Berner Fachhochschule
Haute école spécialisée bernoise
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Swiss Energy Storage Overview

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Symposium elektrische Energiespeicherung Schweiz

Date: 27. November 2018
Time: 09.00 bis 18.15 Uhr
Location: Bern University of Applied Sciences, Biel

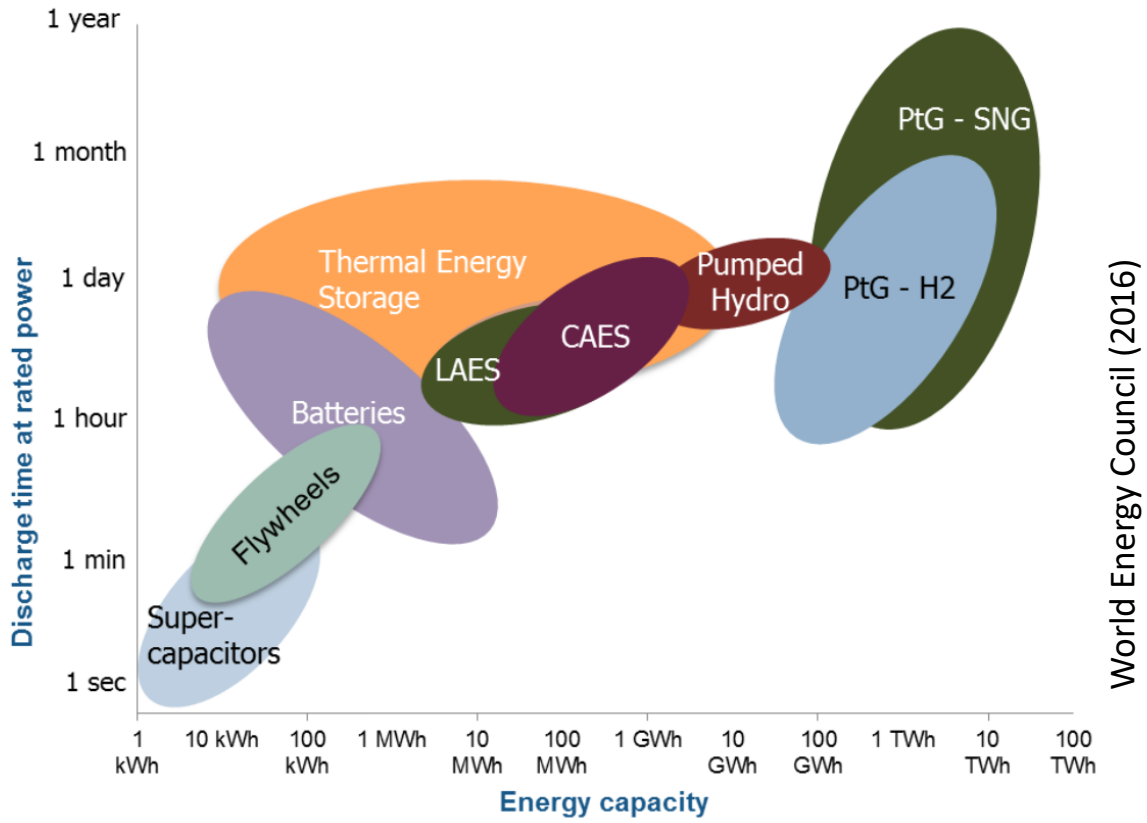
Sign-Up: www.bfh.ch/energy → Veranstaltungen
(limited number of places left)

Background

- The Bern University of Applied Sciences participated in the IEA TCP «Energy Conservation and Energy Storage».
- Part of the work was creating an overview of the energy storage situation in Switzerland.
- To make the results more accessible, we turned the report into a web page.
- This presentation provides an overview of the current energy storage market in Switzerland and a rough estimate of the technical potential of each technology.

