Front-End Engineering & Design: Project Tundra Carbon Capture System

FE0031845

Gerry Pfau

Minnkota Power Cooperative

U.S. Department of Energy

National Energy Technology Laboratory

Carbon Management and Natural Gas & Oil Research Project Review Meeting

Virtual Meetings August 2 through August 31, 2021

Funding and Cost Profile

	2019	2020				2021	
	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Baseline Cost Plan							
Federal Share	21,650	106,401	444,003	2,665,717	4,023,770	2,000,000	560,037
Nonfederal Share	5,413	26,600	111,001	666,429	1,005,943	500,000	921,078
Total	27,063	133,001	555.004	3,332,146	5,029,713	2,500,000	1,481,115
Cumulative Federal	21,650	128,051	572,054	3,237,771	7,261,541	9,261,541	9,821,578
Cumulative Nonfederal	5,413	32,013	143,014	809,443	1,815,386	2,315,386	3,236,464
Cumulative Total	27,063	160,064	715,068	4,047,214	9,076,927	11,576,927	13,058,042
Actual Incurred Cost							**Preliminary**
Federal Share	21,650	106,401	444,003	2,665,717	3,811,320	2,132,533	19,451
Nonfederal Share	5,413	26,600	111,001	666,429	952,830	533,133	1,007,454
Total	27,063	133,001	555,004	3,332,146	4,764,149	2,665,667	1,026,905
Cumulative Federal	21,650	128,051	572,054	3,237,771	7,049,091	9,181,624	9,201,075
Cumulative Nonfederal	5,413	32,013	143,014	809,443	1,762,273	2,295,406	3,302,860
Cumulative Total	27,063	160,064	715,068	4,047,214	8,811,363	11,477,030	12,503,935

New budget under development with recently approved extension to 12/31/21

Performance Dates, Project Team and Objective

Project Performance Dates

12/19/19 – 12/31/21

Objective

Complete a FEED study on the addition of post-combustion CO_2 capture for the Milton R. Young Station's Unit 2 (MRY2)

Project Team

Minnkota Power Cooperative

A Touchstone Energy® Cooperative

FLUOR®

BURNS McDONNELL

AECOM

EERC

UND University of North Dakota

agora

SIEMENS energy

nels

GE

Square Butte Electric Cooperative

GOLDER

David Greeson Consulting

Hunt International Energy Services

Technology & Site Selection

- **Capture Technology:** Fluor's Econamine FG Plus℠
- **Site:** Milton R. Young Station Unit 2, 455 MW, lignite
- MRYS is uniquely suited:
  - Very high historical and projected capacity factor
  - State of ND is extremely supportive and has been a leader in development of policy to incentivize carbon capture, utilization & storage
  - Unique Williston Basin geology: EOR and saline storage both opportunities

Integration and Economics

- **Integration:** Both steam cycle integration and natural gas boilers were considered in this project. Economics from pre-FEEDs were comparable, but gas boilers offered more flexibility and lower risk to overall project. Recent cost updates from the FEED have put steam extraction back on the table.
- **Storage:** Saline formation geologic storage directly beneath MRYS and surrounding area.
- **Economics:** Targets set based on $50/ton 45Q tax credit
  - Economy of scale: ~2.5X size of Petra Nova in a single train design
  - Preliminary financial modeling shows 45Q can be sufficient to finance the project without increasing member electricity rates
  - FEED cost estimate to be converted to lump sump EPC price

Milestones & Success Criteria

Task No.	Description	Planned Completion Date	Actual Completion Date
1	Cooperative Agreement Signed	12/19/2019	12/19/2019
2	Design Manual Completed	02/28/2020	02/10/2020
3	Permitting Meeting with NDDEQ*	07/30/2020	07/29/2020
3	Permitting Strategy Finalized	05/31/2021	
4	FEED Report Submitted	11/30/2021	

Success Criteria

- Sufficient detail for a decision on the commercial project
- Sufficient detail to provide all technical information necessary for permitting
- Completion of design basis for post-combustion capture at MRY2
- Accurate FEED-level cost estimate for simple transition to lump sum EPC
- Support a pathway to achieve DOE cost of capture goals of $30/tonne by 2030

* ND Department of Environmental Quality

Significant Project Risks and Mitigation Strategies*

Perceived Risk	Risk Rating (Low, Med, High)			Mitigation Strategy
	Probability	Impact	Overall	
Personnel availability	Low	High	Low	Capitalize on internal Minnkota expertise to support project objectives.
Insufficient budget to meet objectives	Low	Medium	Low	The scope of work has been scaled to fit the existing budget.
Site accessibility	Low	Low	Low	Minnkota personnel are available to provide site and data access.
Unforeseen Risks, e.g., natural disasters; social, legal, or technical challenges	Low	Medium	Low	Regular updates with DOE and project partners will help solve issues as they arise.

