Round trip efficiency in electrical storage system

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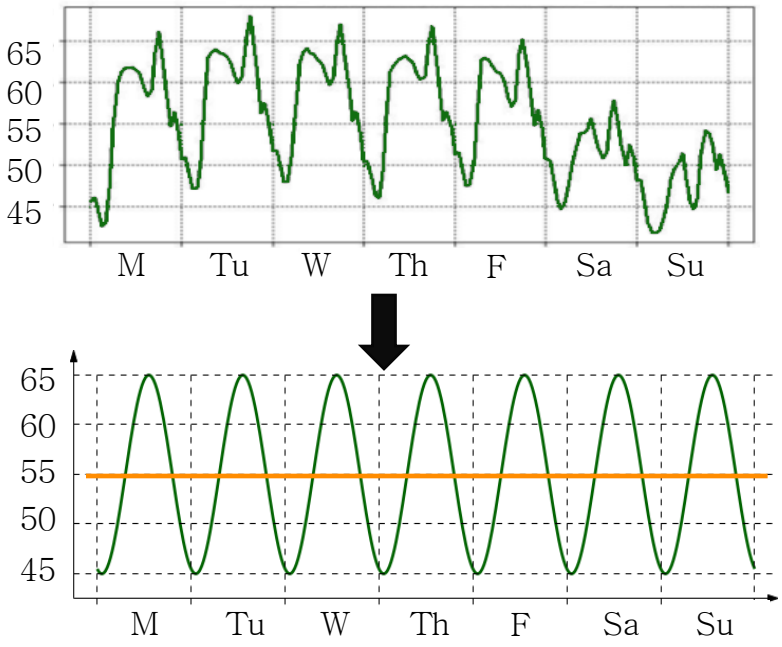
Design a Hydropower Storage System

Consumption profile [GW]



Production source

Power plant produces constantly 55 GW

Environmental respect

Geographic Location : $h = 250\ m$

Assumption

- The level of the water is negligible compared with the altitude of the reservoir.
- The consumption profile can be exceptionally considered sinusoidal
- The overall chain efficiency is 65 %

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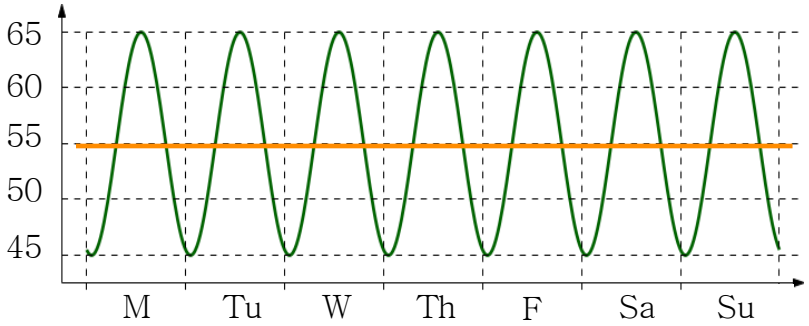
Design a Hydropower Storage System

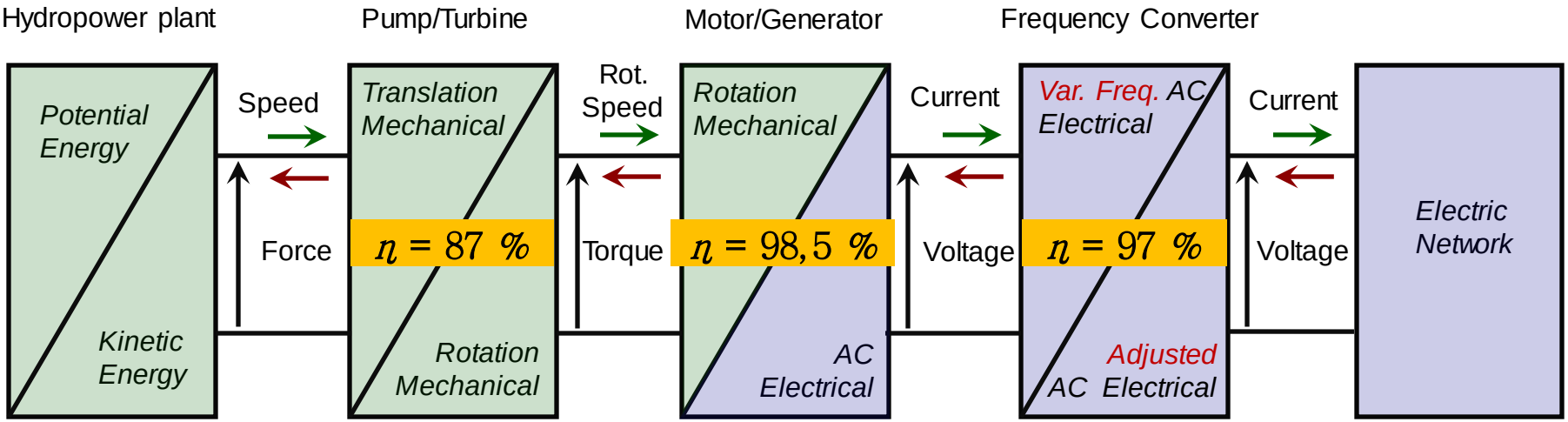
Ideal electrical storage system – without loss



Without losses, the storage system powered **10 GW** during the charge and the discharge of the upper reservoir.

