CONFIDENCE IN CARBON STORAGE FOR INDUSTRIAL SOURCES

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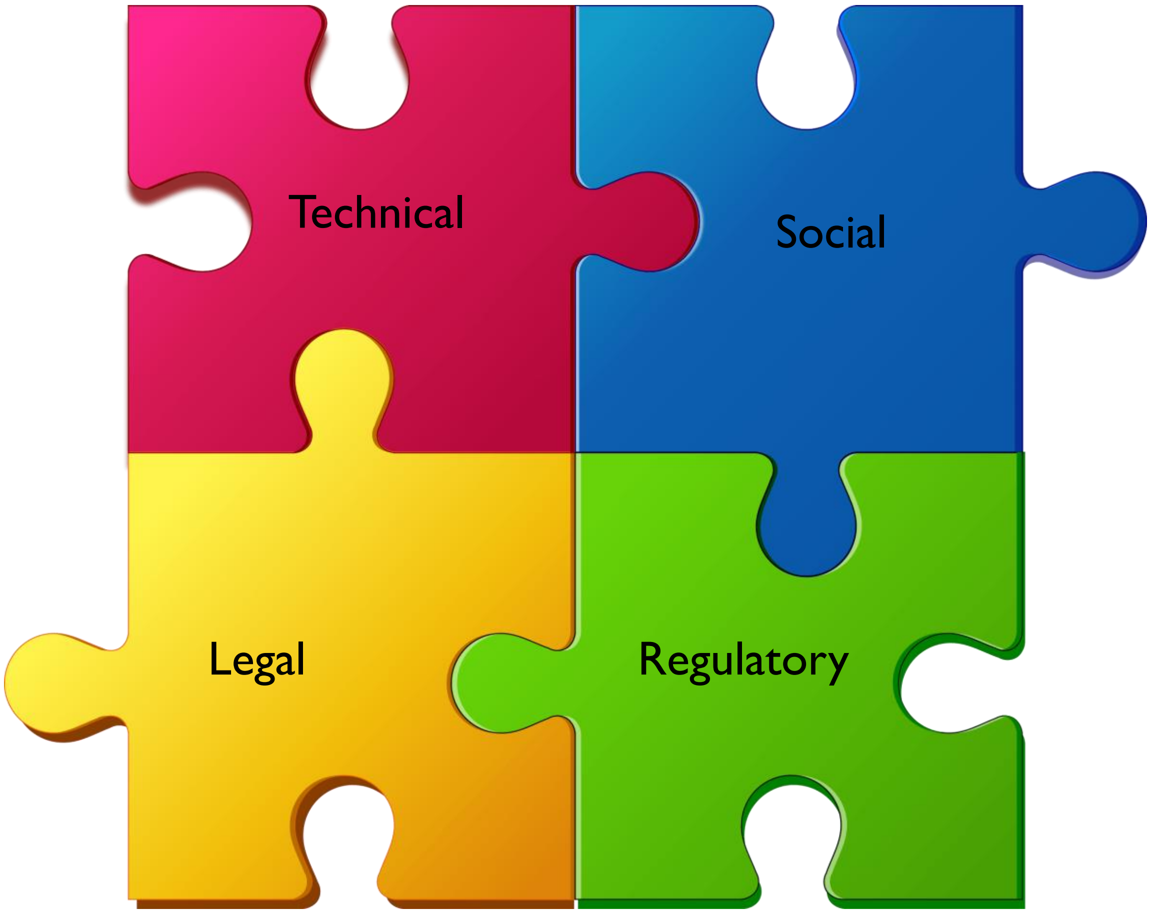
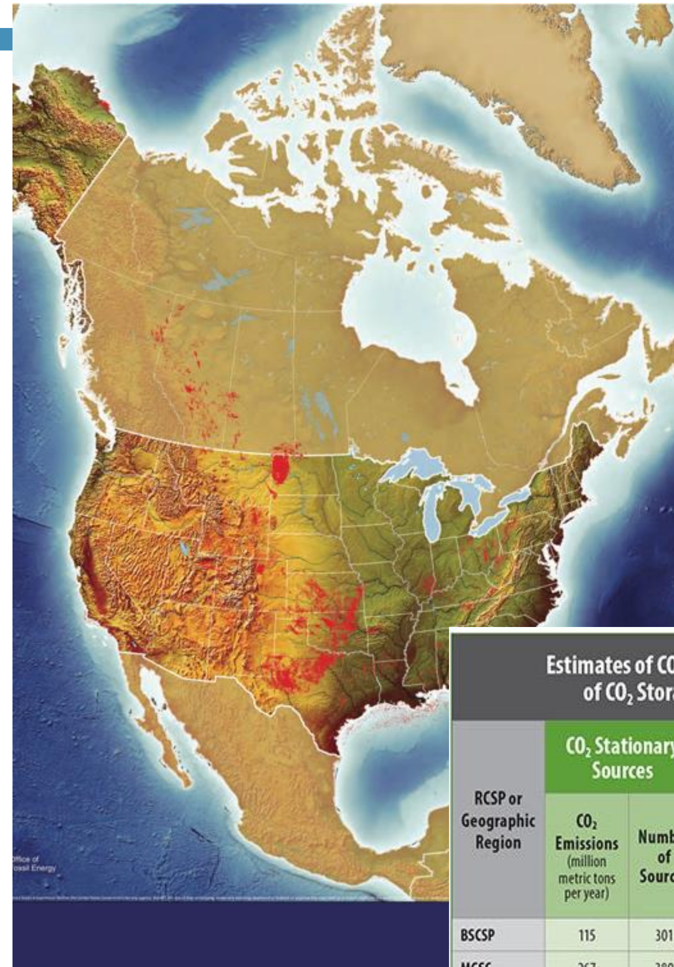
UNIVERSITY OF ILLINOIS – ILLINOIS STATE GEOLOGICAL SURVEY

