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Midwest Regional Carbon Initiative - MRCI

*(Regional Initiative to Accelerate CCUS Deployment in
Midwestern and Northeastern USA)*

DE-FE0031836

U.S. Department of Energy
National Energy Technology Laboratory
CO₂ Storage Project Review Meeting
August 4-6, 2021



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Outline

- Background and Program Goals
- Previous Efforts in the Region and Data Collaboration
- Addressing Key Technical Challenges for CO₂ Storage
- Enhancing Infrastructure Development
- Stakeholder Outreach
- Summary

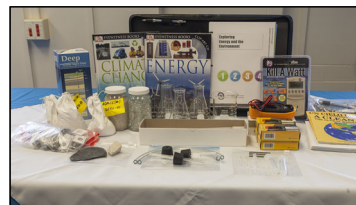
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MRCI Program Goals

- Implement a collaborative Regional Initiative to accelerate CCUS deployment in the Midwestern and Northeastern US.
- Build on more than 20 years of CCUS experience in the region by combining expertise of two RCSPs (MRCSP & MGSC).
- Engage national and international stakeholders, including state geological surveys, universities, industrial partners and advisors, fossil fuel production and utilization companies, and NGOs.
- Advanced CCUS research through four tasks:
 - Addressing key technical challenges.
 - Obtaining and sharing data to support CCUS.
 - Facilitating regional infrastructure planning.
 - Performing regional technology transfer.

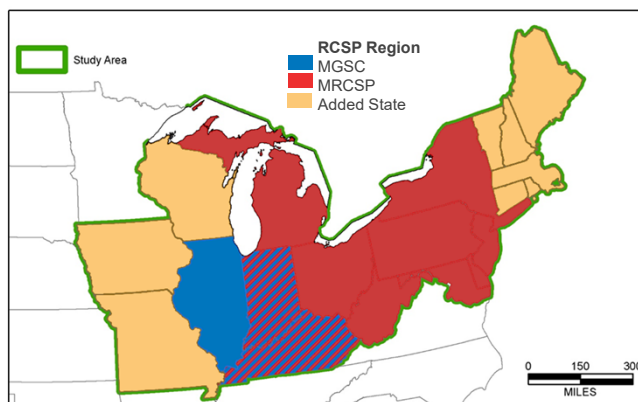


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MRCI – Covering 20 States in Midwest and Northeast

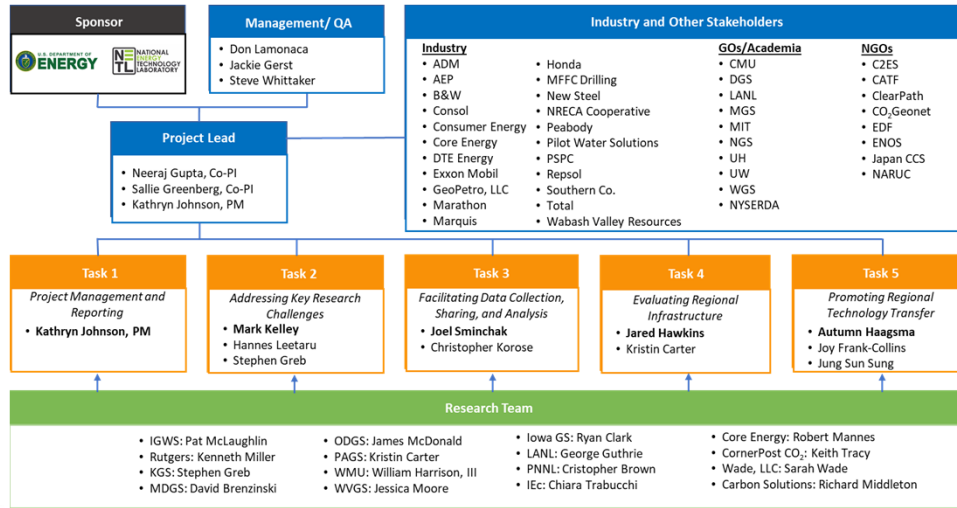
- Battelle and Illinois State Geological Survey combine expertise from MRCSP and MGSC
- Working with State Geological Surveys and Universities across the Region to Accelerate deployment of CCUS



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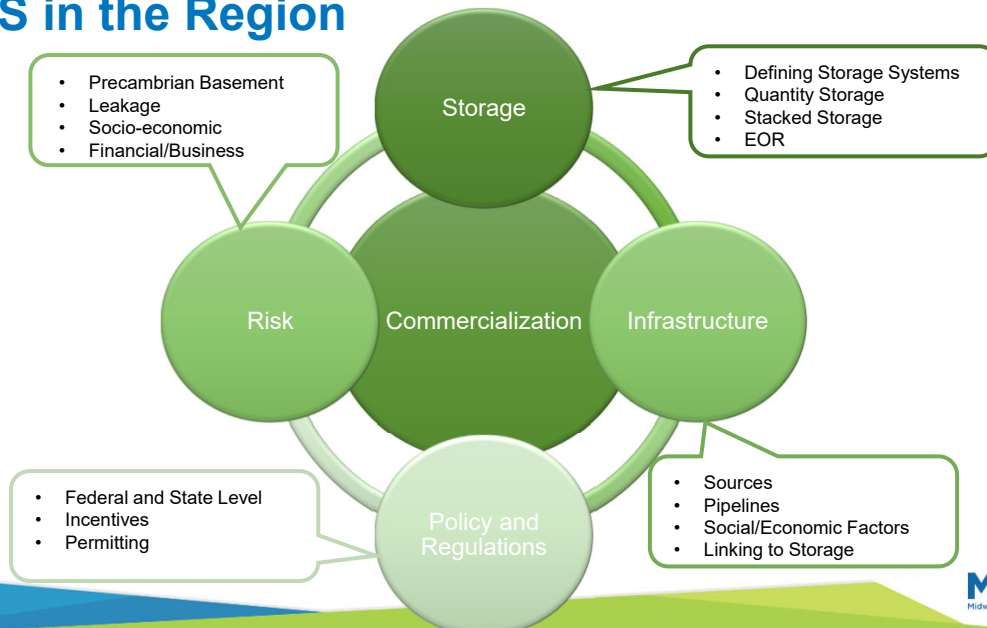
MRCI – Collaboration between Researchers, Industry, and Government, and non-Governmental Organizations



