

Gravity Battery: Harnessing Gravity's Potential with Gravity Batteries".

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Abstract:

As in today's world the penetration of renewable energy resources is increasing for electricity production, the problems due to unpredictable nature and variable output of these resources increases. Solution to these problem leads to the need of proper energy storage systems. There are various energy storage techniques that been developed and being using since long time e.g. battery storage, compressed air energy storage, pumped hydro storage, flywheel storage etc., but each technique has some limitations. This paper explores and gives an overview of recent gravity based energy storage techniques.

Introduction:

Battery Energy Storage Systems(BESS) is used energy storage technique to store the energy from renewable sources. But, the battery being used in this system is lithium-ion batteries and the minimum lifespan of this types of batteries are 5 years or 2000 charging cycle. The disadvantage of this system is it required periodic maintenance. Also, it contains metal such as cobalt, nickel, and manganese which are toxic and can contaminate the water supplies and ecosystems. If it leach of landfills, their energy storage capacity decreases over the time. During peak demand hours the power requirement (demand) and the supply or production there is gap between both supply and demand. This paper is about exploring the energy storage technique based on the (SGES). The SGES uses an electric lifting system to raise one or more weights in vertical direction thereby transferring electrical energy which is then converted into gravitational potential energy. Energy Vault, Gravity Power, ARES and Gravitricity Ltd. are some companies working on this technology to implement the energy storage system for practical use. This project shows that how the Gravity-based Energy Storage System stores energy from renewable resources in efficient way without using the Li-ion batteries.

Farmers can gain a lot of benefits by installing a floating solar power plant. It reduces algae growth and water evaporation in the lake. In Maharashtra, 80% of farmers are small-scale landowners, and they can install solar panels. In drought-stricken regions, the majority of farms have lakes, floating solar power plant project is more beneficial for these farmers.

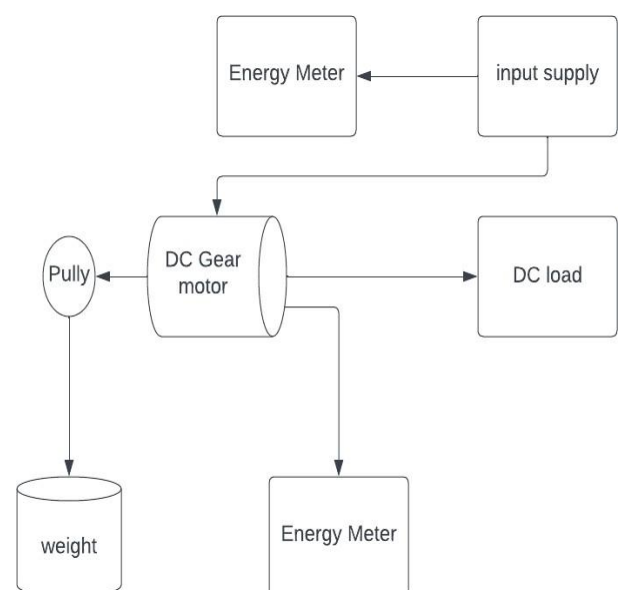
Scope of research:

- Understanding gravitational potential energy conversion.
- Developing durable and cost-effective materials.
- Optimizing system configurations for efficiency.
- Integrating with renewable energy sources.
- Assessing cost-effectiveness and feasibility.
- Analyzing environmental impacts.
- Investigating community acceptance.

Keywords:

Fundamental Principles, Materials Research, System Design, Renewable Energy Integration,

Block Diagram:



Hardware Requirements:

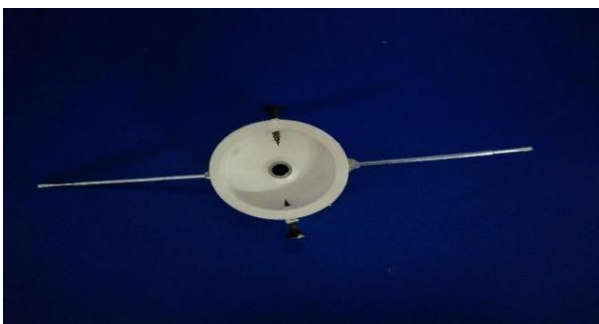
Gear Motor



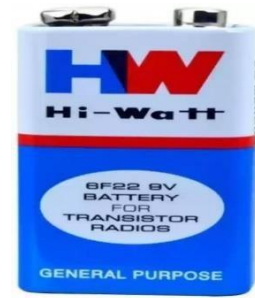
Without a commutator, a dynamo becomes an alternator, which is a synchronous singly fed generator. When used to feed an electric power grid, an alternator must always operate at a constant speed that is precisely synchronized to the electrical frequency of the power grid. A DC generator can operate at any speed within mechanical limits, but always outputs direct current. Typical alternators use a rotating field winding excited with direct current, and a stationary (stator) winding that produces alternating current. Since the rotor field only requires a tiny fraction of the power generated by the machine, the brushes for the field contact can be relatively small. In the case of a brushless exciter, no brushes are used at all and the rotor shaft carries rectifiers to excite the main field winding.

Pulley

Pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable or belt, or transfer of power between the shaft and cable or belt. In the case of a pulley supported by a frame or shell that does not transfer power to a shaft, but is used to guide the cable or exert a force, the supporting shell is called a block, and the pulley may be called a sheave. A pulley may have a groove or grooves between flanges around its circumference to locate the cable or belt. The drive element of a pulley system can be a rope, cable, belt, or chain.