Energy Storage Technologies

- Chemical Energy Storage
  - Oil
  - Gas
- Storage of Electricity
  - Hydro
  - Pumped Hydro
  - Compressed Air (CAES)
  - Hydrogen
  - Batteries
  - Electric Vehicles
- Thermal Energy Storage
  - Geological
  - Seasonal Thermal Energy Storage
  - Hot Water Energy Storage



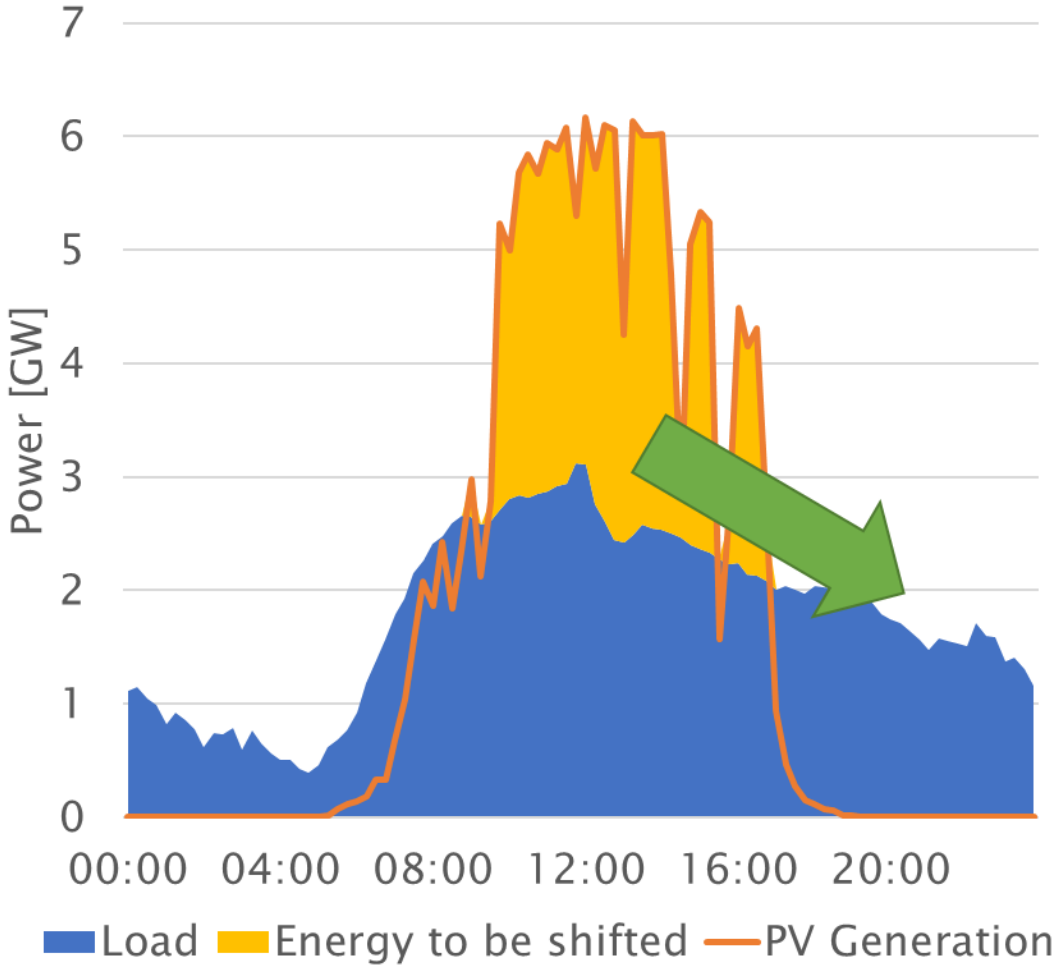
Why energy storage?

Supply:

- Wind and Photovoltaics fluctuate significantly over the day, week and year.
- To ensure reliable electricity supply with a large amount of renewable energy in the grid, some amount of buffering will probably be needed.
- The exact amount of needed storage depends very much on the future energy system.
- For example vertical PV Systems show significantly less seasonal variation than the typical 35° systems on residential roofs.