* Note: This is a paper/desktop study, and therefore all risks identified have low overall risk rating

Project Tasks

- **Task 1** – Project Management and Planning
- **Task 2** – Engineering and Design
  - Subtask 2.1 – Project Design Basis
  - Subtask 2.2 – Carbon Capture System (CCS) Design
  - Subtask 2.3 – Steam Source Selection & Design
  - Subtask 2.4 – BOP Integration and Design
- **Task 3** – Development of Permitting Strategies
  - Subtask 3.1 – Air Emissions
  - Subtask 3.2 – Water Discharge
  - Subtask 3.3 – Waste Disposal Planning
- **Task 4** – Project Tundra Cost Estimating

Task 1 – Project Management and Planning

- New vendors; Nels Consulting, Siemens Energy and General Electric, added to assist in the engineering and design work under Task 2
- Reviewing impact of project completion delays on schedule and budget

Task 2 – Engineering and Design

Project design basis

- Key decisions prior to commencing FEED
  - Water source selection & discharge
  - Steam source selection
  - Oxygen levels in the CO_2 product specification
- A design manual was developed in conjunction with Hunt International and Burns & McDonnell
  - Includes specific requirements for cold weather
  - Being used by Fluor and Burns & McDonnell for capture system design, water treatment, and balance of plant design

Task 2 – Engineering and Design (continued)

Water source selection

- The water source for the CCS was chosen as Nelson Lake adjacent to the plant
  - Sufficient water retention and short pipeline requirement
- Pre-treatment was selected as cold lime softening
  - Ability to lower amount of cooling tower make-up and eventual cooling tower blowdown rates
- Cooling tower blowdown that can't be utilized by the power plant will be deep well injected (Class I well), which is anticipated to be the lowest cost

Task 2 – Engineering and Design
(continued)

Steam source selection

- Direct extraction from MRY2 steam turbine and auxiliary natural gas package boilers considered
- Natural gas boilers were initially selected as best option
  - Significantly lower technical risk
  - Improved CCS and MRY operational flexibility
  - Potentially improved economics from pre-FEED work
- Extraction steam being reevaluated due to updated economics from FEED work

Task 2 – Engineering and Design (continued)

Oxygen specification for CO_2 product

- It was determined that catalytic deoxygenation is not required for geologic storage
  - Short pipeline
  - No oil miscibility concerns in this scenario
- Flexibility will be built into the design to add catalytic deoxygenation in the future for an EOR scenario

Task 2 – Engineering and Design (continued)

Capture island design status

- All PFD, HMB, UFD and P&IDs completed
- Preliminary 2D and 3D plot plans completed
- Modular study was completed
- Major equipment specifications completed
- Major equipment bid packages sent out and preliminary bids received
- Material takeoffs completed
- Level II Process Hazard Analysis HAZOP completed
- Reliability, Availability, & Maintenance (RAM) study completed

Task 2 – Engineering and Design (continued)

BOP design status

- Water treatment system preliminary design completed
- Initial water balance of facility completed
- Wastewater, including tower blowdown will be combined with existing scrubber pond water
- Preliminary design for deep well injection of final wastewater from scrubber pond water almost complete
- Interfaces to existing plant utilities identified and preliminary design completed
- Determined existing plant fire system can supply needs of CCS island

Task 3 – Development of Permitting Strategies

Air emissions

- Held meetings with NDDEQ to discuss monitoring requirements and general permitting questions and overview
- Air dispersion modeling completed by AECOM
- Minnkota contracted with Agora Environmental (formerly RMB Consulting) to develop a monitoring strategy/plan – still underway

Task 3 – Development of Permitting Strategies (continued)

Water supply

- Information was finalized for water appropriation permit to increase the allocation of Missouri River water

Water discharge (zero discharge target)

- Golder Associates finalized information for the Class I wastewater injection well permit
  - Targeting the Inyan Kara formation (~3600-3800 ft. depth) for injection

Waste disposal

- Analysis of waste from the solvent maintenance system is still underway (produced during pilot testing under separate efforts)

Task 4 – Project Tundra Cost Estimating

Preliminary FEED report provided by Fluor

- Cost was higher than anticipated
- Large effort initiated on value engineering to reduce cost with minimal impact to reliability and performance
  - Already found 15% reduction with limited or no impact on system
- Earlier this year, Fluor informed us that due to their current business position they were no longer able to be the fixed price constructor for the project
- Efforts underway to find a construction contractor to finalize the FEED quality estimate
- Continue efforts to finalize additional owner's cost for items outside of Fluor's scope

Next Steps

- Finalize selection of new construction contractor
- Determine schedule and cost impacts to FEED study to evaluate and implement value engineering/cost optimization changes to the scope of facilities and to obtain input from the selected construction contractor
- Finalize owner's cost estimates
- Complete the FEED with the revised scope of facilities

