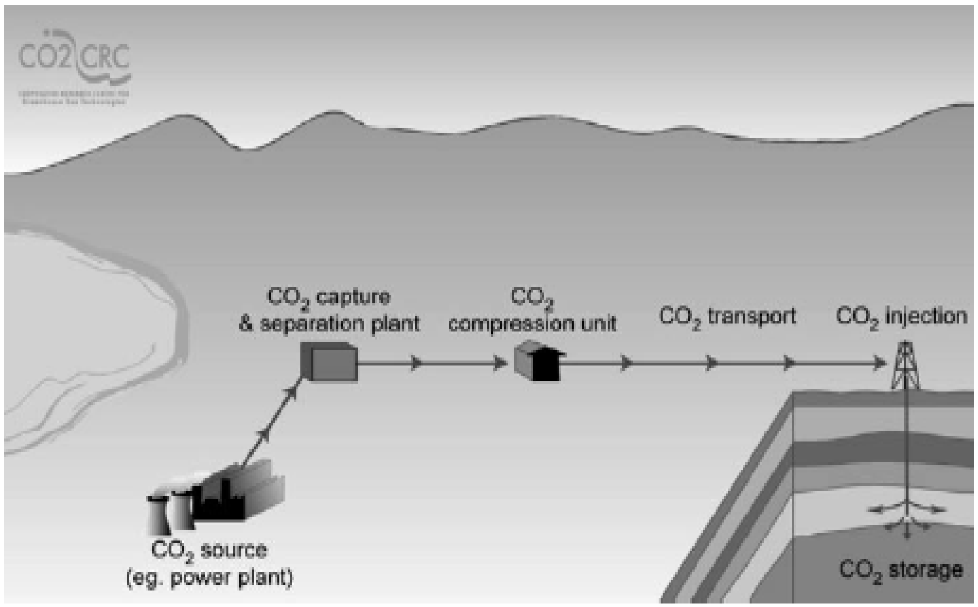
[1] “A Risk Management Standard, AIRMIC, ALARM, IRM (2002)

LTI

What are the elements of risk assessment for carbon capture and storage?

- Risk assessment for a greenhouse gas mitigation (GHG) project or for a project likely to have GHG implications is more complicated than it might be for another type of project.
- One cannot merely assess the technology risk and the financial risk determined by the probably return on investment.
- Consideration of alternative strategies are important
  - Life-cycle considerations are important from the start.
- Policy issues impact risk at project formulation
  - Issues such as additionality continue to plague offset projects
- Financial risks include regulatory concerns, assignment of liability and means to share risk (insurance).

What constitutes a CCS project[1]?



Source: Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC)

Fundamentally, there are three broad areas within CCS. These are the activities of capturing the carbon dioxide (CO2), transporting the CO2 to its storage facility, and the act of storing the CO2 . There are numerous processes within each of the three general activities such as compression of the captured CO2 and injection at the storage facility.

[1] CO2CRC Cooperative Research Center for Greenhouse Gas Technologies

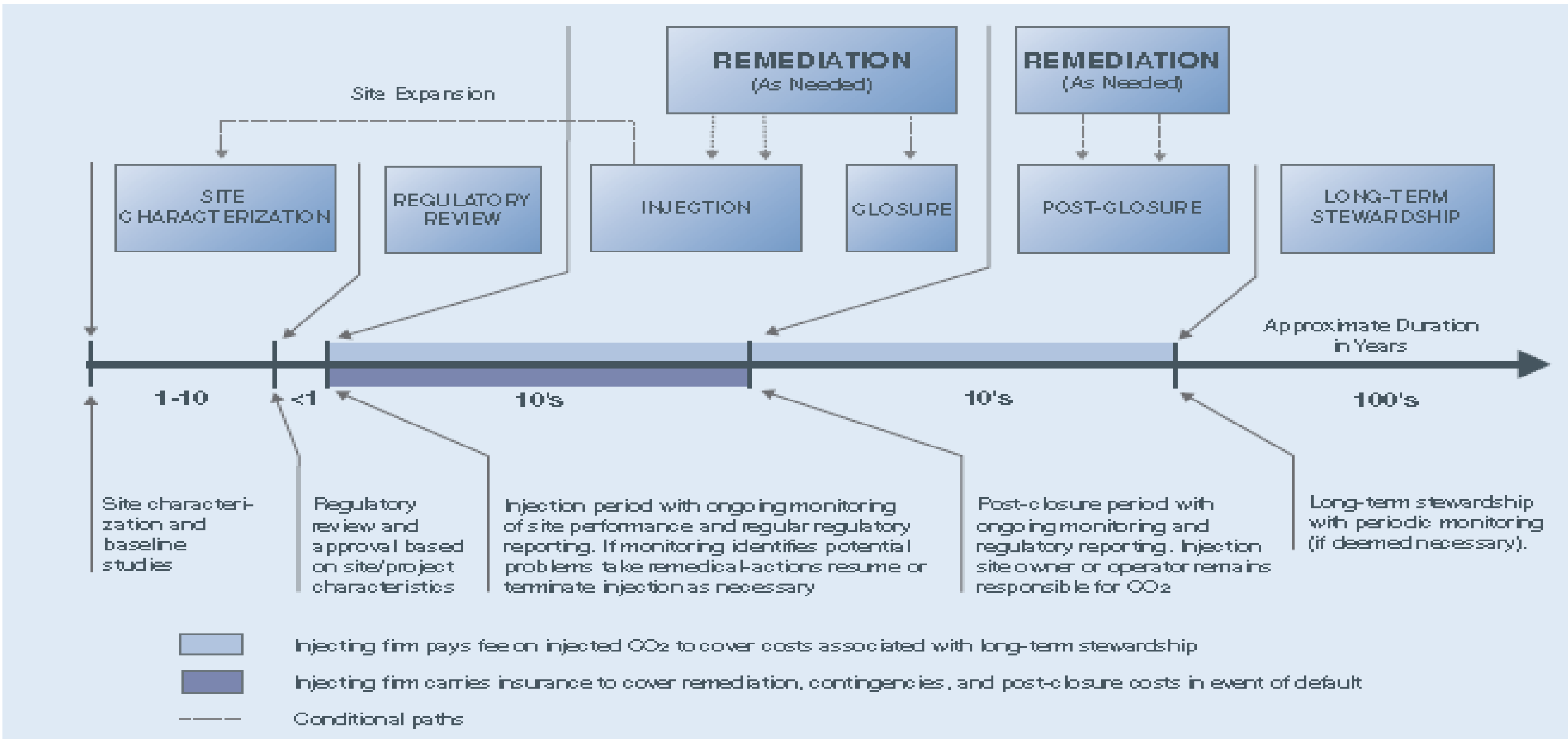
LTI

Definition of a project

- Carbon sequestration projects consist of several process implementation phases. Each phase has a unique set of risks which can vary from project to project, depending on size, location, plant design, storage location, storage site characteristics, etc. Successfully passing one phase (say permitting) does not guarantee continued success in negotiation through subsequent phases.
- Carbon sequestration projects can include single, small projects or may encompass a very large activity handling many power plants.
- For each of the technological subsystems there are potential health, safety, and environmental risks which need to be considered during project assessments.
- Some elements of CCS are not addressed by current regulatory frameworks. ***These vary from country to country.*** Lack of complete regulatory frameworks for CCS adds a degree of uncertainty in performing the risk assessment (RA).
- RA should be performed as soon as possible in the process to minimize unanticipated events.
- In some cases, anticipated risk(s) for the project (power plant, pipeline, and storage site) may provide justification to change the aspects of a project, or in extreme cases, relocate the project.

