

# Gravity Energy Storage Systems (GESS)

## EENG Handout Presentation, HS25

Matteo Frongillo, Michael Moos

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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™. The principle is simple: energy is stored by using excess green electricity to lift heavy masses (such as concrete blocks) and later releases it by lowering them to generate electricity. This process is based on the conversion between potential and kinetic energy (Energy Vault, 2024).



Figure 1: Prototype 1 in Arbedo-Castione, Switzerland

One of the leading companies in this field, Energy Vault, has demonstrated that such systems can reach high round-trip efficiencies of around 80% and long lifespans with minimal environmental impact. Unlike lithium-ion batteries gravity-based storage does not degrade over time, requires no rare materials, and poses no fire risk. Additionally, these systems can be built using local materials reducing transportation costs and carbon footprint (Mombelli, 2020).

Modern gravity storage systems use large cranes or tower structures controlled by advanced automation software. When renewable energy sources like solar or wind produce more electricity than needed, the system powers electric motors that lift the weights. This principle of lifting concrete blocks can also be applied to pumping hydro power, and the fluid will then act as the weight. During times of high demand, the weights are lowered, and the motors act as generators, feeding electricity back into the grid.



Figure 2: EVu™ prototype in China

The main challenges are high initial costs, space requirements, and energy density compared to chemical batteries. However, as renewable energy integration grows, gravity storage provides a scalable and sustainable solution for stabilizing power grids and ensuring energy availability even when the sun doesn't shine or the wind doesn't blow.

## Word Bank

| Term                          | Definition  |
|-------------------------------|---|
| Potential Energy              | Stored energy due to an object's height or position.                                      |
| Kinetic Energy                | Energy released when an object moves or falls.  |
| Renewable Energy              | Power generated from natural, sustainable sources like wind or solar.                     |
| Pumped Hydro Storage          | Energy storage method using water pumped between two elevations.                          |
| Gravity Energy Storage (GESS) | A system that lifts heavy masses to store energy and lowers them to release it.           |
| Round-Trip Efficiency         | The percentage of energy recovered compared to the amount originally stored.              |
| Automation Software           | Computer programs that control machines automatically for precision and safety.           |
| Infrastructure                | The physical structures and systems needed for power generation and storage.              |
| Energy Density                | The amount of energy stored per unit of mass or volume.                                   |
| Mechanical Storage            | Energy storage using physical motion instead of chemical reactions.                       |
| Grid Stability                | The reliability and balance of electricity supply in a power network.                     |
| Sustainability                | Using resources responsibly so they remain available for the future.                      |
| Degradation                   | The process of losing efficiency or capacity over time.                                   |
| Carbon Footprint              | The total greenhouse gas emissions caused directly or indirectly by an activity.          |
| Lifespan                      | The operational duration of a system before replacement or decommissioning.               |
| Local Materials               | Construction materials sourced regionally to reduce transport and emissions.              |
| Energy Conversion             | The transformation of one energy form (e.g., electrical) into another (e.g., mechanical). |
| Scalability                   | The ability of a system to expand while maintaining performance.                          |
| Decarbonization               | Reducing carbon emissions by switching to clean energy technologies.                      |
| Grid Integration              | Connecting renewable or storage systems to the main power grid for coordinated operation. |

## 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/>

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## References

- Energy Vault. (2024). G-vault<sup>TM</sup>: Evx<sup>TM</sup> gravity energy storage for bulk energy shifting [pdf datasheet].  
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- Mombelli, A. (2020, January 3). *Revolutionary idea to store green power for the grid*.  
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