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on Initial Public Workshop on Long Duration Energy Storage Scenarios

Additional submitted attachment is included below.

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DOCKET: 20-MISC-01

FROM: Hydrostor Inc.

DATE: December 17, 2020

SUBJECT: Comments on "Initial Public Workshop for Comments on Long Duration Energy Storage Scenarios"

Background on Hydrostor

As a provider of an innovative large-scale, long-duration storage solution that can be flexibly sited, Hydrostor Inc. ("Hydrostor") appreciates the opportunity to comment on the initial workshop for the two studies (the "Studies") funded by the California Energy Commission ("CEC" or the "Commission") on long-duration energy storage. A siteable and improved non-emitting form of Compressed Air Energy Storage ("CAES"), Hydrostor's Advanced-CAES (or "A-CAES") is a compelling, scalable (50-500+ MW) and long-duration (4-24+ hours) energy storage solution that provides rotational inertia to the grid. A-CAES supports grid stability through its synchronous generators as well as grid resilience by enhancing the ability to recover from system disturbances.

Unlike other long-duration energy storage technologies such as pumped hydro and salt-cavern based CAES, A-CAES can be flexibly sited where the grid requires it. It is also a resource with 30+ years of demonstrated operability and is commercially viable based on proven, bankable technologies and equipment from Tier-1 OEM suppliers.

Importantly, Hydrostor is actively developing a number of projects in California using its Advanced-CAES technology.

Comments

We commend the Commission for its leadership in recognizing the role that long-duration energy storage can play in meeting California's energy and environmental goals. As the Studies are undertaken, we believe the following considerations should be taken into account:

1. Advanced-CAES must be included within the Studies in order to complete a thorough and comprehensive review of currently available and viable technologies. The California Public Utilities Commission's ("CPUC") integrated resource planning process currently includes only pumped hydro storage. The inclusion of a variety of viable long duration storage technologies is a positive and much-needed step. Advanced-CAES has a significantly different set of environmental, operating and cost characteristics when compared to pumped hydro (the proxy for long-duration storage used by the CPUC in the RESOLVE model). Hydrostor recommends the inclusion of the full suite of viable technology options

in this review in order to help ensure in a more comprehensive analysis and cost-effective solutions for California. Hydrostor has provided significant commentary within the CPUC's integrated resource plan proceeding (R.16-02-007 and R.20-05-003) on Advanced-CAES and, specifically, our January 4, 2019 submission[1].

We are further encouraged by the specific inclusion of compressed air energy storage[2] as a resource. However, it is important to highlight that Advanced-CAES has different characteristics compared to traditional CAES. Most notably, Advanced-CAES is emissions-free (no natural gas is utilized), can be flexibly sited where needed and is currently being developed in-state. An overview of how Advanced-CAES works is provided as Appendix A of these comments. We would be pleased to provide additional detail to the participants conducting the Studies. This is particularly important given that Advanced-CAES is a mature, deliverable technology that is actively being developed and commercially bid to California Load Serving Entities ("LSE's").

2. To the extent practicable, we recommend that the current Studies be accelerated from a timeline perspective including interim deliverables. The intent of the Studies is to provide guidance in terms of how long-duration energy storage can help California meet its energy and environmental targets. However, important decisions with respect to technology pathways for decarbonization are being made in the near-term within the CPUC's integrated resource plan proceeding and having the Studies completed sooner would provide critical information to help better inform these decisions.

We look forward to continuing our participation with the Commission in its evaluations of long-duration energy storage technologies and the vital role they will play in California's energy future.

/s/ Jon Norman
Jon Norman
President

[1] "Comments of Hydrostor, Inc. on Administrative Law Judge's Ruling Seeking Comments on Inputs and Assumptions for Development of the 2019-2020 Reference System Plan" dated January 4, 2019.
[2] E3 presentation "CEC EPC-19-056 Assessing Long Duration Energy Storage Deployment Scenarios to Meet California's Energy Goals: Introductory Public Workshop" dated December 3, 2020, pg. 15.

Appendix A

How Advanced-CAES Works

As the Advanced-CAES system is charged, off-peak or surplus electricity from the grid (or a renewable source) is used to power an air compressor, which converts the electrical energy into potential energy and heat stored by the compressed air. The heat generated during compression is captured by a set of heat exchangers and stored separately for later use. The air stream is compressed to match the pressure needed to inject it into a constructed underground storage cavern. Once in the cavern, the air can be stored until electricity is required.