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Project Aims to Tackle Challenges to Pave Way for CCUS in the Region



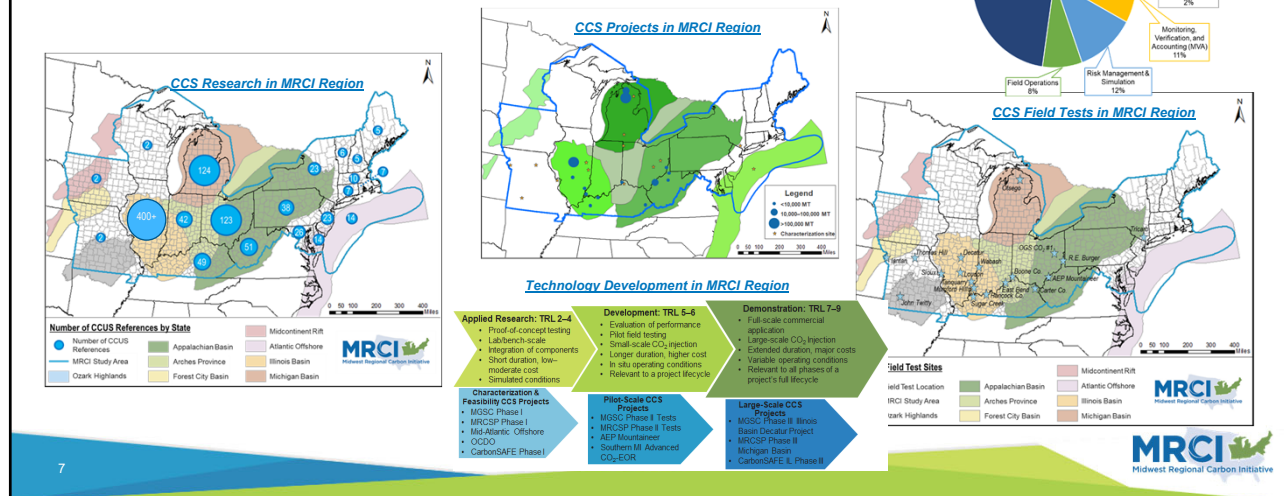
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MRCI Research, Projects, Datasets

Facilitating Data Collection, Sharing, and Analysis

Over 930 reports, presentations, posters, technical papers, datasets inventoried from previous research on carbon storage in MRCI region



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MRCI Data Sharing and Gap Analysis

- Monitored new drilling, industrial development, and oil & gas exploration to find if additional datasets may be available to supplement CO₂ storage information in the MRCI region.

Technical data gap analysis

- Precambrian geologic structural features impact on CO₂ storage
- CS systems: key CS systems for MRCI
- Injectivity verification
- Geomechanics for intermediate injection zones
- Coastal plain injection/rift basins for CO₂ storage

Geographic data gap analysis

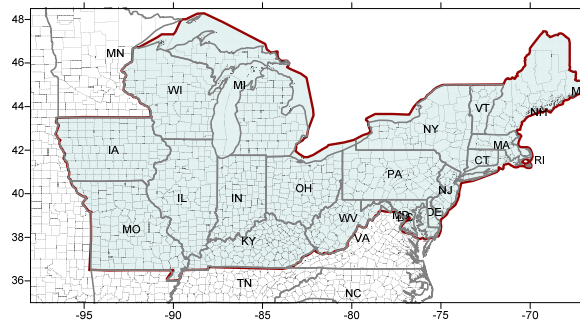
- NE U.S. C-storage potential
- Select areas of Appalachian Basin, Illinois Basin, Michigan Basin
- Missouri- storage update
- Offshore/US-Canada border

Capture/industry needs

- Mineral rights policy
- Class VI vs Class II UIC for CO₂ Related to Oil & Gas Activities
- Energy intensive industry decarbonization/net-zero emissions integration with CO₂ storage
- Low Carbon Hydrogen Generation/Natural gas options with C-storage
- Natural gas power generation capture
- DAC feasibility

Key risks for CO₂ storage in MRCI region

- Injectivity validation in key CS-systems
- Scale up feasibility: large scale storage feasibility (>30 Mt total storage)
- Induced seismicity
- Legacy oil & gas wells
- Stakeholder interests (offshore east coast)
- Water, Energy, CO₂, GHG Emissions Nexus
- Sustainable Development Goals



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MRCI Additional Data Analyses

