# LIFE-CYCLE ANALYSIS (LCA) PERFORMED FOR MIDWEST CARBON STORAGE SCENARIOS DEMONSTRATES NET $CO_2$ STORAGE

Greenhouse gas emissions life-cycle analysis helps illustrate the net benefits of carbon capture and storage.

## LCA FACILITATES CLIMATE RESILENCE IN KEY INDUSTRIAL CORRIDORS IN MIDWEST-NORTHEAST U.S. REGION

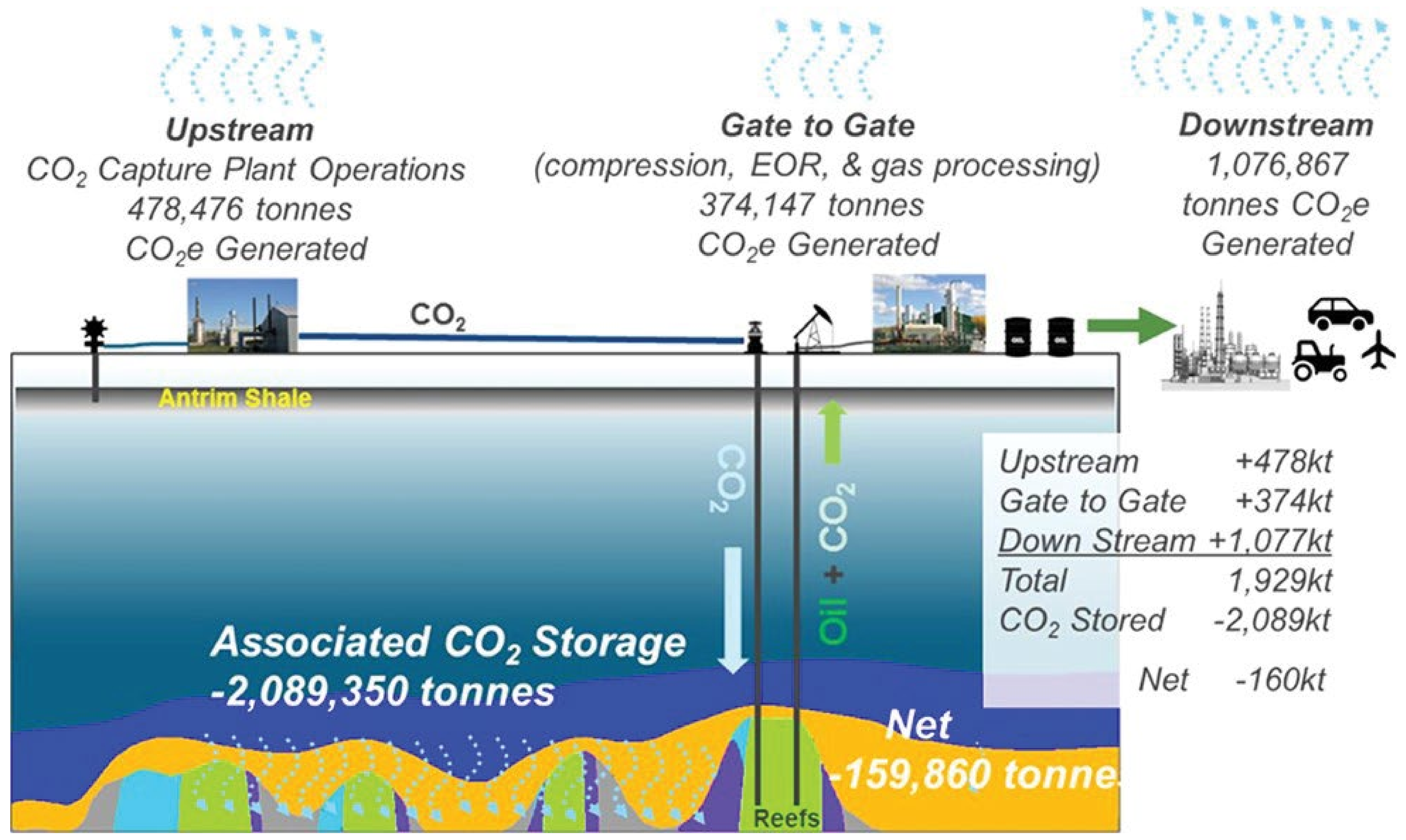


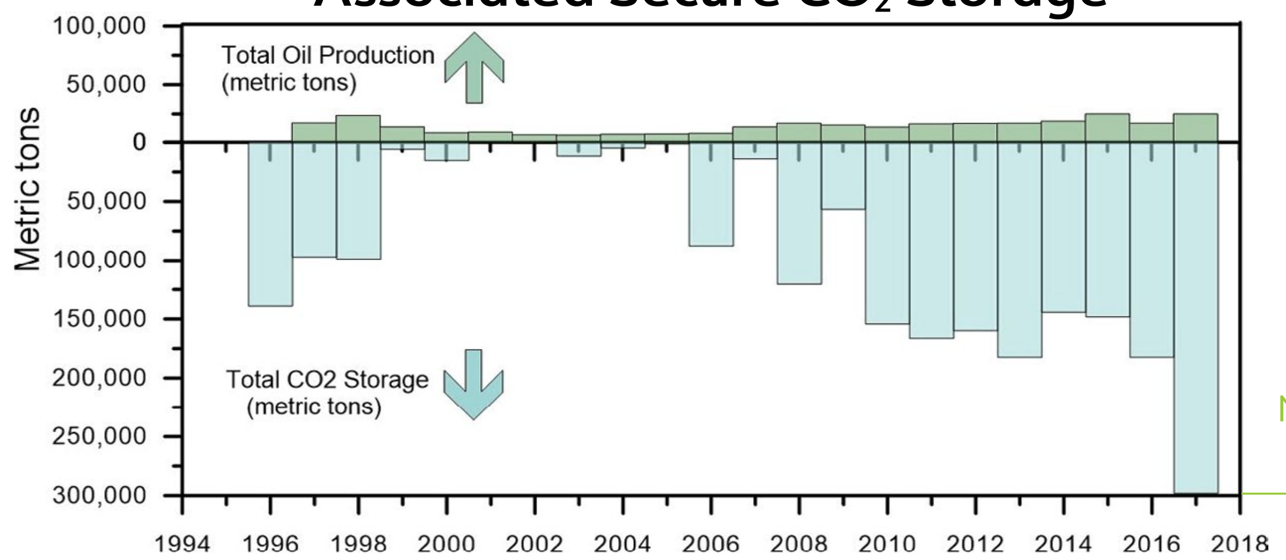

Diagram illustrating the $CO_2$-EOR process at the Niagaran Reef complex.

Life-cycle analysis of net $CO_2$ storage is needed to assess the most impactful carbon capture and storage (CCS) projects in the twenty states of the Midwest Regional Carbon Initiative (MRCI) to mitigate emissions from CCS operations such as capture, compression, and injection that can offset the $CO_2$ stored in geological formations.