The grid should receive **76,4 GWh** of electrical energy.

Hydropower Storage System



The chain efficiency accounts for every component in the chain. It is the product of the efficiency of components connected in serie.

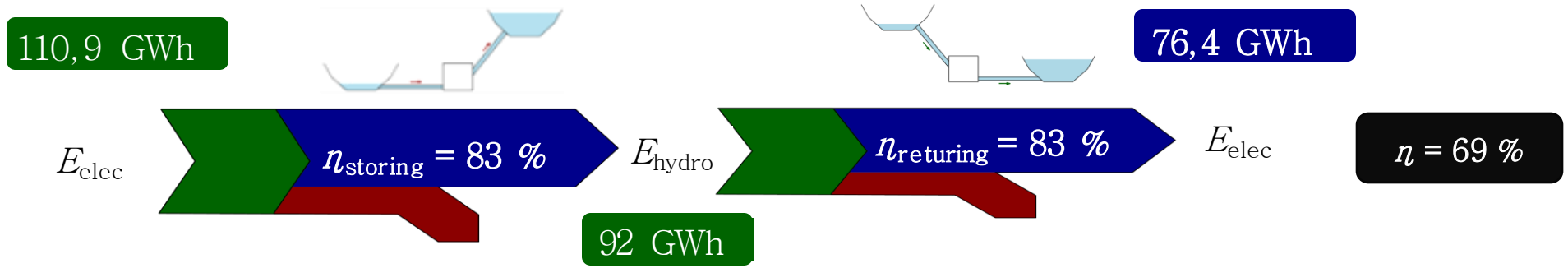
$$\eta_{\text{chain}} = 83\ \%$$

Design a Hydropower Storage System

Realistic electrical storage system – with loss

The round trip efficiency considers the conversion chain for storing and for returning the energy.

$$\eta_{\text{round trip}} = \eta_{\text{storing}}\,\eta_{\text{returning}}$$



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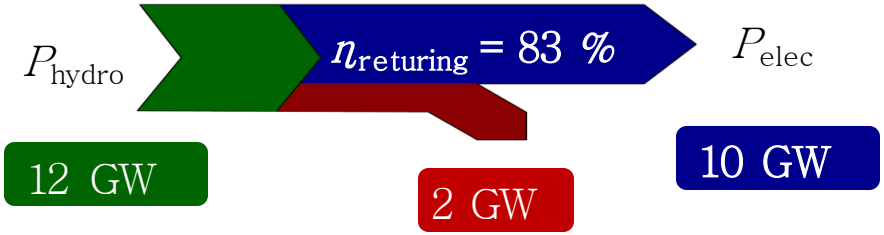
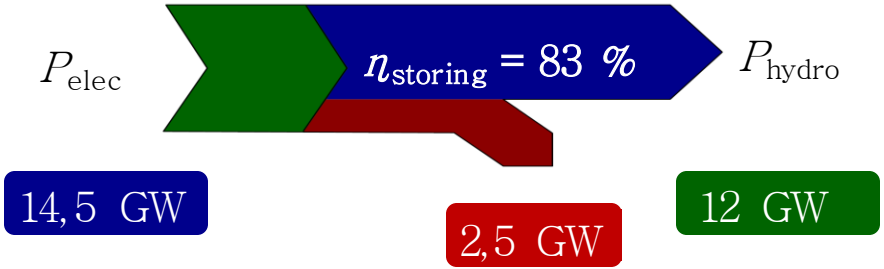
Power management in the storage – with loss

Discharging rated power
can be calculated based on the consumption need of 10 GW and the discharing efficiency of 83 %.

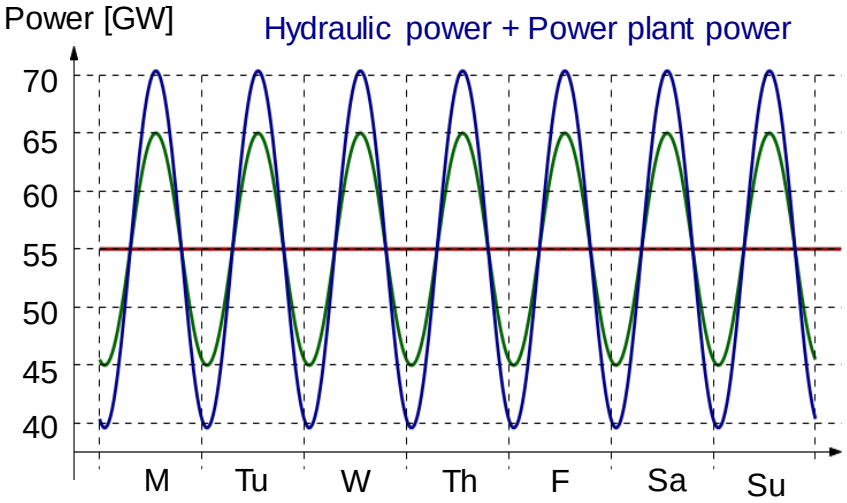


Charging rated power
can be computed from the storage need of 12 GW and a charging efficiency of 83 %.



Design a Hydropower Storage System

Energy management in the storage – with loss



Balancing energy

To feed the grid with 76,4 GWh, we need 110,9 GWh of electrical energy.

Available energy

From the excessive energy of 76,4 GWh and the charging efficiency, we can store 63,4 GWh.

An additional production of 47,5 GWh is required.