Power Supply



A 12-volt power supply delivers a consistent 12-volt output, commonly used in automotive systems, lighting, and electronics. It comes in various types, including switching power supplies, and is known for its versatility. These power supplies are reliable, with stable voltage output and specific connectors for different devices. Amperage rating is crucial, and they find widespread use in both residential and industrial settings.

Dead Weight



Dead weight is a metal solid block with calibrated weight as per standards. Deadweight (DWT) or tons of deadweight (DWT) is a measure of how much weight a ship can carry, not its weight, empty or in any degree of load. DWT is the sum of the weights of cargo, fuel, fresh water, ballast water, provisions, passengers, and crew. DWT is often used to specify a ship's maximum permissible deadweight (i.e. when it is fully loaded so that its Plimsoll line is at water level), although it may also denote the actual DWT of a ship not loaded to capacity.

Energy meter

Direct Current (DC) energy meters measure electrical energy consumption in DC circuits. They are commonly used in applications such as solar power systems, battery charging stations, and electric vehicles. DC energy meters function by measuring the voltage and current in the circuit and calculating the power consumption.

Key points about DC energy meters include:

Measurement Parameters: DC energy meters typically measure voltage (V), current (I), power (P), and energy (Wh or kWh).

Types of DC Energy Meters: There are different types of DC energy meters, including analog and digital meters. Digital meters provide more accurate readings and often come with additional features such as data logging.

String



We used cycle cable as our string in this particular project, as the cycle cable is both long and has strong strength which are our main requirements in this project. This cable has a high Tensile strength and can sustain weights upto 5-10 Kilograms very conveniently.

We have used the weights ranging from 1 kilograms upto 2.5 kilograms which are sustainable for this particular prototype which we have prepared.

Six-pin Switch

A six-pin switch typically refers to a switch with six terminals or pins for electrical connections. These switches are commonly used in electronic projects and circuits.



Common (COM) common connection that is generally used as one of the endpoints for the switch.

Normally Open (NO) is not connected to the common terminal when the switch is in its default state but becomes connected when the switch is actuated.

Normally Closed (NC): In contrast to the NO terminal, this is connected to the common terminal in the default state and disconnects when the switch is actuated.

Micro Switch



A micro switch is a small, sensitive switch that is actuated by minimal physical force. It typically consists of a small spring-loaded lever or button that makes contact with an actuator. These switches are commonly used in various electronic devices and appliances to detect changes in position or pressure, triggering specific actions or functions. Micro switches are known for their durability and reliability, making them suitable for applications where precise and consistent switching is essential, such as in keyboards, limit switches, and control systems.

LED



LEDs are semiconductor devices that emit light when an electric current passes through them. They're energy-efficient, have a wide color range, and last longer than traditional light sources. LEDs are compact, cool to operate, and find applications in lighting, displays, and various electronic devices. Their instant illumination, low heat emission, and environmental friendliness make them a popular choice in diverse settings.

Working of Project:

Energy Storage: During periods of excess electricity generation (such as when renewable energy sources like wind or solar power produce more electricity than is immediately needed), the surplus electricity is used to raise a heavy mass, typically in a vertical shaft or tower. This process involves using electric motors or winches to lift the mass.

Potential Energy: As the mass is raised to a higher position, it gains gravitational potential energy due to its increased height above the ground. The potential energy is directly proportional to the height and mass of the object, as given by the equation: Potential Energy (PE) = mass (m) x gravity (g) x height (h).

Energy Storage Medium: The potential energy stored in the elevated mass serves as a form of energy storage. The height to which the mass is raised and the mass of the object determine the amount of energy stored. The greater the height and mass, the more energy can be stored.

Energy Release: When electricity is needed, the process is reversed. The mass is allowed to descend under the influence of gravity, and as it descends, it releases the stored potential energy. This energy can be converted back into electrical energy through generators, which are driven by the descending mass or its connected mechanical components.

Power Generation: The generated electricity is then fed into the grid or used to power electrical devices and meet the demand. The rate at which energy is released and the power output can be controlled by the speed at which the mass descends.

Potential Energy: When the mass is lifted to a certain height, it gains gravitational potential energy due to its increased position in a gravitational field. The higher the mass is raised, the more potential energy it stores.

Energy Release: When there is a need for electrical energy, the gravity battery lowers the mass back to its original position. As it descends, it converts the stored potential energy back into electrical energy. This process involves a generator or some form of energy conversion system to produce electricity.

Efficiency: The efficiency of a gravity battery system depends on minimizing energy losses during the lifting and lowering processes and maximizing the conversion of potential energy into electrical energy.

Recharge and Discharge: Gravity batteries can be recharged by raising the mass again, effectively storing energy for later use. The cycle of raising, storing, lowering, and releasing energy can be repeated as needed.

Future Scope:

Arduino

We implemented Arduino technology to automate our holding and lifting mechanism, enabling it to hold weight for a specific duration before releasing it to get output energy. This innovation eliminates the need for manual intervention, streamlining the breaking process and enhancing its reliability and efficiency. By leveraging Arduino, we have optimized our breaking mechanism, ensuring safer and more precise operations.



Result:

Efficient Energy Storage, Renewable Integration, Cost-Effectiveness, Sustainable Power Supply, Environmental Impact, Community Empowerment, Technological Advancement, Economic Viability

Advantages:

- Renewable Integration
- Cost-Effective
- Long Lifespan
- Scalability
- Low Environmental Impact

Limitations:

- Site Dependency
- Efficiency
- Land Use
- Mechanical Complexity
- Limited Applications

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