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Underground Pumped Storage Hydroelectric using Salt Domes

William M. Taggart IV, P.E., Taggart Engineering, Houston, Texas

Abstract

The increased use of solar and wind as renewable energy sources has created a demand for large-scale electrical storage because the wind does not blow all the time and the sun does not shine at night. This demand has been recognized by the Department of Energy (DOE), which estimates that the United States currently needs more than 1,000 GW of energy storage capacity but has only 28 GW.

While much of today's focus is on lithium-ion batteries and other developing battery technologies, pumped storage hydroelectric (PSH) is used for 96% of all grid-level electrical energy storage projects worldwide and more than 98% of the actual energy storage volume in the US. PSH requires two large bodies of water with a 500-ft [154-m] to 1,500-ft [462-m] elevation difference between them to make it worthwhile to pump the water uphill to efficiently store electricity. This limits where PSH can be installed; historically, the flat topology of Texas, Louisiana, and Mississippi has made PSH unusable in the Gulf Coast region.

A new approach explores relocating the upper and lower reservoirs used by PSH into salt dome caverns with turbine/pumps at surface. This approach expands the application of using salt dome caverns for energy storage. Caverns are established at different elevations within the salt dome, and compressed air is used to create void spaces in the upper parts of the caverns and to raise the surface pressure. The annuluses of the wells accessing the caverns are used to allow the compressed air to freely flow between the caverns. The brine strings then connect to the pump/turbine. The pump/turbine configuration is the same as is used in conventional PSH with the exception that the fluid is saturated brine.

The benefit of underground pumped storage hydroelectric (UPSH) is that it is more efficient compared with hydrogen or compressed air, and like PSH, it focuses on moving electricity within a 24-hour window. Using caverns for UPSH does not prevent other caverns from being used for hydrogen and compressed air; in fact, all three technologies will likely be required to meet the future demands for energy storage. By removing the topological limitation, UPSH broadens the window of potential locations for energy storage and can help meet rising energy demands around the world.

Keywords: Electrical storage, underground pumped storage hydroelectric, UPSH, renewables