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Energy & Environmental Research Center (EERC)

North Dakota Carbonsafe Phase III: Site Characterization and Permitting (FE0031889)

U.S. Department of Energy National Energy Technology Laboratory Carbon Management and Natural Gas & Oil Research Project Review Meeting Virtual Meeting August 2, 2021

Wes Peck

Energy & Environmental Research Center

Project Overview

Objective:

 Perform commercial-scale site characterization and permitting for the geologic storage of nearly 4 million metric tons (Mt) of CO₂ per year.

Funding	DOE	Cost Share	Project Total
Dollars (MM)	\$16.97	\$7.96	\$24.93
Contribution	68%	32%	100%

- Performance dates:
 - BP1: September 2020 August 2022
 - BP2: September 2022 August 2023







COMPUTER

MODELLING GROUP ITD









Industrial Commission of North Dakota Lignite Research, Development and Marketing Program





Project Overview

- Perform commercial-scale site characterization and permitting for the geologic storage of ~4 million metric tons (Mt) of CO₂ per year.
- Minnkota Power Cooperative, the North Dakota Industrial Commission's Lignite Research Program, BNI Energy, Computer Modelling Group (CMG), and Schlumberger.

	Federal	Cost Share	Total	Performance Dates
Budget Period 1	\$14,832,334	\$6,972,533	\$21,804,867	9/1/2020 - 8/31/2022
Budget Period 2	\$2,141,689	\$986,267	\$3,127,956	9/1/2022 - 8/31/2022
Total	\$16,974,023	\$7,958,800	\$24,932,823	



Project Tundra Overview



Two Projects in One

- Divert flue gas then separate CO₂ in a carbon capture system that strips out the CO₂ then liquifies under pressure.
- Inject CO₂ into storage formation over a mile below lignite mine.

No impact on the power plant and no impact on its costs



Technical Approach

			Major P	roposed	Characte	rization /	Activities			
Major NDIC Permitting Requirements	Core	LOPE	ine Down	ole lesting	restine Mo	Jeline Sim	ulation seism	olle baselin	anning vent	ot wells
Determine Plume Extent	Х	Х	Х	X	Х	Х	X			
Determine Pore Space Amalgamation	х	х	х		х	х	х			
Geologic Properties of Injection and Confining Zones	х	х	х	х						
Regional Faulting Assessment	Х						х			
Potential for Seismic Activity			Х		Х		Х			1
Geologic Maps and Cross Sections		х			х		x		x	
Geomechanics of Confining Zones(s)		х	x	х	х					
Identify and Characterize Secondary Confining Zones		Х	x		х		х			
Determine Area of Review		Х	X	Х	Х	Х	Х	Х	Х]
Baseline Geochemical Data	Х			Х				Х	Х	
Baseline Water and Soil Data				X				Х	X	

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Center, ND (Pop. 588)

J-LOC1 Well (Potential Monitor)

CarbonSAFE Phase II Strat Test (BNI-1) Phase III Strat Test (J-ROC1) Miltón R. Young

1 Mile

CarbonSAFE

Original Planned Injection Well

3-D Seismic Collection

-5 miles

Station

**?!C **CO//~

J-LOC1 Well

 Drilled to the Precambrian basement (10,300 feet)

ACT SIJE THEF

- 1344 feet of core from three reservoir/seal intervals
- 6-mi² seismic survey complete

J-ROC1 Well

.

- Drilled to the Precambrian basement (9871 ft)
- 1207 feet of core from the three reservoir/seal intervals
- 12 mi² seismic survey
- Full COVID-19 safety protocol in place





Core of the Broom Creek Formation

Seismic Collection

• 2019

- 5 mi source test line
- 6.7 mi² of 3D seismic data
- 2020
 - 12 mi² of 3D seismic data
 - 20 mi of 2D seismic data

Seismic Data Extent





Storage Reservoirs

Formation	Designation	Thickness (ft, average)	General Lithology
Opeche through Picard	Cap rock	154	Siltstone, mudstone, evaporites
Broom Creek	Storage Reservoir	249	Sandstone, dolostone, anhydrite
Amsden	Lower Confining Zone	270	Dolostone, limestone, anhydrite
Ice Box	Cap rock	118	Shale
Black Island and upper Deadwood	Storage Reservoir	182	Sandstone, shale, limestone
Deadwood B	Lower Confining Zone	64	Shale

