Recommendations by the International Risk Governance Council for the Regulation of CCS

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Overview

- Ongoing regulatory initiatives
- International Risk Governance Council project on Carbon Capture and Storage
- Regulatory Considerations over a CCS lifecycle
- Creating an adaptive management structure
- Conclusions

US Large-Scale

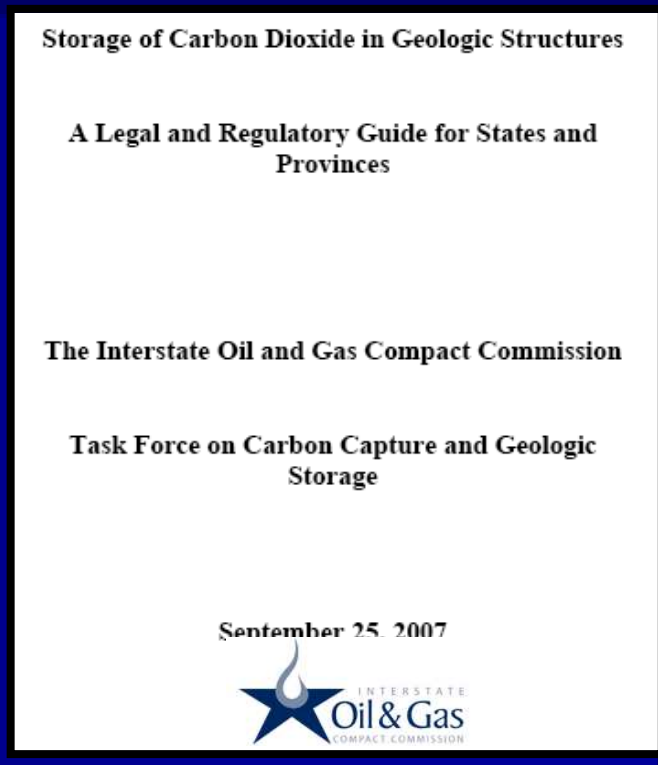
- DOE Awards (>1MT/y) injection studies
  - October 9 they announced the first three:
- **Plains CO2 Reduction Partnership** - Led by the Energy & Environmental Research Center at the University of North Dakota. CO2 from a post-combustion capture facility at a coal-fired power plant. A second test will demonstrate co-sequestration of CO2 and hydrogen sulfide.
  - **Total Project Cost**: $135,586,059 **DOE Share**: $67,000,000
- **Southeast Regional Carbon Sequestration Partnership** - Led by Southern States Energy Board. CO2 will come from a natural deposit and from a coal-fired power plant in the region.
  - **Total Project Cost**: $93,689,242 **DOE Share**: $64,949,079
- **Southwest Regional Partnership for Carbon Sequestration** - Led by the New Mexico Institute of Mining and Technology, will inject into the Entrada Sandstone Formation in the southwestern United States.
  - **Total Project Cost**: $88,845,571 **DOE Share**: $65,437,395

Adaptation of Existing—and creation of—Regulatory Frameworks

- **ADAPTATION**
  - **U.S**. EPA has issued guidance documents to regulate GS pilot-projects through the Underground Injection Control program as Class V experimental wells
  - **U.K.'s** Petroleum Act, and the **Australian** Petroleum (Submerged Lands) Acts informed by the Regulatory Guiding Principles, can both be used to manage early deployment of pilot projects
  - **International** Amendments to the London Protocol and the NE-Atlantic OSPAR marine treaty allow sub-surface injection of CO2 under the sea

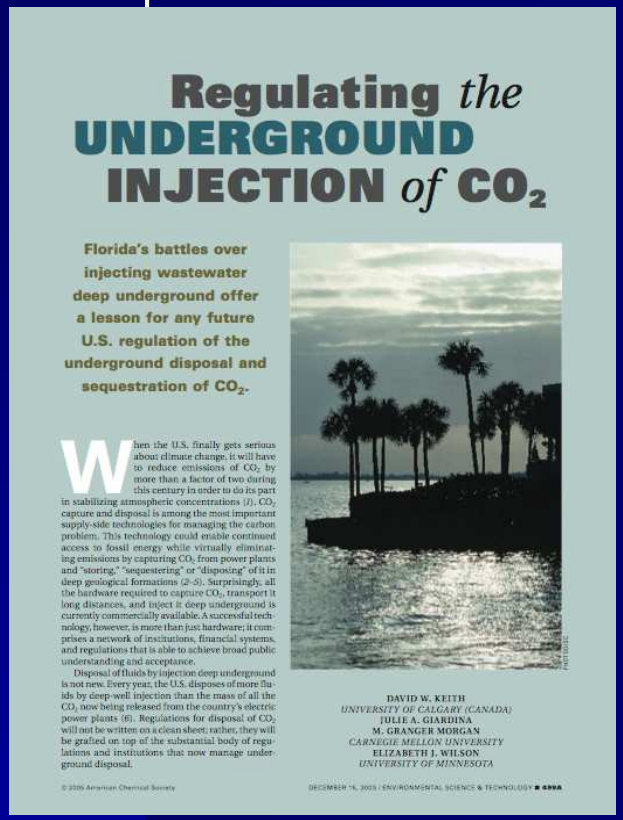
New proposed initiatives

- EU
  - propose new regulation 5 December 2007
- US
  - EPA rulemaking for CCS next year
  - Interstate Oil and Gas Compact Commission Guide for States
- UK
  - Scheduling a consultation and parliamentary time for legislation on regulation by the end of 2008
- UNFCCC
  - CCS in CDM



Source: IOGCC

Pitfalls in scaling up existing regulations



Regulating *the* UNDERGROUND INJECTION *of* CO_2

Florida's battles over injecting wastewater deep underground offer a lesson for any future U.S. regulation of the underground disposal and sequestration of CO_2.