THE PIECES ARE COMING TOGETHER





Estimates of CO_2 Stationary Source Emissions and Estimates of CO_2 Storage Resources for Geologic Storage Sites

RCSP or Geographic Region	CO_2 Stationary Sources		CO_2 Storage Resource Estimates (billion metric tons of CO_2)								
	CO_2 Emissions (million metric tons per year)	Number of Sources	Saline Formations			Oil and Gas Reservoirs			Unmineable Coal Areas		
			Low	Med***	High	Low	Med***	High	Low	Med***	High
BSCSP	115	301	211	805	2,152	<1	<1	1	<1	<1	<1
MGSC	267	380	41	163	421	<1	<1	<1	2	3	3
MRCSP	604	1,308	108	122	143	9	14	26	<1	<1	<1
PCOR*	522	946	305	583	1,012	2	4	9	7	7	7
SECARB	1,022	1,857	1,376	5,257	14,089	27	34	41	33	51	75
SWP	326	779	256	1,000	2,693	144	147	148	<1	1	2
WESTCARB*	162	555	82	398	1,124	4	5	7	11	17	25
Non-RCSP**	53	232	--	--	--	--	--	--	--	--	--
Total	3,071	6,358	2,379	8,328	21,633	186	205	232	54	80	113

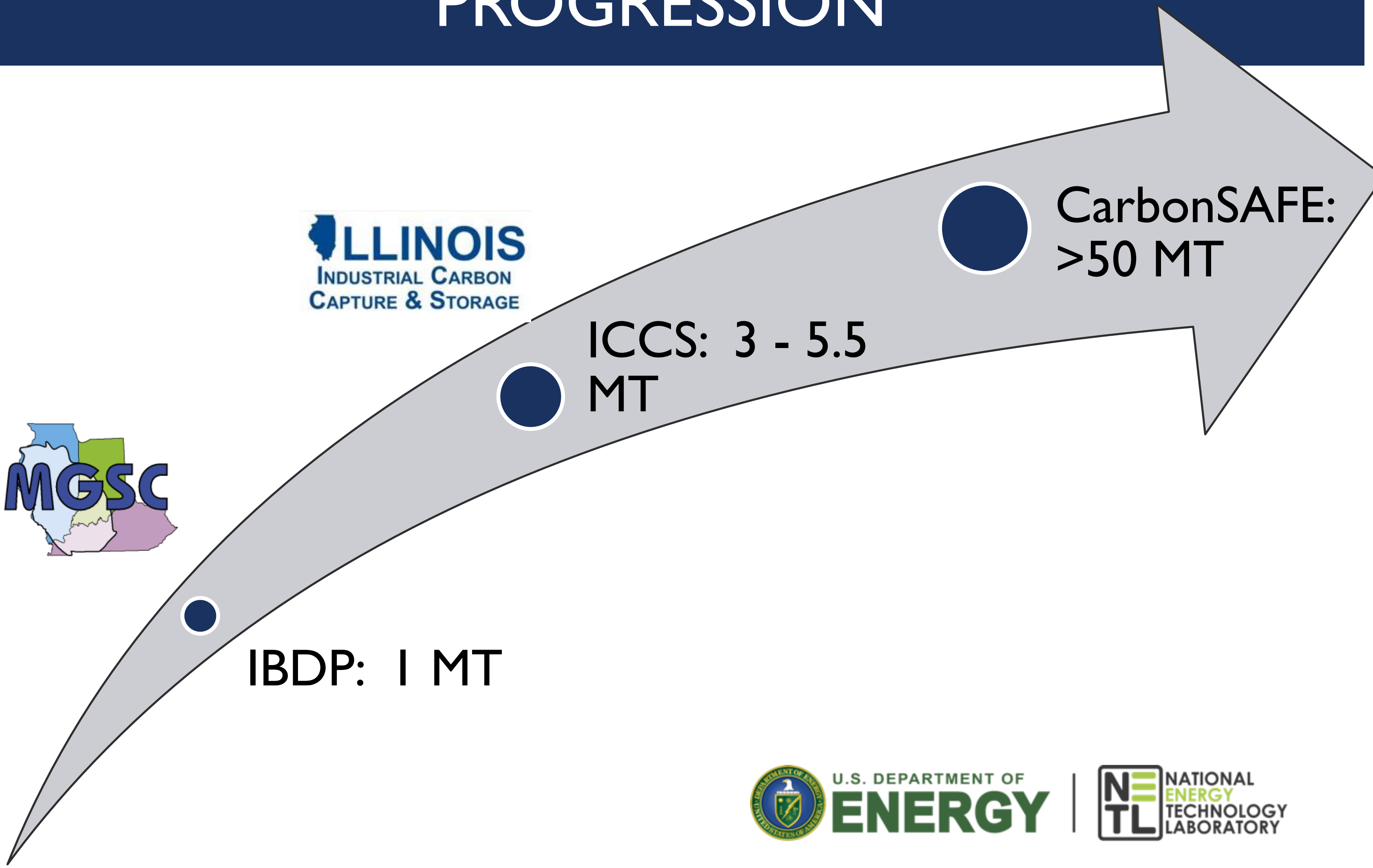
Source: U.S. Carbon Storage Atlas – Fifth Edition (Atlas V); data current as of November 2014