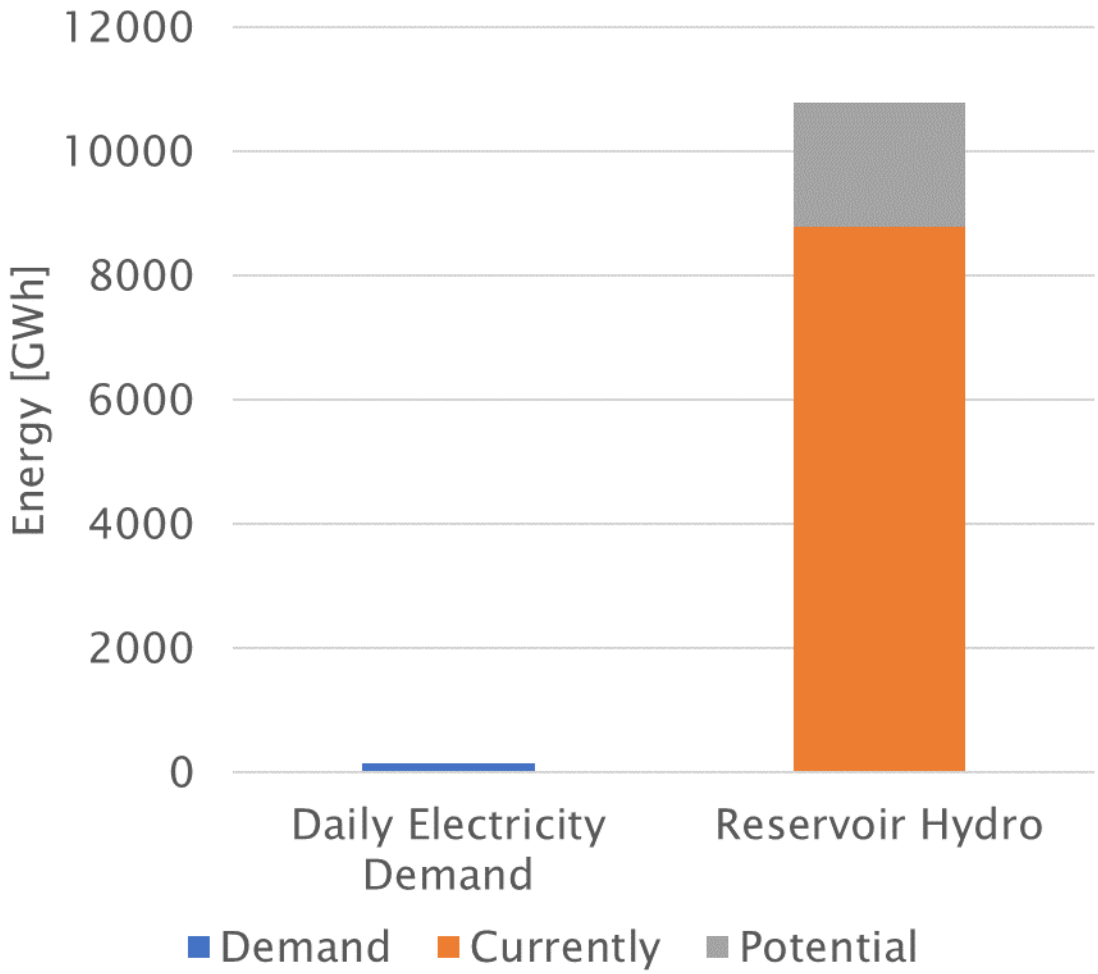
Demand:

- Switzerland uses on average 160 GWh electricity per day.
- Average load is about 6.6 GW, with peaks of about 10 GW.



Reservoir Hydro

- The big water reservoirs in the mountains can store large amounts of energy.
- But flexibility is limited: complete blocking of all rivers during the summer for example would lead to complaints.
- The potential is largely used. PSI estimates another 20% might be possible.
- The reservoirs could cover the entire Swiss electricity demand for 67.5 days, not considering installed power generation devices. (Or the flooding that would result from letting a year worth of water flow in two months)