Summary

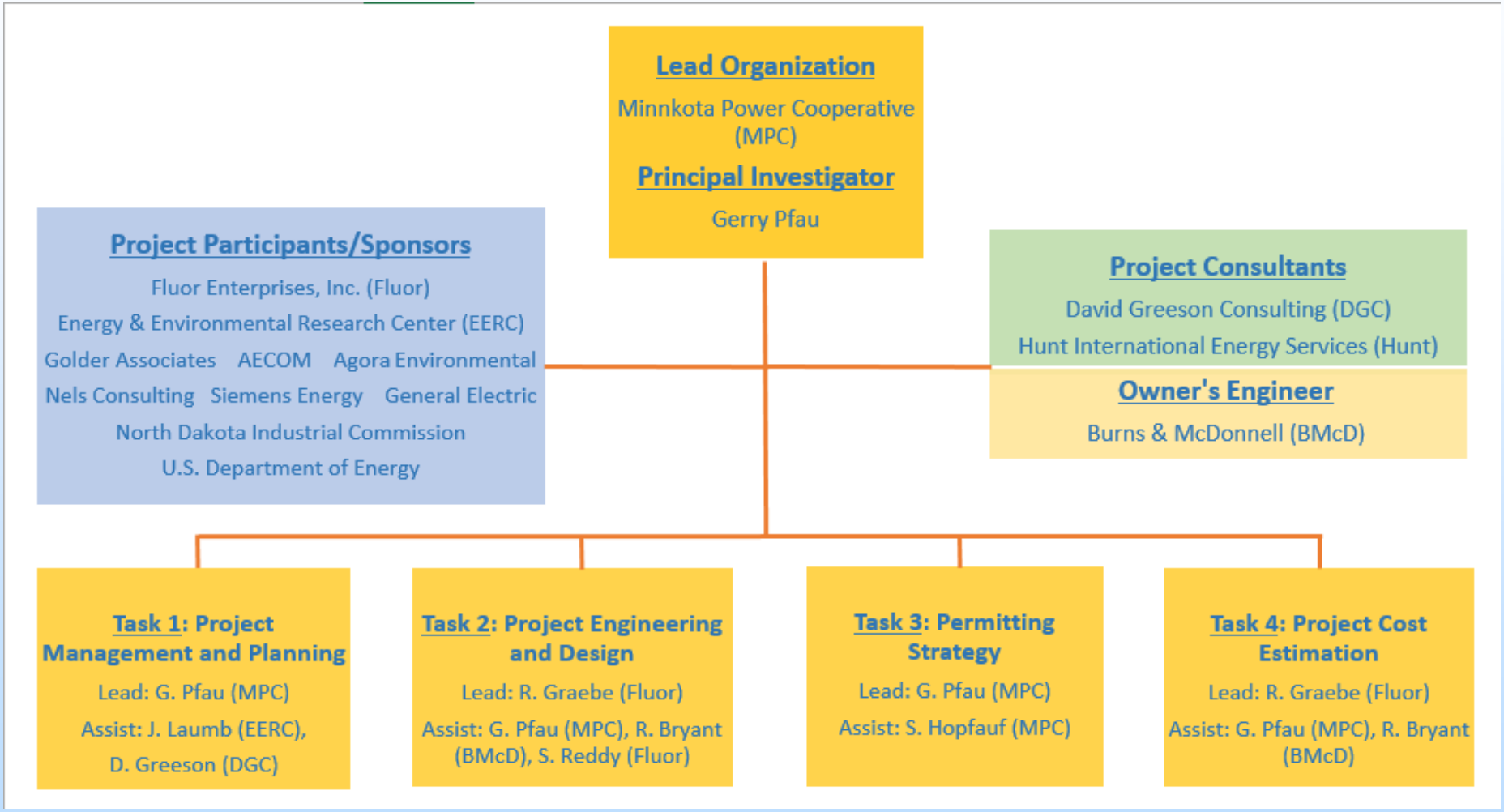
- Project Tundra is a bold initiative to build the world's largest carbon capture and storage facility in North Dakota
- FEED completion delays due to change in Fluor's construction status
- Still have parties interested in investing in the project

PROJECT TUNDRA

Contact Information:
Gerry Pfau
Senior Manager of Project Development
701-794-7234
gpfau@minnkota.com