### Study Objectives

- Quantify greenhouse gases (GHGs) generated for CCS facilities in the MRCI region.
- Assess "cradle to grave" $CO_2$ equivalent ($CO_2e$) emissions for carbon capture, transport, and storage operations in relation to the volume of $CO_2$ stored underground.
- Integrate MRCI-specific factors into analysis of $CO_2$ sources, geology, and geographic location.

**Enhanced Oil Recovery (EOR) and Associated Secure $CO_2$ Storage**

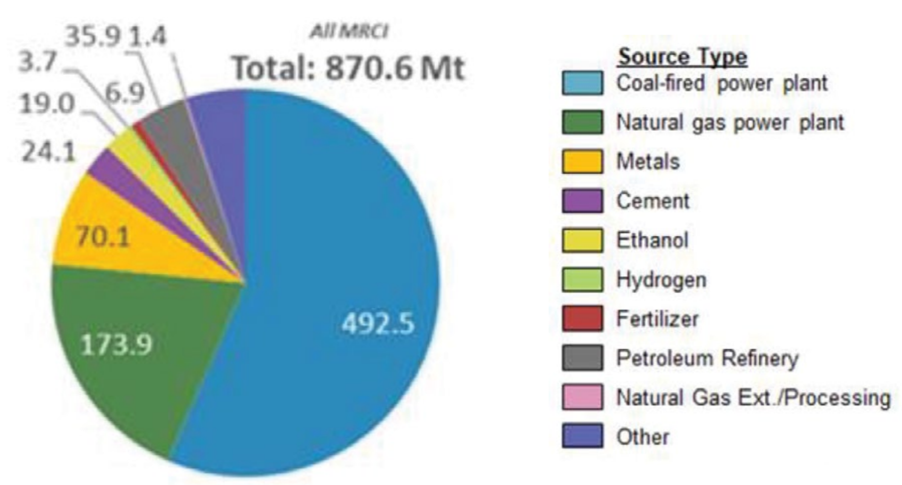



Annual oil production and $CO_2$-associated storage, illustrating the variations in Niagaran Reef $CO_2$-EOR operations over time.