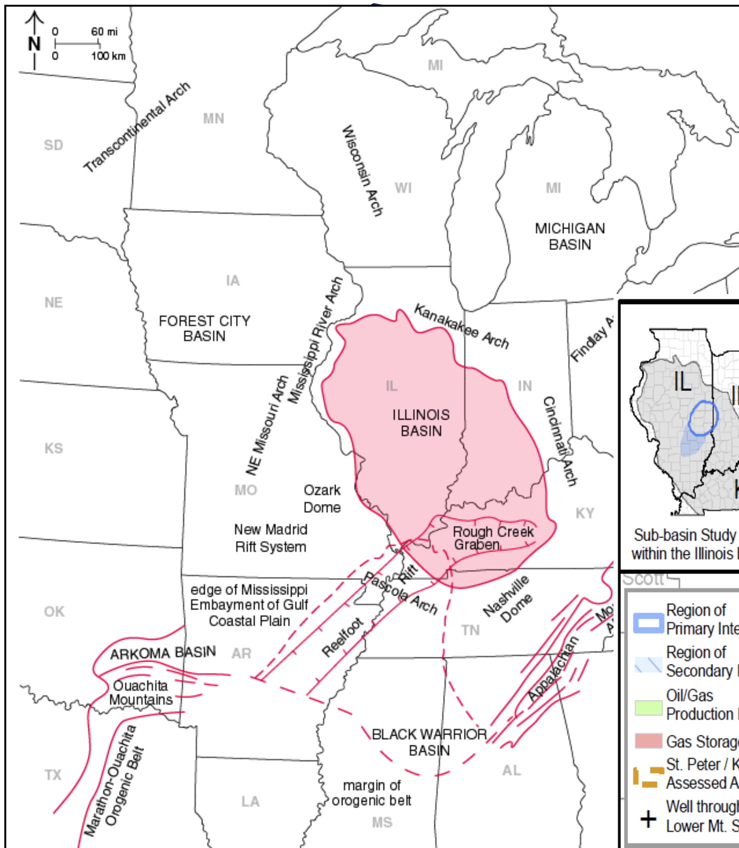
* Totals include Canadian sources identified by the RCSP

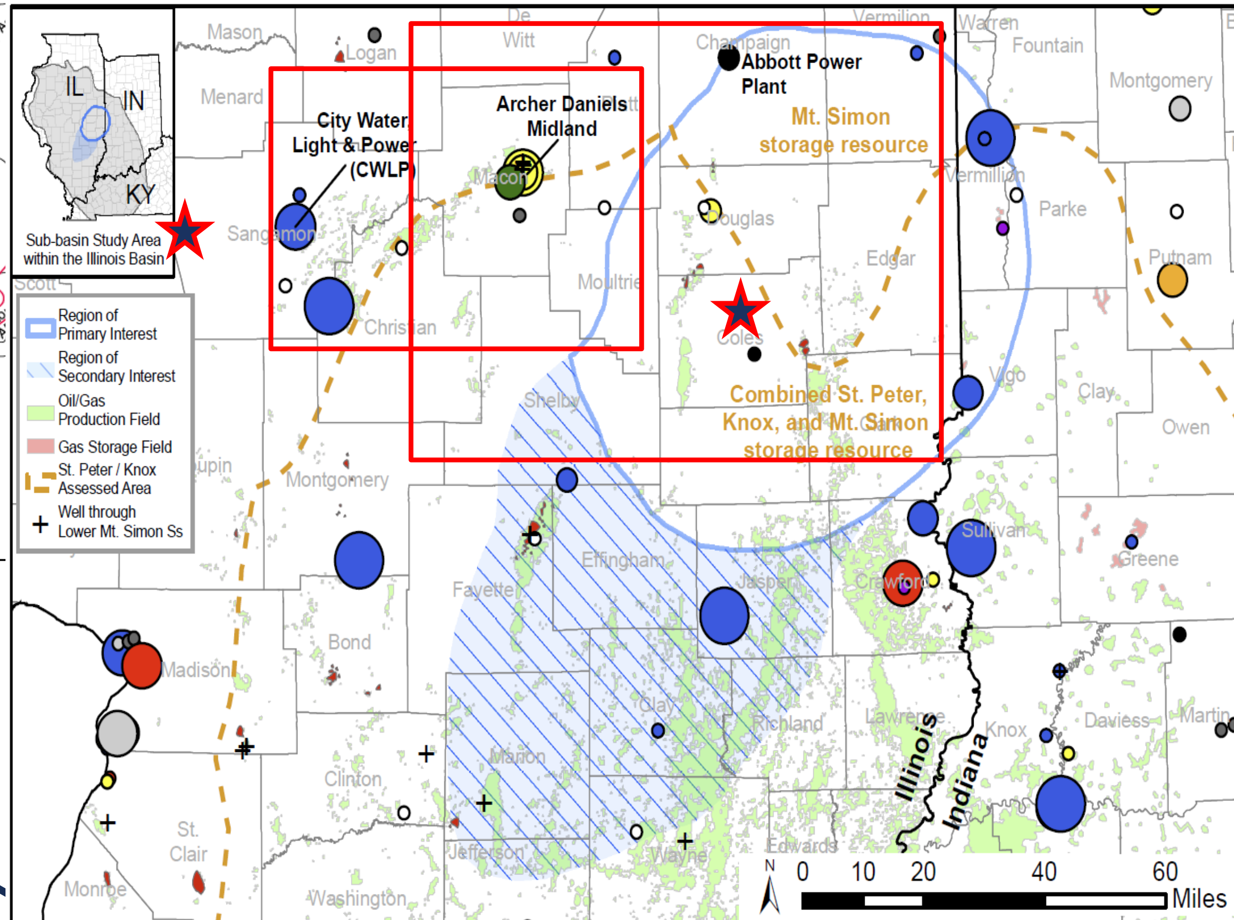
** As of November 2014, "U.S. Non-RCSP" includes Connecticut, Delaware, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, and Puerto Rico

