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Optimizing Water Extraction and Carbon Dioxide Storage in Saline Aquifers

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Abstract

Carbon dioxide (CO_2) capture, utilization, and storage (CCUS) may reduce CO_2 emissions through the capture of CO_2 from power plants and injection into deep saline aquifers for storage. The extraction of brine in surrounding wells through Enhanced Water Recovery (EWR)[1] can manage the reservoir pressure. Pressure management can

(1) increase CO_2 storage capacity,
(2) reduce the risks linked to reservoir pressure such as seismic activity,
(3) manage the CO_2 plume, and
(4) provide brine that can be treated with desalination for beneficial use and provide a source of water that was previously considered unattainable.[1,2]

This water source could be used as the water requirement for CCUS, thermoelectric power operations, or some other societal need without consuming current water supplies in a region.

Energy-Water Interaction

Thermoelectric Power Plants

- Highest freshwater withdrawal source
- Increase in water consumption through energy demand and shift to evaporative cooling
- Water consumption projected to increase between 36-43% by 2035[3]
- Impacted by regional water stress

CO_2 Capture, Utilization, and Storage (CCUS)

- Increase power plant water consumption by 50-90%[4]

Optimization Model

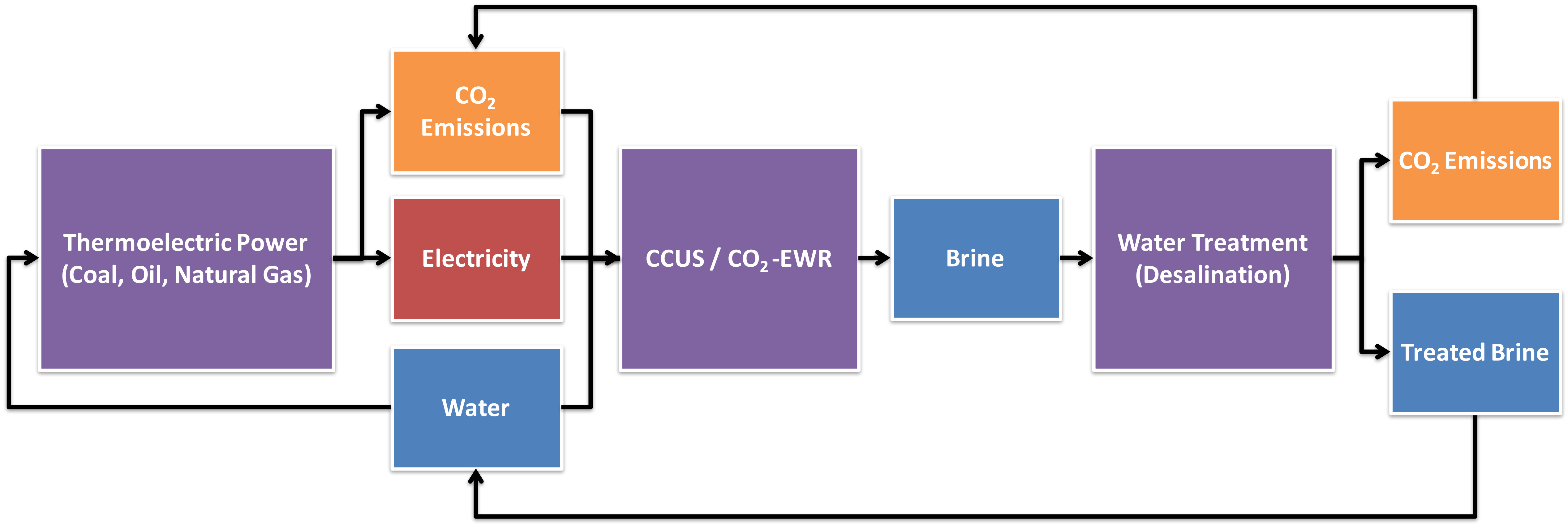
(1) Simultaneously optimize CO_2 storage and water production

