



3. Assess various business case scenarios to accelerate the development and application for commercial EOR

Deliverables will include:

- 1) Screening and selection of a CO<sub>2</sub> EOR ICV pilot pattern in the Cedar Hills South Field;
- 2) Installation of up to 10 ICVs into a horizontal CO<sub>2</sub> injection well and up to ten ICVs into a horizontal production well within the identified test pattern;
- 3) Execution of a tracer study using ICV interval-specific tracers to quantify connectivity within the reservoir and inform the subsequent operational designs;
- 4) Operation of the ICVS during the project to demonstrate reliability and quantitatively show that the deployment of the ICVs can improve conformance, increase CO<sub>2</sub> sweep efficiency, and improve incremental production;
- 5) Collection of downhole measurements which, when combined with analytical and numerical simulation models, provide the empirical data necessary for developing a control system;
- 6) Valuation of various business case scenarios using simulation models to quantify EOR performance metrics and the effect of ICVs on these metrics;

## **METHODOLOGY**

Task 1 – Project Management and Planning

Task 2 – ICV Pilot Systems Design

Subtask 2.1 – Screening and Selection of Test Pattern

Subtask 2.2 – Characterization

Subtask 2.3 – Baseline Modeling

Subtask 2.4 – Pilot Design

Task 3 – Operation and Monitoring

Subtask 3.1 – Install and Test Systems

Subtask 3.2 – System Operation and Monitoring

Task 4 – Active Control System Development

Subtask 4.1 – Database and User Interface Development

Subtask 4.2 – Active Control System Development, Testing, and Optimization

Task 5 – Business Case Development

Subtask 5.1 – Long-term Pilot Test Pattern Performance Simulation

Subtask 5.2 – Business Case Development

## **STATUS**

Contract has been executed.

## **MAY 1, 2020 QUARTERLY REPORT HAS BEEN RECEIVED. KEY ACCOMPLISHMENTS INCLUDED:**

Task 1 – Project Management and Planning:

- EERC worked with DOE from September 2019 to January 2020 to definitize the draft amendment for the project award, which was finalized on January 27, 2020
- EERC participated in weekly project update meetings with Denbury and NCS Multistage
- EERC submitted a Data Management Plan to DOE on December 18, 2019
- EERC delivered a kickoff meeting to DOE on February 10, 2020
- EERC submitted a revised Project Management Plan to DOE on February 25, 2020

Task 2 – ICV Pilot Systems Design

Subtask 2.1 – Screening and Selection of Test Pattern:

- Screening criteria was used to identify a test pattern, and a final candidate injection well was selected for the pilot test: CHSU-43-18NH-15 (API 3301101001)
- With the selection of the injection well, Subtask 2.1 was completed

Subtask 2.2 – Characterization

- Core samples from 12 wells were examined, and descriptions were generated to inform characterization of the pilot project site
- Core samples were submitted for laboratory analyses

Subtask 2.3 – Baseline Modeling

- Model input data was obtained from the NDIC database
- Subsurface structure and thickness maps of the project area were generated

Subtask 2.4 – Pilot Design

- NCS Qumulus Ultimate Recovery System was adapted by the project team
- Design for the injection well was updated based on torque-and-drag modeling to accommodate the Qumulus system

No changes to the project were reported for this quarter. However, due to the COVID-19 pandemic, project participants began to discuss timeline and activity adjustments.

**AUGUST 1, 2020 QUARTERLY REPORT HAS BEEN RECEIVED. KEY ACCOMPLISHMENTS INCLUDED:**

Task 1 – Project Management and Planning:

- Due to the COVID-19 pandemic, several updates to the project timeline and adjustments for field activities were required. A revised Statement of Project Objectives and Project Management plan were provided to DOE

Task 2- ICV Pilot Systems Design

Subtask 2.2 – Characterization

- Laboratory analyses of core plug samples was in progress
- Planned well logging of the injection well and offset production well was delayed to September 2020

Subtask 2.3 – Baseline Modeling

- Structural inputs were used to define a 3D geocellular grid of the Stoughton and Red River formations in the project area
- Basic geologic properties were distributed within the grid using wells within the project area as control points
- Computer Modeling Group’s STARS simulator with FlexWell functionality was tested for its suitability for simulating gas injection via horizontal wells with ICVs, and was found to be suitable for the purposes of project goals

Subtask 2.4 – Pilot Design

- Project team continued to evaluate the Qumulus System design

Although updates to project timeline and adjustment for field activities were required due to the COVID-19 pandemic, no impacts to project reporting, scope of work, or cost were identified.