*** Medium = p50

ILLINOIS BASIN INDUSTRIAL CCS PROGRESSION




N
0 60 mi
0 100 km
Transcontinental Arch
MN
SD
Wisconsin Arch
WI
MI
MI
MICHIGAN BASIN
IA
NE
FOREST CITY BASIN
Mississippi River Arch
NE Missouri Arch
Kanakakee Arch
Findlay Arch
IL
IN
ILLINOIS BASIN
Cincinnati Arch
KS
MO
Ozark Dome
New Madrid Rift System
Rough Creek Graben
KY
Pascola Arch
Rift
Nashville Dome
edge of Mississippi Embayment of Gulf Coastal Plain
OK
ARKOMA BASIN
AR
Reelfoot
TN
Appalachian
Ouachita Mountains
BLACK WARRIOR BASIN
AL
TX
Marathon-Ouachita Orogenic Belt
LA
margin of orogenic belt
MS


IL
IN
KY
Sub-basin Study Area within the Illinois Basin
Region of Primary Interest
Region of Secondary Interest
Oil/Gas Production Field
Gas Storage Field
St. Peter / Knox Assessed Area
Well through Lower Mt. Simon Ss
City Water, Light & Power (CWLP)
Archer Daniels Midland
Abbott Power Plant
Mt. Simon storage resource
Combined St. Peter, Knox, and Mt. Simon storage resource
Mason
Logan
De Witt
Champaign
Vermilion
Warren
Fountain
Montgomery
Menard
Macon
Sangamon
Douglas
Vermillion
Parke
Putnam
Edgar
Moultrie
Coles
Christian
Shelby
Vigo
Clay
Owen
Montgomery
Effingham
Fayette
Jasper
Crawford
Sullivan
Greene
Madison
Bond
Clay
Richland
Lawrence
Knox
Daviess
Martin
Marion
Clinton
St. Clair
Jefferson
Wayne
Edwards
Monroe
Washington
Illinois
Indiana
N
0 10 20 40 60
Miles

SAFETY THROUGH MONITORING

- Atmospheric monitoring
- Remote sensing
- Shallow geophysical monitoring
- Shallow groundwater monitoring
- Injection well monitoring
- CO_2 monitoring
- Injection formation monitoring
- Mitigation plans
- Validation using geochemistry, reservoir engineering, and geophysics

LESSONS DRIVE ADVANCEMENT

- Geology is critical and will always remain key factor
- Iterative scientific investigation allows for advancement and economy of scale
- Baseline environmental assessments are critical
- Unanticipated results provide insights into improvements that benefit all projects
- Incorporate technology changes into life cycle of project
- Occom's Razor applies to CCUS
- Scientific and engineering timeframe not aligned with policy
- Pilot and demonstration projects provide critical insights
- Industry ready to engage and start projects
- Policy drivers are necessary to facilitate commercialization
- Regulatory, legal, and social factors require significant time investment

STEADY PROGRESS IN READINESS AND CONFIDENCE

Barriers (2003)

Obstacles (2009)