When the U.S. finally gets serious about climate change, it will have to reduce emissions of CO_2 by more than a factor of two during this century in order to do its part in stabilizing atmospheric concentrations (1). CO_2 capture and disposal is among the most important supply-side technologies for managing the carbon problem. This technology could enable continued access to fossil energy while virtually eliminating emissions by capturing CO_2 from power plants and "storing," "sequestering" or "disposing" of it in deep geological formations (2–5). Surprisingly, all the hardware required to capture CO_2, transport it long distances, and inject it deep underground is currently commercially available. A successful technology, however, is more than just hardware; it comprises a network of institutions, financial systems, and regulations that is able to achieve broad public understanding and acceptance.

Disposal of fluids by injection deep underground is not new. Every year, the U.S. disposes of more fluids by deep-well injection than the mass of all the CO_2 now being released from the country's electric power plants (6). Regulations for disposal of CO_2 will not be written on a clean sheet; rather, they will be grafted on top of the substantial body of regulations and institutions that now manage underground disposal.

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Source: ES&T,Dec 2005.

- Florida experience with injected buoyant wastewater migrating into 'underground sources of drinking water'
- Highlights how the current EPA framework is not adequate to deal with the injection of large volumes of CO2
- This case illustrates the
  - problems of very large quantities (~3 Gt/yr) injected into unsuitable geological formations
  - difficulties that can arise from making *ad hoc* modifications to an existing regulatory regime.

Overview of IRGC CCS Regulation Project

- Commissioned 11 essays from experts in Australia, the EU and the US
- Workshop in March 2007 in DC
  - Authors
  - Stakeholders
    - NGO, Governmental, Industry
- Draft joint paper, submitted to *Environmental Science and Technology*
- Workshop report, IRGC report

International Risk Governance Council CCS Project

- Essay Authors
  - BP
  - Bellona/Statoil
  - RFF/IVL/CICERO
  - UK Energy Research
  - Australia GHG Office
  - Swiss-Re
  - Carnegie Mellon University
  - MIT
  - Stanford
  - National Resources Defense Council
  - PIK

What we all agreed upon…

- CCS can play an important role
  - Benefits > Liabilities
- Programmatic goals
  - Large volumes, stored long time, 1000's of years
  - "Maximize CO2 avoided, minimize CO2 sequestered"
- Siting is crucial
- Some credit for sequestered CO2
  - Within a trading scheme or otherwise
  - Fungible credits
- Long term stewardship… all agree public assumption of liability is necessary in the long term
  - When? (1 year to 30)
  - Based upon what? (performance, time limit, $$$)

Regulation must provide

- Clarity
- Framework for
  - Safety
  - Investment
  - Operation
  - Responsibility
- Stability
- Flexibility and adaptability to incorporate new scientific information

The good news

- Most risks are manageable… and have already been managed in other contexts
- Insurance industry comfort with potential health, safety and environmental risks
- Just long-term climate risk is unfamiliar