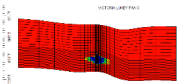
- Planning and Executing Additional Data Analyses
- Central MRCI Ethanol CCUS Screening
- Legacy Seismic Collection & Analysis
- CO₂ Screen Storage Comparison with CO₂ injection AORs
- Greenhouse Gas Emissions Life Cycle Analysis for MRCI Sources
- Support for other MRCI Tasks

GHG LCA Net CO₂ Storage

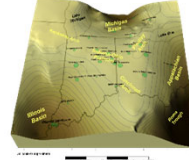
- Ethanol Plant with CS (82-90%)
- Direct Air Capture Plant (59-90%)
(depending on energy source for capture)
- Petroleum refinery (NA)
- Fertilizer/Ammonia Plant (87-88%)
- Natural Gas Power Plant (71-76%)
(accounting for displaced electricity)
- Hydrogen Plant (88-90%)
- Cement Plant (90-91%)
(new facility)
- CO₂-EOR (59-66%)
(not including downstream combustion of fuel products)

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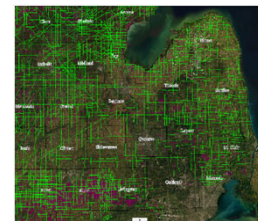
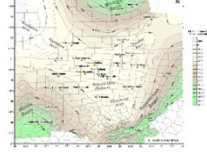
Source	CO ₂ Storage Potential (MMt/yr)	Storage Efficiency (%)	Storage Duration (yr)	Storage Cost (\$/t)
Ethanol Plant with CS	1.2	82-90%	10	100
Direct Air Capture Plant	0.8	59-90%	10	150
Petroleum refinery	0.5	NA	10	120
Fertilizer/Ammonia Plant	0.9	87-88%	10	110
Natural Gas Power Plant	0.7	71-76%	10	130
Hydrogen Plant	0.6	88-90%	10	140
Cement Plant	0.4	90-91%	10	160
CO ₂ -EOR	0.3	59-66%	10	180



2D Diagram of Regional Basins & AORs



Mr. Simon/Basal Sandstone Structure (ft.msl)



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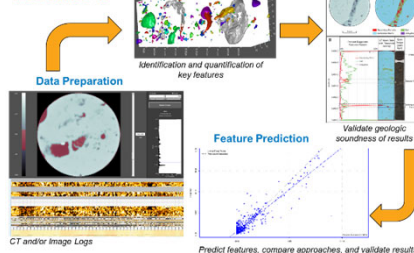
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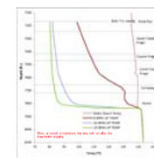
MRCI SMART Initiative

- Machine Learning
 - Topic areas identified for ML analysis
 - BHP/BHT Prediction from Wellhead Data Using Machine Learning
 - Carbonate Characterization using 2D and 3D Images to Predict Reservoir Properties
 - DTS/DAS processing and interpretation
 - Using data from MGSC, MRCSP, and other projects in MRCI into the ML efforts - injection operational pressure/temperature data, geophysical log data, core CT scans, geophysical logs, and CO₂ storage monitoring data.

Workflow



Temperature Logging (Well C)



- The temperature logs run with the dynamic logging passes show that the borehole above ~7,850 ft. underwent cooling - i.e., there is no injectivity below ~7,850 ft.
- A repeat temperature log was not run after the spinner-meter logging runs.