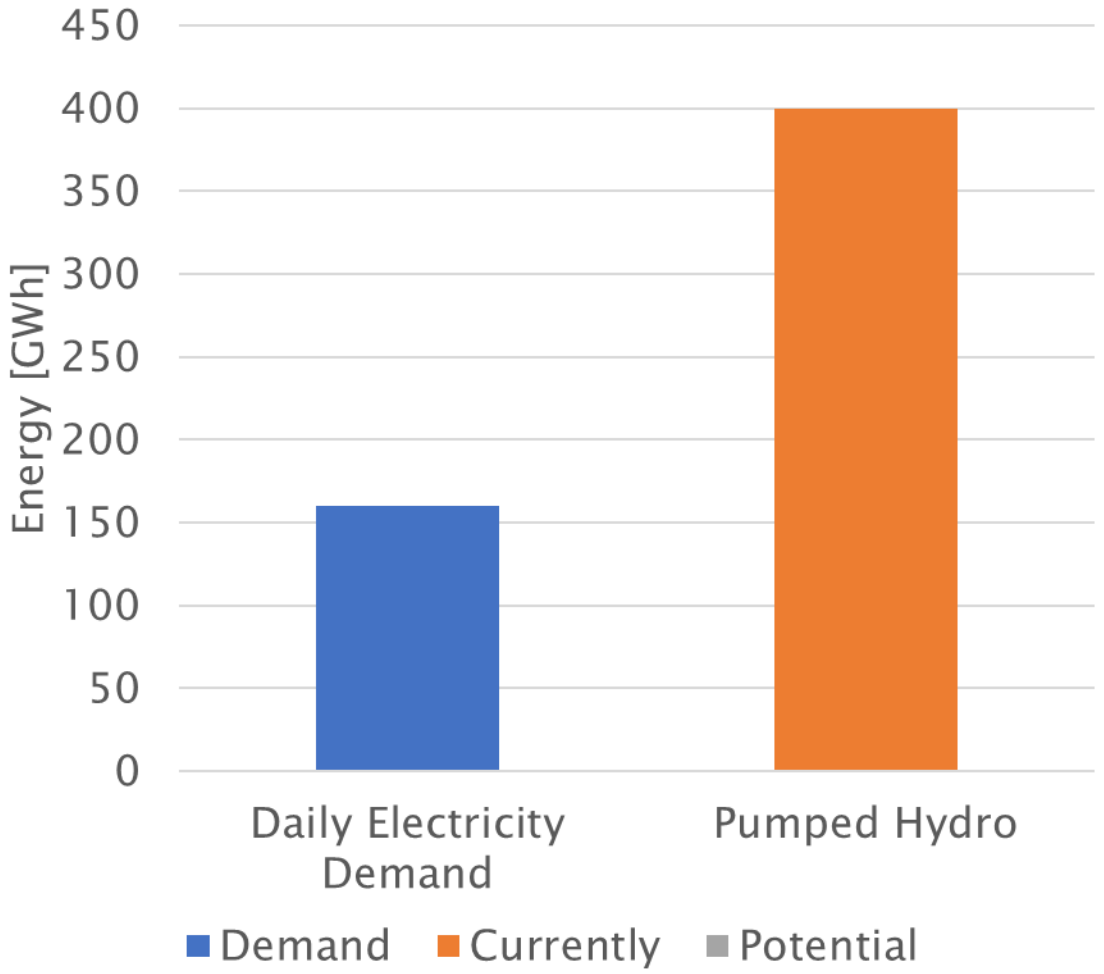


Pumped Hydro

- Pumped Hydro accounts for about 2 GW power with 400 GWh storage.

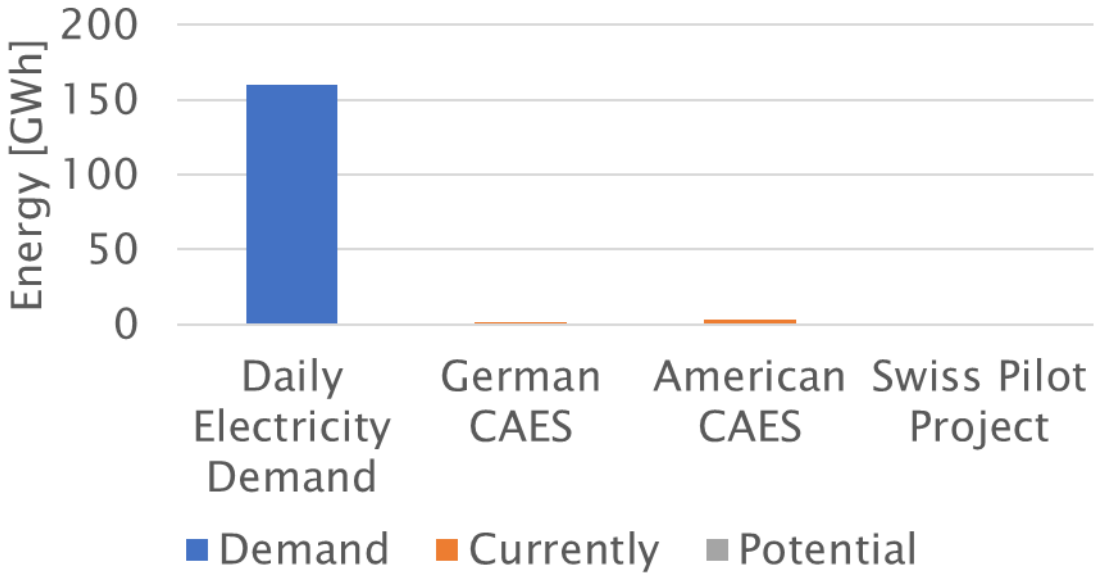
- It used to be very lucrative for transforming cheap nighttime electricity to expensive noon electricity.
- The profit margin used to be up to 1 CHF/kWh.
- Due to the large amounts of renewables in Germany the European noon electricity prices cratered.
- Currently all new pumped hydro projects have been put on hold due to poor return on investment prospects.

