Gravity Energy Storage Systems (GESS)
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In Switzerland, potential energy storage is widely used for producing green energy in the form of pumped hydro plants. Due to the limited space in cities, Gravity Energy Storage Systems (GESS) are an efficient alternative for the generation of clean power (Franklin et al., 2022). In order to make this type of storage possible, the company Energy Vault® developed the G-VAULT™, using excess green electricity to lift heavy masses and later releasing it by lowering them to generate electricity. This process is based on the conversion between potential and electrical energy (Energy Vault, 2024a).

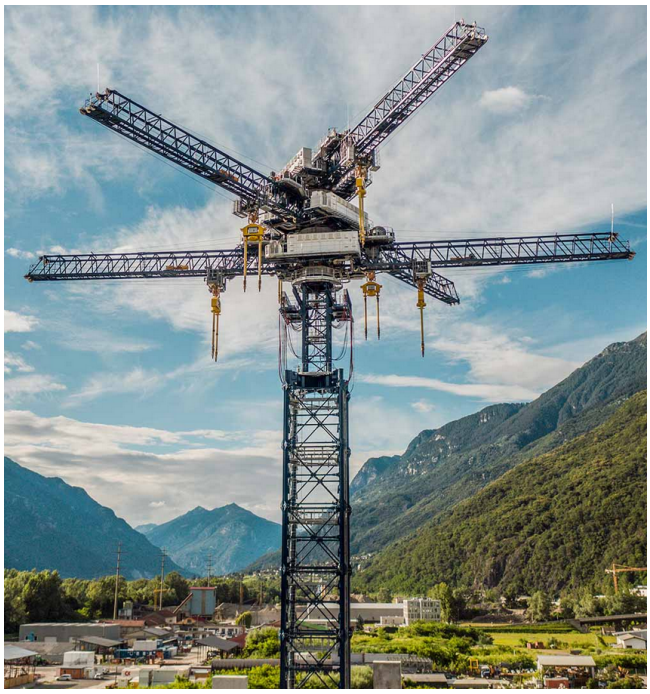

Figure 1: Prototype 1 in Arbedo-Castione, Switzerland

Storage systems based on gravity rely on the reversible conversion between potential and electrical energy. The amount of energy that can be stored depends directly on the mass lifted and the height difference, therefore, larger masses and greater lifting heights result in higher energy. With renewable energy, electric motors lift the mass, whether it is solid blocks or a fluid. During periods of high demand, the mass is lowered, producing kinetic and consequently electrical energy.

Energy Vault® developed the G-VAULT™, one of the first large-scale implementations of gravity energy storage. The system uses a crane tower structure that allows 35-tonne blocks to be lifted and lowered. Prototype 1 in Arbedo-Castione has demonstrated the feasibility of the concept under real operating conditions, reaching high round-trip efficiencies of around 80% and long lifespans with minimal environmental impact (Mombelli, 2020).

Figure 2: EVu™ prototype in China

Modern GESS installations, such as the EVu™ prototype currently under construction in China, represent an important step toward large scale gravity storage capable of supporting large energy grids (Energy Vault, 2024b). With the advent and widespread use of renewable energy worldwide, GESS represents a sustainable and viable option for generating electricity in cities with high green energy demand or in countries with limited grid accessibility.

Word Bank

Term	Definition
Potential energy	Energy stored in a system due to its mass and position
Kinetic energy	Energy associated with the motion of an object due to its velocity
Electrical energy	Energy carried by electric charges moving through a conductor or field
Reversible conversion	Bidirectional energy transformation with minimal losses
Energy storage	The process of capturing energy for later use
GESS	Gravity Energy Storage System that stores energy by lifting and lowering masses
Height difference	The vertical distance between two points that enables potential energy change
Crane tower structure	A vertical mechanical system that lifts and lowers masses
Green energy	Energy produced from sources that minimize environmental harm
Renewable energy	Energy that derives from natural resources that replenish on a human timescale
Clean power	Electricity generated with minimal greenhouse gas emissions
Electric motor	A device that converts electrical energy into mechanical motion
Solid	A state of matter with fixed shape and volume
Fluid	A substance in a liquid or gaseous state that flows and takes the shape of its container
Pumped hydro plants	Facilities that store energy by pumping water to different heights to generate electricity
Real operating conditions	The actual environmental and technical circumstances under which a system operates
Round-trip	The complete charge-discharge cycle of a system
Lifespan	The period during which a system remains functional according to standards
Environmental impact	The effect of a technology on natural ecosystems and resources
Energy grid	The interconnected network that transports and distributes electrical power from producers to consumers

Declarations on the use of AI tools

- "DeepL" and "ChatGPT 5" have been used as a spell-checker
  https://www.deepl.com/
  https://www.chatgpt.com/

List of Figures

References

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