



CARBON SOLUTIONS LLC

Advanced Energy Storage Initiative Program Project Review Meeting

Kevin Ellett

PRESIDENT AND PRINCIPAL GEOSCIENTIST

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April 6th, 2021





Prime Recipient: Carbon Solutions LLC

PI: Kevin Ellett, President and Principal Geoscientist

Sub-Recipient: Indiana University Purdue University Indianapolis.
Lead: Peter Schubert, Professor of Engineering

Location: Bloomington, IN and Indianapolis, IN

DOE Funding: \$199,999

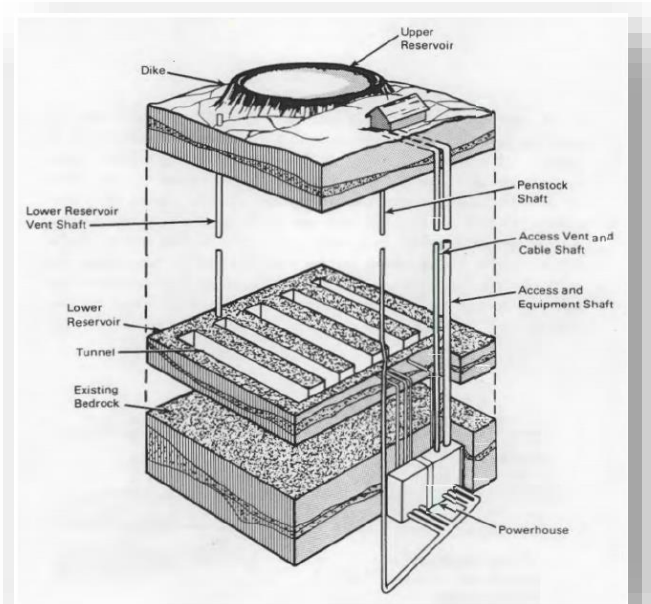
Non-DOE: N/A

Total: \$199,999

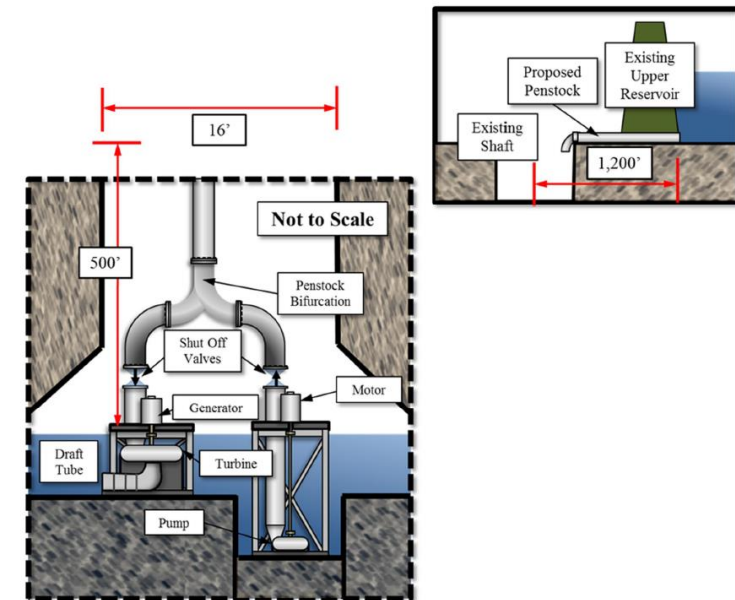
Performance Period:
March-November 2021

Objectives

Advance the commercialization of the nation's first PSHAUM energy storage technology



Early concept for underground PSH.
Source: Allen et al., PNL Report 5142, 1984



Concept for underground PSH using abandoned coal mine
Source: Witt et al., ORNL Report TM-2015/559, 2015

Address key technical knowledge gaps:

- Uncertainties in the performance of abandoned underground mines as lower reservoirs for pumped-storage hydropower systems.
- Prototype engineering design and techno-economic assessment.