(2) Cost-minimizing

  i. CO_2 injection and storage

  ii. Brine desalination and disposal

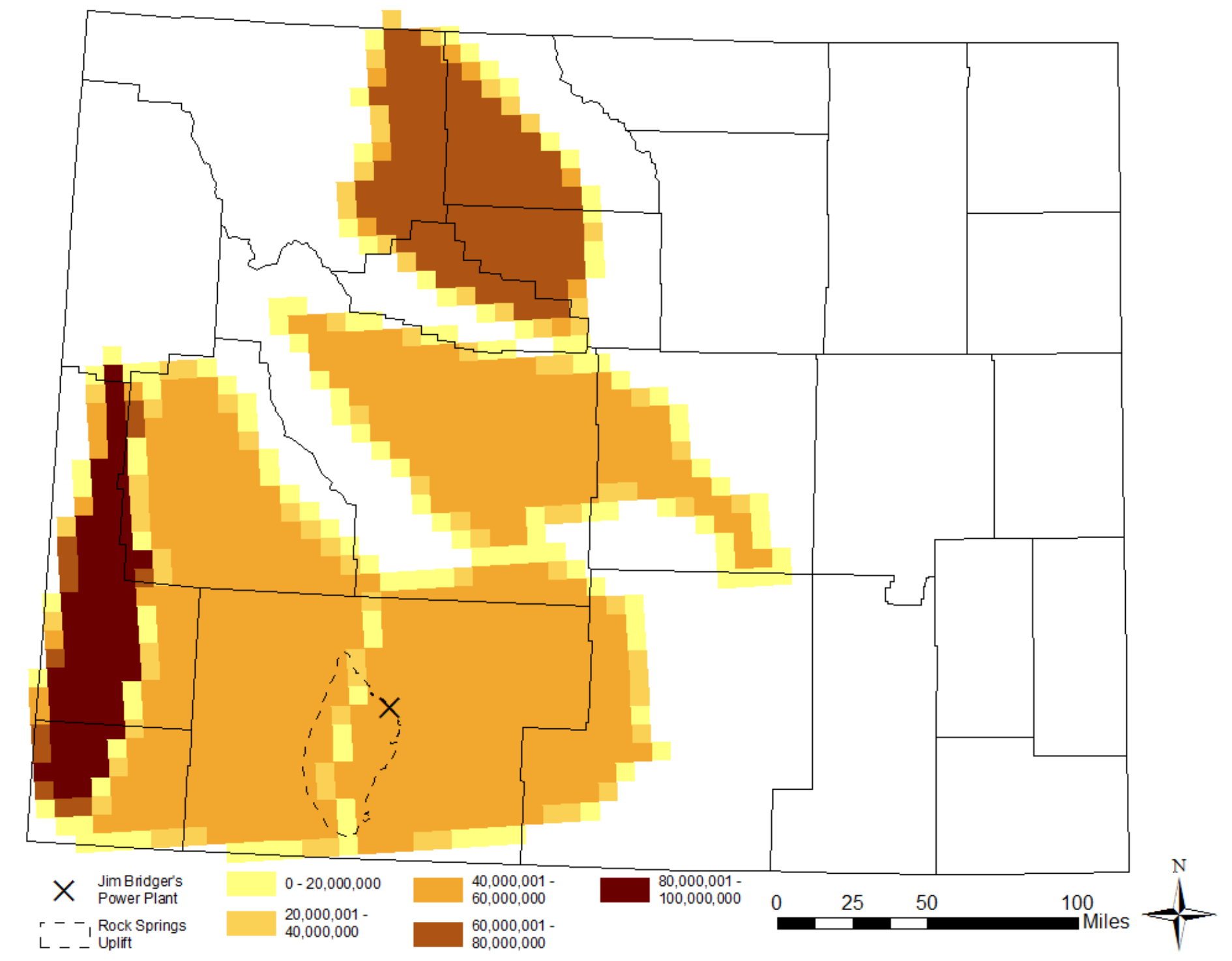
