

GDR DATA PLAN SUBMITTAL*For*

Thomas A. Buscheck
Lawrence Livermore National Laboratory
Active Management of Integrated Geothermal-CO₂ Storage Reservoirs in Sedimentary Formations

SOPO TASKS TO BE PERFORMED AND CORRESPONDING DATA GENERATION:

PHASE 1: The purpose of phase 1 is to determine the feasibility of integrating geologic CO₂ storage (GCS) with geothermal energy production. Phase 1 includes reservoir analyses to determine injector/producer well schemes that balance the generation of economically useful flow rates at the producers with the need to manage reservoir overpressure to reduce the risks associated with overpressure, such as induced seismicity and CO₂ leakage to overlying aquifers. Based on a range of well schemes, techno-economic analyses of the levelized cost of electricity (LCOE) are conducted to determine the economic benefits of integrating GCS with geothermal energy production. In addition to considering CO₂ injection, reservoir analyses are conducted for nitrogen (N₂) injection to investigate the potential benefits of incorporating N₂ injection with integrated geothermal-GCS, as well as the use of N₂ injection as a potential pressure-support and working-fluid option. Phase 1 includes preliminary environmental risk assessments of integrated geothermal-GCS, with the focus on managing reservoir overpressure. Phase 1 also includes an economic survey of pipeline costs, which will be applied in Phase 2 to the analysis of CO₂ conveyance costs for techno-economics analyses of integrated geothermal-GCS reservoir sites. Phase 1 also includes a geospatial GIS survey of potential integrated geothermal-GCS reservoir sites, which will be used in Phase 2 to conduct sweet-spot analyses that determine where promising geothermal resources are co-located in sedimentary settings conducive to safe CO₂ storage, as well as being in adequate proximity to large stationary CO₂ sources.

Task 1.0 – Reservoir Analyses

Task Milestones or Products: This task investigates injector/producer well schemes, including vertical and horizontal wells, for integrated geothermal-CCS for generic representations of potential sedimentary-basin reservoir sites. These analyses address balancing the need to manage reservoir overpressure with the generation of economically useful flow rates at the producers. These analyses will be used to identify well schemes that achieve that balance, which will result in a range of reservoir scenarios used to estimate well-infrastructure cost factors that will be applied in the techno-economic analyses, using the DOE GETEM code. These analyses are also used to demonstrate how integrated geothermal-GCS can be operated to limit overpressure to reduce environmental risks, which is applied to Task 2.0, Environmental Risk Assessment.

Nature of Potential Data: Input and output files from reservoir simulation runs using the NUFT code. Much of the data is illustrated in the FY1 Final Report, with corresponding Excel spreadsheets of simulated reservoir performance, submitted to the GDR.

Data Format: ASCII text files of input and outputs of NUFT reservoir analyses, and Excel spreadsheets of energy production and flow rates. Because of the file lengths, all of the reservoir-model input and output files are saved as *.tar.gz files, corresponding to sections of the FY1 Final Report. A reservoir-model “index” html file is included to organize the reservoir model input and output files according to the section to which they pertain. The recipient should save the reservoir-model index.html file in the same directory that the *.tar.gz files are saved in. All of the Excel spreadsheet files are saved as a .zip file, with a directory structure corresponding to the sections of the FY1 Final Report.

Data Sharing: There are no restrictions on the data.

Comments: All submitted data is organized in a hierarchy corresponding to the sections (2.1.2 through 2.1.6) to which that data pertains in the FY1 Final Report. Any users intending to use the NUFT input files submitted to the GDR will need to obtain a licensed copy of the NUFT code executable from LLNL.

Task 2.0 – Environmental Risk Assessment

Task Milestones or Products: This task addresses the risks of induced seismicity, subsidence, and the potential for fluid flow either to or from neighboring potable-water aquifers, on the basis of results from the reservoir study. This is a minor task because our heat recovery method is designed to minimize pressure buildup or drawdown and thereby minimizing the driving force for fluid migration out of, or into, the storage formation. In Task 1.0 (Section 2.1.5 of the FY1 Final Report) we demonstrate how integrated geothermal-GCS can be operated to avoid unsafe values of reservoir overpressure.

Nature of Potential Data: See Task 1.0.

Data Format: ASCII text files of input and outputs, and Excel spreadsheets.

Data Sharing: There are no restrictions on the data.

Comments: The reservoir analyses in Section 2.1.5 of the FY1 Final Report address Task 2.0.

Task 3.0 – Techno-Economic Analyses of Levelized Cost of Electricity (LCOE) and CO₂ Pipeline Construction Costs

Task Milestones or Products: GETEM (Geothermal Electricity Technology Evaluation Model) is a tool developed for the U.S. Department of Energy that evaluates different geothermal production scenarios with a moderate level of detail. GETEM May 2011 version is used for this task. The model takes financial and technical inputs and estimates the levelized cost of electricity (LCOE). We vary a range of technical and operational parameters, such as resource temperature, resource depth, number of producers, flow rate per producer, the ratio of injectors to producers, and whether submersible pumps are required. We create a comprehensive Excel spreadsheet that determines LCOE, as well as gross and net power output for a wide range of cases. The matrix of

LCOE and net power output results are then applied to specific well-field reservoir scenarios analyzed in Task 1.0 to interpolate LCOE and net power output values pertaining to those specific scenarios.

The other part of the techno-economic analyses pertains to a nationwide survey of pipeline costs applicable to CO₂ pipelines. Pipeline costs are estimated for each of the 48 contiguous states. The states are then ranked according to pipeline cost, based on a 50-km pipeline. An Excel spreadsheet submitted to the GDR provides pipeline costs for 50, 100, 500, and 1000 km pipelines capable of flowing 8, 16, and 33 million metric tonnes of CO₂ per year (16, 24, and 32 inch diameters, respectively).

Nature of Potential Data: The GETEM input and output data are summarized in an Excel spreadsheet. The results are organized in a matrix format where different operational parameters, such as the number of producers, the ratio of brine injectors to producers, production rate per producer, hydraulic drawdown, thermal drawdown, and whether or not submersible pumps are used, can be selected from a pull-down menu.

Data Format: All data is provided in Excel spreadsheets. The Excel files are found in folders: Section2.3.1-GETEM-spreadsheets and Section2.3.2-Pipeline-spreadsheets, both in the same .zip file that contains the Task 1.0 Excel files.

Data Sharing: There are no restrictions on the data.

Comments: None.

Task 4.0 – Geospatial Analyses of Integrated Geothermal-GCS

Task Milestones or Products: Geospatial surveys of the 48 contiguous states are conducted of sedimentary deposit thickness, resource temperature, and of saline reservoirs that have been determined by the NATCARB Regional Carbon Sequestration Partnership (RCSP) as being suitable for GCS. The products are a map of the thickness of sedimentary deposits, a contour map of the temperature at the crystalline basement, and contour maps of temperature at 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 km, restricted to areas with 1.0 km or more of sedimentary rock thickness and which coincide with the NATCARB RCSP saline basins.

Nature of Potential Data: The data will be primarily given in contour maps of sedimentary deposit thickness and temperature. A histogram of resource temperature and depth is also provided.

Data Format: All data submitted to the GDR are contained in ArcGIS .mpk files. The .mpk files are found in the folder: Section2.1.4-mpk-files, in the same .zip file that contains the Tasks 1.0 and 3.0 Excel files.

Data Sharing: There are no restrictions on the data.

Comments: None.