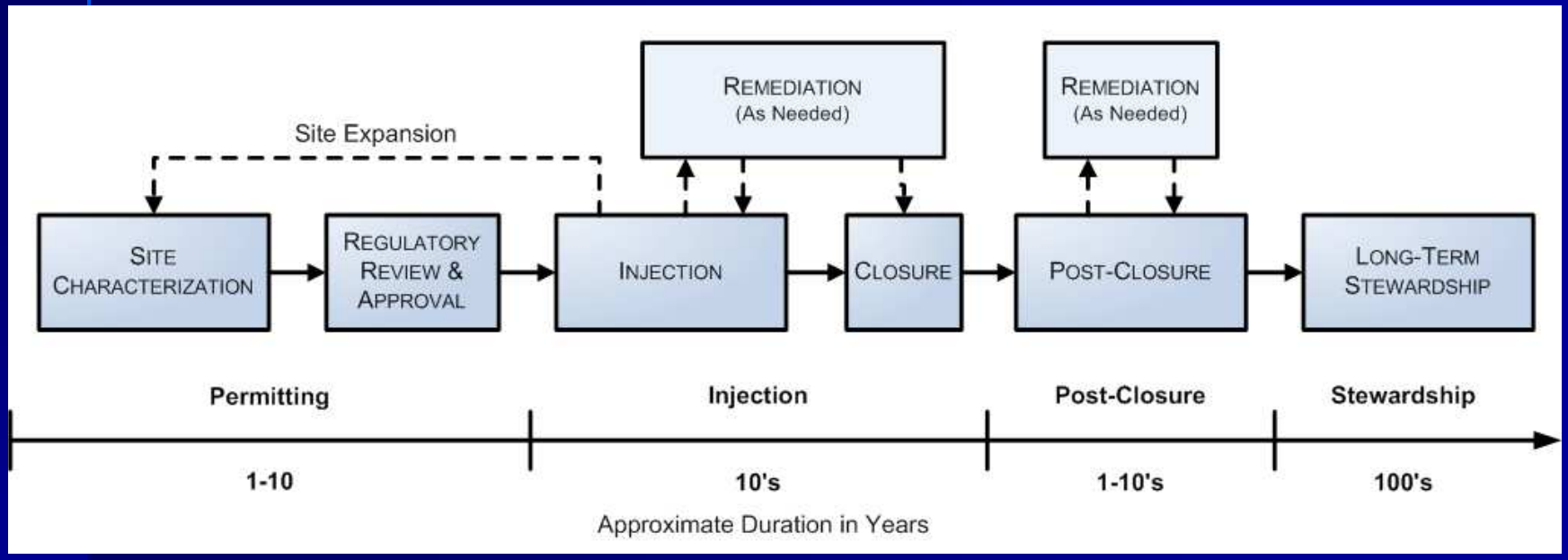
Early Deployment Now

- Limited number of large early projects now under existing regulations to learn
  - Capture reliability
  - Geologic site performance
  - Adequacy of models to predict reservoir performance at scale
  - MMV methodology, detection limits
  - Long-term liability
  - Industrial organization
- EU plan, US plans…
  - Beware the 'Power (point) Plant'

Transition to Commercial Deployment

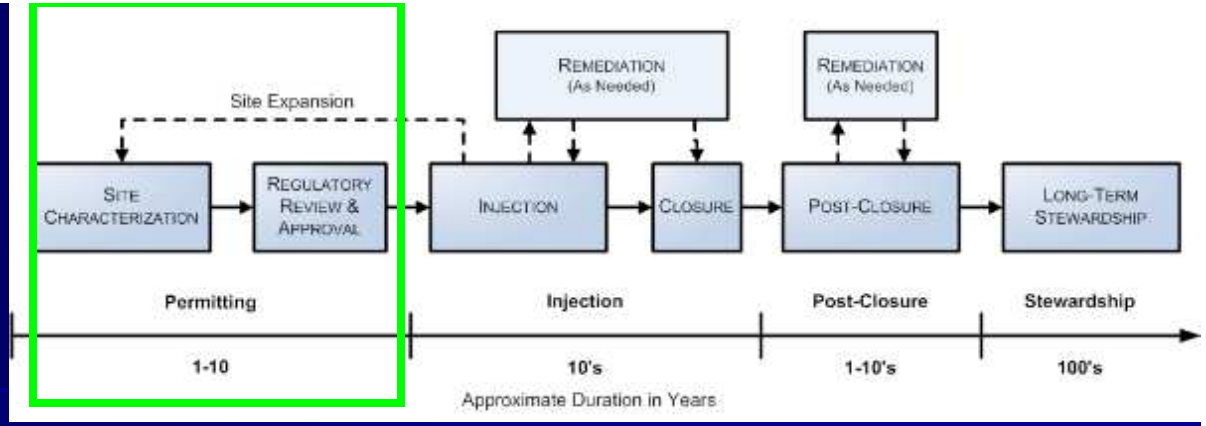
- Boutique regulations are fine for first projects, but more stability and predictability is needed for
  - Operators, financial interests, insurance, regulators, and public
- Regulations must provide predictability, accountability, and be adaptable
- Debate on whether this should be a formal two-stage process or more gradual transition

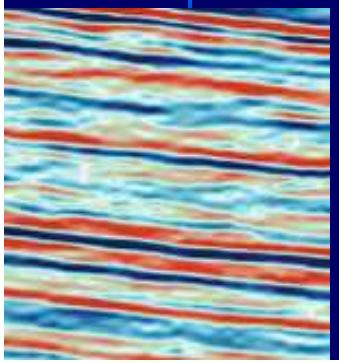
4 Stages of Regulation over the Lifecycle of CCS