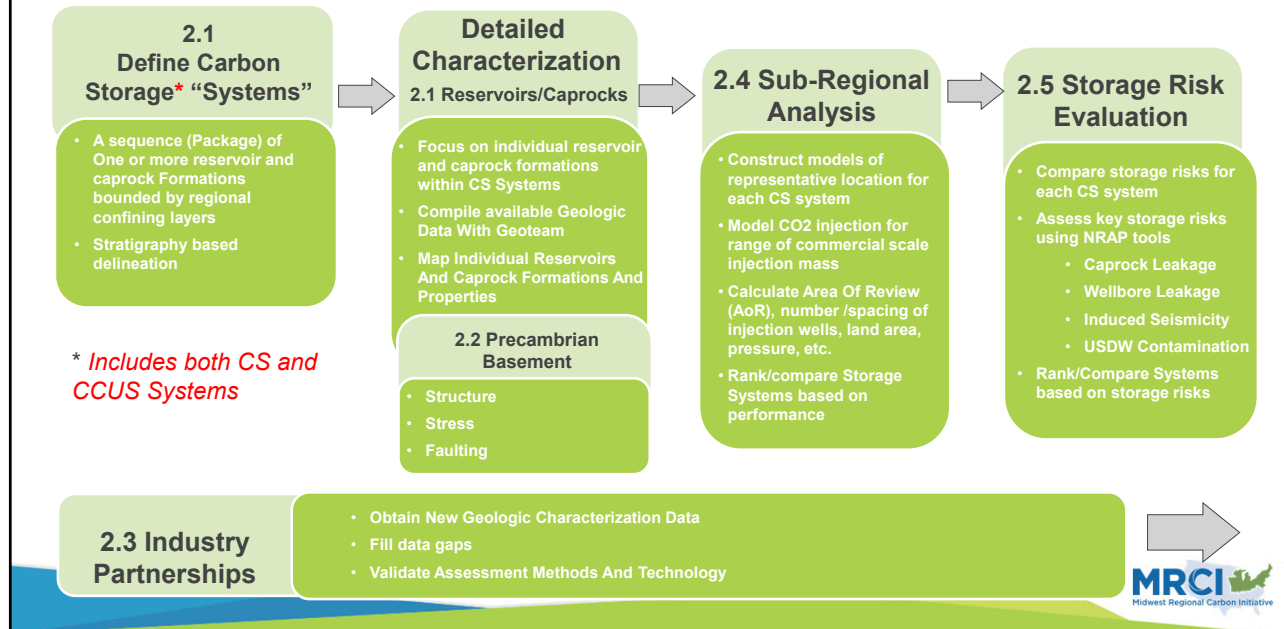


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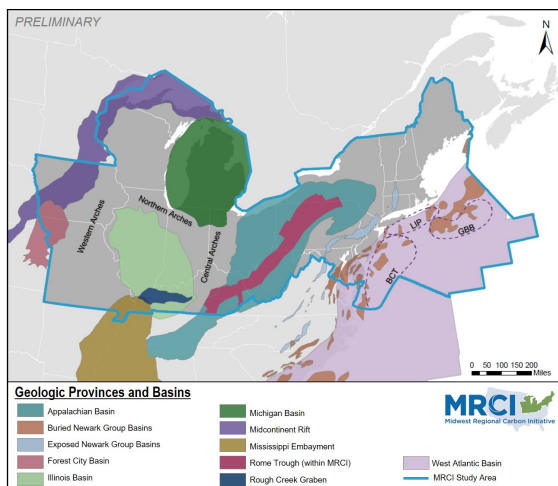
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Addressing Key Technical Challenges

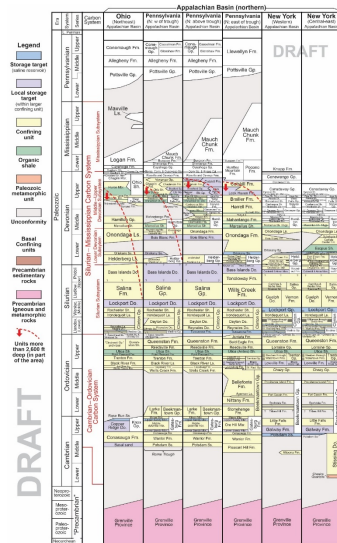


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Building Blocks for Defining MRCI Storage Systems



Geologic Provinces and Basins

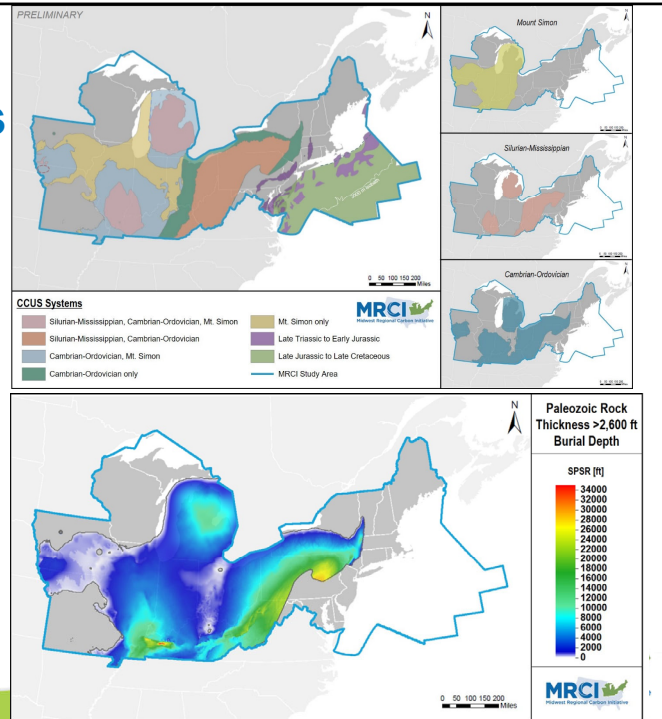


Stratigraphy of Provinces and Basins

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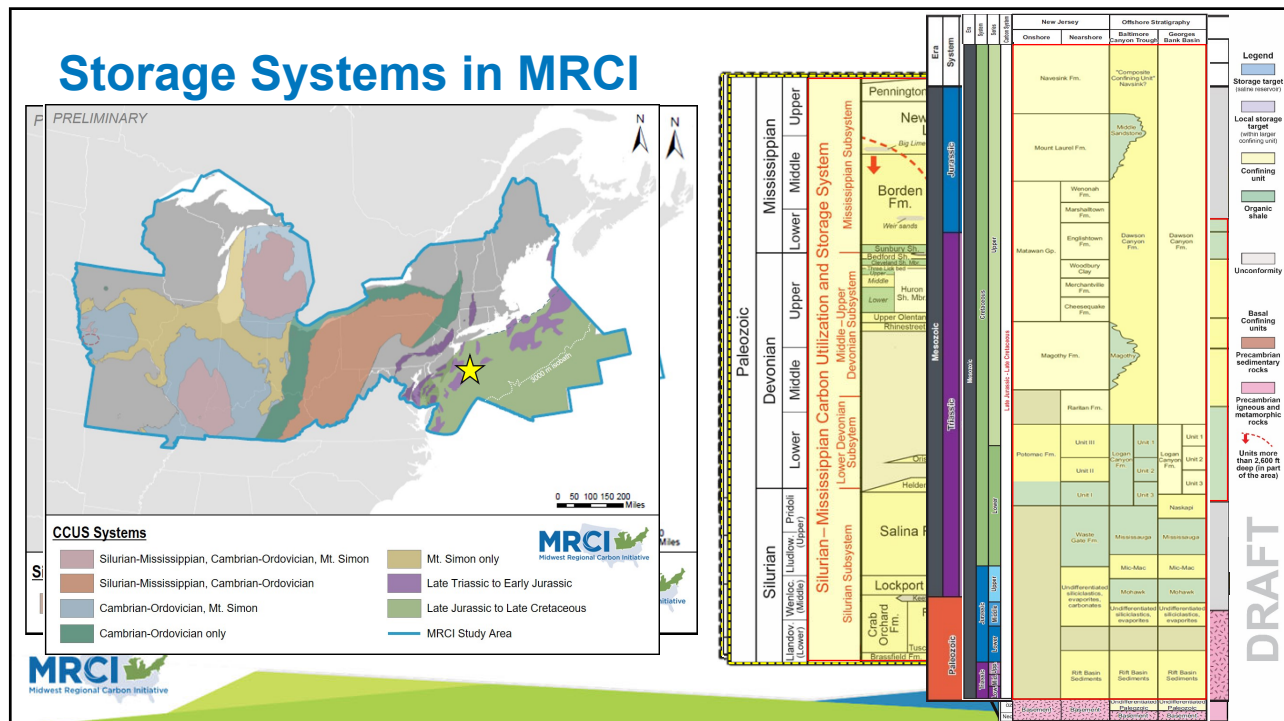
Steps to Defining Carbon Storage Systems