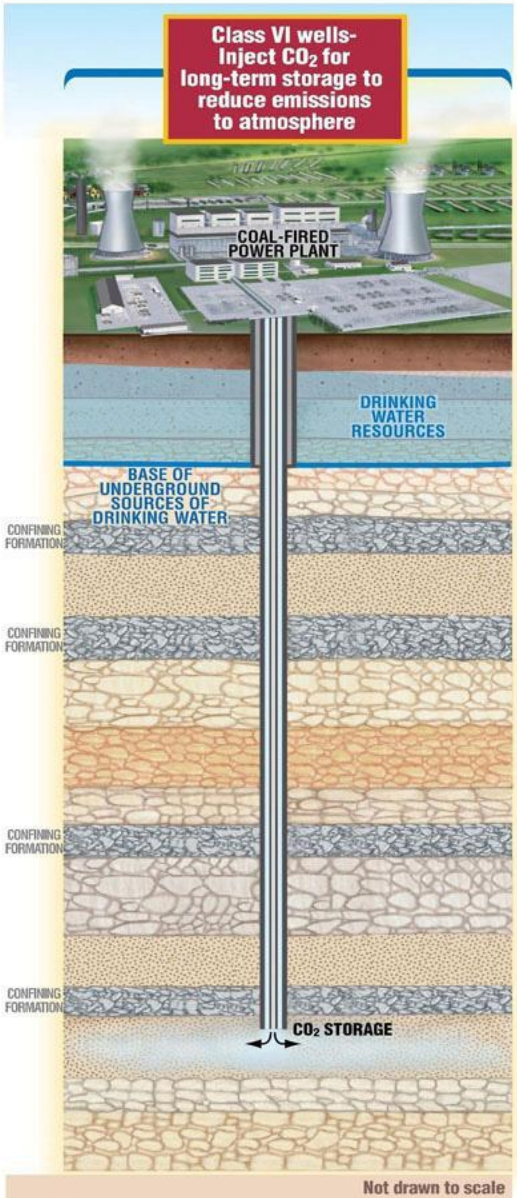
Challenges (2011)

Success (2015)

Commercial Deployment (2017 and beyond)

Proven technology	Policy and Regulatory	Success Metrics	Spheres of Engagement
• Saline and EOR storage • ISO Standards 27914 and 27916	• UIC Class VI • Tax Incentives	• Suitable geology • Good partnerships • Leverage resources • Experience	• Project • Policy • Public

Safe storage of CO_2 is viable and happening now



REGULATORY FRAMEWORK

Underground Injection Control (UIC) Program:

- Protects drinking water resources
- Specific class dedicated to carbon storage:
  - Siting
  - Construction
  - Operation
  - Testing
  - Monitoring
  - Closure
- Unique Issues:
  - Buoyancy of CO_2
  - Subsurface mobility
  - Corrosivity
  - Large injection volumes

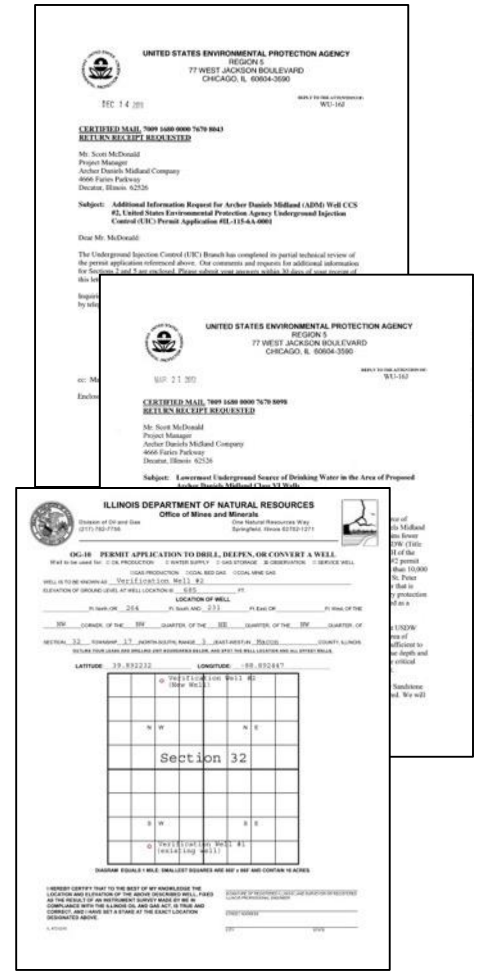
https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-co2