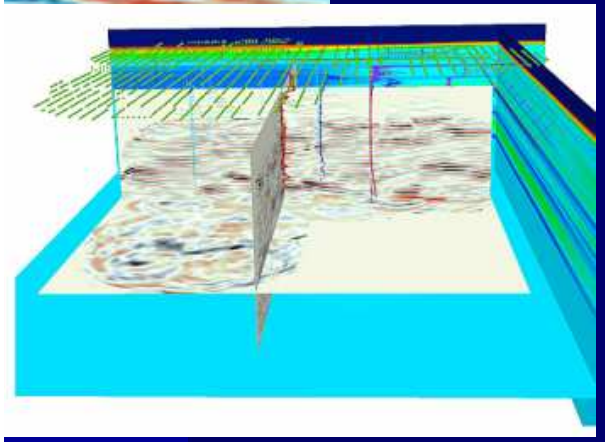


Source: Rubin et al. 2007

Siting





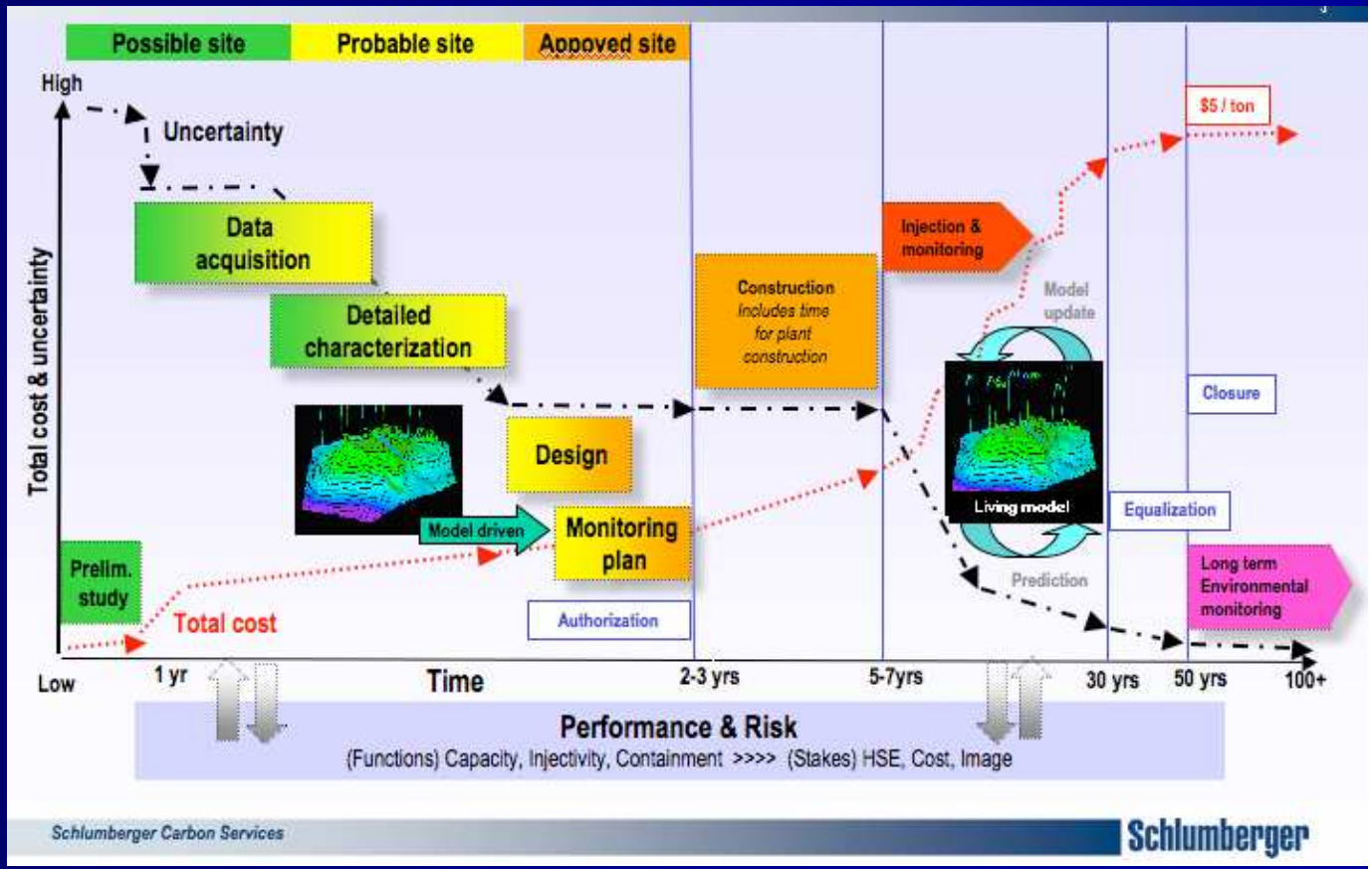


- Technical/Regulatory:
  - more sophisticated characterization than is now common
  - Site demonstration
- Legal/Regulatory:
  - Location, location, location
  - Will need to address salient international, national and local issues
    - Off-shore v. onshore risk
    - In US acquisition of pore space where surface rights interests also own sub-surface pore space, mineral rights also privately held

