

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

DOE Kick-off Meeting
Project FE0031845
November 12, 2019



PROJECT TUNDRA



Square Butte
ELECTRIC COOPERATIVE



Minnkota Power
COOPERATIVE

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Agenda

- Who is Minnkota?
- Introduction to Project Tundra
- Project Participants and Sponsors
- Project Overview
- Project Management
- Questions/Discussion

Who is Minnkota?



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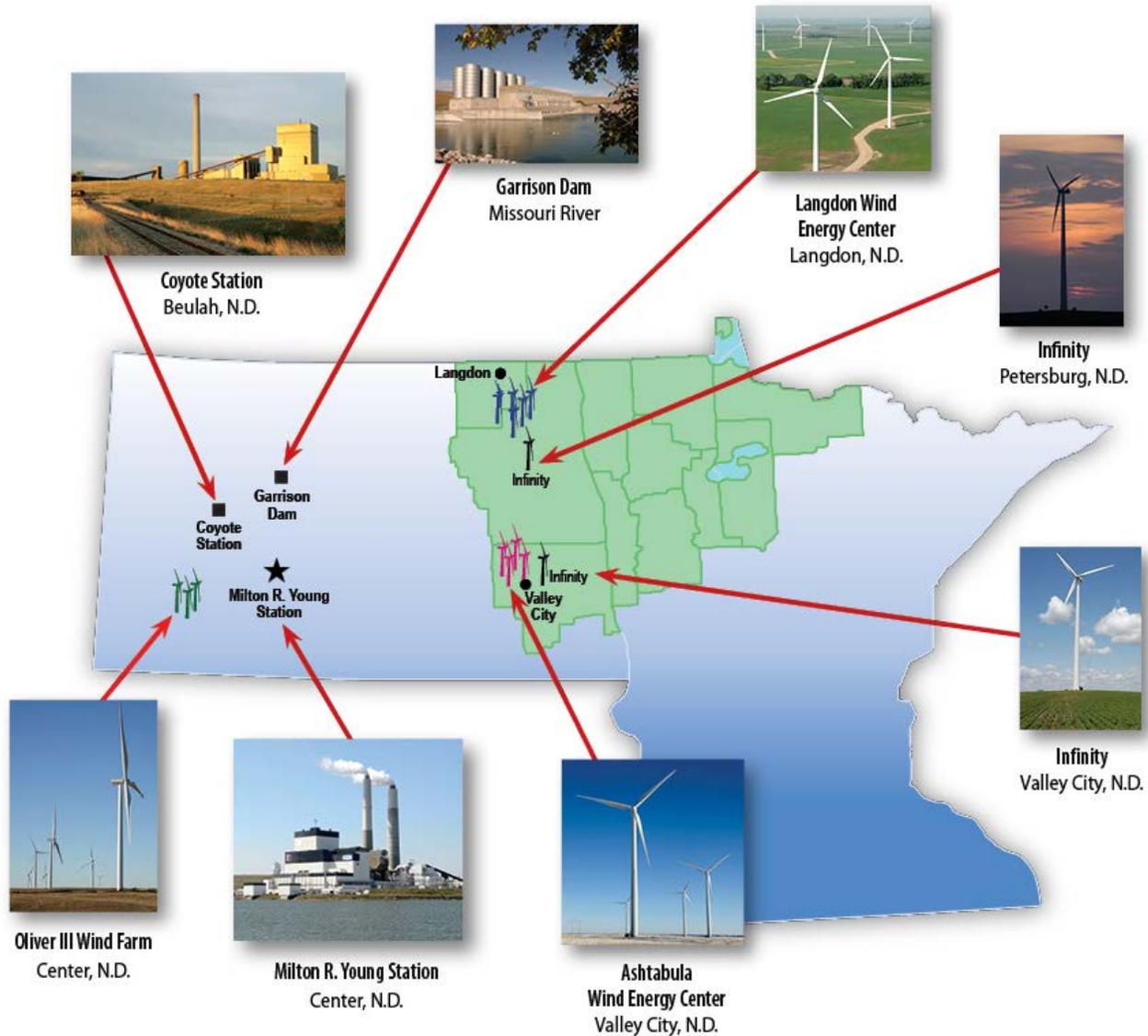
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Minnkota Company Profile