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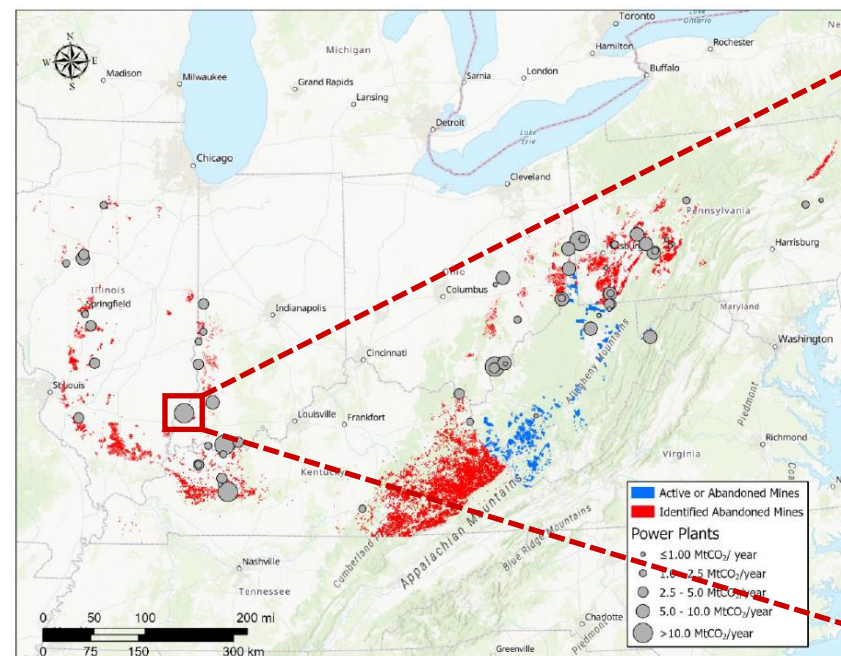
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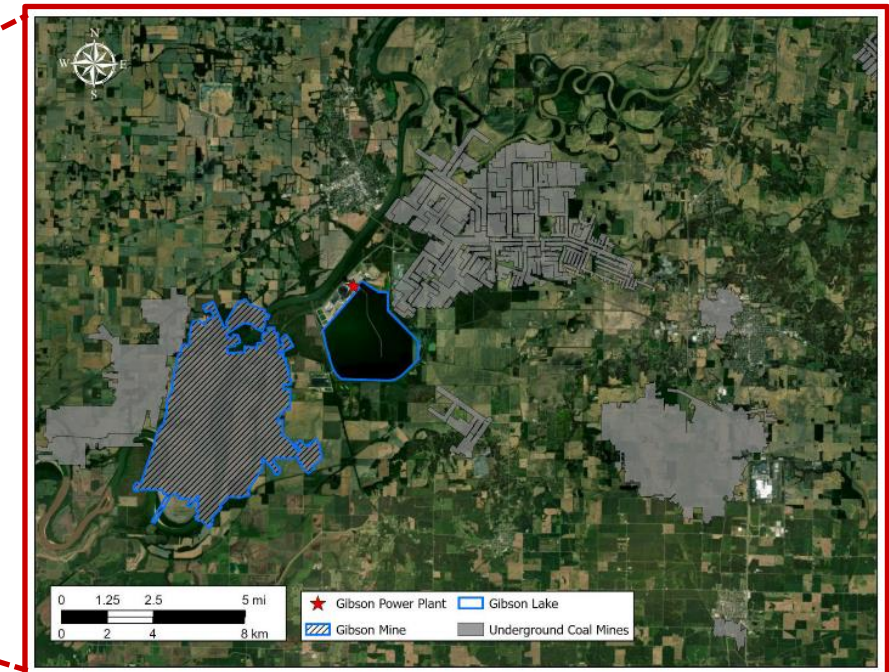
Advance the commercialization of the nation's first PSHAUM energy storage technology

Address key deployment/commercialization gaps:

- National screening analysis for optimal siting of fossil-integrated PSHAUM.
- Targeted engagement with potential customers and project developers (via IP licensing).



Map of northeastern US showing initial results from site screening for a six-state region. Identified 61 fossil power plant facilities as candidates for PSHAUM technology.



Duke Energy's Gibson Station is a top-tier candidate in Indiana: long expected lifespan, CCUS potential, 3,000 acre upper reservoir (~55 GL) and ~75 GL mine void volume at 244 m depth (800 ft)

- ***Task 1: PSHAUM Concept Design Feasibility Study: Suitability of AUM as lower reservoir***

- LANL's FEHM and PFLOTRAN and LBNL's TReactMech top candidates.

