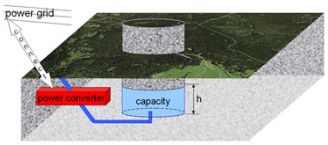
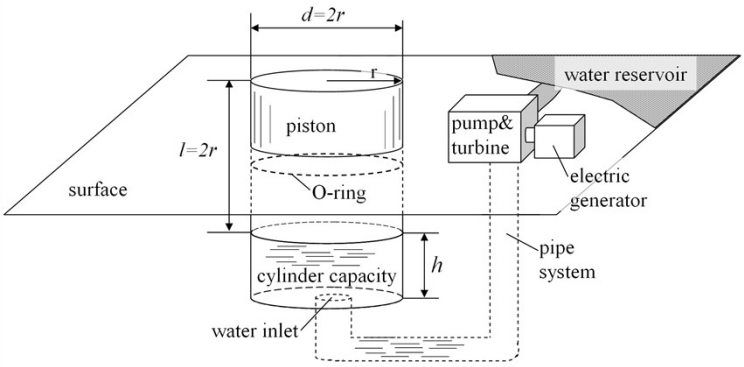


Hydraulic Hydro Storage 2000 GWh

Prof. Dr. Eduard Heindl, Furtwangen University



radius of the piston	r	**62.5**	**125**	**250**	**500** m
pressure at O-ring	p	25	52	103	206 Bar
pressure at top of piston	p	20	39	78	157 Bar
hydraulic hydro storage capacity	E	**0.5**	**8**	**124**	**1980** GWh

Energy capacity of a body

$E = g * \rho * R * V * h$. (1)

If the piston is a cylinder with a radius r and the height h where the height is of the same length as the diameter d of the cylinder, the volume can be calculated by

$V = 2 * \pi * r^3$. (2)

The piston can be lifted by only half the length l of the piston

$r = l/2$ (3)

due to the O-ring limitation, otherwise the O-ring would leave the outer cylinder. The potential energy E_r of the piston, using the density of rock ρ_R, is

$E_r = 2 * \pi * g * \rho_R * r^4$. (4)

The energy E_{HHS} that could be stored in the Hydraulic Hydro Storage (HHS) plant is reduced by the potential energy loss E_W of the water with density ρ_W which is injected in the cylinder capacity from a surface reservoir like the ocean, a large lake or strong river,

$E_W = -3/2 * \pi * g * \rho_W * r^4$ (5)

resulting in the total energy capacity of

$E_{HHS} = E_R - E_W = 2 * \pi * g * \rho_R * r^4 - 3/2 * \pi * g * \rho_W * r^4$ (6)

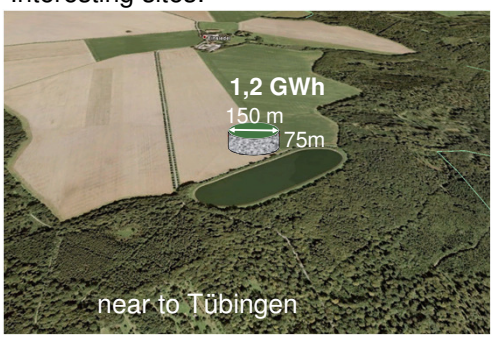
equals to

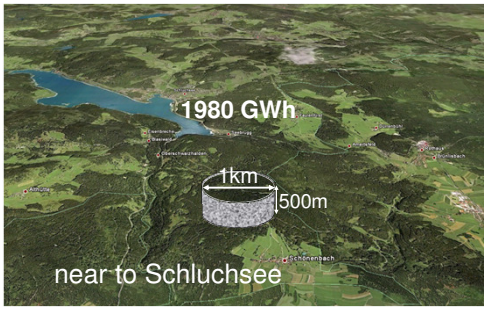
$$E_{HHS} = (2*\rho_R - 3/2*\rho_W) * \pi * g * r^4$$

- The capacity grows with the 4th power of the radius
- The cost grows with the 2nd power of the radius
- Result: arbitrary cheap storage systems feasible

Compare:	**Conventional Pumped Hydro Storage***	**New Hydraulic Hydro Storage***
Energy density	10 kWh/m²	2 000 kWh/m²
Water demand	1000 l/kWh	250 l/kWh
Flooded area	1000 m²/MWh	0 m²/MWh
Cost	70 €/kWh	< 7 €/kWh
*system design:	400m pond heigth, similar to Atdorf, Germany	radius 500m lower source is a river or existing lake

Interesting sites:





Prof. Dr. Eduard Heindl, Furtwangen University, Robert Gerwig Platz 1 , D-78120 Furtwangen, hed@hs-furtwangen.de