LTI

Life-cycle of a carbon capture and storage project



[Illustration from Rubin et al., 2007]

- The International Risk Governance Council recently issued a report: Policy Brief: Regulation of CarbonCapture and Storage (International Risk Governance Council, Geneva, 2008)
- The figure above depicts the stages in a CCS project.This model assumes that: commercial firms will operate CCS sites; those firms will continue to be responsible for some period of time post-closure; and, ownership will pass to a government entity at some point.

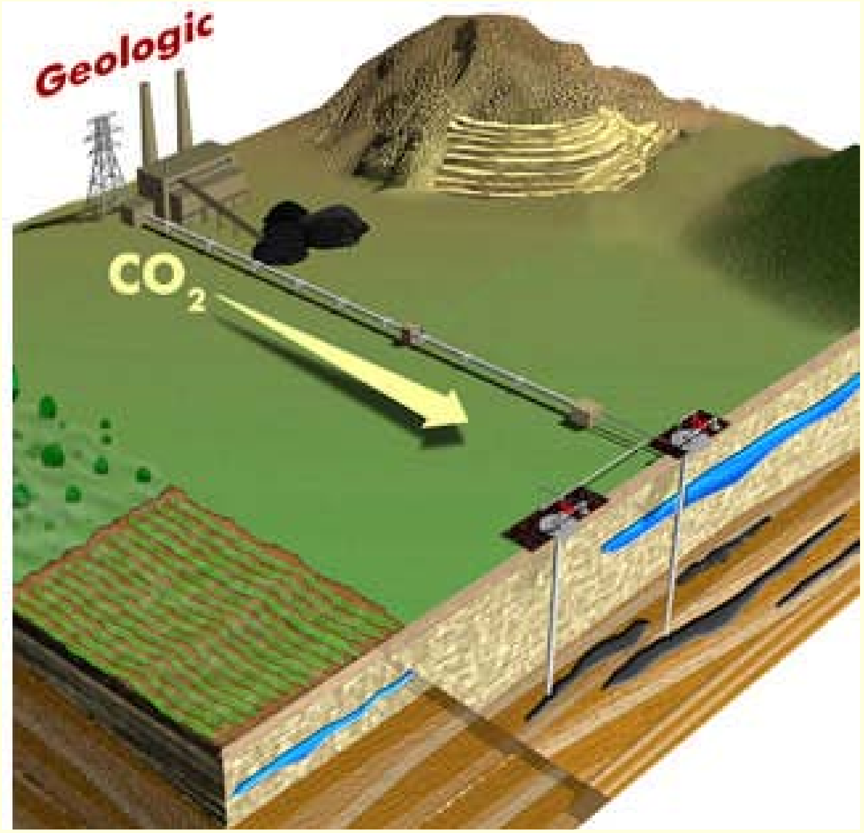
Project Risk Assessments

- Detailed risk assessments are beneficial in developing input for risk management of project(s). Demonstrated commitment to practice of risk management can have positive consequences.
  - Results of the RA for a particular project may be beneficial if the results are above average. Lower insurance and finance rates may be in order for lower risk CCS projects.
  - Higher rates may result and raise financial risks to an unacceptable level for a high risk. CCS project that lacks mitigation plans or risk management strategies.
- Carbon capture and storage projects need to have risks assessed at every phase. Drivers that may require on-going risk assessments include:
  - Changing business environment
  - Changing regulations
  - High cost of project, general escalation of costs in the industry, fuel price volatility
  - Safety, health, liability
  - Long-term storage requirements (measurement, monitoring, and verification)
  - Who are the project performers (Have they changed?)
  - Who is responsible for each phase?

LTI

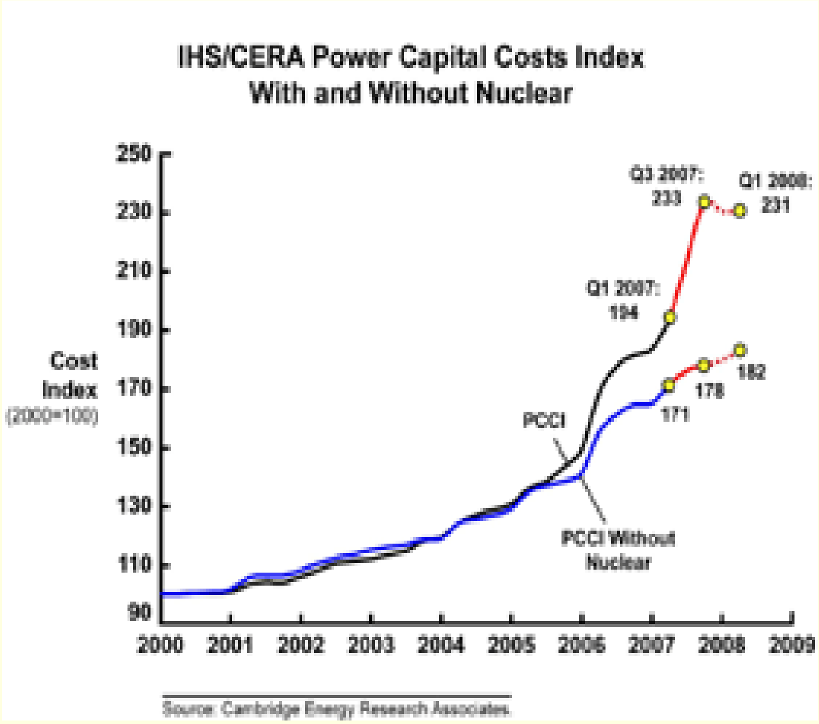
Technical risk for carbon capture and storage

- We've already heard a number of talks about the technical risks associated with carbon capture, transport, and long-term storage.
- It is easy to forget that the CCS portion is only a part of the full project.
- There is an immense amount of global activity in the energy sector. This activity has had significant impacts on cost and availability.
- So while we recognize the issues associated with the system shown in the picture to the right, there are several other issues that contribute to project risk.



