

Project Title:

Fuel-Free Geologic Compressed Air Energy Storage From Renewable Power

Task # 3 Deliverable Report

For:

New Technology Implementation Grant Program

582-11-13126-3225

Submitted by:

General Compression, Inc.

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Abstract/Executive Summary

General Compression has installed a second-generation, commercial 2 MW advanced compressed air energy storage system utilizing a fuel free, near-isothermal compressor/expander at an existing geological salt cavern in West Texas. General Compression additionally has installed and integrated a 2MW or equivalent wind turbine alongside the GCAES™ compressor/expander technology to demonstrate our ability to use wind to provide firm dispatchable power (including peak, intermediate and baseload) and ancillary services to the Texas electrical grid. This project will allow for a minimum of 500 MWh of energy storage at an installed cost of approximately \$15/kWh (or \$24/kWh including the wind turbine), and will provide the necessary foundation to allow for the wide-scale ramp up to hundreds of thousands of megawatt hours of energy storage throughout Texas.

Introduction / Background

General Compression has developed a near-isothermal compressor/expander module that will allow the construction of utility-scale storage projects from a minimum of 2W to over 1,000 MW in power rating and over 300 hours of storage. The General Compression Advanced Energy Storage ("GCAES") project enables renewable generators to output energy to almost any power curve required by a customer. These modules use electricity as an input, either from intermittent renewable generators such as wind turbines and solar arrays, or from off-peak grid generators. The projects require no fuel to turn the air into power, lowering operating and permitting costs compared to other compressed air energy storage technologies and expanding the number of potential project sites. GCAES units feature a round-trip electrical efficiency of 75% and an installed cost of between \$800-\$1,000/kW. The projects are targeted at increasing the value of renewables, eliminating curtailment, enhancing transmission utilization, and making dispatchable renewable power available to customers, thus making it possible for renewables to displace coal or natural gas on the grid and significantly reduce total state-wide emissions. Projects can be built in remote areas, allowing renewables to more completely utilize remote transmission lines. General Compression plans to partner with utilities and developers of wind farms, existing underground storage facilities, transmission lines, etc. to develop integrated wind/storage projects. Standalone storage projects can also be built within urban power constraint areas, where peak/off-peak power arbitrage opportunities are highest because of the difficulty of siting new generation and transmission. The compressed air is stored in geologic formations and then expanded on demand to convert it to electric power. Value is created by absorbing power when it is not required by customers and generating power when it is. Unlike conventional compressed air energy storage projects, no fuel is burned when air is expanded and power is generated.

GCAES projects are responsive enough to be eligible in various markets for their ability to provide spinning reserves, capacity, voltage support, frequency regulation, etc. GCAES

projects do not have gas line connections, air pollutant or CO2 emissions, radioactive risks, or coal ash containment. They are ideally suited to areas where conventional power projects cannot receive air permits.

Project Objectives / Technical Approach

General Compression has eight operational goals and objectives for this project:

- 1) Build and install a commercial unit of the General Compression Advanced Energy Storage at a demonstration facility being developed jointly between General Compression and ConocoPhillips.
- 2) Integrate the GCAES system into an existing cavern formation at the demonstration facility.
- 3) Build and install approximately 3 to 10 MW of wind turbines at the same site.
- 4) Integrate electricity generation from the wind turbine into the GCAES system for optimal delivery of wind power to the grid.
- 5) Provide and maintain energy storage and generation services to supply power to the Texas electrical grid over multiple timeframes.
- 6) Work with the Bureau of Economic Geology at the University of Texas ("BEG") to develop the test protocol to analyze the function of the GCAES unit and the wind turbine together as a project so that they respond to appropriate market signals.
- 7) Work with BEG to analyze the further integration of renewables into the electrical grid throughout the state of Texas in order to support the reduction of emissions and create opportunities for existing and future clean energy industry expansion within the state.
- 8) Reduce emissions by displacing baseload power generated from fossil fuels with renewable resources thus improving overall air quality in the state of Texas.

Tasks

TASK 3

Specific project site preparation **(from Grant Activities (Scope of Work))**

TASK 3 Deliverables:

General Compression, project partner ConocoPhillips, EPC firm Waldron Engineering and Cavern EPC Lonquist and CO have successfully planned, funded and executed development plans, and have prepared the demonstration site. Specifically:

Constructing the project site, BOP, building and related infrastructure to support the integration of GCAES technology and operation of the demonstration project.

Repurposing an existing salt cavern to Compressed Air Energy Storage Service and successfully integrate with GCAES technology.

Objectives vs. Results

Description of how work described for Task(s) was completed

- Waldron Engineering ConocoPhillips and General Compression managed the process with site construction schedule and reporting; Waldron Closeout Suretrack Schedule submitted as *"Confidential/Proprietary"*.
- Lonquist developed Railroad Commission of Texas, Oil and Gas Division cavern Permit application and plan to create, operate, and maintain and an underground compressed air energy storage facility by repurposing an existing salt cavern for air service. The TRRC Rule 97 permit application submitted as *"Confidential/Proprietary"*. The removal of the hydrocarbons was performed as required to obtain the RRC permit. Please reference **The Gaines Cavern Workover and Completion Report (2011)** for further details. This report was provided under separate delivery in April 2013.

Task 3 deadline(s) from Grant Activities (Scope of Work)

2.3.3. Schedule: (Deadline) The PERFORMING PARTY shall complete this task within 4 months of the signed Notice to Proceed Date as issued by the TCEQ, The signed Limited Notice to Proceed was sent to General Compression on July 25, 2011. Therefore, the Task 3 deadline is November 25, 2011. However, the due date was amended/extended to

Task 3: Details or attachment of final results/deliverables (submitted separately as "Confidential/Proprietary": inform applicant and seek AB opinion before releasing")

GCAES/Site Construction:

- Site Construction Waldron Engineering Suretrack Construction Plan and Schedule

Cavern:

- Rule 97 Texas Rail Road Commission Permit Application

Submitted April 8, 2013:

- The Gaines Cavern Workover and Completion Report (2011).

Submitted on December 12, 2012:

- The Gaines Cavern Project Work Commissioning Completion Certificate
- The Gaines Cavern Project Scada Commissioning Completion Certificate
- The Gaines Cavern Project Turbine Mechanical Completion Certificate
- The Gaines Cavern Project Turbine Commissioning Certificate

Submitted February 12, 2013:

MPR letter (report of successful commissioning of the Gaines project)

Technical and commercial viability of the proposed approach

N/A

Scope for future work

(Suggestions for future work, regardless of funding source)

Intellectual Properties/Publications/Presentations

Does not apply to this Task 3 deliverable.

Summary/Conclusions

- Task 1, 2 and Task 3 deliverables are completed.
- The GCAES machine is mechanically complete.
- Watertown commercial demonstrator endurance testing to achieve 950 operating hours is on going.

Based on the documents provided here and separately as "**Confidential/Proprietary**": **inform applicant and seek AB opinion before releasing** GC believes that we have satisfied all requirements for Task 1, 2 and 3. GC continues to move forward with completing Task 4 and 5 objectives before receiving the Notice to Proceed to pursue Tasks 6 and 7.

END OF TASK 3 REPORT