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In May 2024, Energy Vault, a company specializing in long-duration, grid-scale energy storage, announced an exclusive global partnership with SOM. Having made strides in gravity energy storage systems (GESS)--which hold the potential to store and supply renewable energy to the power grid safely, for long periods, and without degrading--the global company sought out SOM"s architecture and engineering expertise to develop the next generation of GESS technology. When integrated into tall buildings, these systems can maximize sustainability, accelerate carbon payback of building construction, and lower the levelized cost of energy consumption. They can also bring sustainable energy storage to natural landscapes with minimal environmental impact.

As part of this strategic partnership, SOM is the exclusive architect and structural engineer for fixed frames and deployable structures for all new Energy Vault gravity energy storage systems, including incorporating gravity energy storage technology into tall buildings in urban environments and deployable structures in natural environments.

Gravity energy storage systems operate using similar principles as pumped hydro storage, which is currently the largest source of grid storage. GESS installations use surplus energy to lift heavy blocks, which creates potential energy that can later be converted into electricity when lowered to the ground. Unlike pumped hydro storage facilities, which can only be built on specific natural sites, GESS installations can theoretically be constructed anywhere--opening up wide new possibilities for clean energy storage and distribution.

Energy Vault collaborated with SOM to find efficiencies in their existing EVx(TM) platform, enabling the design and engineering of several new typologies--including towers over 300 meters and up to 1,000 meters tall--which would be able to achieve a carbon payback within accelerated timeframes of 3 to 4 years. Through this partnership, Energy Vault and SOM are designing a new platform of G-VAULT GESS solutions focused on improved economics, energy density and sustainability.

SOM"s partnership with Energy Vault demonstrates a commitment not only to accelerate the world"s transition away from fossil fuels, but also to explore, together, how the architecture of renewable energy can enhance our shared natural landscapes and urban environments.

Gravity energy storage (GES) is an innovative technology to store electricity as the potential energy of solid weights lifted against the Earth's gravity force. When surplus electricity is available, it is used to lift weights. When electricity demand is high, the weights descend by the force of gravity and potential energy converts back into electricity (Fig. 1). A specific GES configuration that uses pulley systems working in tandem with a motor-generator to move the weights is known as lifted weight storage (LWS).

Technical Characteristics

The energy capacity of LWS is proportional to the cumulative potential energy of weights

where (M) is the total mass of all the weights, (g) is the acceleration due to gravity, and (H) is the height of vertical movement of the gravity center of the weights (Berrada, Loudiyi, and Zorkani, 2017; Franklin, et al., 2022; Morstyn and Botha, 2022; Li et al., 2023). The installed power of LWS is equal to the sum of operating power of all incorporated lifting systems (Kropotin and Marchuk, 2023a). The LWS efficiency depends on the efficiency of the lifting mechanisms. It has been shown that the round-trip efficiency of the LWS can reach 86% (Kropotin and Marchuk, 2023b).

The operational principle of LWS eliminates the fire hazards of lithium-ion batteries and flooding risks specific to pumped-hydro storage (PHS). LWS is virtually free from disadvantages, such as degradation of performance over time or the cycle number limit. The former is due to the absence of leakage currents in the given engineering solution, as occurs in Li-ion batteries, and loss of weight mass, as occurs in PHS. The latter is related to the fact that the number of charge–discharge cycles weakly affects the lifetime of the structure and the equipment degradation is eliminated by repairs, which are classified as operations and maintenance costs (O& M).

The structure with a height of more than 100 meters has an area comparable to that of a Li-ion storage system of the same power and energy capacity (Kropotin, Penkov, and Marchuk, 2023). The majority of the literature on GES highlights its extended service life of about 40–60 years (Berrada, Loudiyi, and Zorkani, 2016; Berrada, 2022), high full-cycle efficiency of about 85% (Emrani et al., 2022; Kropotin and Marchuk, 2023b), and even the high maneuverability in the range of milliseconds (Tong et al., 2023). Thus, LWS can provide: load shifting, renewable energy integration, black start capability, absorbance of reactive power, and even fast-response frequency regulation.

Economic Characteristics