Escalating costs for power sector projects

- **The IHS/CERA Power Capital Costs Index (PCCI)** tracks and forecasts the costs associated with the construction of a portfolio of 30 different power generation plants in North America. For further information on the PCCI. please contact Candida Scott at (cscott@cera.com).
- The PCCI based on methodology that tracks the "purchase price" of a portfolio of projects. As component costs (e.g., steel, insurance, labor rates) rise and fall, so will the cost of a given portfolio. Approach relies on methodology that calculates the ratio and influence of each component, as follows:
  - Define representative portfolio of projects.
  - Project modeled to equipment level of definition
  - Each project is then "priced" using a multi year database of industry costs.
  - Individual project values are then aggregated into indices, with the components compared and analyzed.



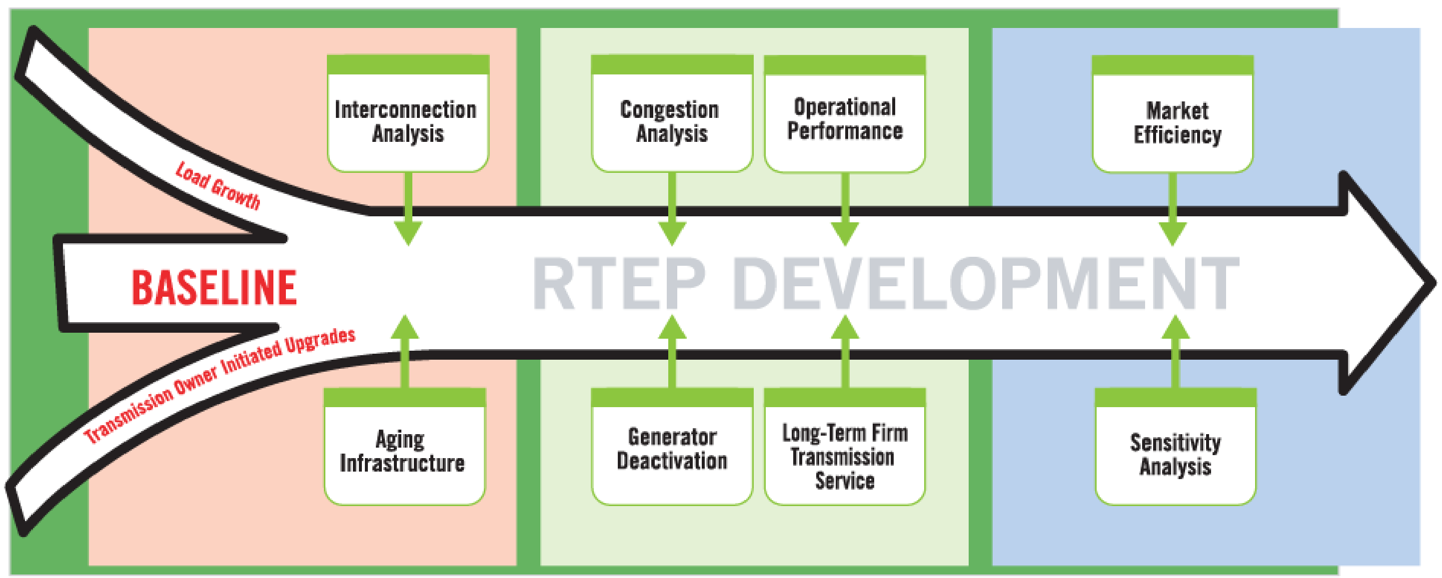
Strategic sourcing issues

- As an example, Fluor Corporation has developed strategic sourcing approaches to deal with todays suppliers market. The company relies on strategic suppliers for certain key items and uses a process which suggests that certain key components be procured at the start, followed by detailed engineering, a second round of procurement, and finally construction.
- This approach seeks to counter increasing lead times required for key components and rapidly escalating costs. These components include the boiler, turbines, high energy piping and shop fabricated steel and piping. Lead time for steam turbines has doubled from 20 weeks to 40 weeks while that for high energy piping has increased from an industry standard 20 -30 weeks to the current 70 -80 weeks.
- This approach to implementing risk management has had positive consequences. These practices are not particularly exciting but they yield important results in terms of project performance. Familiarity with a methodology and uniform application can raise the level of trust amongst the project team, regulators, and the interested public.

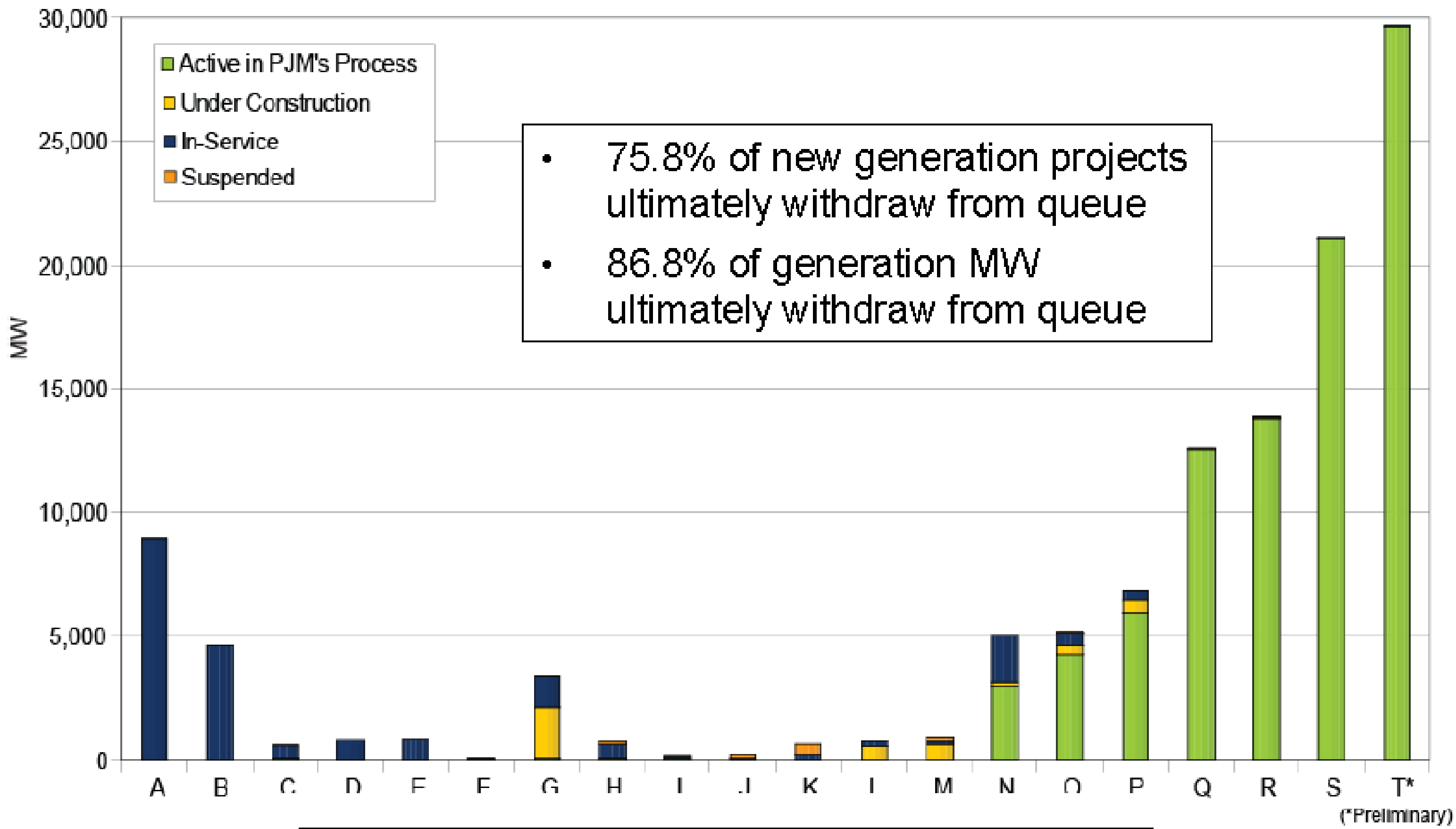
Capacity planning requirements can add to uncertainty – PJM example