Source: NETL

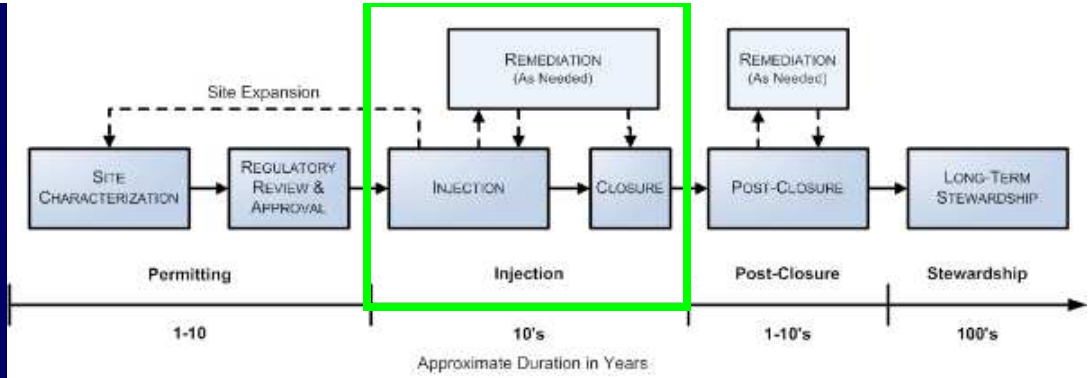
Geotechnical firms business plan

3-D seismic @ ~100k$/mi2
Several test wells @ ~2-5M$ ea

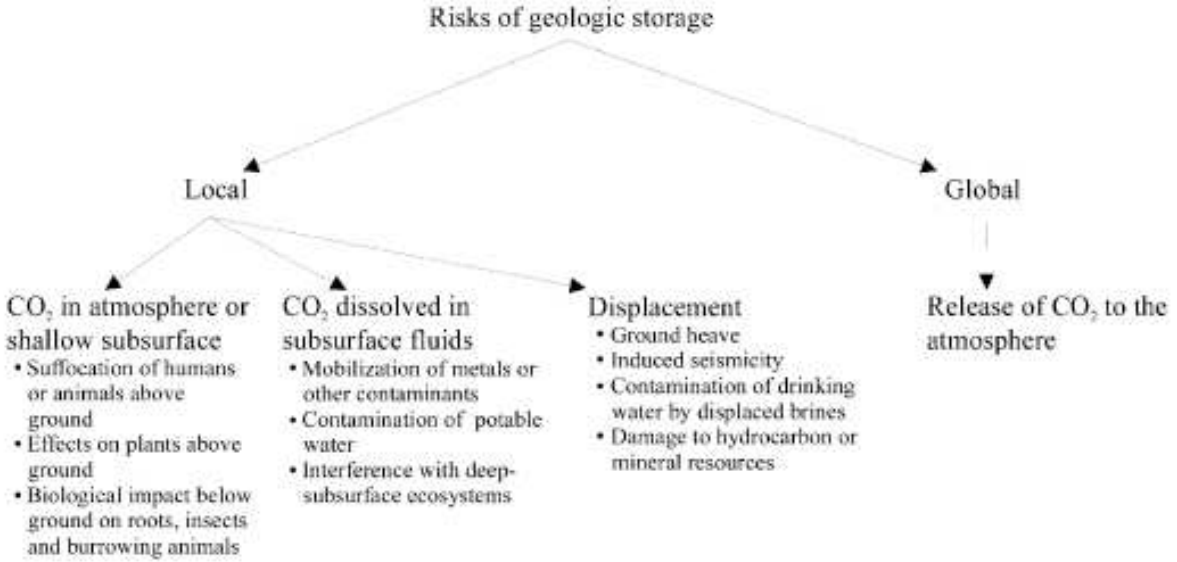


Source: Schlumberger Carbon Services Tombari, 2007

Site Operation

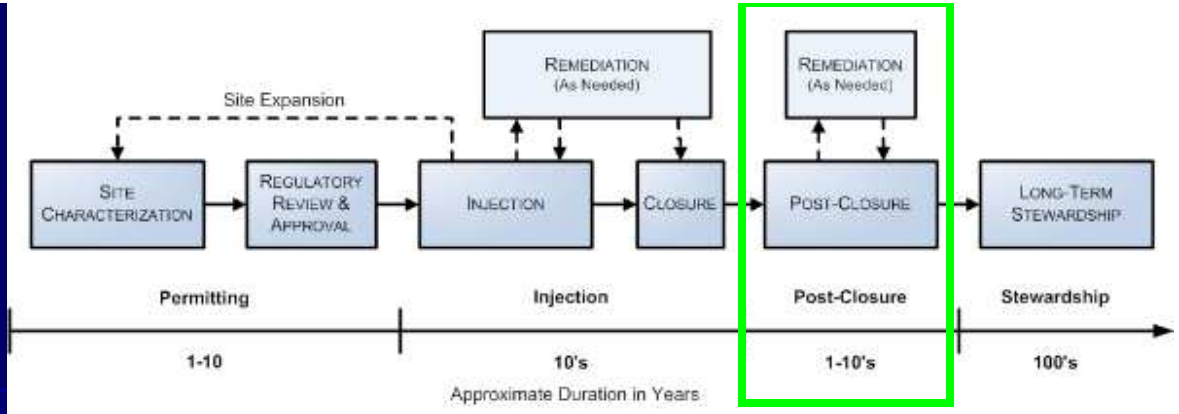


- Technical/Regulatory:
  - Need for continual monitoring - not just of bore holes but of entire injection field
  - Need for surface surveillance and leak detection
  - Criteria for identifying when problems are developing, and strategies for addressing and remediating them
- Legal/Regulatory:
  - Issues vary by jurisdiction and site… may include trespass and liability



