Compressed Air Energy Storage (CAES) in Eastern Canada

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DRESSER-RAND
A Siemens Business

ABSTRACT

Governing institutions are transitioning towards renewable energy sources in response to climatic issues associated with a fossil fuel based energy economies. Existing, intermittent renewable sources are frequently curtailed in order to ensure grid reliability. As we head towards a decarbonized future with renewables, the need for large-scale energy storage systems becomes increasingly more important as mechanisms for grid management and load leveling. (Kim et al., 2012).

Compressed air energy storage (CAES) offers a highly reliable, market competitive solution to capture and balance large scale renewable based energy. CAES provides substantial load absorption and storage capacity in the form of compressed air and typical projects have in excess of 20,000 MWh of storage capacity.

Research and development (R&D) scale projects are needed to address challenges that arise with different grid and storage facilities, to aid grid-scale implementation of CAES plants (Dusseault personal communication, 2017).

This is a brief outline of the proposal that will be put forward by Bobby Bailie, Business Development Director of Dresser-Rand A. Siemens, to set up a research and development phase CAES pilot study in Nova Scotia (NS) and New Brunswick (NB).

BACKGROUND

CAES compresses air with low cost electricity from the power grid at off-peak times, and with some gas fuel can utilize it to generate electricity as needed. For a larger scale operation the compressed air is stored in underground caverns (such as salt domes) or in aboveground air vessels (smaller scale) (Kim et al., 2012).

In Nova Scotia there are massive storage opportunities within the thick accumulations of salt and salt dome structures (Dusseault personal communication, 2017). Nova Scotia's legislated renewable portfolio has been set to achieve 40% renewable generation by 2020 and thus is leaning towards more wind and tidal generation facilities.

The use of energy storage systems, such as CAES will be a significant towards achieving this initiative and is necessary in order to ensure a stable power input environment with tidal and wind energy economies (Dusseault personal communication, 2017). With the maritime provinces (NS,NB, and PEI) future in wind and tidal, there is a clear opportunity to export green power with the coupling of CAES systems.

With Nova Scotia's relatively simple grid system**,** renewable future and significant storage opportunities, the province has the potential to be a prime hub for cultivating CAES projects and in turn will receive the long-term energy benefits.

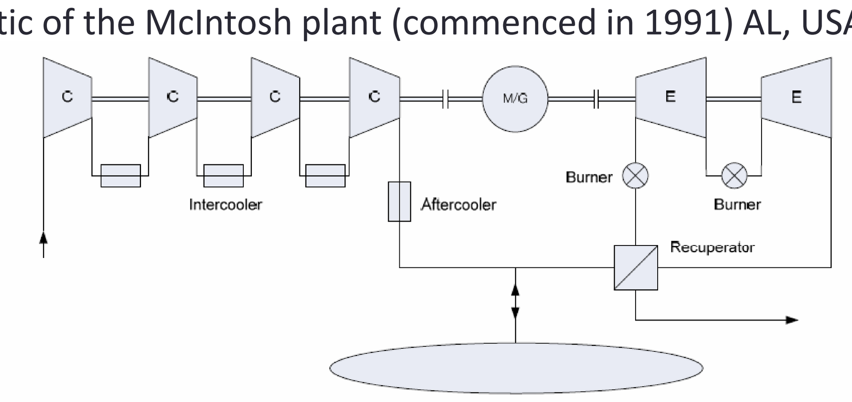
OBJECTIVE

- Propose R&D project in NS & NB
- Multi-stakeholder environment: Collaboration of universities, industry, and government
- Gain funding from both federal and provincial institutions
- Generation of grid models, methods, and potential sites
- Involvement of multiple specialties: geology, geo-mechanics, mechanical engineering, power engineering

CAES DESIGN

CAES System Modeling:

Ex: Schematic of the McIntosh plant (commenced in 1991) AL, USA (Kim et al., 2012)



Dresser-Rand, a Siemens business (D-R), designed and supplied turbo-machinery train and plant controls for McIntosh plant and has pioneered CAES development for 30 plus years

Ontario Pilot Study

- CAES demonstration project in Ontario
- Possibility for 135 MW facility
- Looking at new designs for gas turbines
- Industry and government support

Goderich Salt Mine, Ontario

Cost Comparison:

- CAES in salt caverns has low / intermediate per kWh cycle costs, moderate capital costs and low environmental impact (small long-term costs).