Permitting has been rate-limiting step for Illinois Projects

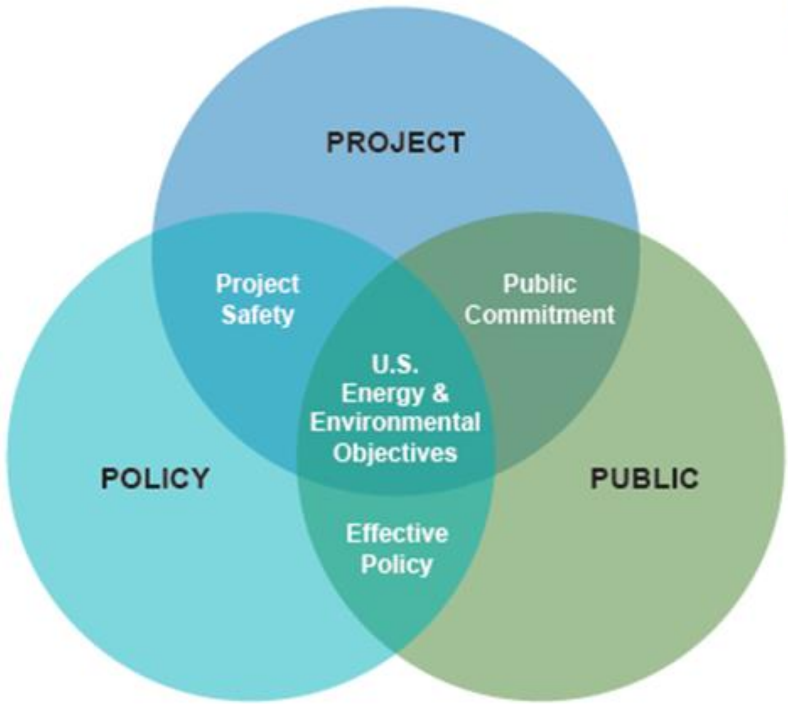
- Permits for two projects linked together in permitting
- Modeling
- Agency/project interaction
- Timing

- Key points
  - Final permit can be issued in 18 months or less
  - Final permit only allows for drilling an injection well
  - Next is completion report on as-built well conditions and remodeling
  - Additional agency/project question periods
  - Permission to inject is given once all conditions met, can be up to 3 years

1st UIC Class VI Permit Applications by the USEPA



STAKEHOLDER ENGAGEMENT



Project Stakeholder Engagement

1. Conduct projects to demonstrate safety and address gaps in knowledge or experience.
2. Engage local stakeholders, regulators, and project developers.
3. Provide proof of concept.

Policy Stakeholder Engagement

1. Create effective legal and regulatory mechanisms and policy to support widespread deployment of CCUS.
2. Engage lawmakers, coalitions, policymakers, and industry.
3. Set policy to incentivize CCUS actions and development.
4. Identify common ground and potential opposition points.

Public Stakeholder Engagement

1. Create public engagement programs and opportunities.
2. Engage the public to build trust in carbon management.
3. Increase understanding and support.
4. Connect with the "big picture"— economy, climate, creation of jobs.

Greenberg, 2019. Stakeholder spheres of engagement.

CHANGING THE CONVERSATION

Corporate Social Responsibility and Environmental Social Governance in a changing world

- Both of these things are true:
  - The world requires oil and gas
  - The dominant public view is "the age of fossil fuels is over" and these things are a given:
    - Climate change is happening and addressing it is a priority
    - Emissions from fossil fuels must be reduced
    - We are well on our way to making this happen
- The problem:
  - "Around the world, billions of people are coming to have and expect a middle class quality of life and its requisite available, affordable, reliable energy"
  - Because energy is so available and reliable *"it has become figuratively invisible, laying the groundwork for a public that believes they no longer require it."*

CONTACT INFORMATION

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