- Pumped hydro could cover the entire energy demand for about 2.5 days, not considering power issues or flooding.



Compressed Air (CAES)

- Only two systems worldwide, one in Germany, one in the USA.
- Switzerland is developing an adiabatic version with significantly higher efficiency.
- Other countries such as Canada are undertaking similar pilot projects.
- The Swiss project is not in production (yet) and has a maximum power of 500 kW.
- Large scale potential in Switzerland seems limited. 220'000 m^3 are needed for 1 GWh.
- Excellent for peak shaving though.



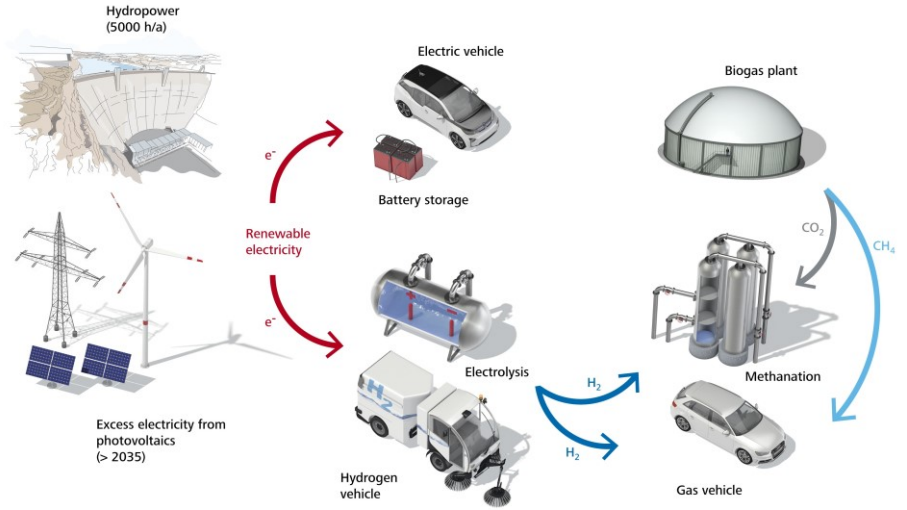
www.alacaes.com

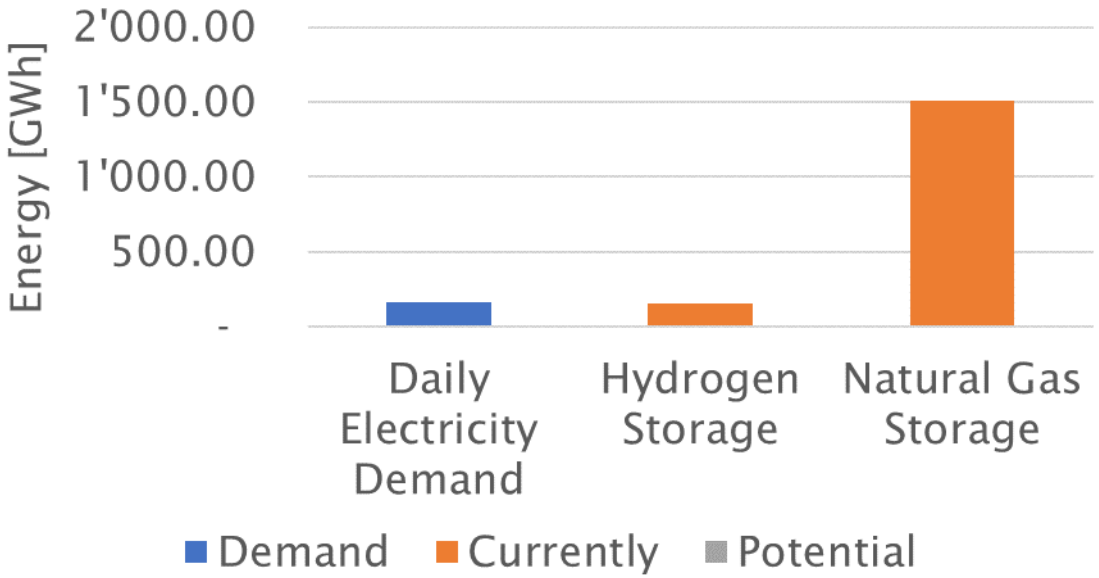
Hydrogen / Power-To-Gas

- Intrinsic disadvantage of the concept:
  - Electrolyzer efficiency: ~65 - 80%
  - Fuel Cell: ~50 - 70% efficiency
  - Round Trip efficiency: ~30% - 50%.