- Stratigraphic columns were developed for each area geologic province
- Each formation labeled/classified as a reservoir, caprock, or confining layer
- Formations were then grouped into CS/CCUS systems based on proximity of the individual formations.
- Five CS/CCUS systems were defined within the region
 - Cambrian Mount Simon System
 - Cambrian-Ordovician System,
 - Silurian-Mississippian System,
 - Late Triassic to Early Jurassic System,
 - Late Jurassic to Early Cretaceous System



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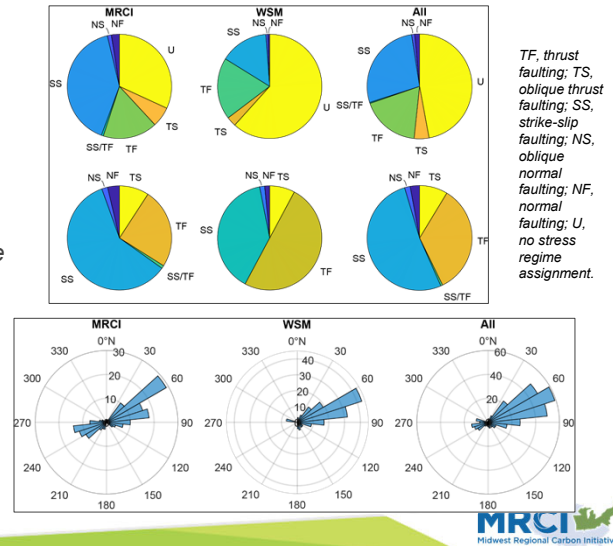
Storage Systems in MRCI



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Precambrian Stress (cont'd)

- **Upper Figure:** Distributions of stress regime attributes in the MRCI data compilation for new data (left column), WSM data (middle column), and the combination of the two (right column). The distribution of stress regimes excluding "U" data are shown in the lower row.
- **Lower Figure:** Distributions of SHmax azimuths in the MRCI compilation, in the WSM dataset, and for the composite dataset

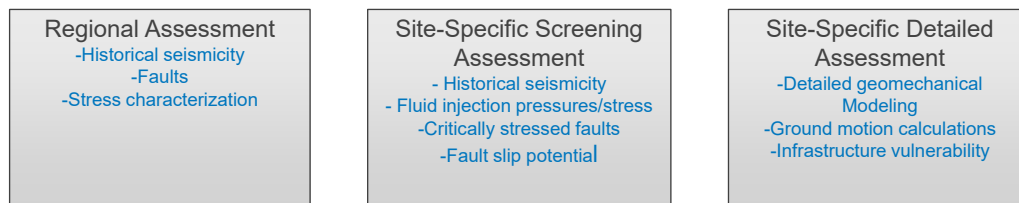


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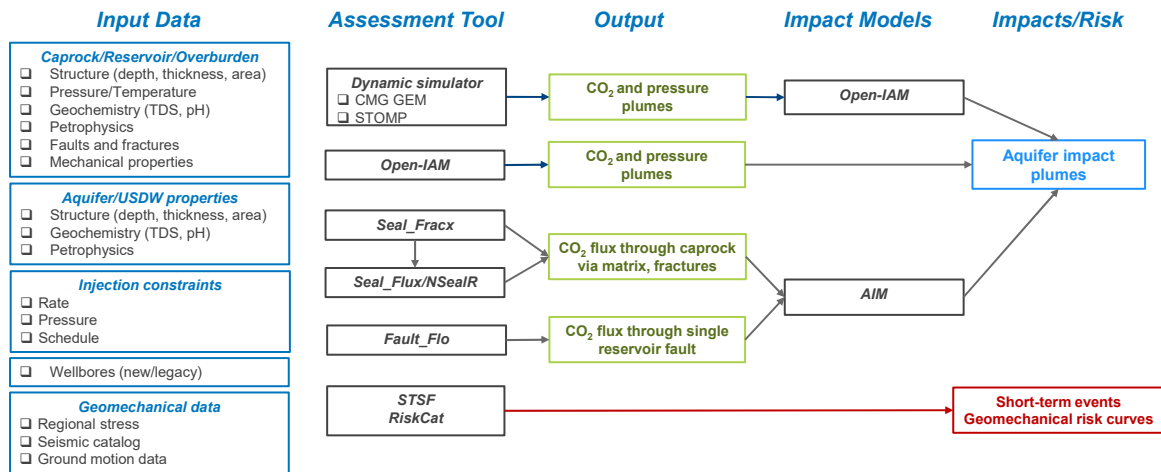
Induced Seismicity Methodology and Assessment