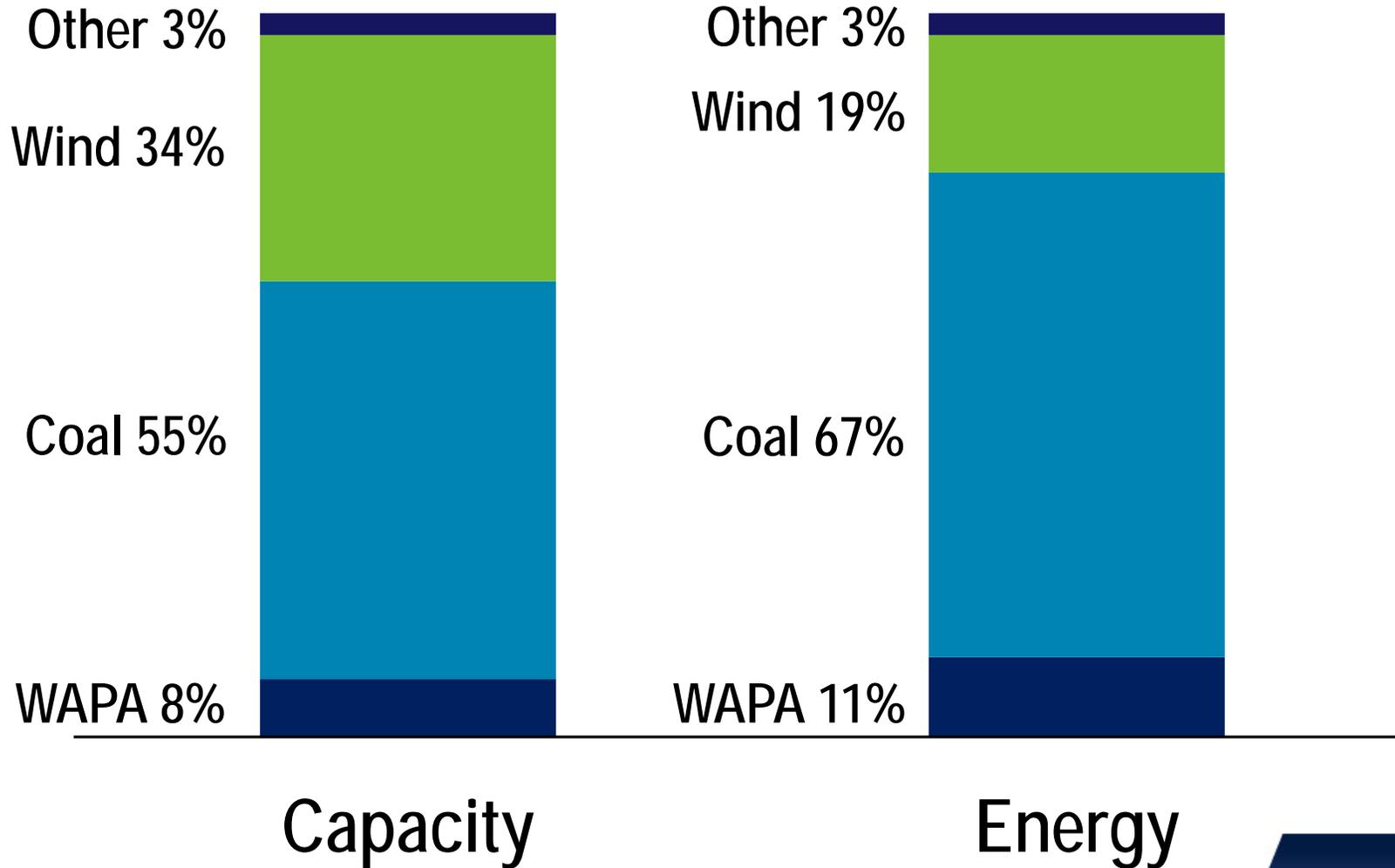
- Minnkota Power is a wholesale electric generation and transmission cooperative
- Headquartered in Grand Forks, N.D.
- 11 member-owner cooperatives
- 3 in ND, 8 in MN
- 12 municipals – Northern Municipal Power Agency
- Serve 35,000 square miles in 33 counties
- About 150,000 consumers
- 390 employees



Generation Resources



Typical Joint System Resources



Introduction to Project Tundra



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What is Project Tundra?