Regional Transmission Expansion Planning Process

- 15 year planning horizon
- Evaluates all needs and solutions in the region



Many projects are proposed; few are built



Interconnection Queue

Risk Assessment and Risk Management

Perform risk assessments for each implementation phase & technology subsystem of a CCS project following four (4) fundamental steps:

- Identification and description of risk factors,
- Develop risk models,
- Calculate the risk for each phase with an applicable risk analysis method, and
- Develop options, including expected impacts, to decrease or eliminate risks as practical.

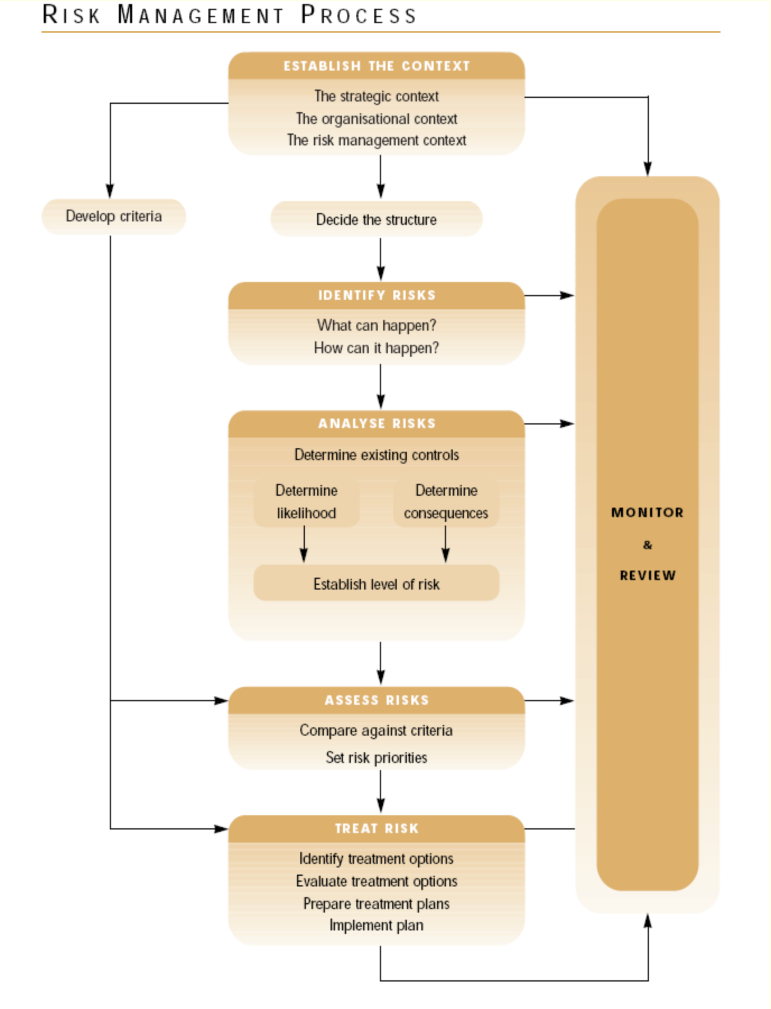
Note: There is a different time horizon for the assessment of risk for the first four phases - capture, compression, transport, and injection – compared to the final phase –long-term storage. The first four phases are consistent with conventional operational periods - a time frame of approximately 40 years. The storage phase has both short-term and long-term risk components. The short term coincides with operational periods – injection for 40 years – while the long term phase require assessment of risk up to and beyond, 1,000 years.

- Risk management[1] is the term applied to a logical and systematic method of identifying, analyzing, evaluating, treating, monitoring and communicating risks…Risk management is as much about identifying opportunities as avoiding or mitigating losses.

[1] Ministry of the Premier and Cabinet, "Guidelines for Managing Risk in the Western Australian Public Sector." Government of Western Australia ISBN 0 7307 0101 8 , 1999