- Goal is to assess induced seismicity potential on a regional scale for the MRCI region and demonstrate method for evaluating site-specific induced seismicity
- Draw from nuclear, geothermal experience
- Develop regional map of induced seismicity potential
- Conduct site-specific assessments for selected example storage site(s)



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Risk Assessment Workflow Using NRAP Tools



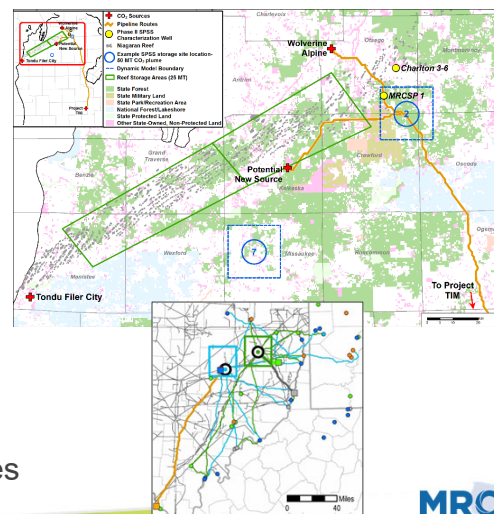
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Evaluating MRCI Regional Infrastructure

GOAL: Evaluate current infrastructure and future needs to accelerate CCUS deployment

- Task 4.1 – Conduct a screening level assessment of **surface and subsurface infrastructure**
- Task 4.2 – Assess **site readiness** to rank areas
- Task 4.3 – Conduct analysis of **social, economic, and workforce development** factors
- Task 4.4 – Analyze current **regulatory, pore space issues**, gaps, policy and tax incentives

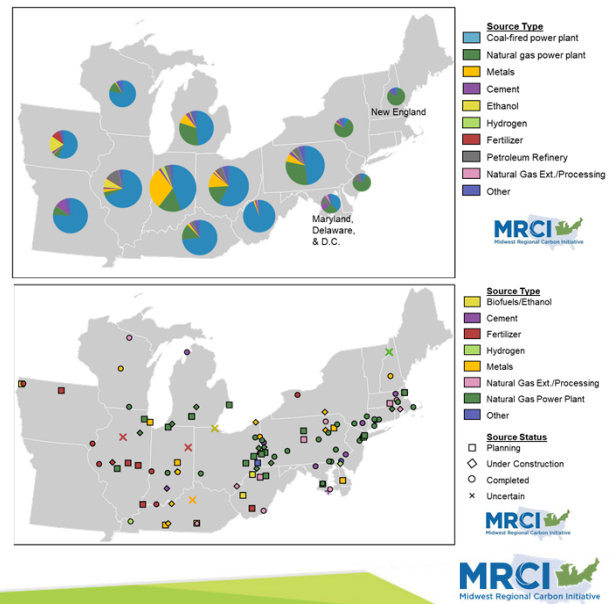


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Surface/Subsurface Infrastructure

- Completed source analysis examining existing sources, identifying source additions and retirements, aggregating sources, and generating electrical capacity profiles for each of the MRCI states.
- This work could help CCUS deployment by:
 - Identifying the existing sources available for capture
 - Keeping a running list of sources coming online

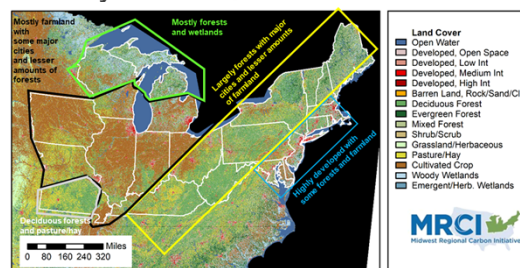
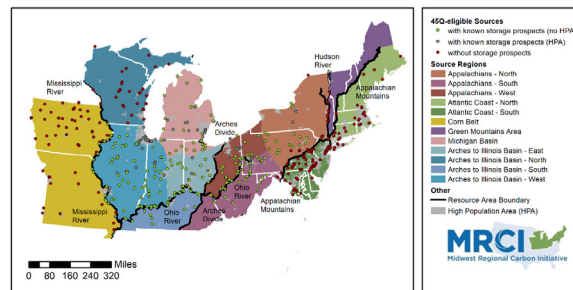


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Surface/Subsurface Infrastructure

- Continuing to develop methodologies for Source-Sink/Transport study
 - Realistic projects
 - Basis for jobs and economics analyses
- Investigate emerging technologies
- Investigate infrastructure security and safety



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Legal and Regulatory Assessment

- Policy review:
 - State Climate Policy
 - Current and Pending legislation and regulations directly applicable to CCUS deployment.
 - Policies from model states: Montana, Wyoming, and North Dakota
 - Researched policy from CCUS projects in the MRCI study area: IBDP, CarbonSAFE Illinois/East Sub-Basin
- Future policy analysis to address region and state-specific issues

