ADM CCS Projects UIC Class VI Permitting Experience

7th IEA CCS Network Regulatory Meeting

April 23, 2015 Scott McDonald Biofuels Development Director scott.mcdonald@adm.com







- The Industrial Carbon Capture and Storage (ICCS) project is administered by the U.S. Department of Energy's Office of Fossil Energy and managed by the National Energy Technology Laboratory (award number DE-FE-0001547) and by a cost share agreement with the Archer Daniels Midland Company, University of Illinois through the Illinois State Geological Survey, Schlumberger Carbon Services, and Richland Community College. This ICCS project received DOE funding from the American Recovery and Reinvestment Act of 2009 (\$141.4 million).
- The Midwest Geological Sequestration Consortium is funded by the U.S. Department of Energy through the National Energy Technology Laboratory via the Regional Carbon Sequestration Partnership Program (contract number DE-FC26-05NT42588) and by a cost share agreement with the Illinois Department of Commerce and Economic Opportunity, Office of Coal Development through the Illinois Clean Coal Institute.
- The Midwest Geological Sequestration Consortium (MGSC) is a collaboration led by the geological surveys of Illinois, Indiana, and Kentucky

Objectives of Today's Presentation



- Overview of the ADM Decatur IL CCS Projects
- Review of the Project Permitting Process
 - Site Characterization
 - Monitoring, Verification and Accounting
 - Alternative Time Frame: Post Injection Site Closure (PISC)
 - Non Endangerment Demonstration & Site Closure
- Public Outreach & Education



ADM

Illinois Basin Decatur Project (IBDP)

LLINOIS INDUSTRIAL CARBON CAPTURE & STORAGE

Program Objective

Large scale geologic test to inject 1.0 million tons of CO_2 over a three year period (1,000 MT/day).

Project Team Members







Knowledge Base

- Site Geological Characterization
- Risk Assessment & Reservoir Modeling
- Engineering Design & MVA

Began injection in Nov 2011 under IEPA Class 1 Permit.

Reached 1.0 million tons in Nov 2014.

Currently in Post injection monitoring



Illinois Industrial Carbon Capture (IL-ICCS)

Program Objectives

- Target & Demonstrate Advanced CCS Technologies at Industrial Scale Facilities
- Inject and Store One Million Tons of CO₂ Annually (3,000 tons/day)

Project Team Members



Knowledge Base

ADN

- Site Geological Characterization
- Risk Assessment & Reservoir Modeling
- Engineering Design & MVA
- Education and Public Outreach

Study the interaction between the CO_2 plumes from two injection wells within the same formation.



LLINOIS

INDUSTRIAL CARBON

CAPTURE & STORAGE

Decatur Site Overview

NSEC

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VW#1

CCS#1

GM#1



GM#2

CCS#2

HANS Substation

Compression & Dehydration

F.F. Dr

CO₂ Collection Blower Area



UIC Class VI Program



business	Fire	supplemental
car	disability	automobile
casualty	health ha	omeowners
INSUR	RANCE	
life	Flood	
major ma	edical rent	ers
property	accident	



- Protection of Underground Sources of Drinking Water under Safe Drinking Water Act.
 - UIC Permit Elements
 - Site Characterization
 - Well Construction & Mechanical Integrity
 - Operational Site Monitoring
 - Post Injection Site Monitoring & Closure
 - Alternative PISC Timeframe
 - Demonstration of Non Endangerment
 - Quality Assurance
 - Financial Responsibility

Permitting Timeline USEPA: UIC Class VI Permit

- UIC Class VI permit application submitted in Jul & Sep 2011 (ICCS & IBDP).
- US EPA Region V issued a draft permit on Apr 2014.
- Public hearing conducted on May 21, 2014.
- Public Comment Period concluded May 31, 2014.
- ICCS Final permit issued Dec 2014.
- IBDP Issued Feb 2015.

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1st UIC Class VI

Reviewed by the

USFPA

Permit Applications

ADM

Site Selection Regional Geologic Characterization

- Cratonic basin
- 60,000 square mile area
- Structurally complex to the south with faulting and seismicity

- ADM Decatur facility is located near the center of this geologic formation
- Estimated CO₂ storage capacity between 27 to 109 billion metric tons



ADM

Site Specific Characterization Seismic Acquisition





Test Well Construction





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Coring and Well Logging

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Final Site Evaluation

The ADM site has excellent features for CO₂ storage High purity source of CO_2 Thick permeable formation for storage. Porosity <20% and permeability 26 mD **Formation depth** Thick seal with no resolvable faulting Additional seal formations No local penetrations of the primary seal formation

Low population density









Detailed Modeling Flow Chart





Detailed Modeling Flow Chart



Model Calibration Flow Chart

Permeability and skin factors were the main parameters impacting the injection pressure calibration and were used as fitting parameters.