LTI

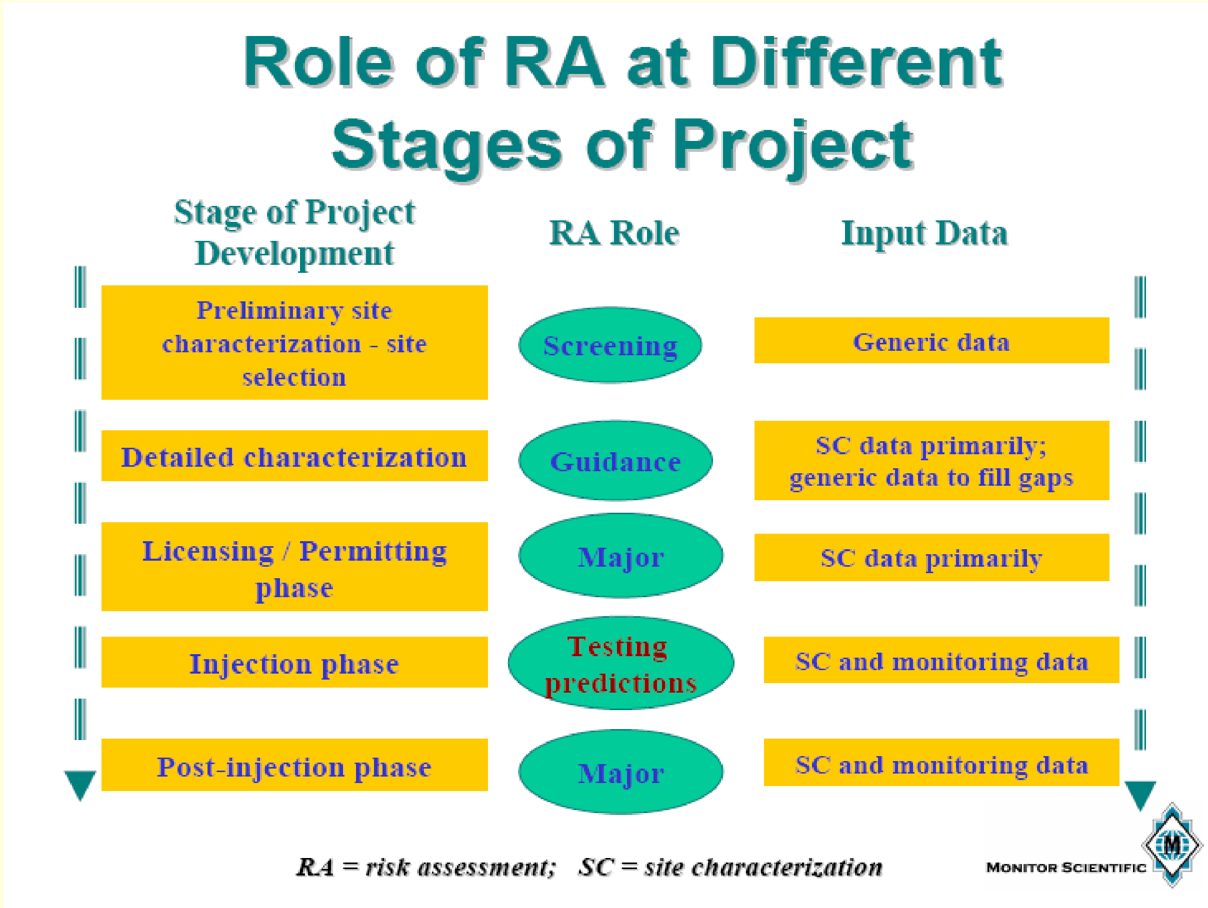
Risk Management Process



Subsystems of a CCS project may include:
Capture
Compression
Transport
Injection
Storage (Monitoring & Verification)

Documentation for risk calculations for any subsystem must provide descriptions of inputs and resultant outputs and facilitate performance of subsequent revisions that would need to incorporate updated CCS project data.

Role of Risk Assessment at Different Phases of a CCS Storage Project[1]



[1] Stenhouse, Mike, "Approach to Building Confidence Concerning Geological CO2 Storage: Risk Assessment Perspective." Monitor Scientific LLC, METI/IEA GHG Workshop, Mitsubishi Research Institute, Tokyo, Japan January 24-25, 2007

LTI

Detailed Risk Assessments

- Detailed RAs are performed and provide input for risk management of project(s). Risk models tabulate a list of variables and act as a checklist in order to ensure that nothing is taken for granted and that analyses are performed on a consistent and repeatable basis. Variables in risk models usually have a range of values.
- Without RAs, projects may be unable to secure adequate insurance or even funding from investors, financial institutions and/or government programs. RAs need to incorporate mandated requirement(s) in regulations.
- Risks are to be calculated for each subsystem in the CCS project. The first four phases will involve many of the same types of risk components such as system integrity failures, external interference, and environmental factors.
- The system integrity failures would involve equipment-piping, valves, instruments, etc. Human interaction (human error) would be a direct risk factor during operation of the actual equipment or an indirect risk factor by externally affecting the system.
  - An indirect risk factor example would be the inadvertent drilling into the storage area due to poor record keeping and causing a release of CO_2.

LTI

Storage – risk management overview[1]

Risk Management

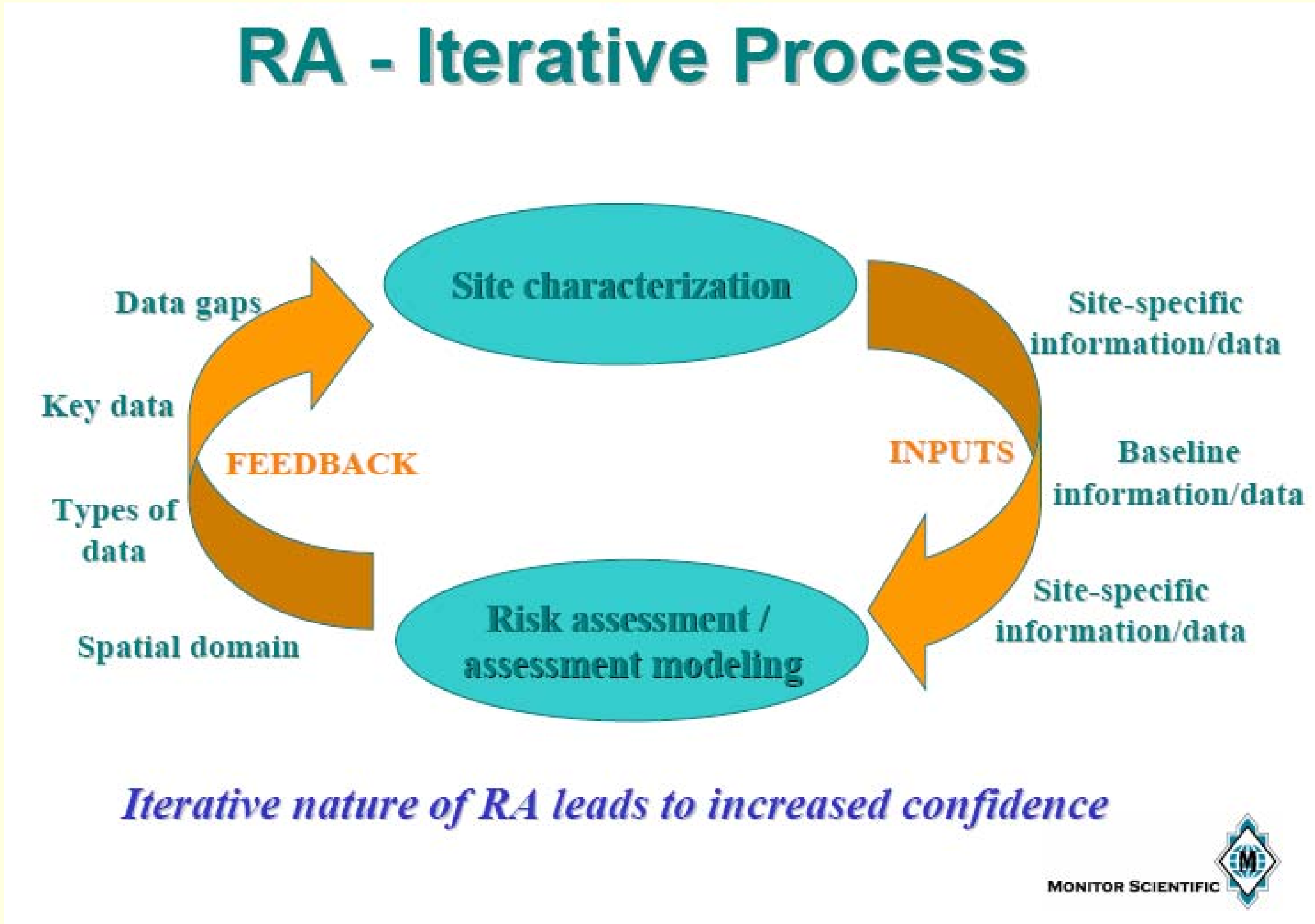
1. Site Selection
2. Risk Assessment
3. Monitoring & Verification
4. Remediation Planning