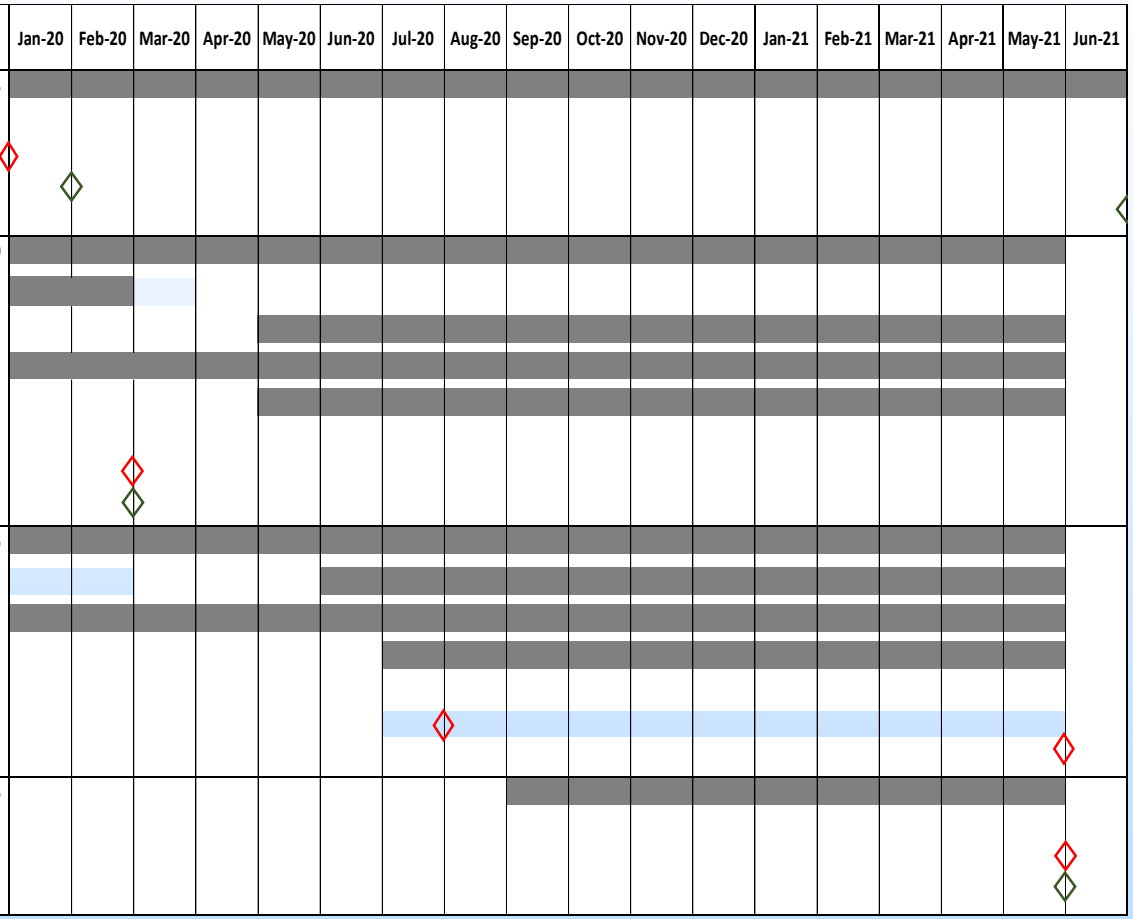
APPENDIX

Project Organizational Chart



Project Gantt Chart

Task/Milestone Description	Start Date	End Date	Estimated Cost
Task 1 - Project Management and Planning	12/19/19	06/30/21	$ 3,251,043
Milestones/Deliverables			
M0 - Cooperative Agreement Signed		12/19/19	
D1 - Updated PMP		01/31/20	
D4 - Final Report		06/30/21	
Task 2 - Project Engineering and Design	12/19/19	05/31/21	$ 8,446,119
Subtask 2.1 - Project Design Basis	12/19/19	02/28/20	
Subtask 2.2 - Carbon Capture System Design	04/30/20	05/31/21	
Subtask 2.3 - Steam Source Selection & Design	12/19/19	05/31/21	
Subtask 2.4 - BOP Integration and Design	12/19/19	05/31/21	
Milestones/Deliverables			
M1 - Design Manual Completed		02/28/20	
D2 - Design Manual		02/28/20	
Task 3 - Permitting Strategy	12/19/19	05/31/21	$ 923,445
Subtask 3.1 - Air Emissions	03/01/20	05/31/21	
Subtask 3.2 - Water Discharge	12/19/19	05/31/21	
Subtask 3.3 - Waste Disposal Planning	06/01/20	05/31/21	
Milestones/Deliverables			
M2 - Permitting Meeting with NDDEQ		07/30/20	
M3 - Permitting Strategy Finalized		05/31/21	
Task 4 - Project Cost Estimation	06/01/20	05/31/21	$ 437,435
Milestones/Deliverables			
M4 - FEED Report Submitted		05/31/21	
D3 - FEED Study		05/31/21	



New schedule under development with recently approved extension to 12/31/21

DOE Disclaimer

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