Broom Creek Measured Values

Depth: ~4900 ft Porosity (%): 2 – 27 Permeability (mD): 0.06 – 2690

Black Island/Deadwood Measured Values Depth: ~9400 ft Porosity (%): 3.4 – 15 Permeability (mD): 0.03 – 2060



Step Rate Injection Tests



KCl solution used to test injectivity and breakdown pressures of the Broom Creek and Deadwood Formations.

Favorable results from both formations supported a permeability modifier to be applied to the simulation models.

TTE 75747

Lithofacies Distribution: Broom Creek Formation





Lithofacies Distribution: Black Island/Deadwood Formations





Pulling it all Together

- Two injection wells into the Broom Creek Formation
- On injection well into the Black Island/Deadwood interval (contingency)
- One monitoring well that extends to the Black Island/Deadwood (NRDT-1)
- USDW monitoring well

• One Class I wastewater disposal well into the Inyan Kara Formation.



Depths and thicknesses not to scale

Storage Facility Permit

Storage Facility Permit Sections:

- Pore space
 - 46 landowners including Minnkota and BNI
- Geologic exhibits
- Area of review
 - Risk-based

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- Supporting permit plans
- Injection Well and Storage operations
- ~1100 pages of material



Accomplishments to Date

- Drilled a stratigraphic test well.
- Geophysical surveys
 - 3D seismic survey
 - 2D seismic survey
 - Microgravity survey
- Core and fluid sampling and analysis
- Injection test
- Geologic modeling
- CO₂ injection simulation

- Geochemical and geomechanical modeling
- MRV plan well underway
- Environmental Information Volume (EIV) well underway
- Two North Dakota CO₂ storage facility permit applications submitted (May 28th)
- Class VI well permit applications submitted.



Lessons Learned

- Injection tests are worth it!
- Scenario iteration takes time...every answer generates more questions.
- Pore space acquisition takes more time than you think.
- Third party review is nice.
- Working in a state with Class VI primacy...priceless.





Next Steps

- Monitoring, Reporting, Verification (MRV) Plan underway
- Environmental Information Volume (EIV) underway
- Review/analyze data collected for:
 - Controlled source electromagnetic (CSEM) survey
 - Gravity survey
 - Magnetic survey
- Prepare for public hearing regarding the storage facility permits (~December)



Synergy Opportunities

- FEED study
- PCOR Accelerating...technical and regulatory
- WY CarbonSAFE and other CarbonSAFE efforts from a technical and regulatory perspective.



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Appendix

Project Overview– Goals and Objectives

- The goal of the proposed effort is to accelerate wide-scale deployment of CCUS by assessing and permitting two safe, cost-effective commercial-scale storage sites within a storage complex for CO₂ emissions captured from MRYS in central North Dakota. Achieving the goal of Phase III will require acquisition, analysis, and development of geologic information to fully characterize a storage complex in the region around MRYS to demonstrate storage resources for commercial volumes of CO₂.
- Through the proposed effort, the following key activities will be performed: 1) identify and characterize two commercial-scale CO₂ stacked storage sites; 2) apply and obtain approval for an UIC Class VI permit to construct each proposed injection well; and 3) prepare an Environmental Information Volume (EIV) to assess any NEPA (National Environmental Protection Act)-related issues for the identified capture, transport, and storage sites.



