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**DOCKET:** 19-SB-100

**FROM:** Hydrostor Inc.

**DATE:** December 18, 2020

**SUBJECT:** Comments on "SB 100 Draft Report Workshop" held December 4, 2020

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**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 SB 100 Draft Report Workshop held on December 4, 2020 by the California Energy Commission (the "Commission" or "CEC"), the California Public Utilities Commission ("CPUC") and the California Air Resources Board ("CARB") (collectively, the "Joint Agencies"). 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 an emissions-free resource (no natural gas burned) 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 Joint Agencies for their leadership in advancing California's clean energy goals under SB 100 including the requisite studies. However, Hydrostor continues to have concerns regarding the inputs and assumptions used by the Joint Agencies to determine a decarbonization pathway for California.

Specifically, the Joint Agencies continue to use RESOLVE as the key planning tool with only a limited set of technologies considered. As with the CPUC's integrated resource planning process, the only long duration storage technology contemplated in RESOLVE is pumped hydro storage. Advanced-CAES should be included as a candidate resource as it is a currently available technology and has a significantly different set of environmental, operating and cost characteristics when compared to pumped hydro. It is also being actively being developed and commercially bid to California Load Serving Entities ("LSE's"). 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].

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 Joint Agencies.

Important decisions with respect to technology pathways for decarbonization are being made in the near-term within the CPUC's integrated resource plan proceeding. As the work undertaken by the Joint Agencies is intended to inform state planning, the inclusion of viable long duration energy storage solutions, such as Advanced-CAES, can only result in a more robust and cost-effective outcome for California.

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We look forward to continuing our participation with the Commission, the CPUC and CARB in its evaluations of SB 100 pathways to a decarbonized energy future for California.

/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.

# 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.

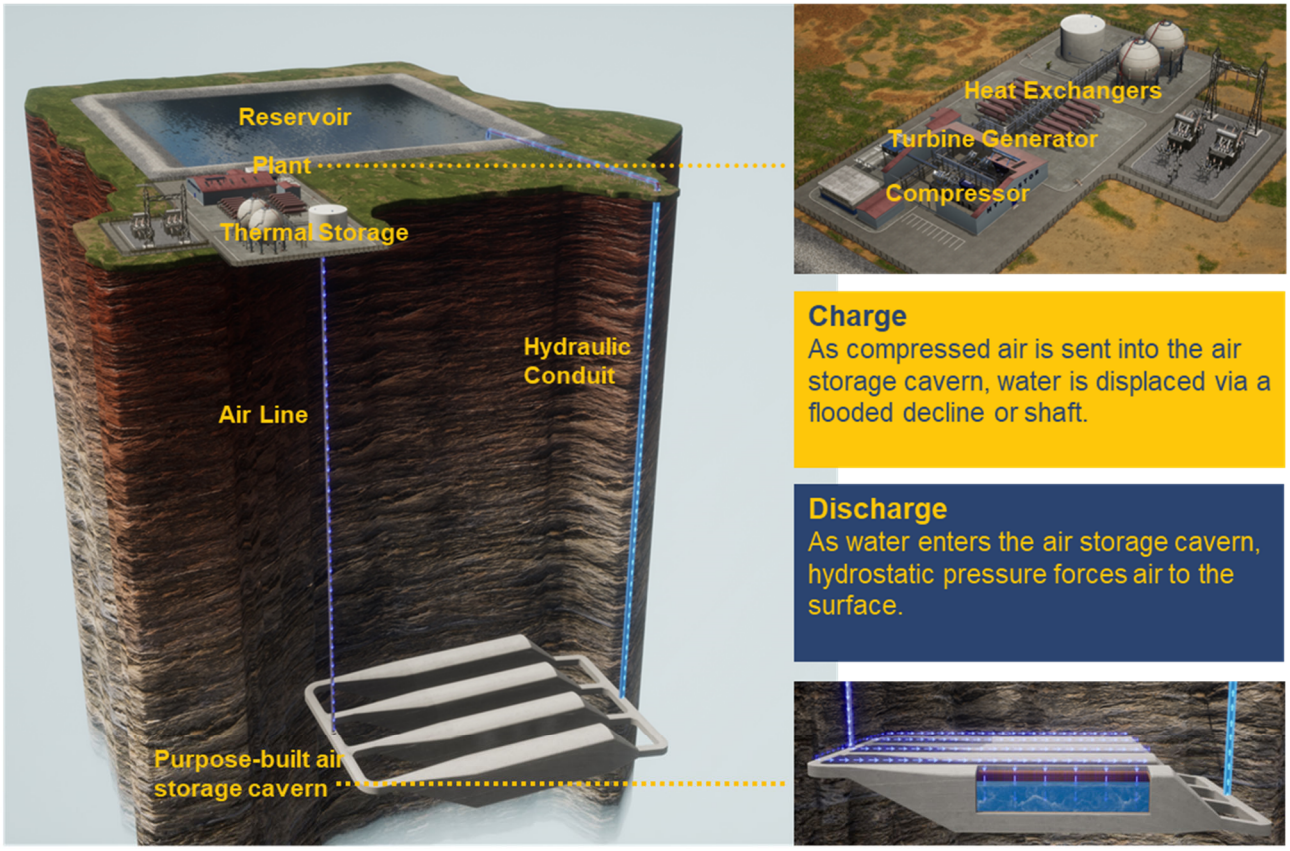
Hydrostatic compensation (using water head, analogous to a pumped hydro facility, in order to maintain a constant air pressure underground) is provided by a surface reservoir of water, connected to the cavern through the construction access facilities (either a shaft or a helical decline, depending on 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