- **Pre-Injection**
  - Characterization of the site
  - Long-term risk assessment
  - Monitoring
  - Remedial measures
- **Operation**
  - Short-term prediction
  - Monitoring of the site to verify the prediction
- **Abandonment**
  - Update of long-term assessment
  - Decide on duration of site-specific monitoring
- **Post-abandonment**
  - Update assessment & transfer of liability
  - site-specific monitoring, if necessary

[1] Heidug, Wolfgang, "Risk Management for CCS and CO_2 Policy." Shell International Renewables SBSTA 24, Bonn Presentation, WBCSD/IETA side event, 19 May 2006

LTI

Risk assessment must be an iterative process



LTI

Risk Acceptance

Risk acceptance criteria are necessary to define what risks are acceptable versus unacceptable.

- For the capture and compression phases, risk acceptance criteria developed on a health and safety basis. For example, in the vicinity of selected capture and compression equipment at a source, more leakage could be tolerated in specific areas of the facility where personnel will be barred from entry or physically shielded.
- High traffic or personnel exposure areas near other equipment may require more stringent risk acceptance criteria.
- However, to keep matters simple, the more stringent risk acceptance criteria may be adopted everywhere within the capture and compression facilities.
- Regulations can be a source of the risk acceptance criteria.
- Company policy may require risk acceptance criteria superseding that which is based wholly on safety and health considerations.

LTI

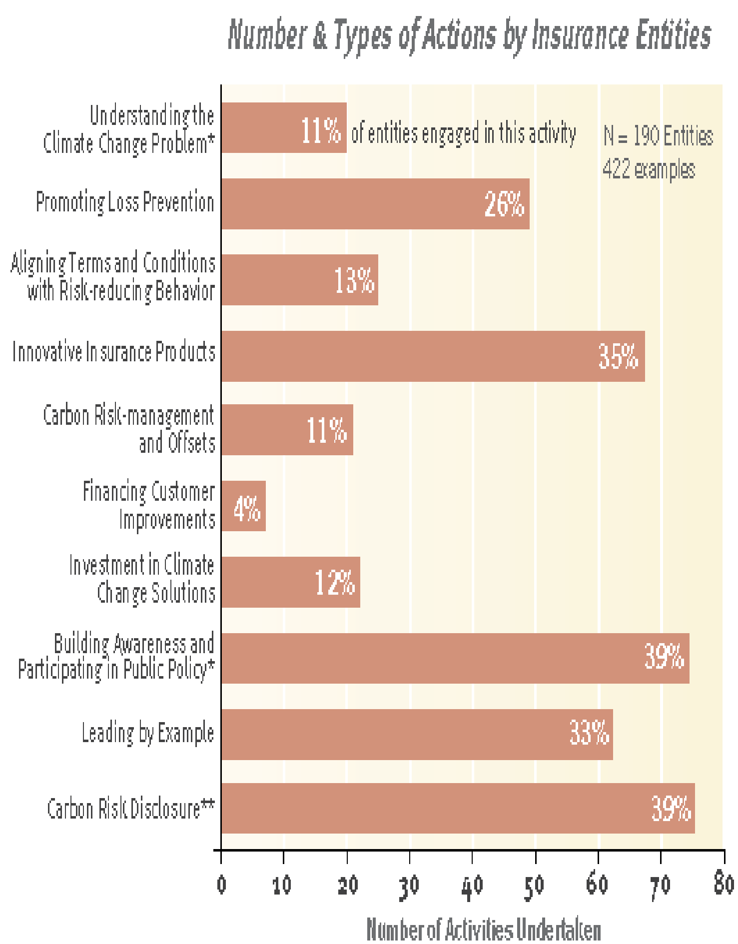
Incentives and Insurance

- Innovations in policy and creation of new instruments to encourage investment are needed.
- Might include regulatory exemptions for demonstration projects, use of special purpose vehicles, bond issues or privatization initiatives to underwrite development, operation, and legacy management of key infrastructure needed for a sequestration industry
- These incentives or risk-sharing and risk management approaches might produce most efficient results if applied globally meaning that risk, incentives, and risk management would flow across whatever boundaries are crossed by the project or series of projects.
- Trends in infrastructure privatization suggest CCS as an infrastructure that allows continued use of fossil fuels - an essential need for society - through a substantial portion of this century[1]
  - For example, notions of government ownership of stored CO2 after site closure have been suggested in the Tyndall Centre report[2].
  - Weather hedging strategies or risk-sharing amongst insurers has been proposed for catastrophic losses
  - Insurers exploring instruments to cushion against carbon market volatility

1. IPCC WGIII, 3rd Assessment Summary for Policy- Makers; and Ryan Orr The Privatization Paradigm, the Infrastructure Journal at www.infrastructurejournal.com;
2. Clair Gough and Simon Shackely, An Integrated Assessment of Carbon Capture and Storage in the UK, Technical Report 47, Tyndall Centre for Climate Change Research (October 2005)

LTI

Role of insurance



- What are we insuring against?
  - Are we insuring against damage caused by changes?
  - Are we insuring against liabilities arising from failed policies and technologies
- What is the current status?
  - What is the industry doing?
  - The chart at the left comes from a CERES[1] report discussing insurance industry awareness and actions.

A Ceres Report - From Risk to Opportunity: 2007, Insurer Responses to Climate Change, Evan Mills (November 2007)
available at : http://insurance.lbl.gov/opportunities.html

How is the insurance industry responding?

- Climate change can have adverse impacts on insurance affordability and availability, potentially slowing the growth of the industry and shifting more of the burden to governments and individuals. Most forms of insurance are vulnerable, including property, liability, health, and life. It is incumbent on insurers, their regulators, and the policy community to develop a better grasp of the physical and business risks. Insurers are well positioned to participate in public-private initiatives to monitor loss trends, improve catastrophe modeling, address the causes of climate change, and prepare for and adapt to the impacts.
- See: http://insurance.lbl.gov/

- **INDUSTRY ACTIVITIES**
  - ··Case studies of insurers' climate change responses
  - ··Insurer Corporate Sustainability Reports
  - Examples of insurer climate change sites
- ··AIG (USA)
- ··Allianz (Germany)
- ··Insurance Australia Group (Australia)
- ··Lloyds of London
- ··Marsh (USA)
- ··Millea Holdings (Japan)
- ··Munich Re (Germany)
- ··Swiss Re (Switzerland)
- Trade Associations
- ··Association of British Insurers (UK)
- ··Malaysia Insurance Institute (Malaysia)
- ··National Association of Insurance Commissioners (USA)
- ··National Association of Mutual Insurance Companies (USA)
- ··United Nations Environment Programme's Finance Initiative

Specific concepts...