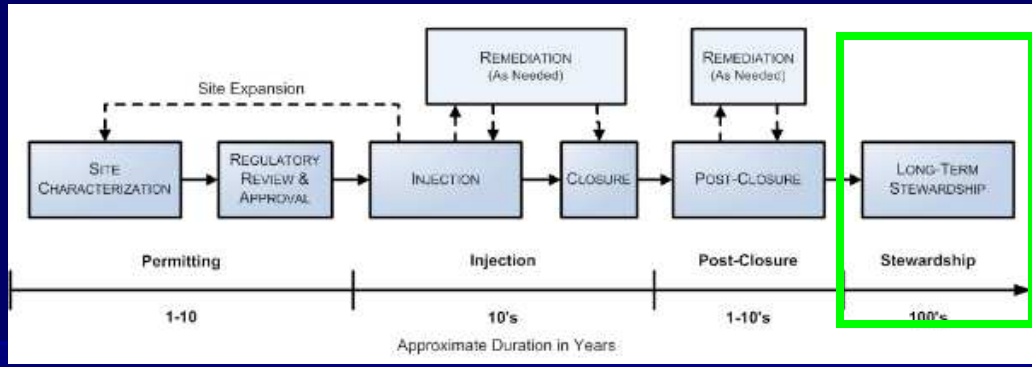
Source: Wilson et al., ES&T, 2003.

Site Closure



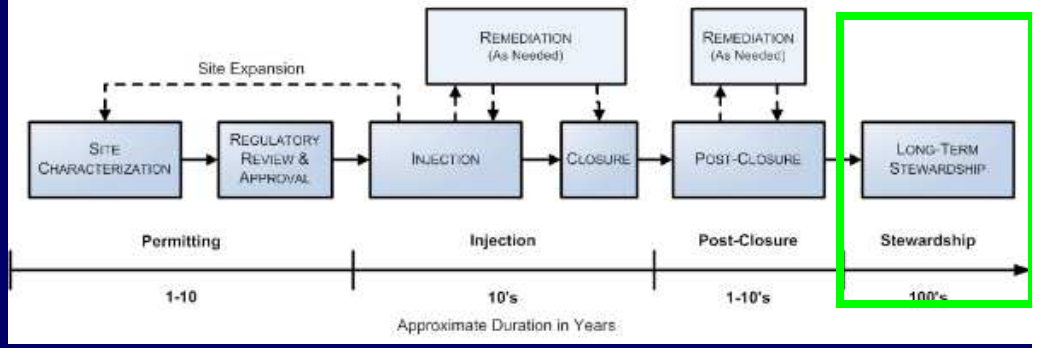
- Technical/Regulatory:
  - Need to develop criteria for establishing when a site is appropriate for closure
  - what procedures should be adopted
  - what ongoing monitoring is needed
  - when and how needed remediation is undertaken
- Legal/Regulatory:
  - Issues continue to include liability
  - transfer of responsibility

Long-term Stewardship



- Some interests argue that once the site is closed, responsibility should be immediately transferred to government.
- This is a bad idea for two reasons:
  - 1) Proper incentives. If operators continue to bear some responsibility for the site during the initial post-closure decades, they will be better motivated to assure the site is characterized, operated and monitored in a safe and secure way.
  - 2) Public perception. Public concerns may complicate the deployment of GS
- Operators who argue that sites are perfectly safe, while rushing to handoff all responsibility to government, will not be credible to the public.