Project Tundra is a bold initiative to build the world's largest carbon capture facility in North Dakota



Why is Minnkota Pursuing CCUS?

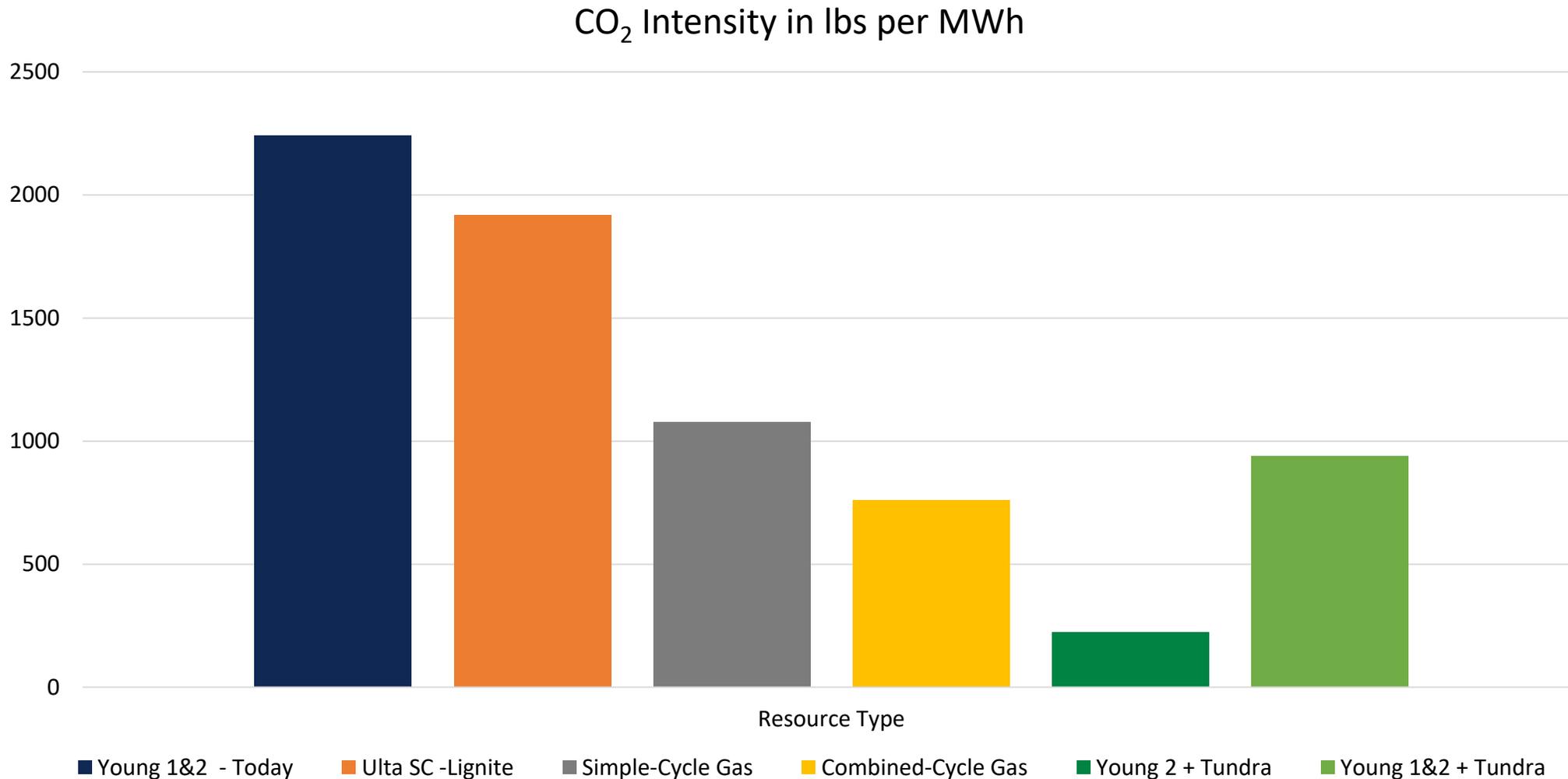
■ Resource planning

- Young Station with Tundra – lowest cost of reliable electricity
- Combined Cycle – similar cost, but subject to variable gas prices
- Simple Cycle – good for back-up, but too expensive for 24/7 power
- Wind – competitive with combined cycle, but not reliable in extreme cold

■ Carbon managed future

- Young 2 with Tundra – 0.11 tons CO₂/MWh
- Combined Cycle – 0.35 tons CO₂/MWh
- Simple Cycle – 0.54 tons CO₂/MWh
- Ultra Supercritical Lignite – 0.96 tons CO₂/MWh

Carbon Intensity Comparison



Best firm capacity resource is Young station with Tundra

Also the lowest cost

Why is Minnkota Pursuing CCUS?