- The ability of insurers and reinsurers to assess risk will depend on which activities they are asked to cover and the limits on liability (if any) provided under national, state, or provincial law.

Considerations for Utilities([insurance, self-insurance, reinsurance]

- **Infrastructure repair, redesign, fortification** [property]
- **Service provision & lost revenues**

– Changes in demand for energy and water
– Failure to deliver [contingent business interruption]
– Eroded water quality [product liability]

- **Liability**

– As providers of services [general liability]
– As emitters [various liability]
– As impacted businesses [directors and officers liability]

- **Reputation**

– Part of problem or solution?
– Preparedness in the eyes of public, customers, shareholders, regulators

- **Risk profiles of climate responses**
- **Insurance availability & affordability**

*The insurance sector has a key role to play in **helping to mitigate the effects** of climate change … and by developing new products **and solutions** that can support emerging greenhouse-gas and renewable energy markets.*
- Marsh & McLennan

Carbon Markets

Carbon markets are in their infancy:

- Volatility in European Unions Emission Trading System (EU ETS) carbon market in Phase I demonstrated complexity of emissions commodity markets.
- EU ETS Phase II operating under more stringent emissions cap and with other "fixes". More substantial changes considered for Phase III (2013) contingent on global "deal".
- Other carbon markets of various sizes are forming around the world. U.S. regional markets underway increasing pressure to rationalize processes. But, carbon markets seem headed towards continued volatility for many years.
- Carbon markets will have scope far larger than the SO_2 allowance market in the United States. (EU ETS Phase II - $37 billion (US); US SO_2 - $2.25 billion (US))
- Study[1] of the EU-ETS by Hepburn et al, offered the following suggestion:

  "*Auctioning may also provide a hedge against projection uncertainties, reduce price volatility, and increase investor stability. The recent EU ETS market collapse is a dramatic manifestation of uncertainty in emission projections. Reserving some allowances for periodic auctions: could assist transparency and liquidity ; offers a potential price cushioning mechanism (as in US transmission auctions) to create a more stable EU ETS market; might facilitate ex-ante agreed target price ranges, thereby increasing predictability for investors*"

[1] Hepburn, Cameron, et al. "Auctioning of EU ETS Phase II Allowances: How and Why." Jun 2006. *United Kingdom Electricity Policy website*. Accessed 4 Jun 2007 http://www.electricitypolicy.org.uk/pubs/wp/eprg0621.pdf.

LTI

Balancing needs of involved/interested parties through the project cycle

- Comprehensive CCS regulatory frameworks must balance needs and interests of local, national and international publics, CO2 generators, CO2 pipeline operators, geological storage site developers, financial and insurance institutions supporting the project, government agencies setting safety and environmental requirements, and national and international agencies managing climate regimes[1].
- Look more closely at several parties – those not directly involved in the technical aspects:
  - Public interest in CCS from a global view is to avoid dangerous climate change. National and state interests are concerned with economic competitiveness, the cost of electricity, and with cost to regulate and oversee compliance. Close to any project site, the local populace will focus on health, safety and environmental concerns, on property rights and property values.
  - Local and national regulators are charged with protecting human health and the environment. They are also pressed to minimize the cost of regulation and equitably balance CCS risks between public and private parties. .
  - Those managing a climate regime need accurate measurements of CO2 emissions avoided. Development of well-defined, widely-accepted greenhouse gas (GHG) accounting procedures and standards is essential for CCS site operating procedures and transportation. These will enable international carbon trading and ensure that the value of emissions allowances is not eroded by leakage from CCS sites.
  - The ability of insurers and reinsurers to assess risk will depend on which activities they are asked to cover and the limits on liability (if any) provided under national, state, or provincial law.
  - Financial institutions will require that CCS be profitable. No investment can occur before legal operation is assured. Regulation and guidance must clarify ownership rights and responsibility for injected CO2, and clarify ownership of subsurface pore space and ownership of mineral rights affected by CO2 storage. Long-term contracts between site operators and those capturing and dispatching CO2 are essential.

- The International Risk Governance Council recently issued a report: Policy Brief: Regulation of Carbon Capture and Storage (International Risk Governance Council, Geneva, 2008)

A few recommendations from the IRGC[1]

- CCS regulation must:
- Establish a framework encouraging responsible operation and investment; they must balance stability and predictability with flexibility and adaptability to new scientific information;
- Encourage evolutionary approach to developing CCS regulations. Early CCS projects should be regulated under modifications to existing regulations. Results from early projects can be used to create CCS regulations sufficient to manage commercial deployment.
- Encourage full transparency and careful evaluation of results and experience from early projects.
- Address political and economic barriers to CCS deployment and create conditions where project financial backers have confidence that investment decisions will earn a satisfactory economic rent, that a predictable regulatory framework will apply, and that liability issues will be resolved.
- Support effective risk communication by both regulators and industry. This is vital public acceptance of CCS.
- Development of a regulatory framework is necessary but not sufficient to catalyze CCS deployment. Economic and political barriers will also need to be addressed.

- The International Risk Governance Council recently issued a report: Policy Brief: Regulation of Carbon Capture and Storage (International Risk Governance Council, Geneva, 2008)

Communications are essential

- Beyond the need to perform best-in-class risk assessments, there is a need to communicate the results of such analyses.
- Much has been written about the importance of communications…
  - The Tyndall Center report cited earlier explored issues related to CCS for the UK. The report focused on off-shore disposal in inactive oil and gas fields and in saline formations. The authors found that, given the sense of urgency that they found for dealing with climate change – and surveys of public attitudes was a key part of this study – CCS was viewed as an acceptable alternative if done off-shore.
  - An report prepared for NETL suggested that local concerns are often focused on practical and less philosophic concerns so there may be opportunities for a different sort of discussion or risk communication[1].
  - **Experience in a risk communication for other environmental issues confronting industry has resulted in a widespread understanding that the issue is not about facts, it is about trust[2]: "…On the other hand, one thing that you must assume is that the general public is well educated... The primary objective of risk communications is not to change public opinion about the size of the risk but rather to build trust about the corporate commitment to contain and control it."**

- Early and thorough communications aimed at building and maintaining trust is essential.

1. Adler and Kranowitz, A Primer on Perceptions of Risk, Risk Communication, and Building Trust, the Keystone Center, Feb 2005
2. AWMA Publications, http://gcisolutions.com/bertawma02.htm

LTI

How do we tell a complete story?

'Risk" relates to many things and each instance may be treated via different frameworks. Investments in projects for climate change mitigation will be made in the face of great uncertainty. Investment choices including evaluation of risk are somewhat in the eye of the beholder.

CCS a relatively new "option" in the GHG mitigation technology portfolio but an essential one.