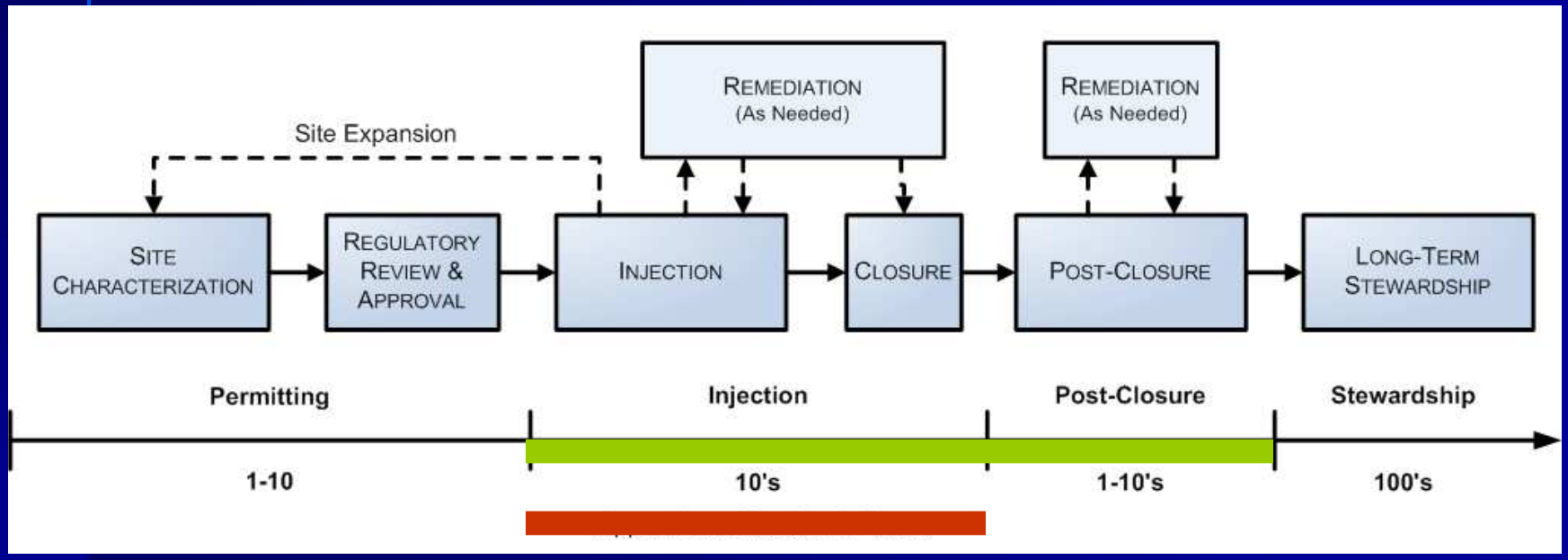
Long-term Stewardship



- Technical/Regulatory:
  - Need to develop criteria for deciding when a site is ready to be moved from post-closure to long-term stewardship
  - Fixed time period of time (e.g. 10 years) a performance-based standard is probably preferable
  - Must determine what ongoing monitoring is needed
- Legal/Regulatory:
  - Issues continue to include trespass and liability

Covering the costs of long-term stewardship

Integrating adaptive governance into site operation

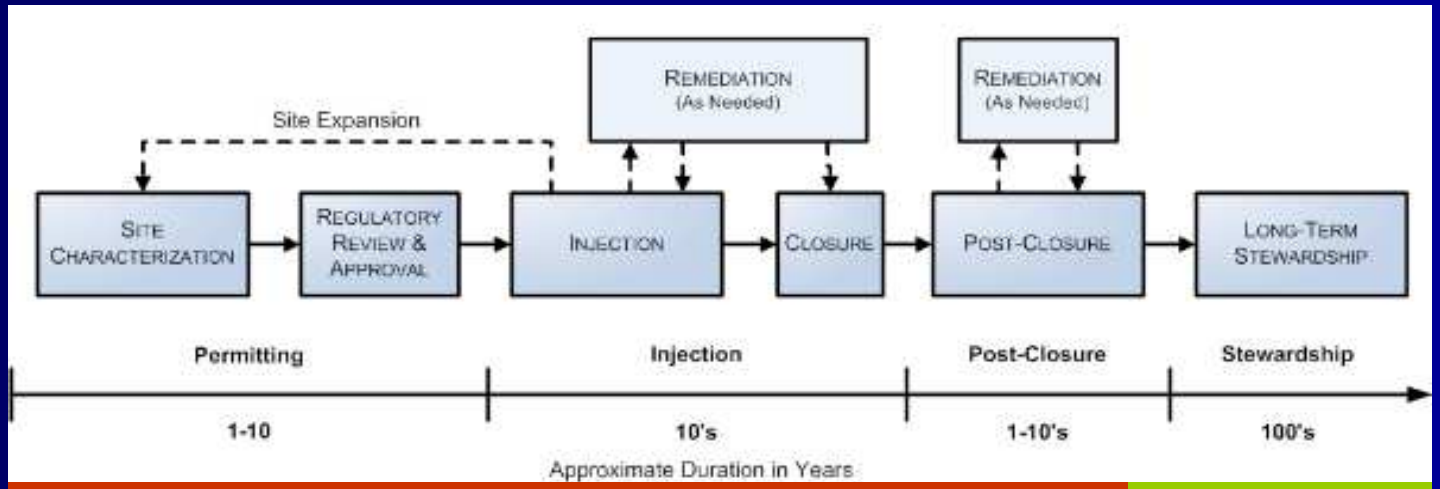


Insurance/bond for liability in case of default

Fee on injected CO_2 to cover long-term stewardship via a private or public fund

Separation of responsibilities to avoid conflicting incentives

- Agency responsible for long term stewardship should *not* be the same agency responsible for the approval of new sites and regulatory oversight during the operation and closure phases of existing sites.



Regulatory agency responsible for overseeing site selection, operation and closure

Agency responsible for accepting site into stewardship

Fungible CCS credits

- Credit for injected CO_2 in national and international markets
  - ETS and CDM discussions
- Assurances to prove
  - Injected CO_2 stays there
  - Can buy insurance to cover these credits to hedge against risk future leakage
    - Insurers will benefit from strong regulatory framework to ensure quality of credits

Not today: Power plants and pipelines

- Regulatory issues affecting power-plants and pipelines

Pipelines:

Who builds them?

Who has access?

Power plants:

Who pays for the added cost?

Impacts of state/nation-state policy goals

Source: Source: Professor Lars Strömberg, Vattenfall AB

Public Assumption of Responsibility (and public perception risk…)

- FEAR: Requiring public assumption of liability too early may undermine public confidence
  - General sentiment: "if it is as safe as you say, why do you want the government to take responsibility?"