**NOVEMBER 1, 2020 QUARTERLY REPORT HAS BEEN RECEIVED. KEY ACCOMPLISHMENTS INCLUDED:**

Task 1 – Project Management and Planning:

- On June 30, 2020, the Project Investigator submitted a budget reallocation and scope adjustments letter to DOE, proposing the following adjustments in project scope:
  - Deferring a portion of field expenses to budget period 2
  - Reallocating costs of originally planned ICV system in offset production well to repeat 3D seismic of the area
  - Deferring portion of field labor to budget period 2
- Due to supply chain issues, the estimated time to deploy a complete ICV system was increased from 6 months to 12 months

- Due to Denbury's decision to defer the companies CO<sub>2</sub> delivery to the project area, planned installation of the ICV system was deferred until October 2021
- DOE concurred with the proposed modifications

Task 2 – ICV Pilot Systems Design

Subtask 2.2 – Characterization

- X-ray diffraction, thin section slides, mercury injection capillary pressure, porosity, permeability and total organic carbon laboratory analyses were completed for the core plug samples
- Finalized logging plan for the injection well

Subtask 2.3 – Baseline Modeling

- Baseline Geomodel Version 1 was finalized and clipped to the test pattern area
- Initial equation-of-state parameter tuning was conducted using a 10-component model
- A pattern-level STARS model was developed to study flow behavior in the pilot test pattern

Subtask 2.4 – Pilot Design

- Project team continued to evaluate the Qumulus System design

Updates to the Project Management Plan and Baseline Cost Plan were required due to the COVID-19 pandemic delaying field activities until later in 2020 than originally planned. No increase in project spending was anticipated, as costs were reallocated between budget periods.

**FEBRUARY 1, 2021 QUARTERLY REPORT HAS BEEN RECEIVED. KEY ACCOMPLISHMENTS INCLUDED:**

Task 1 – Project Management and Planning:

- Due to the COVID-19 pandemic and delays in field work, field characterization and the Go/No Go decision was not able to be completed by the end of the 2020 calendar year. EERC requested a no-cost extension from DOE to June 30, 2021

Task 2 – ICV Pilot Systems Design

Subtask 2.2 – Characterization

- A baseline 3D seismic survey was acquired from the test pattern area
- Processing of the seismic data began

Subtask 2.3 – Baseline Modeling

- Following discussions of equation-of-state parameter tuning with Denbury, changes were made to the 10-component model to reflect feedback received
- Stochastic fracture modeling was conducted and integrated into the STARS simulation model
- Baseline reservoir simulations were conducted using the STARS model to emulate the ICV system

Task 4 – Active Control System Development

- Project team developed a Task 4 plan and staffing model to reflect project timeline changes

Task 5 – Business Case Development

- Project team developed a Task 5 plan and staffing model to reflect project timeline changes

Budget period 1 was requested to be deferred from January 31, 2021 to June 30, 2021 to reflect field work delays due to the COVID-19 pandemic as well as delays by Denbury in commencing construction of the CO<sub>2</sub> supply pipeline. The extension is not expected to increase project costs.

**MAY 1, 2021 QUARTERLY REPORT HAS BEEN RECEIVED. KEY ACCOMPLISHMENTS INCLUDED:**

Task 1 – Project Management and Planning:

- Under advisement from DOE, EERC amended the no-cost time extension of budget period 1 for one full calendar year to January 31, 2022
- EERC submitted a no-cost time extension to DOE requesting to move the project end date to September 30, 2025

Task 2 – ICV Pilot Systems Design

Subtask 2.2 – Characterization

- Processing of acquired 3D seismic data was completed
- Interpretation of processed P-wave and PS products began

Subtask 2.3 – Baseline Modeling

- Equation-of-state parameter tuning underwent QA/QC and was finalized for reservoir simulation

Task 3 – Operation and Monitoring

- Project team reviewed current ICV system design with Denbury and NCS Multistage

**AUGUST 1, 2021 QUARTERLY REPORT HAS BEEN RECEIVED. KEY ACCOMPLISHMENTS INCLUDED:**

Task 1 – Project Management and Planning

- DOE approved the request to extend the project end date to September 30, 2025

Task 2 – ICV Pilot Systems Design

Subtask 2.2 – Characterization

- Full-stack geometric attributes were calculated with IHS Kingdom Geophysics and OpendTect and extracted from the PP and PS 3D seismic volumes along the Red River Formation

**NOVEMBER 1, 2021 QUARTERLY REPORT HAS BEEN RECEIVED. KEY ACCOMPLISHMENTS INCLUDED:**

Task 2 – ICV Pilot Systems Design

Subtask 2.2 – Characterization

- Results from geometric attribute calculations suggested that a seismic feature, such as a fault, could be present in the Precambrian basement and could affect Red River Formation geology in the project area
- The seismic attributes were imported into a Petrel project for use with its “ant-tracking” algorithm, which would be used to further illuminate features that could model fracture networks within the zones of interest

Due to pandemic disruptions and rig availability, field work was delayed until late November or early December 2021.

**FEBRUARY 1, 2022 QUARTERLY REPORT HAS BEEN RECEIVED. KEY ACCOMPLISHMENTS INCLUDED:**

Task 2 – ICV Pilot Systems Design

Subtask 2.2 – Characterization

- Project team performed initial seismic-based fracture analysis with plans to integrate with additional field characterization data to ground-truth fracture patterns interpreted from the baseline 3D seismic attribute extractions

**MAY 1, 2022 QUARTERLY REPORT HAS BEEN RECEIVED. UPDATES INCLUDE:**

Fieldwork necessary to complete the next project milestone has been delayed until 2023, beyond the currently planned go/no go decision point on July 31, 2022. In addition to the delays in fieldwork, the lead-time for the fabrication of the ICV system has been extended from 6 to 12 months.

EERC is seeking a no-cost time extension to the project timeline to accommodate the revised field schedule and longer lead-times for the ICV system fabrication. EERC estimates the request to be approved by DOE in the next quarter.

Updated 6/9/2022