IPCC reports recognize different sorts of concerns and barriers may exist when looking at macro-level issues compared to those that apply to power sector or to decisions regarding an individual plant. Consistency may be lacking.

High level policies can efficiently promote beneficial technologies; or they can effective block their implementation in favor of other technologies; legislation can result in unintended consequences that have substantial negative impacts. Note: IPCC assessments assume we do it right.

To succeed, we must link the flow of information on authorities, policies, incentives, liability frameworks to barriers that they erect or to opportunities that can be created to further the cause of climate mitigation. We must use this knowledge base to create a level playing field for CCS

LTI

Maintain an overview of risk and liability for CCS

- Many are examining risk, liability, and risk management strategies. Studies cover issues ranging from technology-specific risk assessment guidance, risk issues and incentives relevant to sector-wide implementation of CCS to assessment of CCS as an option compared to other mitigation options. Good answers will emerge but will they be effectively and rapidly communicated?

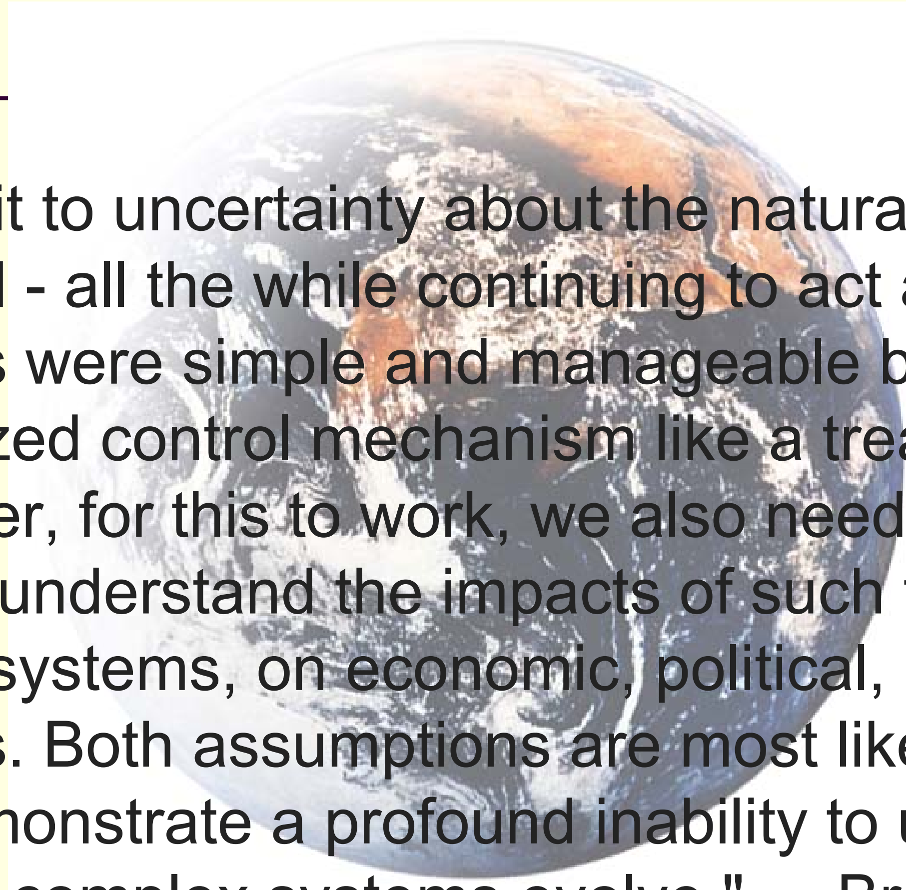
- Information needed to evaluate the likelihood and benefits of carbon sequestration technologies is rapidly increasing. Analysts are looking at issues such a technology- neutral vs. technology-specific policies, and targeted incentives for demonstration or deployment.

- Evaluations of factors contributing to risk, assessments of the impact of perceived risk on carbon markets, assessments of frameworks for assigning liability, compilation of lists of existing incentives and suggests of actions to reduce risk or to craft effective incentives and to otherwise encourage and accelerate deployment of CCS need to be updated regularly.

- Effective communications strategies are an essential part of managing risk for CCS and of communicating what risks are acceptable.

LTI

Uncertainty is Inherent to Natural Systems



"We admit to uncertainty about the natural system involved - all the while continuing to act as if the systems were simple and manageable by a centralized control mechanism like a treaty… Moreover, for this to work, we also need to believe that we understand the impacts of such treaties - on natural systems, on economic, political, and cultural systems. Both assumptions are most likely wrong and demonstrate a profound inability to understand the way complex systems evolve." -Braden Allenby

LTI

Conclusions…

- Risk assessment and risk management are essential actions. Demonstrated commitment to practice of risk management can have positive consequences. Risk management is as much about identifying opportunities as avoiding or mitigating losses.
- As most risk is part perception, an aggressive communication strategy is essential.
  - Communications must be clear and tailored to each stakeholder group
  - Communications must come from or through trusted sources
  - Clearly define what constitutes “Acceptable risk”
- Knowledge development must support actions to ensure a level playing field for CCS compared to other mitigation options.
  - Incentives for near-term deployment of CCS are important but are they enough?
  - Investors pursue sure money provided by legislative mandates and strong tax incentives.
  - Policies and incentives must recognize all concerns vis-a-vis CCS and address them
  - The unanswerable question of long-term storage and the liability that might attach to it may require special instruments – including investment vehicles – to manage this particular risk.
  - Assurances of long-term safe storage must be backed by some financial guarantee that remediation of any leakage or other failure will occur.

LTI

Discussion

LTI

What is the status of regulations focusing on CO_2 transport in the U.S.?

- **Testimony of the Honorable Joseph T. Kelliher, Chairman, Federal Energy Regulatory Commission before the Committee on Energy and Natural Resources, United States Senate, January 31, 2008**
  - He testified about two bills, S.2144, which would direct the Secretary of Energy, in coordination with the Federal Energy Regulatory Commission (FERC), the Secretary of Transportation, the Administrator of the U.S. Environmental Protection Agency, and the Secretary of the Interior, to conduct a study to assess the feasibility of the construction and operation of pipelines to be used for the transportation of carbon dioxide...AND
  - S. 2323 This bill would fund carbon dioxide capture and storage research and development, and both carbon dioxide capture and sequestration demonstration projects. The bill has other provisions relating to establishment of an inter agency task force to develop regulations for carbon dioxide capture and storage.
  - The U.S. has used three different regulatory schemes for transportation of energy resources by pipeline that might be relevant to regulatory aspects of carbon dioxide transportation. First, there is the model that has governed the existing carbon dioxide pipeline network, namely continuing the current regulatory scheme for interstate carbon dioxide pipelines. Second, there is the oil pipeline model. Under this model, oil pipelines are sited under state law and FERC sets the transportation rate. The third model is the natural gas pipeline model. Under the current version of this model, FERC both sites interstate natural gas pipelines and sets their transportation rates.