Conclusions

- Data from full-scale operations necessary to demonstrate CCS performance to public, insurance and financial industries and regulators
- Adaptive management approach necessary for managing geologic uncertainties and ensuring long-term care
- Industrial organization will shape regulatory needs

Fin

- Project Outputs
  - Workshop report
  - Report for conference
  - General article for ES&T
  - Essays available on IRGC website www.irgc.org
- Invited proposal with the Doris Duke Charitable Trust

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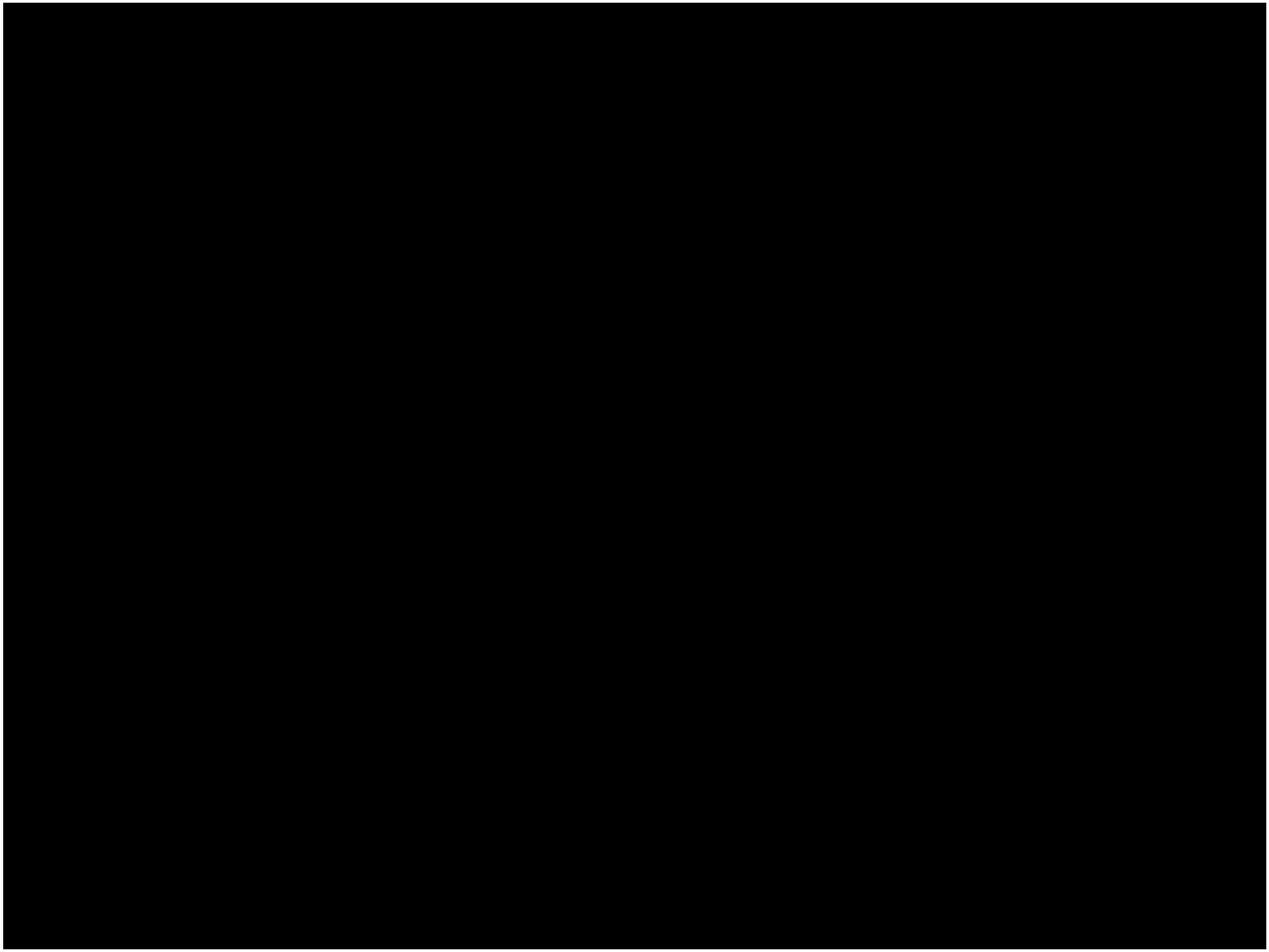
- The views expressed may not be shared by any of the sponsors.



Adaptive Management of Commercial CCS

- Goal:
  - Clear expectations for all parties
  - Incorporate emerging site information and evolving risk management strategy
- Challenge:
  - Develop a regulatory framework that is both predictable, yet able to incorporate new information

Adaptive management for long-term care

- Operational period with regular, scheduled 'true up' performance reviews
  - Performance-based decision nodes would govern management for next period
  - Operator has control as to how to manage project
  - Regulatory procedures established beforehand
  - Financial community able to judge risk and performance
  - Public assurance that project is being actively managed
- At point of transfer to public, high level of confidence in site performance and funds for long-term care established (no unfunded public mandate…)

Adaptive management, long-term care and climate hedging

- Example:
  - Operator: Payment into a fund that covers both site closure and long-term care
  - Initial amount is set by site risk profile and past performance
  - Periodic 'true up' would raise or lower payments into fund and be based upon operational data and site performance
- Advantages
  - Predictable, manageable by operator and financial community
  - "Moral hazard" of bonding avoided
  - Good site selection and responsible management encouraged

Source: Source: Professor Lars Strömberg, Vattenfall AB