State	Climate Action Plan	Enacted CCUS Legislation	Pending CCUS Legislation
Connecticut	Yes	No	No
Delaware	Yes	No	No
Illinois	Yes	Yes	Yes
Indiana	No	Yes	Yes
Iowa	Yes	Yes	No
Kentucky	Yes	Yes	No
Maine	Yes	Yes	No
Maryland	Yes	No	Yes
Massachusetts	Yes	Yes	No
Michigan	Yes	Yes	No
Missouri	No	No	No
New Hampshire	Yes	Yes	No
New Jersey	Yes	No	Yes
New York	Yes	Yes	Yes
Ohio	No	Yes	No
Pennsylvania	Yes	Yes	No
Rhode Island	Yes	No	No
Vermont	Yes	Yes	No
West Virginia	No	Yes	No
Wisconsin	Yes	Yes	No

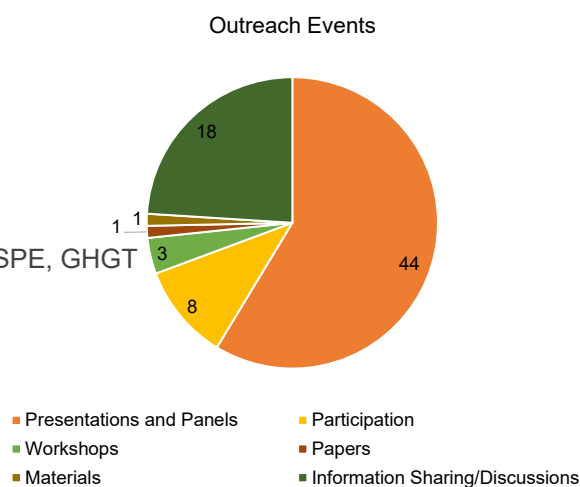
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Communicating CCUS Advancements in the MRCI Region

- Website development
 - www.midwestccus.org
 - Project background, partners, research, resources, announcements, and blogs
- Numerous outreach activities
 - Technical presentations and panels – e.g., AAPG, SPE, GHGT
 - Workshops – e.g., NARUC
 - Event participation
 - Information sharing and educational
- Planning future activities
 - Outreach strategy and plan



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Outreach Strategy – Aligned with Target Audiences

General Public	Technical	Academic/Educators/ Students	Industry	Policy/Regulators
<ul style="list-style-type: none"> • Annual Meetings • Website • Newsletter • Fact sheets • Educational Videos • Story Maps 	<ul style="list-style-type: none"> • Annual Meetings • Newsletter • Website • Webinars • Podcasts • Story Maps • Conferences and papers • Short courses 	<ul style="list-style-type: none"> • Annual Meetings • Newsletter • Website • Fact Sheets • Educational Videos • Story Maps • Short courses 	<ul style="list-style-type: none"> • Annual Meetings • Newsletter • Website • Fact Sheets • Story Maps 	<ul style="list-style-type: none"> • Annual Meetings • Newsletter • Website • Fact Sheets • Story Maps • CURC engagement

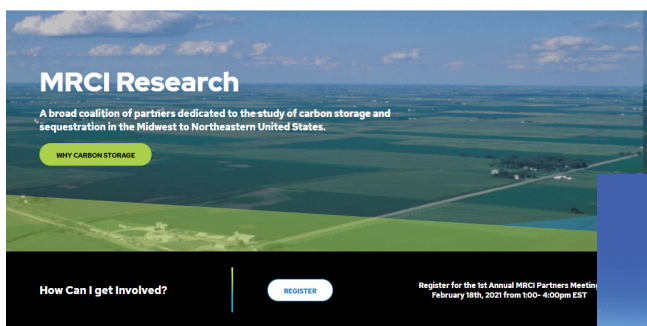
• 2020-2021 considered “passive” phase, will be moving into an “active phase”
 • 2022- big things planned and more engagement on state and federal levels!

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Website and Newsletter



MRCI Research

A broad coalition of partners dedicated to the study of carbon storage and sequestration in the Midwest to Northeastern United States.


WHY CARBON STORAGE

How Can I get Involved? [REGISTER](#)

Register for the 1st Annual MRCI Partners Meeting
February 18th, 2021 from 100-400pm EST

MRCI In-Person Meeting
Morgantown, WV
Nov. 9-11, 2021

mrci@battelle.org



Welcome to the inaugural issue of **MRCInfo**, a newsletter created to keep subscribers up to date on the latest goings on with the Midwest Regional Carbon Initiative and in the ever-growing field of Carbon Capture, Utilization, and Storage.