- North Dakota jobs
 - Young Station with Tundra – 400 with mine
 - Combined Cycle– 25
- Environmentally friendly enhanced oil recovery (EOR)
 - Pipeline & oilfield jobs
 - Even California recognizes as “green” oil
- North Dakota Geology
 - Internationally recognized as excellent storage capacity
 - DOE has funded two phases of storage study and analysis
 - Minnkota to partner with EERC on third phase and permitting process

Project Tundra Summary

- Retrofit Milton R. Young Unit 2
 - 455 MW lignite-fired
 - Capture approximately 90 percent of the CO₂
- Permanent storage
 - CO₂ injected into deep saline formations beneath the nearby coal mine
- Enhanced Oil Recovery
 - CO₂ transported 100+ mile pipeline
 - CO₂ substantially increases production in declining fields
 - 45 year history



Project Participants and Sponsors



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FEED Project Major Participants

Technical Team

- Minnkota Power Cooperative
- Fluor Enterprises, Inc.
- Burns & McDonnell
- David Greeson Consulting
- Hunt International Energy Services
- Energy & Environmental Research Center
- Golder Associates
- AECOM
- Square Butte Electric Cooperative



FEED Project Sponsors

Funding Support

- U.S. Department of Energy NETL
- Lignite Research Program - North Dakota Industrial Commission



FEED Project Overview



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Objectives

- FEED study to install a post-combustion carbon capture system at the Milton R. Young Station Unit 2
 - Design, costing, & performance data for financing activities
 - Engineering & material balances to file permits
 - Final project construction schedule
- Advances over current state-of-the-art
 - Investigation of steam cycle integration
 - Solution for aerosol emissions & solvent degradation
 - Design of largest capture facility in the world
 - Optimization for cold climate
 - Establishment of lowest levelized cost of capture at world-scale



Tasks

- Task 1 – Project Management and Planning
- Task 2 – Engineering and Design
- Task 3 – Development of Permitting Strategies
- Task 4 – Project Tundra Cost Estimating

Task 2 – Engineering and Design

- Will build on previous Pre-FEED studies
- Subtask 2.1 – Project Design Basis
- Subtask 2.2 – Carbon Capture System Design
- Subtask 2.3 – Steam Cycle Integration
- Subtask 2.4 – BOP Integration and Design
- **Key Deliverable** – comprehensive design package that minimally includes: **1)** general arrangement drawings, **2)** PFDs, **3)** heat and mass balances, **4)** P&IDs, **5)** tie-in list, **6)** equipment list, **7)** preliminary structural, civil and architectural drawings, **8)** HAZOP review

Task 3 – Permitting Strategies

- Preliminary list of permitting requirements already developed
- Will build on Pre-FEED study and past Fluor installations
- Subtask 3.1 – Air Emissions
- Subtask 3.2 – Water Discharge
- Subtask 3.3 – Waste Disposal Planning
- **Key Products:** All technical information needed to support future filing of permit applications

Task 4 – Cost Estimating

- FEED-quality estimate for conversion into a firm lump sum price w/ minimal updates for commodity escalation and inflation
- Includes project schedule for engineering, procurement and construction

Milestones/Deliverables

Task No.	Milestone Description	Planned Completion Date	Verification Method
1	M0 – Cooperative Agreement Signed	Project Initiation	Executed Agreement Document
2	M1 – Design Manual Completed	End of Month 2	Subsequent quarterly report
3	M2 – Permitting meeting with NDDEQ*	End of Month 3	Subsequent quarterly report
3	M3 – Permitting Strategy Finalized	End of Month 9	Subsequent quarterly report
4	M4 – FEED Report Submitted	End of Month 9	Subsequent quarterly report

