Addressing CCS Liability

Using a Risk Log to Better Define "Liability" and Consider Mitigation Options

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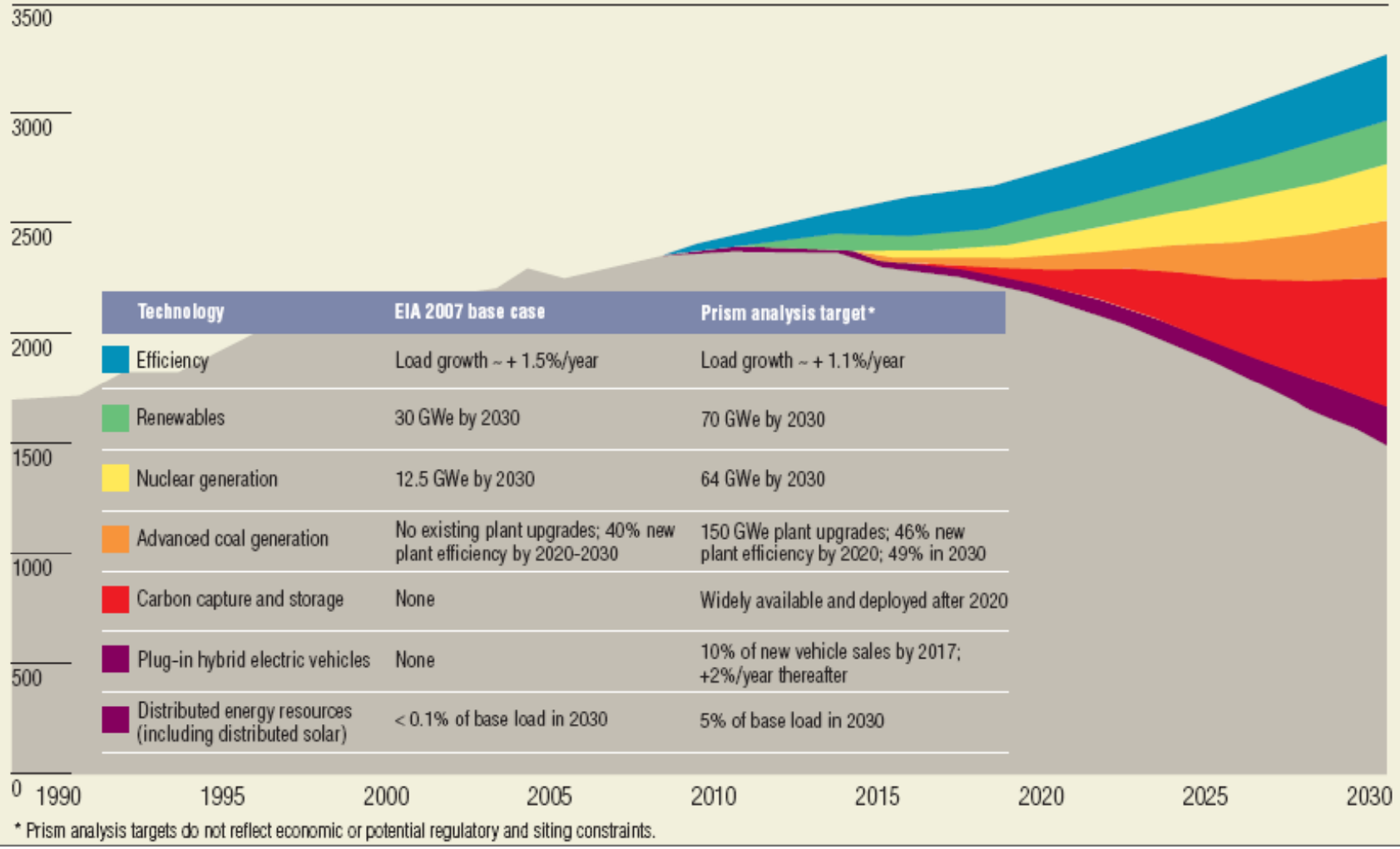
Overview

- Liability as an “Issue”
- Use of the Risk Log
  - Description
  - Process
  - Preliminary Findings
  - Next Steps
- Implications and Next Steps