Type	Rating / Module	Storage Duration	$/kWh Capacity	Life Cycle (years)	Surface Impact
PHS (Pumped Hydro)	100 - 2000 MW	Hours - Months	*5 - 100	40 - 60	High - land flooding
CAES	2 - 400 MW	Hours - Days	*2 - 50	20 - 40	Low - small footprint
Battery (Li – ion)	1-100 MW	Mins - Days	*600 - 2500	5 - 15	High - rare earth mining

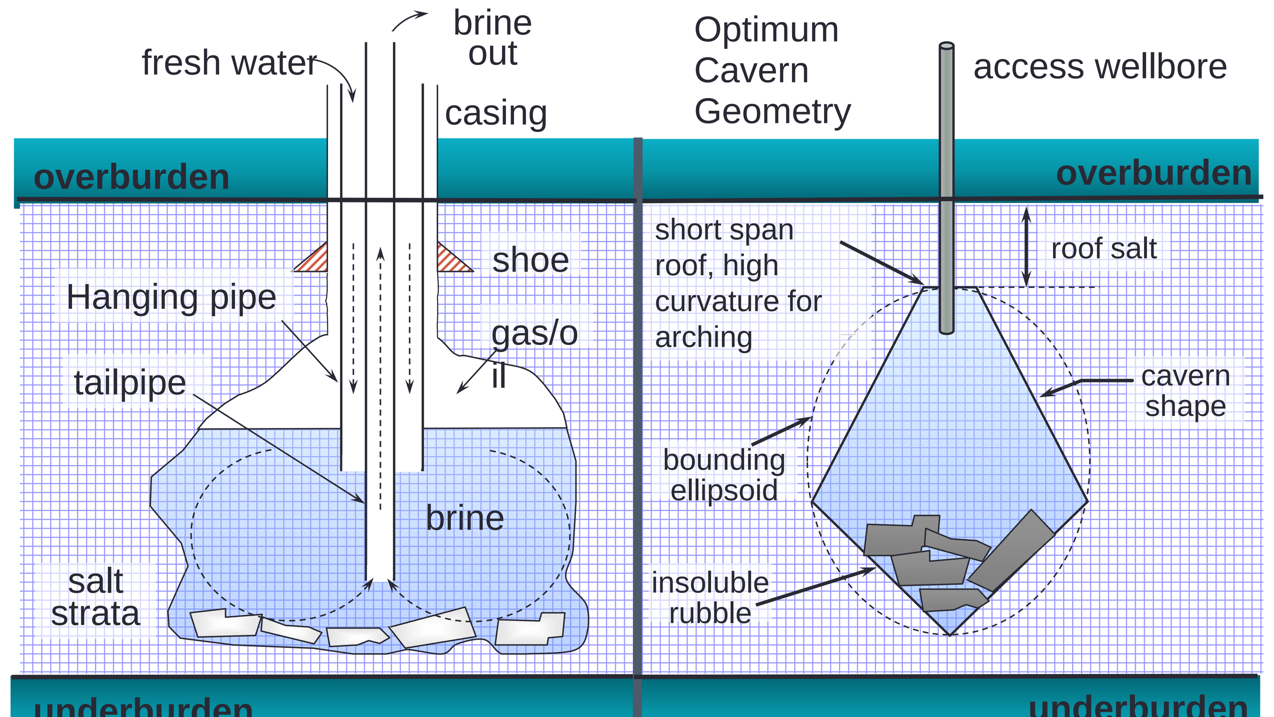
* Estimates only, costs vary from project to project.

Salt Cavern Creation:

- Dissolve NaCl with fresh water
- Control shape with gas/oil pad
- Control depth with pipe rates
- Confirm shape with sonar survey

Stability Issues:

- Long-term roof span stability (doesn't seem to be a salt rock issue)
- Cyclic loading and permeability/gas effects
- Creep behavior of cyclically loaded caverns
- Modeling rock mass behavior is needed