- **Task 2: Techno-economic Analysis of Prototype System**

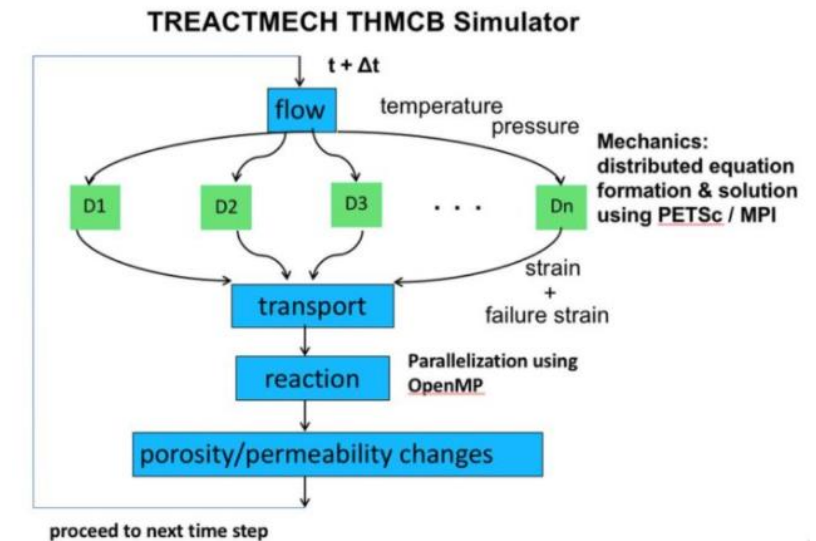
- Acquired HydroHelp 5 software to assist with engineering design and cost calculations/sensitivities.
- Evaluating key parameters and assumptions of pre-feasibility estimates for a 200 MW concept system (~ \$1,460/kW CAPEX and \$90/kWh LCOS).

- **Task 3: National Screening Analysis for Optimal Siting**

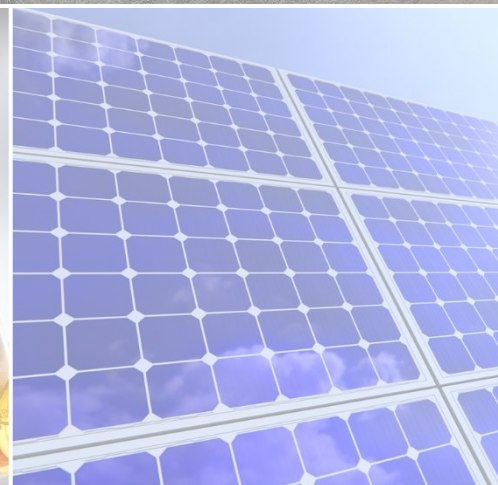
- Fossil power plant data compiled. Filtering underway for expected plant lifespan. Underground mine data compilation underway.

- **Task 4: Early Phase Commercialization Effort**

- Engagement with CONSOL, Southern Company, DTE, Duke and Peabody



Bill of Materials			
Number	Description	Specs	Cost
1	Fencing	10 ft. razor wire around perimeter of 205 acres	\$ 500,000
2	Reservoir	200 acres and 35 ft. deep w/ vol of 2.28 B gal.	\$ 15,000,000
3	Stainless Steel piping	5ft diameter at 500 ft length (x2)	\$ 14,800,000
4	Rooms	10ft by 10 ft room	\$ 3,000,000
5	Pelton Turbine	40 ft. diameter able to produce 200MW	\$ 70,000,000
6	Mine	600 acre mine	\$ 10,000,000
7	Pump Stage 1	440,000 gpm	\$ 25,000,000
8	Pump Stage 2	440,000 gpm	\$ 25,000,000
9	STIR-425 Filter	20 filters plus other expenses	\$ 13,000,000
10	RD6536 skid and Shotcrete	10 skids with parts plus shotcrete mix	\$ 113,187,227
11	Labor	All the miners to Engineers	\$ 2,300,000
		TOTAL COST	\$ 291,787,227



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