CCUS with EWR Flowchart



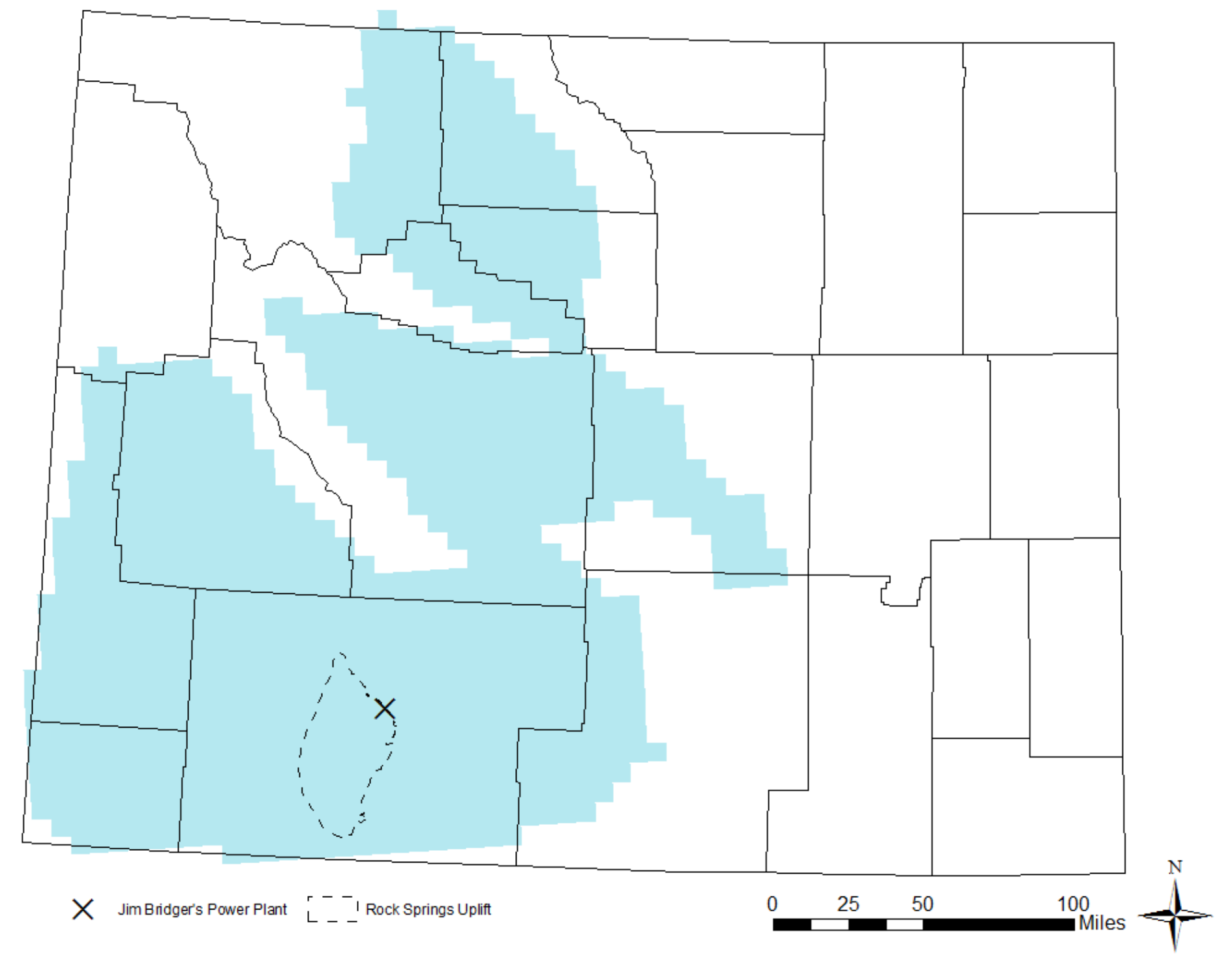
Rock Springs Uplift – Madison Formation

Rock Springs Uplift[5,7]