Organization Chart





Gantt Chart

			Pre-Av	vard				Budget Peri	od 1				Budget Period 2				
			01	2020	. 03	04	2021	08	07	08	2022	010		011	012	013	014
	Start	End	May Jun Jul	Aug Sep	Oct Nov Dec	Jan Feb Mar Apr	May Jun Jul	Aug Sep Oct	Nov Dec Jan	Feb Mar Apr	May Jun Jul	Aug Sep	Oct	Nov Dec Jan I	Feb Mar Apr	May Jun Jul	Aug Sep
Task 1.0 – Project Management and Planning	5/1/20	9/30/23	XXX XXX XXX					D5 🗸				D5					D5, D7
1.1 – Project Management Plan	10/1/20	9/30/23			D1 🔽												
1.2 – Data Management Plan	10/1/20	9/30/23														D8 🔻	
1.3 - Technology Naturation Plan	10/1/20	9/30/23			D2	•											
Task 2.0 – National Environmental Protection Act (NEPA)	10/1/20	7/31/23															•
2.1 – Preparation and Submission of NEPA Documentation for Site Characterization and CO ₂ Capture Assessment	10/1/20	5/31/21															
2.2 – Preparation and Submission of an Environmental Information Volume (EIV) for Potential Future Construction and Operation	11/1/20	7/31/21					D3	·									
2.3 – Preparation and Submission of NEPA Documentation for Potential Future Construction and Operation	8/1/21	7/31/23														D4	
Task 3.0 – Site Characterization	6/1/20	9/30/21	XXX XXX	XXX XXX													
3.1 – Stratigraphic Test W el Drilling	6/1/20	3/31/21	XXX XXX	M1 XXX													
3.2 – 3-D Seismic Survey and Geophysical Methods	6/1/20	9/30/21	XXX XXX	xxx xxx			M2 <										
3.3 – Laboratory Analysis	8/1/20	1/31/21		XXX XXX													
Task 4.0 – Modeling and Simulation	8/1/20	9/30/21		XXX XXX													
4.1 – Geologic Modeling	8/1/20	9/30/21		XXX XXX													
4.2 - CO ₂ Injection Simulation	9/1/20	9/30/21		XXX	M3												
4.3 – Area of Review Determination	10/1/20	9/30/21						M5 🔷									
4.4 – Geochemical Modeling	10/1/20	6/30/21															
4.5 – Geomechanical Modeling	11/1/20	6/30/21															
Task 5.0 – Permitting and Regulatory Compliance	8/1/20	9/30/23		XXX XXX													
5.1 - Storage Facility Permit Application	8/1/20	9/30/22		XXX XXX				M6🔷									
5.2 - Class VI Permit Application	11/1/20	9/30/22								M9 >		D6					
5.3 – MRV Plan Development and Approval	5/1/21	9/30/23									M 10	•					
Task 6.0 – Outreach	7/1/20	7/31/23	XXX	XXX XXX													4
Task 7.0 – Monitoring	9/1/20	9/30/22		XXX													
7.1 – Baseline Data Collection	9/1/20	9/30/22		XXX													
7.2 – Install Fax Hills Wells	4/1/21	6/30/21					M4 🔷										
Task 8.0 – Crosscutting Collaboration with other DOE Initiatives	9/1/21	4/30/23															
8.1 – NRAP	9/1/21	3/31/23												M7 🔶			
8.2 - SMART Initiative	9/1/21	4/30/23													M8 <		
Task Duration			D4 D 1		Deliverables ((D) 🔻	14 6	Mile	stones (M)		11.25.20 n	sk					
Award Date (10/1/20)]		D1 – Proj D2 – Carl	ect Mangen bon Capture	nent Plan (PIVIP) e Technology(ies)) Maturation Plan (TM	P) M2 – Geop	nit Permit to Dril shysical Data Ad	I cquisition Compl	ete							
Pre-Award Activity 2003 Pre-Award Activity 2003			D3 - Envi D4 - NEF D5 - Geo D8 - Topi Clas D7 - Fin D8 - Date	ironmental I A Documer logic Catalo ical Report s VI Well P al Technica a Submitted	n formation Volum ntation - Summary of St Vermit Application I Report to NETL EDX	ne lorage Facility and Is	MB - Simu M4 - Fax H M5 - Area M6 - Stors M7 - NRAI M8 - ML A M9 - Class DO	lations Initiated fills Well Installa of Review Deter ge Facility Perr P Supplemental ligorithm Testing S VI Permitting S E Project Manag	ation Complete rmined mit Application C Testing Complet and Evaluation Status Presented ger	omplete te							
NIVERSITY OF							M10 - MR	V Progress Pres	sented to DOE P	roject Manager					~ .		~



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