Cavern Creation **Cavern Stability**

NS PILOT PROJECT

CAES in Atlantic Canada

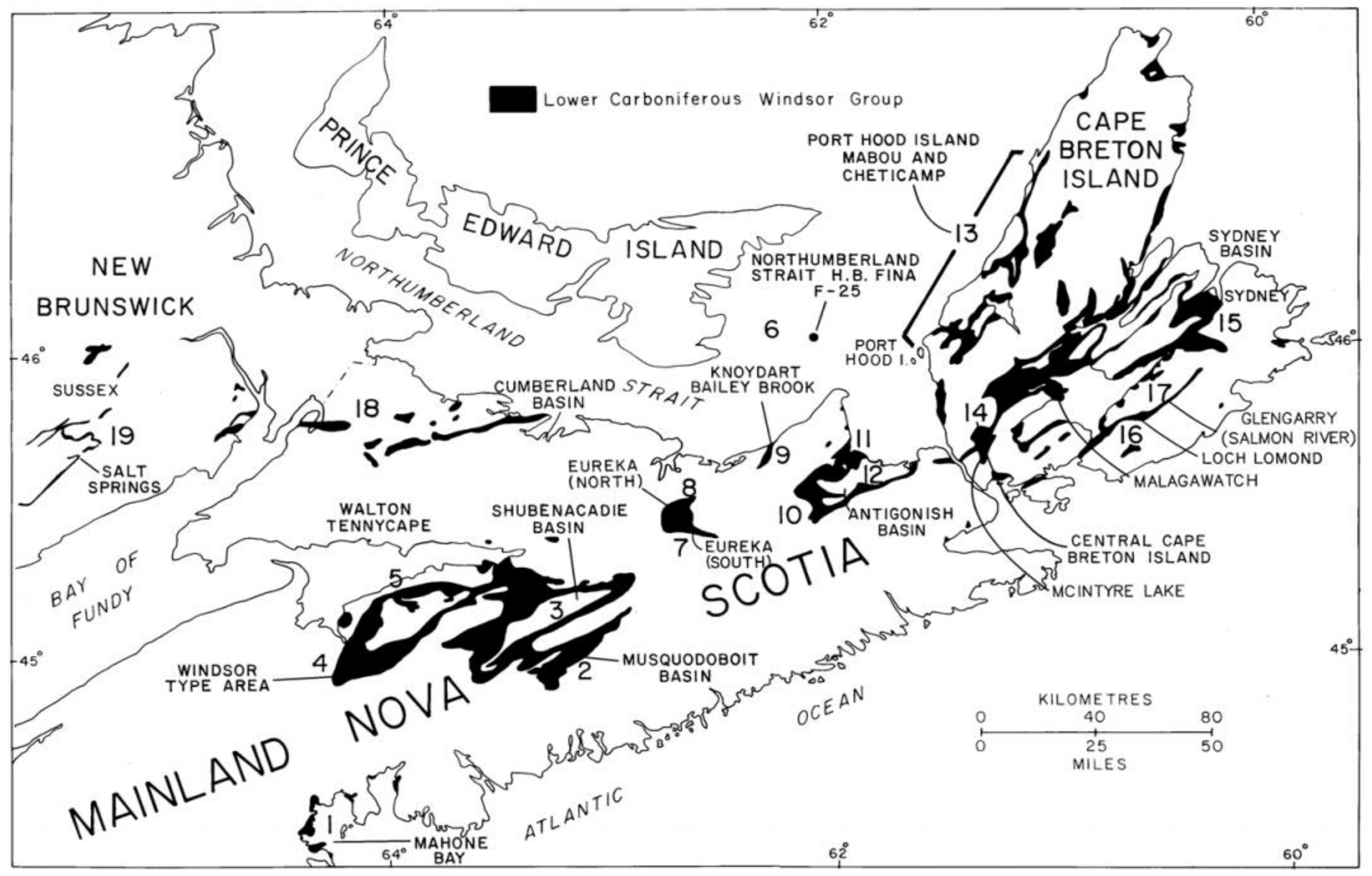
- Opportunity to couple CAES plants to wind facilities
- Great storage opportunities in salt domes in NS, NB, PEI (refer to figure below)
- Relatively simple grid
- Atlantic Canada's plan to have a renewable future

Potential Nova Scotia Design

- D-R current design has independent compression and generation trains for added flexibility and less complexity.
- Simultaneously absorbs load and provides generation, acting as both a MW-day storage asset, and an ultra-flexible generator.

Feasibility in North East, Nova Scotia:

- Vertical caverns with a potential to be 200 m high and 65 m in diameter (800 000 m^3) i.e. Malagash Anticline
- Caverns can be spaced at 300 to 400 m centers
- Given NS salt diapir size, it is feasible to have many caverns
- Potential salt storage caverns are advantageously proximal to wind facilities



Distribution of Nova Scotia salt deposits and potential sites for cavern development (i.e. Malagash Anticline)

FUTURE WORK

- Aim to implement a project in NS and NB similar to Ontario R&D study
- Further steps required to gain multi-stakeholder interest in project
- Research and development project proposal in progress
- Further developing technologies to improve operating efficiency, flexibility, and focusing on reducing CAES's inherently low carbon emissions

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