CCS a Critical Technology

TABLE 1

U.S. ELECTRIC SECTOR

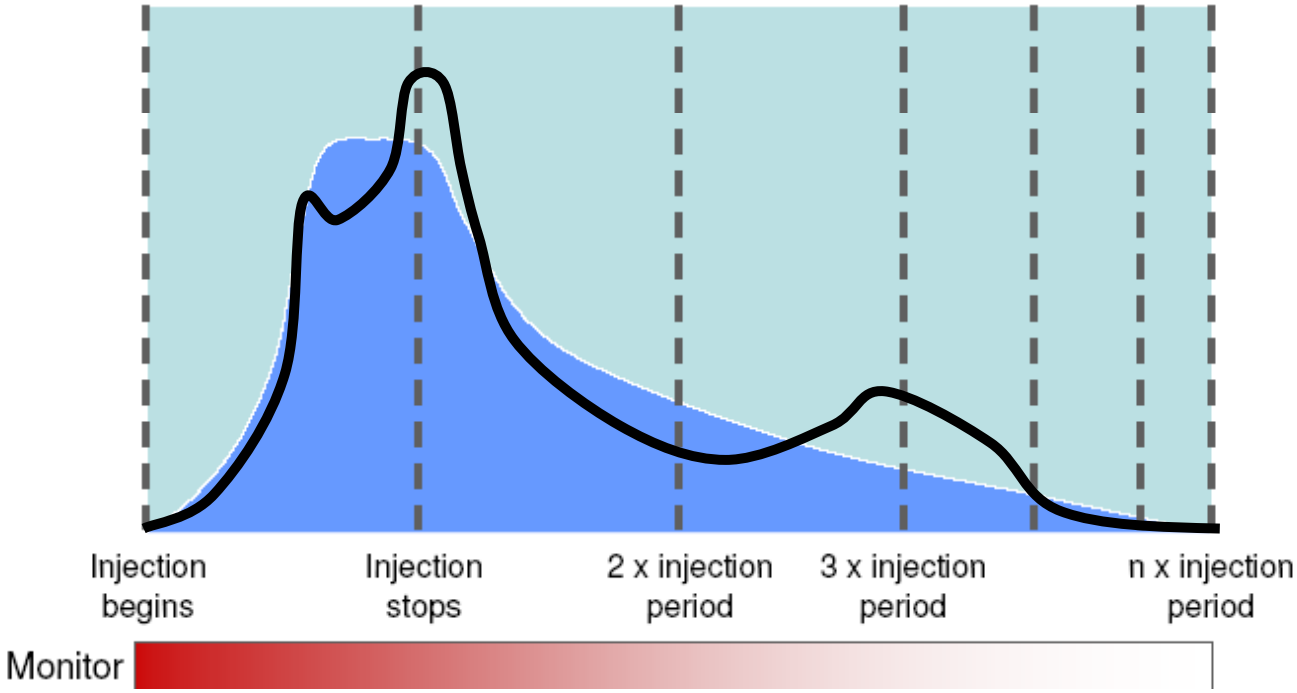


Technology	EIA 2007 base case	Prism analysis target*
Efficiency	Load growth ~ + 1.5%/year	Load growth ~ + 1.1%/year
Renewables	30 GWe by 2030	70 GWe by 2030
Nuclear generation	12.5 GWe by 2030	64 GWe by 2030
Advanced coal generation	No existing plant upgrades; 40% new plant efficiency by 2020-2030	150 GWe plant upgrades; 46% new plant efficiency by 2020; 49% in 2030
Carbon capture and storage	None	Widely available and deployed after 2020
Plug-in hybrid electric vehicles	None	10% of new vehicle sales by 2017; +2%/year thereafter
Distributed energy resources (including distributed solar)	< 0.1% of base load in 2030	5% of base load in 2030

* Prism analysis targets do not reflect economic or potential regulatory and siting constraints.

Source: EPRI - http://mydocs.epri.com/docs/CorporateDocuments/AssessmentBriefs/The_Full_Portfolio.pdf

