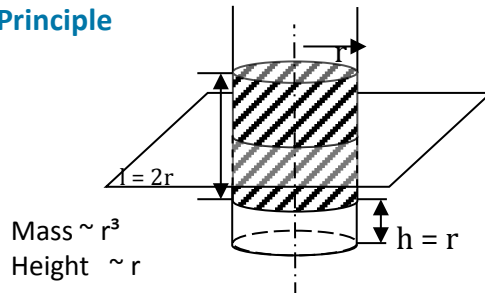


Principle



Mass $\sim r^3$

Height $\sim r$

Storage capacity $E = 2 \pi g \rho * r^4$

Exact value:

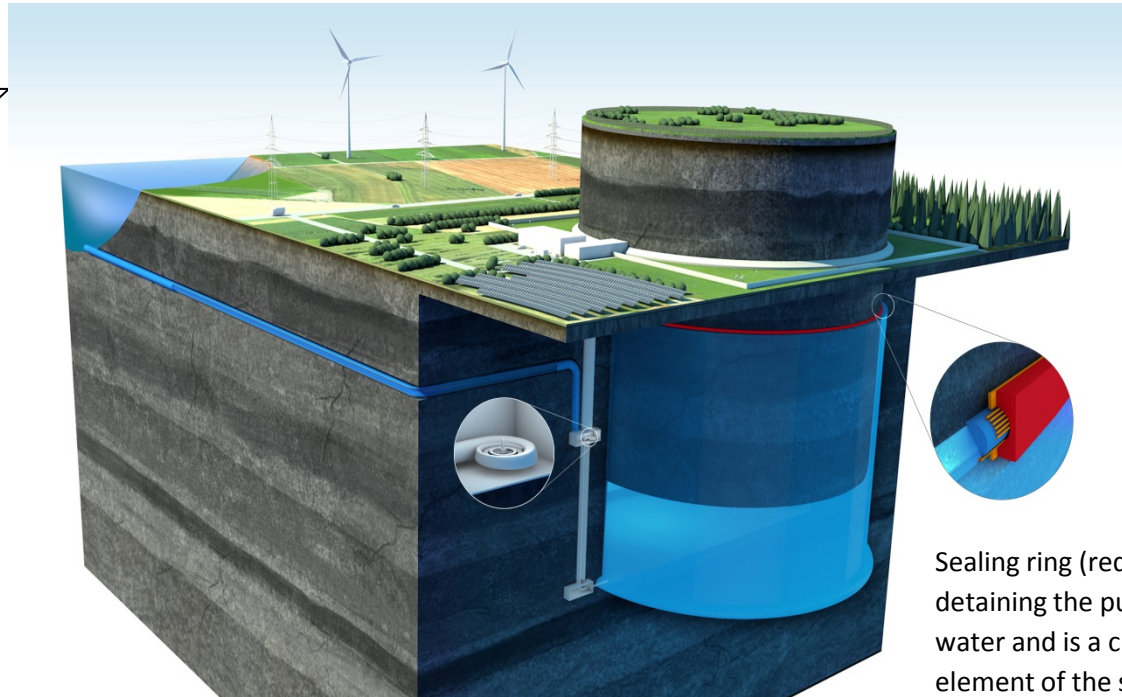
$$E_{HHS} = (2 * \rho_{\text{rock}} - 3/2 * \rho_{\text{water}}) * \pi * g * r^4$$

Cost of construction: $b \sim r^2$

-> Costs per kWh $\sim 1/r^2$

Construction

- The rock piston needs to be dismantled from its and he side walls will be cleared with rock cutting machines.
- All exposed surfaces will be sealed with geomembranes against environmental impacts and water.
- The piston wears a gasket, which is flexible.
- The storage can be constructed with approved technologies from mining and tunnel constructions.



Sealing ring (red) is detaining the pumped water and is a crucial element of the system. We developed a bulg-sealing which is flexible to cover the gap of 2-3 m between piston and the rough surface of the cylinder.

Site prerequisites

Geology: In general, some sites are more suitable than others if they have rock that is as compact as possible, and with few fissures.

Hydrology: The HHS needs to be built close to access of water, like near lakes or a basins (similar to pumped hydro storages, but it takes only one basin).

Grid connection: The HHS should be connected to the high-voltage-grid.



Photo: Petra Dirscherl / pixelio.de

Photo: Christine Brauner, pixelio.de

Advantages of the HHS

- ✓ Profitability: economies of scale with increasing diameter, costs drop by $1/r^2$
- ✓ Efficiency: ca. 80% (comparable to pumped hydro storage)
- ✓ Construction is mainly done with proven technology from mining and tunnels
- ✓ Relative little land use
- ✓ Long life time of operation
- ✓ Less water needed as compared to pumped hydro storage (ca. 1/4)
- ✓ Black start capable and flexible operation in the power market

About us

Heindl Energy GmbH, based in Stuttgart, Germany, is developing the concept of HHS in order to prepare a first pilot project. For proving its feasibility we are conducting several studies with experts from mining, geology, geophysics and construction engineering.

The company is owned by Professor Eduard Heindl and financed by HTG Ventures AG.

Please contact us for further information:

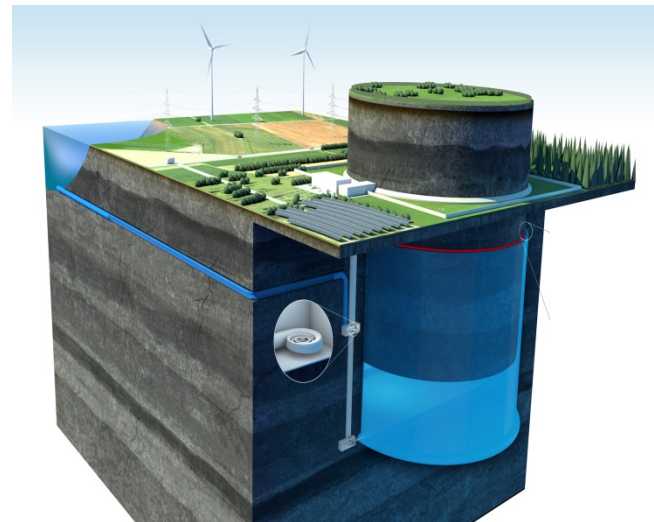
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Hydro Hydraulic Storage – a new concept for storing electricity

Functionality: The concept of hydraulic hydro storage (HHS) offers an innovative solution because it can store large amounts of energy for a long time. A piston of rock that has been exposed from its natural surroundings, is raised up using water pressure, and when power is needed, the water is released and routed to turbines.

Benefit: The storage capacity increases with the fourth power of the radius. The construction costs however only increase with the square of the radius. This means that the construction costs increase substantially more slowly than the storage capacity.

Potential: The HHS can be built in different sizes (see table below). At a diameter of 250 meter the capacity of 8 gigawatt-hours corresponds with a large pumped hydro storage!



Capacity in GWh	0,5	8	124
Diameter in meter	125	250	500
Mass of rock in Mill. tons	4	31,1	255
Pressure at sealing ring in bar	20	39	78