### End Product

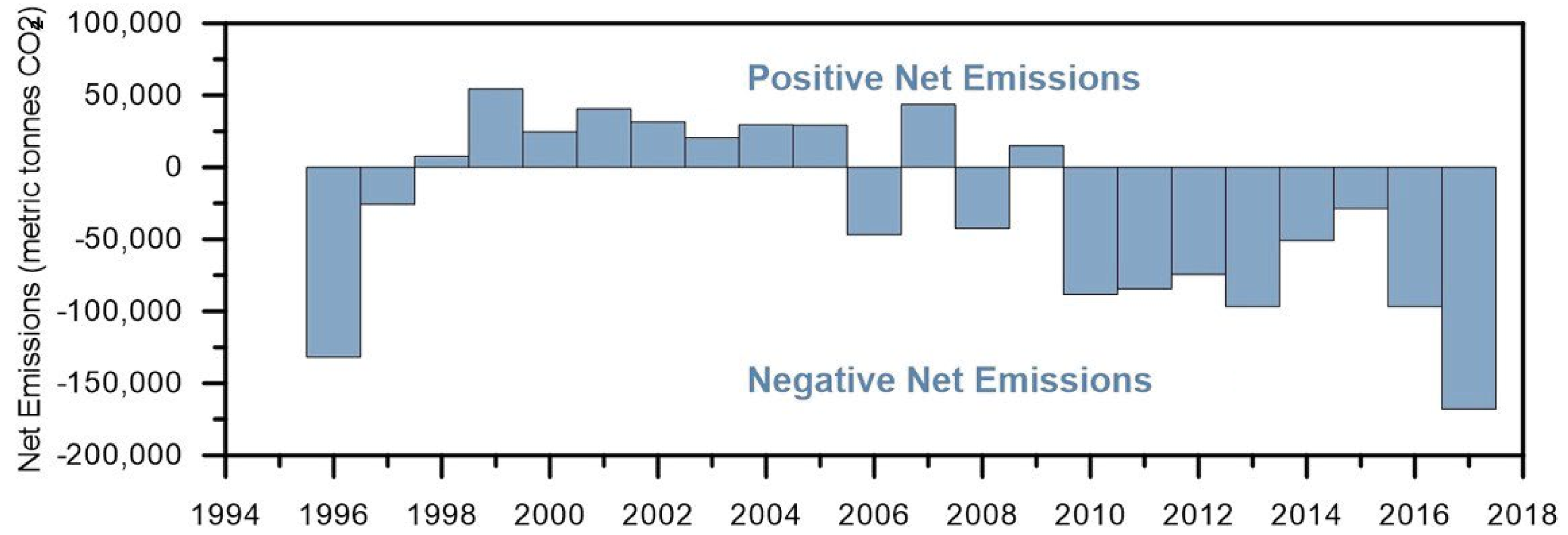
- GHG life-cycle guidance for developing CCS in the MRCI region in terms of maximizing net $CO_2$ storage effectiveness. Optimizing decarbonization of these large point sources will facilitate climate resilience in this key industrial corridor of the U.S.

**Annual $CO_2e$ Emissions for MRCI Region**




## LCA DEPICTS THE NET BENEFITS OF CCS

- Eight scenarios were assessed: Ethanol Plant, Natural Gas Power Plant, Direct Air Capture Plant, $CO_2$ Enhanced Oil Recovery, Hydrogen Plant, Petroleum Refinery, Cement Plant, and Fertilizer/Ammonia Plant.
- The analysis integrated the following specific factors for CCS: geologic storage setting, geographic location, $CO_2$ emissions details, capture requirements, compression needs, $CO_2$ transport possibilities, and $CO_2$ injection. Combustion of fuel products and displaced electricity were not included.
- The analysis included the following key inputs: source size (based on existing sources in MRCI), energy for capture, compression requirements, pipeline transport distances, and fugitive emissions. Scenarios were evaluated for low, average, and high source emissions. The life-cycle model includes more than 200 other input parameters from MRCI data.




Graph illustrating annual trends considering gate-to-gate, downstream, and $CO_2$ storage net emissions.

### Results

- Historical analyses of net $CO_2$ stored vs. emissions from the CCS process included the following: capture, compression, transport, injection, and economies of scale.
- There are many opportunities for CCS in the MRCI region.
- Sources that integrate capture and compression achieve the highest net storage percentages.
- CCS LCA emissions are likely to change over time as operations are optimized to reduce emissions.

PARTNERS

MRCI Midwest Regional Carbon Initiative

BATTELLE

AWARD NUMBER

**FE0031836**

PROJECT BUDGET

$23.7M

DOE .............................. $14,849,641

PARTNERS ...................... $8,819,554

CONTACTS

DOE HQ PROGRAM MANAGER
**Darin Damiani**

NETL TECHNOLOGY MANAGER
**William Aljoe**

FEDERAL PROJECT MANAGER
**Dawn Deel**

PRINCIPAL INVESTIGATOR
**Neeraj Gupta**

CONTRACT SPECIALIST
**Maureen Davison**

CONTRACTING OFFICER
**Angela Harshman**

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