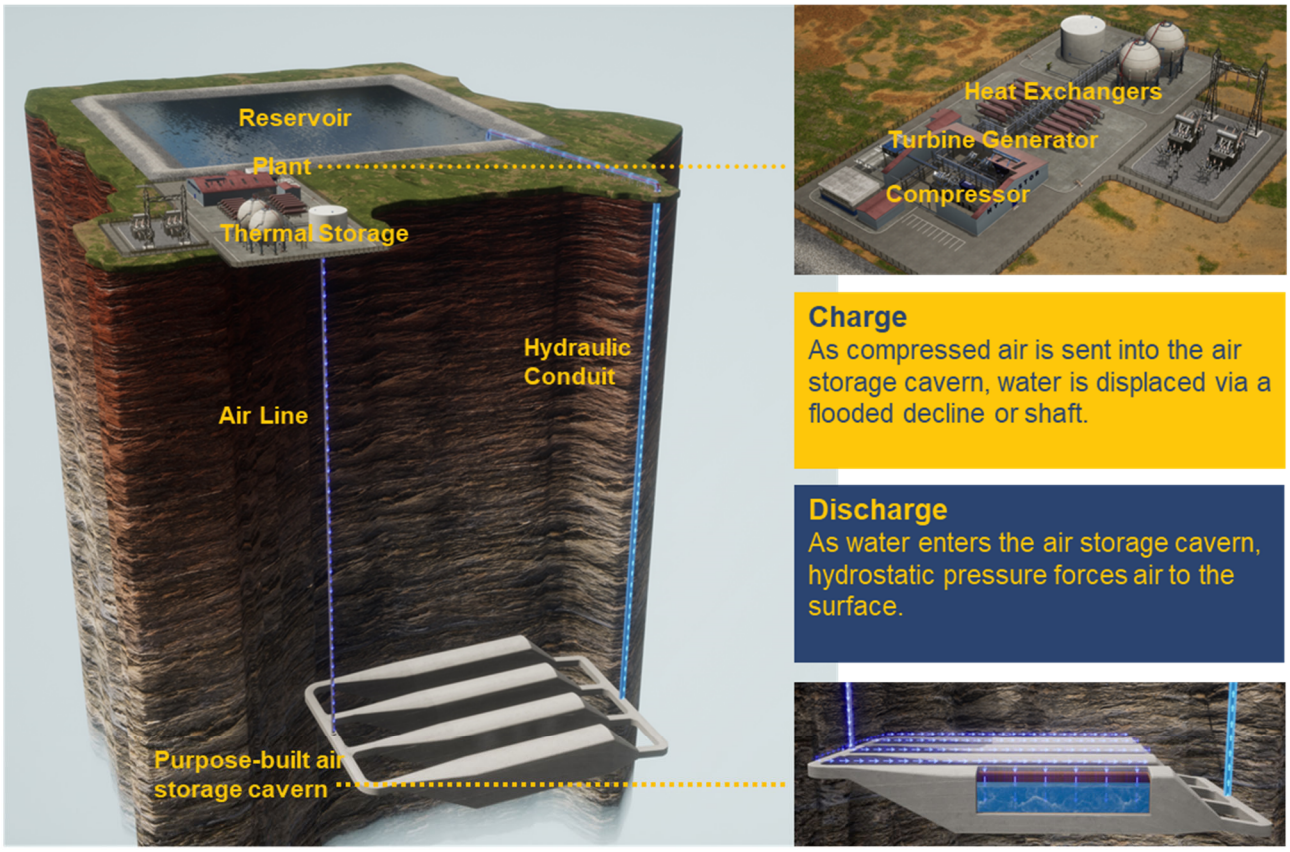
Hydrostatic compensation (using water head, analogous to a pumped hydro facility, in order to maintain a constant air pressure underground) is provided by a surface reservoir of water, connected to the cavern through the construction access facilities (either a shaft or a helical decline, depending on geology). As air is charged into the storage cavern, water is displaced up the access shaft and into the surface reservoir, storing substantial potential energy in the large elevation difference. With hydrostatic compensation, the air pressure within the cavern is maintained at a near constant level. This is essential for the efficient performance of the air handling equipment (whereas in traditional CAES the storage pressure varies significantly, which limits system efficiency and performance).

When energy is required, the compressed air is permitted to flow back to surface, which it does so under the process of the compensation water re-flooding the cavern. The stored heat is reinjected through the same heat exchangers before the compressed air is used to drive a turbine, generating electricity and supplying it back to the grid. As turbines require heat for both adequate power production and thermal protection, it is only through the use of the thermal storage system that Hydrostor's Advanced-CAES can be fossil fuel and emissions free.

Because of the use of hydrostatic compensation, all the stored air is fully recoverable; this is unlike traditional CAES which requires a substantial portion of the air to maintain a minimum storage pressure for either cavern protection or turbine operation. This drastically reduces storage volume requirements. Therefore, hydrostatic compensation enables Hydrostor's Advanced-CAES to utilize economically constructed mined storage caverns (at lower volume requirements) and benefit from the ability to be constructed in most geologies.

How Advanced Compressed Air Energy Storage (A-CAES) Works

1	2	3	4
Compress Air Using Electricity	**Capture Heat in Thermal System**	**Store Compressed Air**	**Convert Compressed Air to Electricity**
Off-peak or surplus electricity from the grid or a renewable source is used to operate a compressor that produces heated compressed air.	Heat is extracted from the air stream and stored inside proprietary thermal store. This adiabatic process increases overall efficiency and eliminates the need for burning fossil fuels during expansion.	Air is stored in purpose-built storage caverns where hydrostatic compensation is used to maintain the system at a constant pressure during operation.	Hydrostatic pressure forces air to the surface where it is recombined with the stored heat and expanded through a turbine to generate electricity on demand.



Charge
As compressed air is sent into the air storage cavern, water is displaced via a flooded decline or shaft.

Discharge
As water enters the air storage cavern, hydrostatic pressure forces air to the surface.

Industry-proven air and heat processing equipment with decades of operational history in power and oil & gas sectors.	Well-established mining techniques for storage cavern construction based on precedents of more than 190 analogous storage caverns globally.	Proven application of hydrostatic compensation and thermal management systems.

FIGURE 1: HOW ADVANCED-CAES WORKS