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Technical Conference Paper

Maximizing Salt Cavern Opportunities in Alberta: The Marguerite Lake CAES and Hydrogen Project

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SMRI Fall 2024 Technical Conference
22-25 September 2024
Edmonton, Alberta, Canada

Solution Mining Research Institute Fall 2024 Technical Conference

Edmonton, Alberta, Canada 22–25 September 2024

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Abstract

This paper presents the development of a diabatic Compressed Air Energy Storage (CAES) project north of La Corey, Alberta, Canada, which is a collaboration between Federation Group Inc.(Federation), Cold Lake First Nations (CLFN), and RESPEC Company, LLC (RESPEC). Strategically located adjacent to the Marguerite Lake substation, this project leverages underutilized high-voltage infrastructure and suitable salt formations for underground energy storage caverns. The CAES system stores surplus renewable electricity by compressing air into solution-mined salt caverns. During peak demand, the stored air is released to turbines, providing dispatchable, low-emission electricity. This process stabilizes the grid and supports Alberta's net-zero strategies by integrating with the Alberta Interconnected Electric System (AIES), enhancing the grid's capacity to accommodate new renewable generation.

The Marguerite Lake CAES Project is designed to provide a 250-megawatt (MW) load and 640-MW generation capacity. Each phase includes a 125-MW compressor and two 160-MW expanders capable of full load within minutes and efficient turndown rates. Salt caverns will be designed to accommodate a minimum of 48 hours of generation, which provides a full week of long duration energy storage with the forecast dispatch profile. Complementing the CAES system, the Marguerite Lake Hydrogen Hub Project will establish a hydrogen production facility and underground storage, co-located with the CAES Project. Federation has partnered with Babcock & Wilcox Enterprises, Inc. (B&W) to generate near-pure hydrogen and carbon dioxide (CO2) using natural gas. By 2035, the project aims for 100 percent hydrogen firing, enabling net-zero electricity production. Co-location with the CAES facility eliminates the need for hydrogen transportation pipelines and leverages the local geology for storage caverns.

Two subsurface salt formations, the Prairie Evaporite and Lotsberg Salt, will be used for solution-mining salt caverns for underground storage. Various freshwater and brackish aquifers have been identified to supply adequate leach fluid for cavern development, and a deep injection zone exists for brine disposal. Based on a 5-year analysis of the AIES, an hourly dispatch cycle was developed of the anticipated air cavern charging and discharging. Thermodynamic and geomechanical analyses of the air caverns and hydrogen caverns were performed to evaluate their performance and ability to satisfy the dispatch cycle requirements.

This paper synthesizes key aspects of the surface and subsurface infrastructure, encompassing the CAES and hydrogen equipment and storage caverns, to provide a comprehensive overview of the project’s contributions to grid stability and net-zero goals.

Keywords: Alberta, compressed air energy storage (CAES), hydrogen storage, Lotsberg Salt, Prairie Evaporite, salt caverns