October 5, 2020

Idaho Public Utilities Commission
P.O. Box 83720
Boise, Idaho 83714

**Re**: **Case No. AVU-E-19-01 In the matter of Avista's 2020 Electric Integrated Resource Plan – Comments of the Commission Staff**

Highview Power is a developer of a zero-emissions, long-duration energy storage technology based on the principle of air liquefaction ("Liquid Air Energy Storage" or "LAES") and we appreciate the opportunity to clarify staff's comments dated August 19, 2020 regarding Liquid Air Energy Storage, and our technology specifically. Highview Power's system utilizes surplus electricity at times of low demand to make liquid air, which can then be stored for long periods of time and later converted back into energy at times of high demand to meet load and ensure reliability of the electrical grid. Long duration technologies play an integral role in cost-effectively achieving decarbonization while maintaining reliability of supply. Highview Power is backed by a major industry investor, and along with our strategic partners, is developing projects across the United States. Highview Power would like to clarify the following comments made by Commission Staff:

- ***"Staff doubts that such roundtrip efficiencies [of 65-75%] will be obtainable during the 2020 IRPs 25 year planning horizon."***

Roundtrip efficiencies of 65-75% are specifically applicable to the electrical conversion efficiency of a Liquid Air Energy Storage system configured to receive high-grade waste thermal energy from an external source, and refers to the quantity of electrical energy that can be recovered from a unit mass of liquid air compared to the quantity of electrical energy used to produce a unit mass of liquid air. While not a complete accounting of the external energy inputs to this type of system, since the thermal energy in such a configuration generally has no economic value, efficiency stated in this way is usually sufficient

for economic evaluations. Without external thermal energy, roundtrip efficiencies of up to 60% are achievable.

- ***"An external source of energy must still be supplied to vaporize the liquefied air/nitrogen"***

The above-mentioned integration with waste thermal energy is one possible configuration of a Liquid Air Energy Storage facility. However, Highview Power's standard cycle configuration does not require an input of external thermal energy. The standard Highview Power cycle uses only AC electrical energy input. To charge the system, an industrial air liquefier comprising compressors and expansion devices is operated to refrigerate and produce liquid air at low pressure. The inputs to this process are limited to AC electrical energy and atmospheric air. The outputs of this process are liquefied air, which has undergone a latent phase change, and heat from the compression in the refrigeration cycle. Energy is stored in the form of temperature differentials relative to the ambient datum. Energy is recovered from the system by vaporizing the liquid air and raising its temperature. The heat used for heating the liquid air is the heat recovered from the refrigeration process, thus no external thermal input is required.

- ***"Although the Carnot efficiency of an LAES using ambient air at 70 F is about 74%, its actual efficiency is expected to be less than 40%."***

The Carnot efficiency describes the theoretical maximum conversion efficiency of heat (thermal energy) to work (mechanical energy) in a heat engine. Liquid Air Energy Storage is not itself a heat engine but the combination of a liquefaction cycle on the charge side and a heat engine on the discharge side. The Carnot efficiency is not applicable to this type of cycle. Highview Power has obtained third-party validation from DNV-GL of 55% efficiency-- without the use of external thermal energy-- on its design for the first commercial systems currently in development using only proven equipment readily available from the industrial supply chain.

- ***"A pilot project completed in 2015 at the University of Leeds achieved an efficiency of about 15 percent."***

Highview Power's 350 kW pilot system was sited near London, UK, on a commercial power plant and performed as predicted. The system was the first of two operational demonstration plants completed in the UK and was built to demonstrate the Liquid Air Energy Storage cycle and validate models. It was designed to work with available equipment at small scale and was by necessity a sub-critical pressure liquefaction process. Super-critical liquefaction, used in commercial designs, is well known and enables much greater efficiency. Furthermore, turbo-machinery efficiencies benefit from scale; the second demonstration system (5 MW) showed improved performance and Highview Power is developing systems at the 50 MW scale.

Highview Power appreciates the opportunity to submit these comments and provide clarification to Staff's comments.

Respectfully submitted,

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Policy and Regulation Manager