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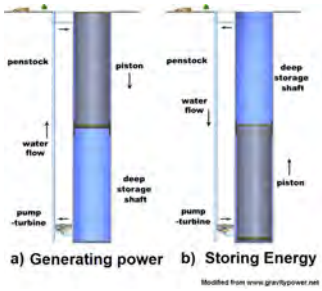
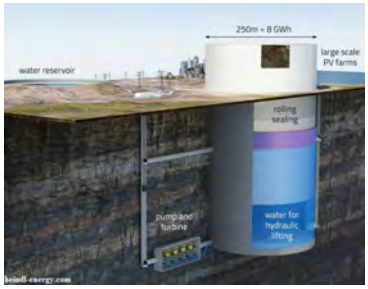
Gravitational Energy Storage

Introduction

Gravitational Energy Storage: Use renewable energy to lift a large mass to a given height and store energy in the form of gravitational potential energy. When energy is needed out of the system, the mass is allowed to descend and its kinetic energy is used to spin a turbine which generates electricity.





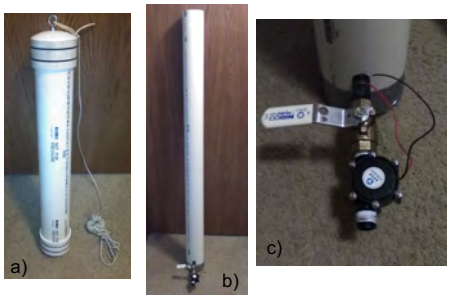
Importance of large scale energy storage

- Match variable supply of renewable energy with the variable demands of the electric grid
- Prevent power outages when production is low
- Prevent curtailment when energy supply outweighs demands

Experimental Methods

Small scale model system components:

a) Piston, sealed with two sets of double o-rings
b) PVC cylinder
c) Microhydro turbine generator with flow valve piston

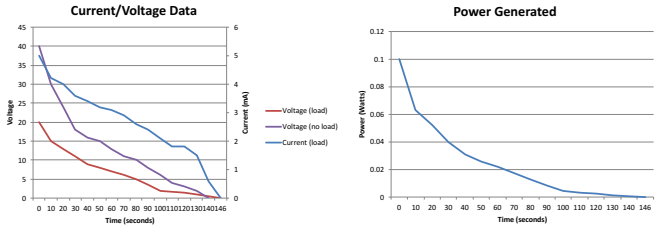


Setup: Valve closed, fill with water, piston resting at top of cylinder. Turbine leads connected to nightlight with meter to measure current and voltage

Experiment: Valve opened, piston forces water through turbine

1. Voltage measured with no load
2. Voltage measured with load
3. Current measured with load

Results



Energy Balance Equation

Starting Potential Energy (**PE**) = Kinetic Energy of water leaving turbine (**KE**) + Electrical Energy generated (**EE**) + Lost Energy (**LE**)

PE = 60.9 Joules **KE** = .5 Joules **EE** = 3.83 Joules **LE** = 56.57 Joules

Efficiency (η) = 4.33 J / 60.9 J = 7.1%

Discussion & Conclusions

Majority of energy lost due to friction between o-rings and cylinder walls. Large scale design features rolling rubber membrane:

- Low friction
- Watertight seal
- Withstand high pressures

Piston Diameter (m)	Energy Capacity
1	.0025 kWh
5	1.5 kWh
25	952 kWh
100	.24 GWh
500	152 GWh

➢ Assuming piston length = diameter & lifted height = piston radius

In order to be economically feasible, Gravity energy storage systems need to be sized as large as possible

Next Steps - Plans for Future Work

Improve gravitational storage model :

- Add solar powered DC pump to lift the piston inside the cylinder (add the storing energy functionality) Larger diameter components with heavier piston to store more energy
- Rolling rubber membrane with less friction to greatly improve efficiency
- Larger microhydro turbine to generate more power
- Water reservoir to allow multiple cycles of charging/discharging

Acknowledgements

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