MRCInfo News from the Midwest Regional Carbon Initiative

JUNE 2021

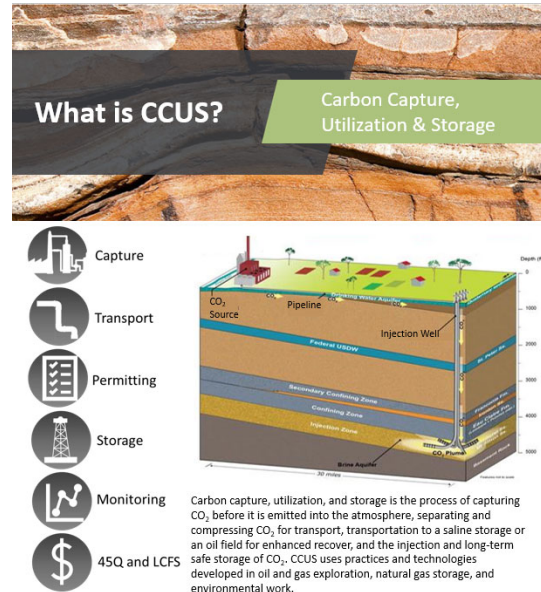
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Fact Sheets development

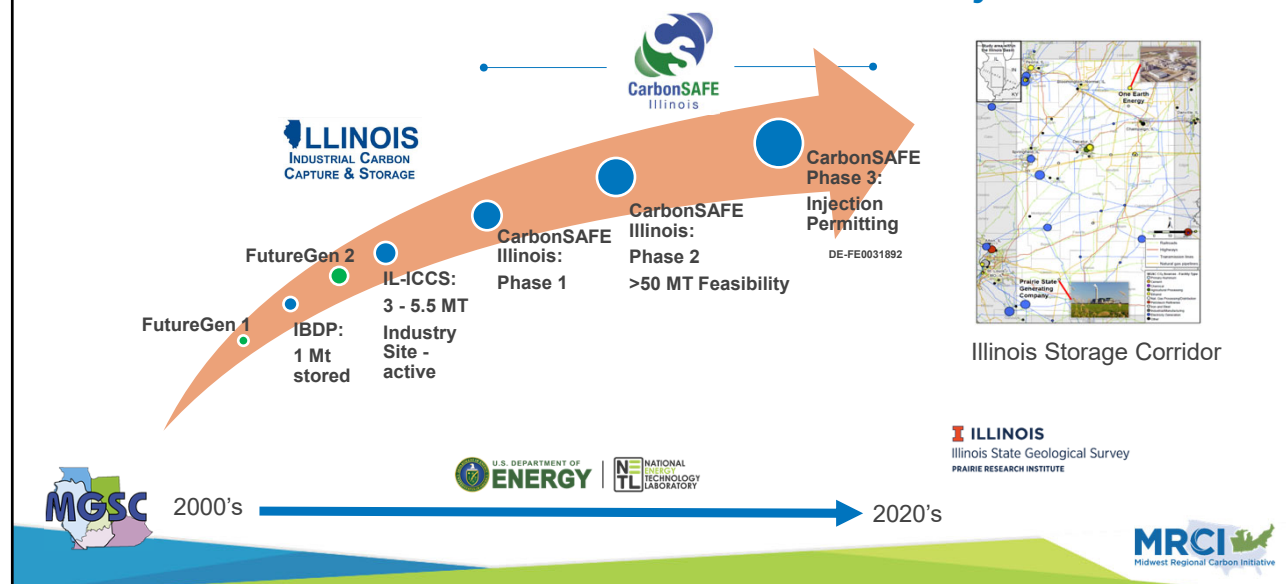
- MRCI branded fact sheets to cover a variety of CCUS topics targeted to educate across audiences
 - What is CCUS?
 - Saline storage
 - CO₂-EOR
 - CO₂ sources
 - Site selection and characterization
 - Modeling
 - Monitoring
 - CO₂ capture
 - Transportation
 - Permitting
 - 45Q, MRV, LCFS
 - Safety
 - LCA
 - State requirements



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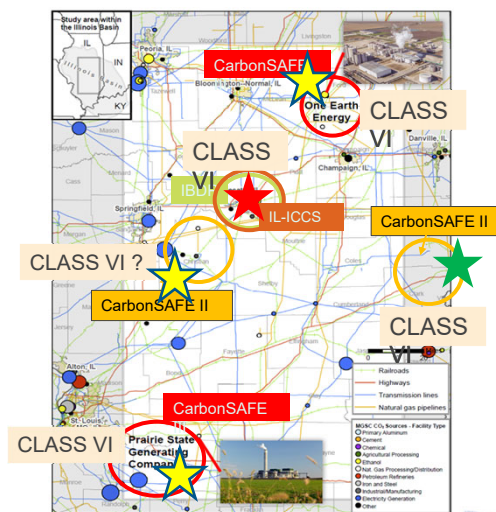
Synergistic Projects - Illinois Basin CCUS Growth A Preview of What's Possible in MRCI and Nationally



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Synergistic Projects

- Example projects synergistic with MRCI efforts:
 - Wabash Valley hydrogen – Indiana
 - 21st Century Clean Power Plant – Pennsylvania
 - Equinor/US Steel – Appalachian Basin
 - KeyState Ammonia – Pennsylvania
 - Advanced CO₂-EOR pilot – Michigan
 - Navigator Hub – central Illinois
 - Several private projects in planning across the region
 - ACT3 funding for international collaboration selected with Norsar as lead
 - Multiple DOE technology R&D projects
 - FORGE Geothermal program



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Summary and Expected Outcome

- Establishment of a broad-based consortium of researchers and stakeholders
- Collection, compilation, sharing, and utilization of CCUS related data from across the region
- Assessment and analyses to improve certainty of geologic characterization underway
- Identification of viable storage reserves, including stacked storage.
- Identification of available information and methods useful for Basement characterization
- Outline source-sink scenarios and pipeline routes for CCUS
- Application of a Risk-Based Probabilistic Model to value potential risks of CCS
- Assessment of policy, economic, and social issues, including knowledge sharing materials and workforce development plans

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