- According to current research the only option for large scale long term energy storage.
- Only attractive with large amounts of surplus, cheap electricity.

- Currently 1510 GWh energy storage capacity for natural gas, about 5-10% hydrogen possible.
- That is sufficient for about 5 days of electricity, a 10-fold seems feasible.
- Large scale hydrogen storage would require significant upgrades to the infrastructure.

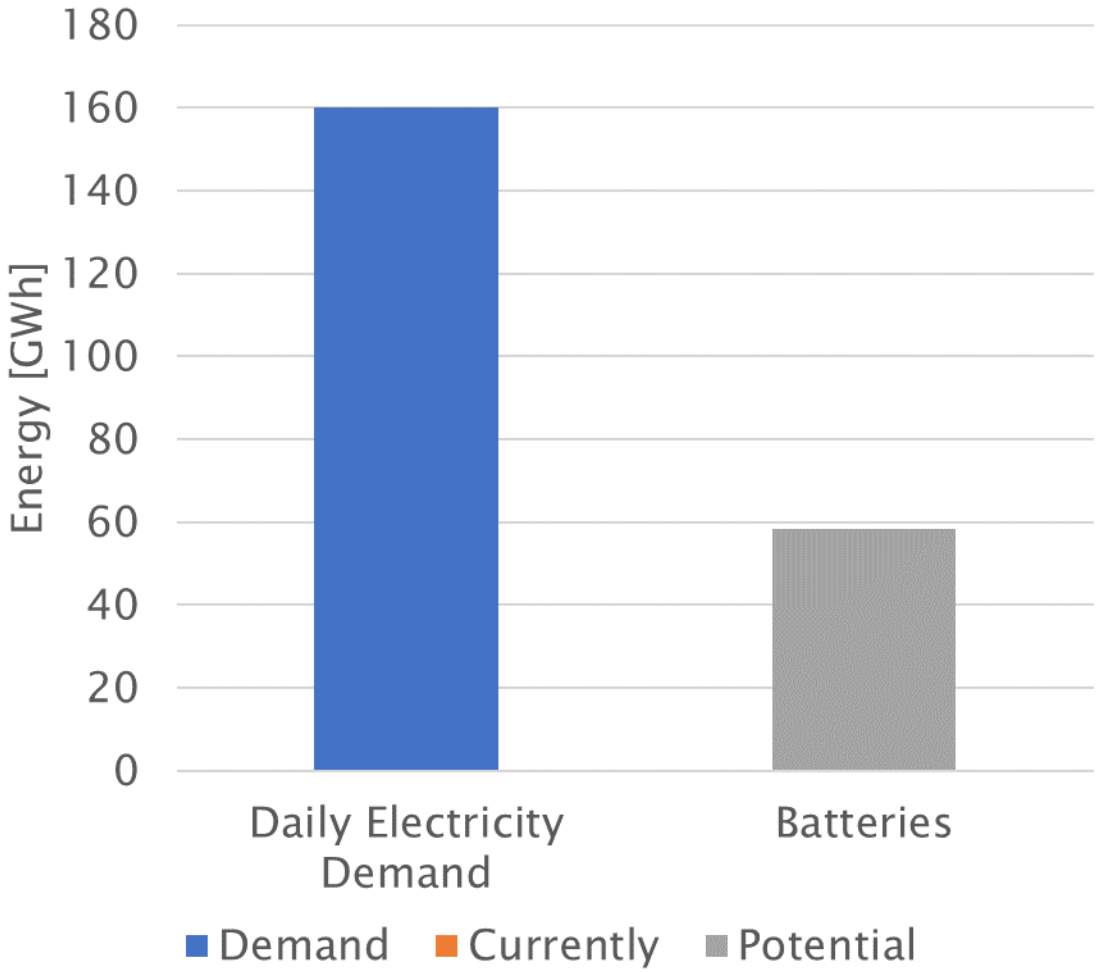




https://www.empa.ch/web/move

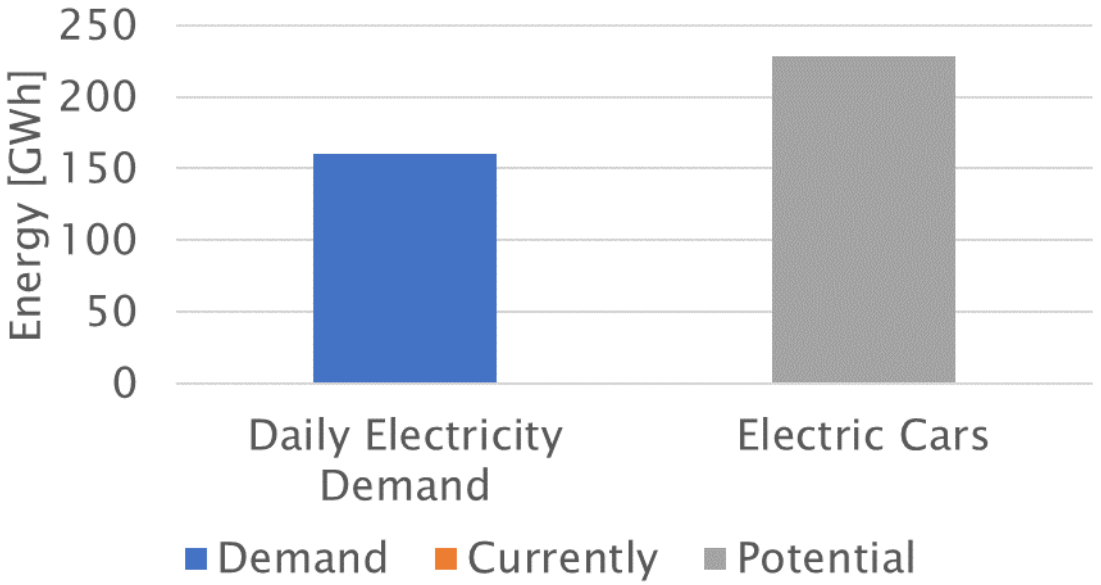
Batteries

- PV Battery Systems are currently not very widespread in Switzerland.
- An increasing number of pilot and demonstration projects are being built.
- The cumulated number of installed systems in Switzerland in 2017 is less than 1500 with a useful capacity of 13.5 MWh.
- According to studies the optimal amount of batteries for most systems is about 1 kWh Battery per MWh of electricity demand.
- For Switzerland this would be 58.3 GWh, competing strongly with for example pumped hydro.
- Significant price decreases would be needed for mass deployment.
- Installed are so far typically 1.3 - 1.6 kWh per MWh of demand.