* North Dakota Department of Environmental Quality

Task No.	Deliverable Description	Planned Completion Date
1	D1 – Updated PMP	End of Month 1
2	D2 – Design Manual	End of Month 2
4	D3 – FEED Study	End of Month 9
1	D4 – Final Report	End of Month 12

Project Schedule

Task/Milestone Description	Start Date	End Date	Estimated Cost	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20
Task 1 - Project Management and Planning	10/01/19	09/30/20	\$ 3,251,043												
<i>Milestones/Deliverables</i>															
M0 - Cooperative Agreement Signed		10/01/19		◇											
D1 - Updated PMP		10/31/19			◇										
D4 - Draft Final Report		07/30/20											◇		
D5 - Final Report		09/30/20													◇
Task 2 - Project Engineering and Design	10/01/19	06/30/20	\$ 7,665,049												
<i>Subtask 2.1 - Project Design Basis</i>	10/01/19	11/30/19													
<i>Subtask 2.2 - Carbon Capture System Design</i>	10/01/19	06/30/20													
<i>Subtask 2.3 - Steam Cycle Integration</i>	10/01/19	06/30/20													
<i>Subtask 2.4 - BOP Integration and Design</i>	10/01/19	06/30/20													
<i>Milestones/Deliverables</i>															
M1 - Design Manual Completed		11/30/19				◇									
D2 - Design Manual		11/30/19			◇										
Task 3 - Permitting Strategy	10/01/19	06/30/20	\$ 923,445												
<i>Subtask 3.1 - Air Emissions</i>	12/01/19	06/30/20													
<i>Subtask 3.2 - Water Discharge</i>	10/01/19	06/30/20													
<i>Subtask 3.3 - Waste Disposal Planning</i>	04/01/20	06/30/20													
<i>Milestones/Deliverables</i>															
M2 - Permitting Meeting with NDDEQ		12/31/19				◇									
M3 - Permitting Strategy Finalized		06/30/20											◇		
Task 4 - Project Cost Estimation	05/01/20	06/30/20	\$ 437,435												
<i>Milestones/Deliverables</i>															
M4 - FEED Report Submitted		06/30/20													
D3 - FEED Study		06/30/20											◇		

NOTE: Discussed with DOE/NETL to move end date to 12/31/20 due to late project start

Project Management



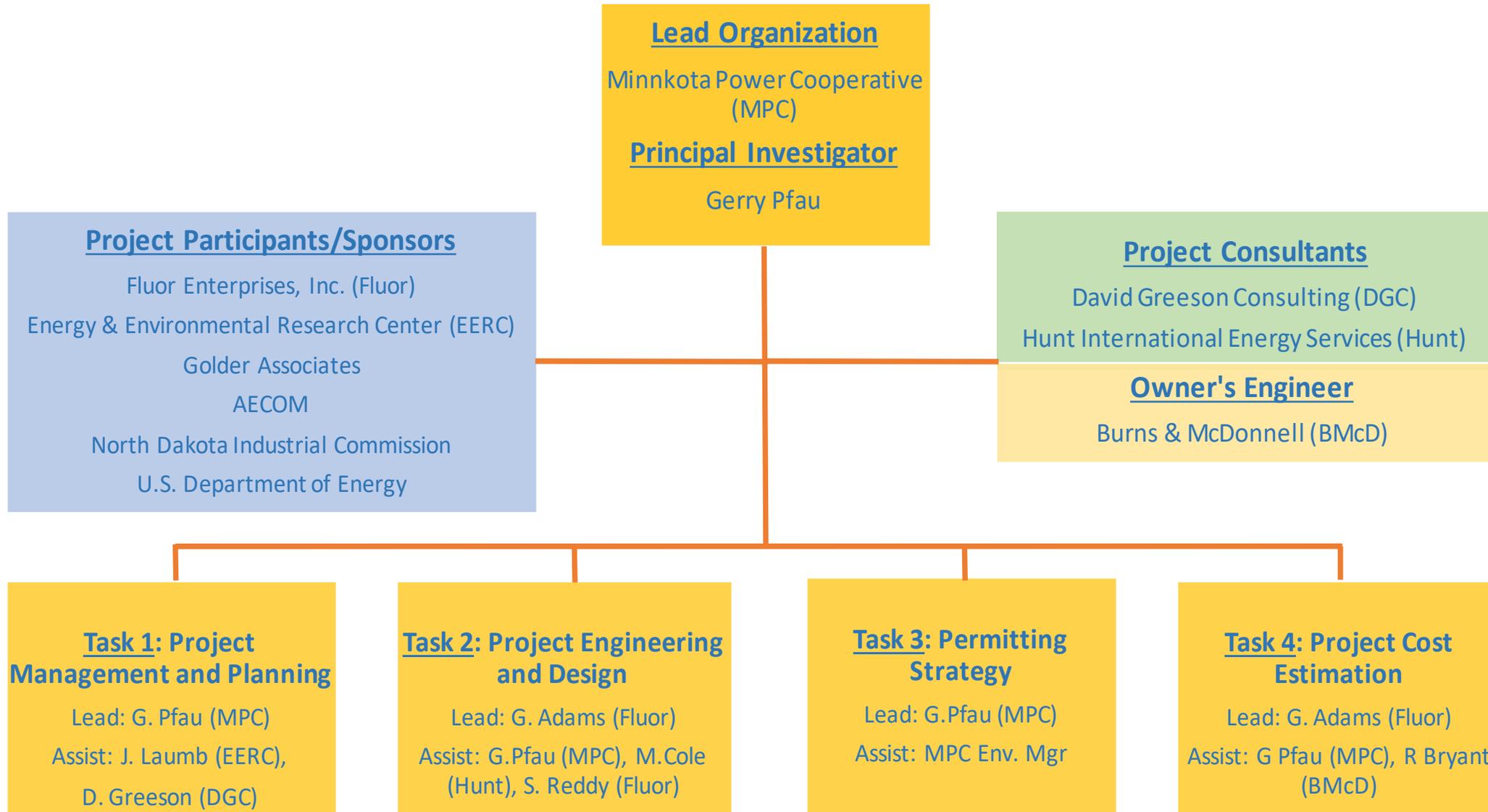
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Roles of Organizations