With Important Uncertainty Today

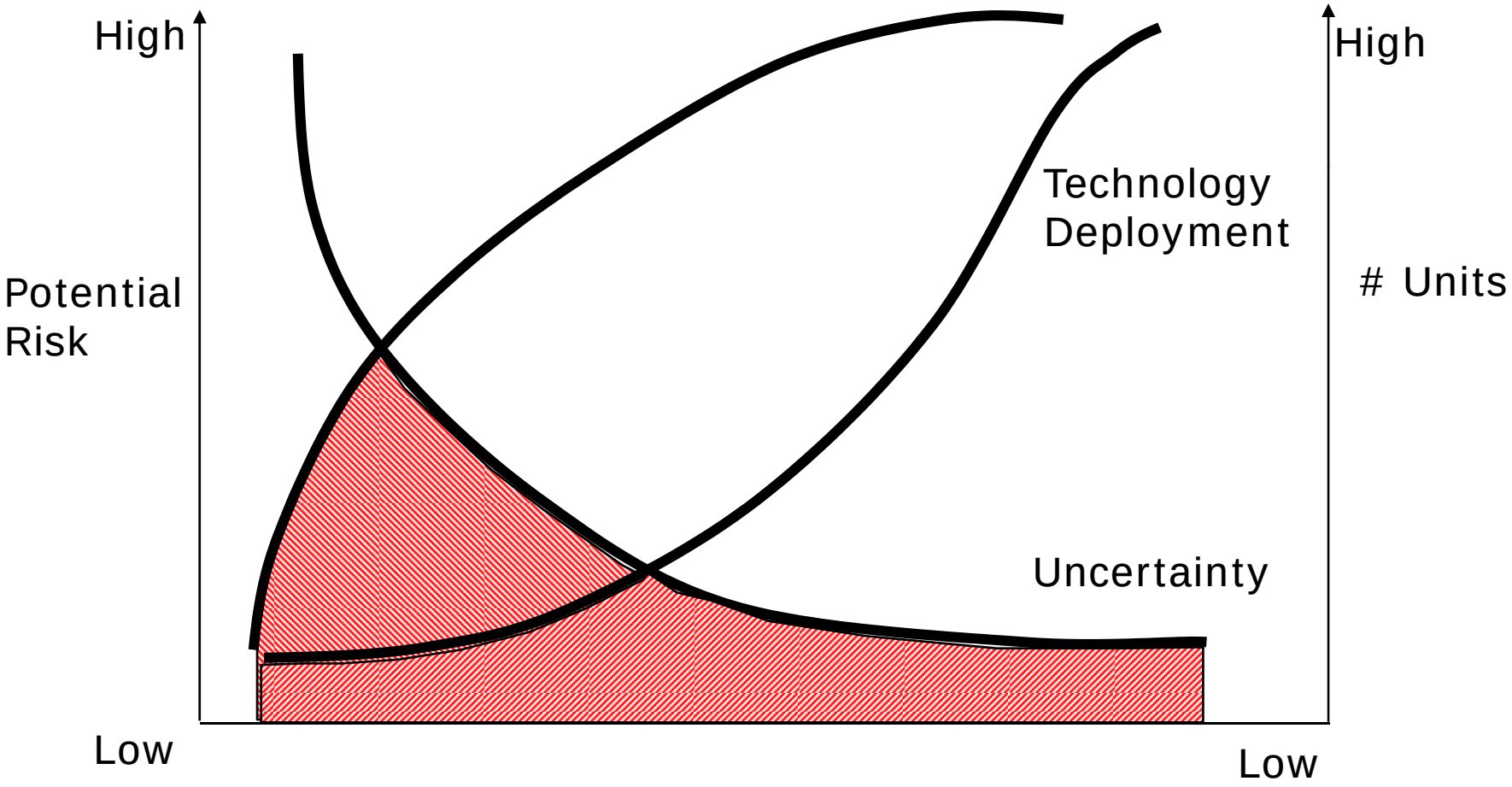


"The blue curve represents a project with increasing pressure to some predetermined limit and decreasing risk subsequent (Courtesy of S. Benson, Stanford). The black line represents an alternate potential risk profile in which secondary increases in risk are a function of local geochemical risks and rock kinetics." (Courtesy of J. Friedmann, LLNL)

And No One Wants To Be Left "Holding The Bag" For Uncertainty

- Capital markets want predictable returns on investment and exit
- Project developers – especially utilities – worried about shareholder value and reputation
- Public wants adequate incentives for safe operation and accountability for problems
- Insurers want predictability in evaluating potential losses and pricing policies

The Cost of Uncertainty



Potential CCS Liability

- Liability = legal obligation to do or pay
- Predictable components:
  - Regulatory requirements (costs estimated up front)
  - Best practices (property rights acquisition, voluntary measures such as insurance)
- Less predictable components:
  - Cost increases due to inflation, resource constraints, changes in regulations (costs update during project life)
  - Risks = probability of damages x cost (predictable or reactionary?)
- Timing is an important dimension
  - Focus is on duration and open-endedness of long-term liability, BUT risk management has to take place in the short term and is a factor in go/no go decisions

"To answer your question. Yes, if you shoot an arrow into the air and it falls to earth you know not where, you could be liable for any damage it may cause."