Extent of Plume & Saturation Cross Section January 1, 2012 $[DP_{ii} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$

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Extent of Plume & Saturation Cross Section January 1, 2013 $[DP_{ii} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$

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Extent of Plume & Saturation Cross Section January 1, 2014 $[DP_{ii} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$





Extent of Plume & Saturation Cross Section January 1, 2015 $[DP_{ii} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$





Extent of Plume & Saturation Cross Section January 1, 2016 $[DP_{ii} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$

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Extent of Plume & Saturation Cross Section January 1, 2017 $[DP_{ii} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$





Extent of Plume & Saturation Cross Section January 1, 2018 $[DP_{ii} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$





Extent of Plume & Saturation Cross Section January 1, 2019 $[DP_{ii} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$





Extent of Plume & Saturation Cross Section January 1, 2020 $[DP_{ii} \ge 86 \text{ psi}, SCO_2 \ge 1.0\%]$





Extent of Plume & Saturation Cross Section January 1, 2025 [SCO₂ ≥ 1.0%]





Extent of Plume & Saturation Cross Section January 1, 2030 [SCO₂ ≥ 1.0%]





Extent of Plume & Saturation Cross Section January 1, 2040 [SCO₂ ≥ 1.0%]





Extent of Plume & Saturation Cross Section January 1, 2050 [SCO₂ ≥ 1.0%]





Extent of Plume & Saturation Cross Section January 1, 2060 [SCO₂ ≥ 1.0%]





Extent of Plume & Saturation Cross Section January 1, 2070 [SCO₂ ≥ 1.0%]





Environmental Monitoring (MVA) ÂĎŇ **Conceptual Framework** Deep **Near Surface** Subsurface Injection Ground Above Soil and Vadose Zone Seal Zone Water Geophysical Geophysical **Surveys** Surveys **Aerial Imagery** Geochemical Soil CO₂ Flux Geochemical Geochemical Seismic Sampling Monitoring Seismic P/T Seismic P/T Monitoring Monitoring

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AĎN **Environmental Monitoring (MVA) Required Under UIC Permit** Deep **Near Surface** Subsurface Injection Ground Above Soil and Vadose Zone Water Seal Zone Geophysical Geophysical **Surveys** Surveys Geochemical Geochemical Geochemical Sampling Seismic P/T Seismic P/T Monitoring Monitoring

Environmental Monitoring Near Surface Monitoring



- Near infrared aerial imagery will be used to evaluate plant stress
- Soil resistivity characterized shallow depths for identification of optimum GWM locations
- 3 years GWM for baseline conditions and operational surveillance.





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Environmental Monitoring Deep Subsurface Monitoring



- CCS#1 & CCS#2 T/P monitoring
- Distributed Temp Sensor
- VW#1 Westbay system
- VW#2 IntelliZone System
- Multi-level sampling ports reservoir fluid collection and T/P monitoring
- P/T sensors to monitor above the reservoir seal
- GM#1 has 31 sensor array
- GM#2 5 level 20 sensor array w P/T at 3500'
- Allow offset or walkaway
 Vertical Seismic Profile
 (VSP)
- Well logging (RST)



Deep Seismic Monitoring



- 3 Level Geophone Array in CCS#1
- 31 Level Geophone Array in GM#1
- 5 Level Geophone Array in GM#2
- 4 Borehole Monitoring Stations (USGS)









Seismic Monitoring Data



Alternative PISC Timeframe

- Default PISC is 50 Years
- Permittee allowed to petition for an alternative timeframe
- ADM Proposed 10 Year PISC
 - Reservoir Pressure Decline
 - Plume Stabilization
 - CO₂ Partitioning



Alternative Timeframe Reservoir Pressure Decline









CCS#1 & CCS#2 - Pressure Differentials [P(t_i)-P(t₀)]

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Alternative Timeframe Plume Stabilization









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Alternative Timeframe CO₂ Partitioning



Over 50% of the CO₂ is trapped within the reservoir after 10 years.

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Demonstration of Non Endangerment

Prior to approval of the end of PISC period, the operator will submit a demonstration of non-endangerment of USDWs. The report will contain:

- Comparison of Monitoring Data vs Model Predictions
- Evaluation of Carbon Dioxide Plume
- Evaluation of Mobilized Fluids
- Evaluation of Reservoir Pressure
- Evaluation of Potential Conduits for Fluid Movement
- Evaluation of Passive Seismic Data

Non Endangerment *Reservoir Pressure Decline*



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Non Endangerment *Time Lapse Geophysical Surveys*



LINOIS

INDUSTRIAL CARBON CAPTURE & STORAGE

LINOIS **Non Endangerment** INDUSTRIAL CARBON CAPTURE & STORAGE **Time Lapse Geophysical Surveys** Time Lapse VSP surveys show the development of the vertical and lateral extent of CO₂ over time. 82000 86000 88000 90000 92000 94000 78000 80000 96000 98000

Non Endangerment *Time Lapse Geophysical Surveys*



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Non Endangerment



Passive Seismic Data



Outreach and Education Building on Current CCS Activities



Trusted Information Source

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- Local, Regional, National, and International Events
 - Decatur Public Events
 - AAPG Short Courses
 - IEA GHG Summer School 2011
- Providing Information
 - Invited presentations
 - Technical presentations
 - Model presentations
 - Teacher workshops
 - Coordination with STEM.
- Education Development
 - STELA Learning Environment
 - Undergraduate CCUS course Working with local programs to leverage funding.



Thank You!



Industrial Carbon Capture and Storage Project:

- U.S. Department of Energy Award No. DE-FE-0001547
- Administered by the DOE's Office of Fossil Energy
- Managed by the National Energy Technology Laboratory
- DOE cost share from American Recovery and Reinvestment Act of 2009

Cost Share Agreements:

- Archer Daniels Midland Company
- University of Illinois through the Illinois State Geological Survey
- Schlumberger Carbon Services
- Richland Community College

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