- **Lead Organization/Prime Recipient** – Minnkota
- **FEED Technical Lead** – Fluor
- **Technology Provider** – Fluor
- **Owner's Engineer** – Burns & McDonnell
- **Project Management and Development Consulting** – David Greeson
- **Project Development, Engineering and Construction Consulting** - Hunt International
- **Technical and Administrative Management** – EERC
- **Permitting/Environmental Support** – Golder and AECOM

Management Structure



Risk Management Plan

- This is a paper study – All risks identified as low overall risk rating
- All team members have committed necessary personnel and resources to accomplish proposed work
- Have secured firm commitment for required non-federal funding. Additional non-federal funding may be available in unlikely event of cost overruns or if new scope is required to achieve project objectives.
- Established a clear decision making and communication strategy
- Risk management plan will be continuously updated throughout project and new mitigation methods will be established for any unforeseen issues that arise.

Funding and Cost Profile

Organization	Federal	Non-Federal**	TOTAL
Minnkota	848,175	212,044	1,060,219
Fluor	7,085,138	1,771,284	8,856,422
Burns & McDonnell	424,316	106,079	530,395
Greson Consulting	42,736	10,684	53,420
Hunt International	77,440	19,360	96,800
EERC	908,493	227,123	1,135,616
Golder Associates	367,280	91,820	459,100
AECOM	48,000	12,000	60,000
Stack Icing Study*	20,000	5,000	25,000
TOTAL	9,821,578	2,455,394	12,276,972
% Cost Share	80	20	100

* Vendor to be determined

** NDIC has approved \$15 Million in cost share towards Project Tundra. A portion of this, matching up with scope of FEED study, will be allocated

	CY 2019 (\$)	CY 2020 (\$)
Q1 (Jan-Mar)		3,683,092
Q2 (Apr-Jun)		3,683,092
Q3 (Jul-Sep)		3,069,243
Q4 (Oct-Dec)	1,227,697	613,849
Total (\$)	1,227,697	11,049,275

Assumes December 1, 2019 actual start of work

Success Criteria & Decision Points

- At the end of the project, Minnkota anticipates making a decision on whether or not to move forward with the commercial project
- FEED must include sufficient detail to file for all permits and secure Final Investment Decision
- Specific success criteria include:
 - Completion of design package
 - Accurate FEED-level cost estimate
 - Support pathway to achieve DOE's cost of capture goals

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Questions?