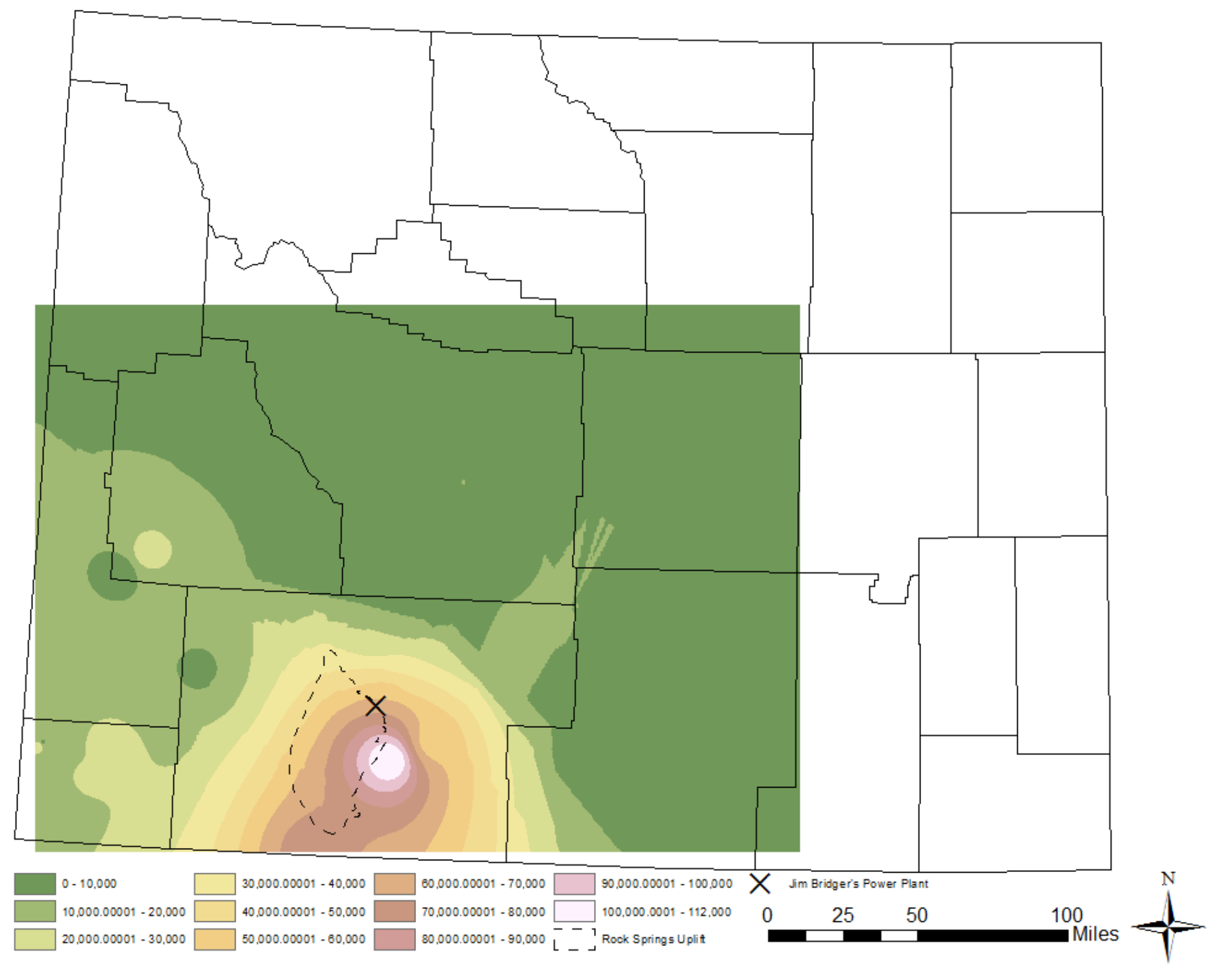
- 50 by 35 square mile area
- Doubly-plunging anticline formation to trap injected CO_2
- Over 10,000 feet of closed structural relief
- Madison formation is an average depth of 7,500 feet
- Madison formation is an average thickness of 250 feet
- Capped by 5,000 feet of thick, low-permeability Cretaceous shale
- Capacity to store approximately 8 million tons of CO_2
- Jim Bridger's Power Plant is the nearest thermoelectric site and anthropogenic CO_2 source



High estimate of subsurface storage capacity for the Madison formation within the Rock Springs Uplift measured in metric tonnes.[6,7]



Spatial extent of the Madison formation within the Rock Springs Uplift and location of the Jim Bridger's Power Plant, a potential anthropogenic source of CO_2.[6,7]



Spatial interpretation of the Madison formation's salinity level in total dissolved solids (TDS) measured in parts per million (ppm).[6,7]

Site Data

Thermoelectric Power Plant[7]

Thermoelectric Power Plant	Plant Annual Net Generation (MWh)	Plant Annual Net CO_2 Emissions (metric tonnes)
Jim Bridger's	13,625,134.8	13,603,135.7

Madison Formation[6]

High Volume (metric tonnes)	Depth (ft.)	Thickness (ft.)	TDS (ppm)
52,480,896	11,816	380	64,359

Impact

This research is a systems level approach to identify the viability of CCUS with EWR and to identify ideal locations for the operation. Current results focus on data collection through NATCARB and eGRID resources, which will be incorporated into a model that explores simultaneous optimization of CO_2 storage and water extraction. The model will compare CO_2 injection and storage with brine extraction and the resulting desalination treatment necessary to treat and provide a usable water source. This comparison will determine if the benefit of increased CO_2 storage through brine production outweighs the costs associated with brine extraction, treatment, and disposal.

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