Purpose of Risk Log Exercise

- To begin to develop comprehensive understanding of potential risks of CCS and potential risk mitigation options
- To throw light on the potential risks by naming, describing, and placing them in context

Development of Risk Log

- Used qualitative risk assessment concept to develop straw “Risk Log”
- Breaks a CS project into six stages; lists potential events or damages at each stage, describes them, and provides framework for ranking and estimating costs
- Small workgroup reviewed initial risk log
- 16 experts and stakeholders rank priority and cost for each event or damage
- Results tabulated and assessed

Sample of Risk Log

1. Siting	2. Construction	3. Operation	4. Closure	5. Post Closure	6. LT Maintenance & Stewardship
12-36 months	12-36 months	1-30 years +	12-36 months	Time limit or Performance driven	Indefinite post closure
1.1 Worker safety 1.2 Damage to private property 1.3 Incomplete site characterization 1.4 Public Opposition 1.5 Failure to obtain access or storage rights 1.6 Failure to obtain permit 1.7 Drilling "dry hole's)"	2.1 Worker safety 2.2 Damage to private property 2.3 Damage to confinement zone (by fracturing a cap for example) 2.4 Contractor delays / cost over-runs 2.5 Poor well construction 2.6 Failure to adequately complete old wells/boreholes	3.1 Worker safety – OSHA 3.2 Worker safety – CO_2 exposure 3.3 Groundwater: mechanical failure 3.4 Groundwater: confinement zone failure 3.5 Property damage (mineral rights) 3.6 Ecosystem degradation (terrestrial or aquatic) 3.7 Public exposure to CO_2 release (surface pipeline leak, borehole, well blow out) 3.8 Prolonged atmospheric release	4.1 Worker safety 4.2 Improper well abandonment 4.3 Failure to adequately install MMV system 4.4 Materials failure	5.1 Groundwater: CO_2 and geochemical reaction products 5.2 Groundwater: brine or gas displacement 5.3 Subsurface property damage (mineral rights) 5.4 Ecosystem degradation (terrestrial or aquatic) 5.5 Public exposure to CO_2 5.6 Atmospheric release 5.7 Lawsuits	6.1 LT groundwater contamination 6.2 LT Subsurface property damage (mineral rights) 6.3 LT ecosystem degradation (terrestrial or aquatic) 6.4 LT public exposure to CO_2 6.5 LT atmospheric release (loss of credits / compliance) 6.6 LT lawsuits 6.7 LT third party damage to confinement zone 6.8 Seismicity 6.9 Change in law

ID	4.2 Improper well abandonment procedures (borehole leaks)	4.3 Failure to adequately install MMV system
Description	The sealing mechanism is not properly installed leaving the plug weak or with small leaks	MMV components either are rendered inoperable because of installation issues, or they are not located as planned and therefore miss key signals
Timescale	Would take place during closure but might not be manifested for some time	Problem would take place during the actual phase of closure
Potentially Involved Parties	Operator, team constructing the plug / closing the well, Fed or State Agencies, CCS Fund	Closure team, project planning team, Operator, Fed or State Agencies
Preventive Action	Training, integrity tests for the seal, MMV	Hire reputable installation firm; periodic testing of MMV system
Mitigation Response	Repair plug	Repair MMV systems around well; install new equipment if needed
Residual Risk	None likely	MMV fails to detect unexpected migration of plume
Warning Signals	MMV results	Inconsistent MMV results
Interdependence / Risk Coupling	None likely	
Priority Ranking		
Mitigation Cost		

General Types of Damages

- Harm to Workers
- Harm to the Public
- Environmental Damages
- Cautionary Events
- Property Damage
- Project Delays / Cost Overruns

Preliminary Findings

- Difficulty in applying ranking generically to all reservoir types
- Risks are interconnected – actions taken at the start of the project have a huge impact on, but are not solely responsible for, the potential for risk arising later
- There is a set of conventional damages, that although potentially high risk (probability x cost) they are managed in conventional industrial settings – worker safety, industrial operations
- Greatest uncertainty related to potential for and impacts of leakage

Implications for Projects

- Risk assessment applied to a project will influence site selection and project design.
- Mitigation tools include risk based monitoring, management protocols, third party contracts for service, property rights acquisition, insurance, and other financial instruments (e.g., hedges)
- Short-term, the potential for low probability / high cost events is problematic because it is not zero
- Long-term, phased-in liability sharing seems desirable given public benefit of addressing climate change by inducing CCS investment and having proactive institutional oversight of sites. The tension will be in determining the limitations, criteria, and timing of such phase-in.

Next Steps

- Allow the ideas and discussions coming from the workshops to percolate
- Refine the articulation of damages and the scale for assessing likelihood and cost
- Do a second round of the risk log
- Review the efficacy of various risk management mechanisms
- Write up process and findings in a paper