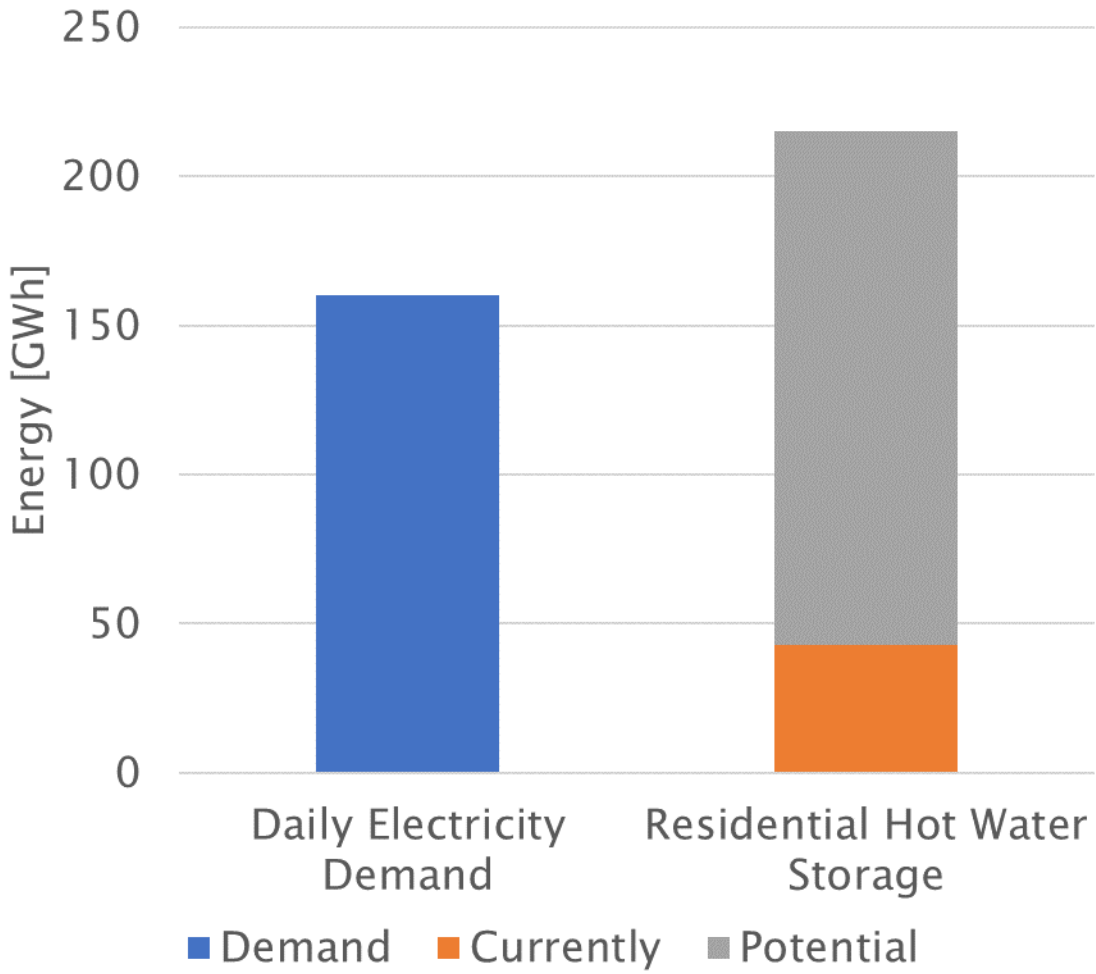
Electric Vehicles

- The electric vehicle penetration rate is rising.
- Vehicle-to-grid is already possible with current systems.
- Car battery capacities are in the range of 20-100 kWh.
- Partial discharges have typically a low impact on battery aging.
- Right now the estimated battery capacity in all EV combined is about 360 MWh.
- Car batteries could cover 1.4 days if all cars are electric and all owners don't need their car the next day.



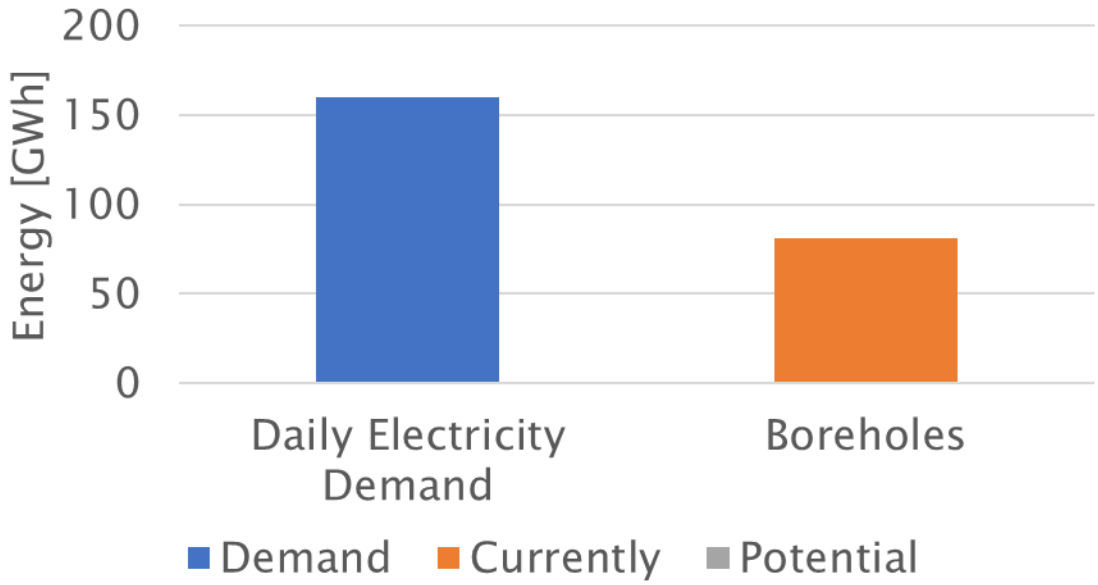
Hot Water Storage for Households

- Energy use for domestic hot water and heating represent a large percentage of the total energy consumption.
- Full energy systems integration (meaning widespread installation of heat pumps) would turn this demand into electricity demand.
- Hot water storages can cheaply store large amounts of energy.
- Due to high losses the storage is only feasible for a few days.
- Typical installations are sized to buffer the energy demand of about a day.
- Research into reducing storage losses could yield large benefits for the future energy systems by providing incentives to install larger buffer storages.



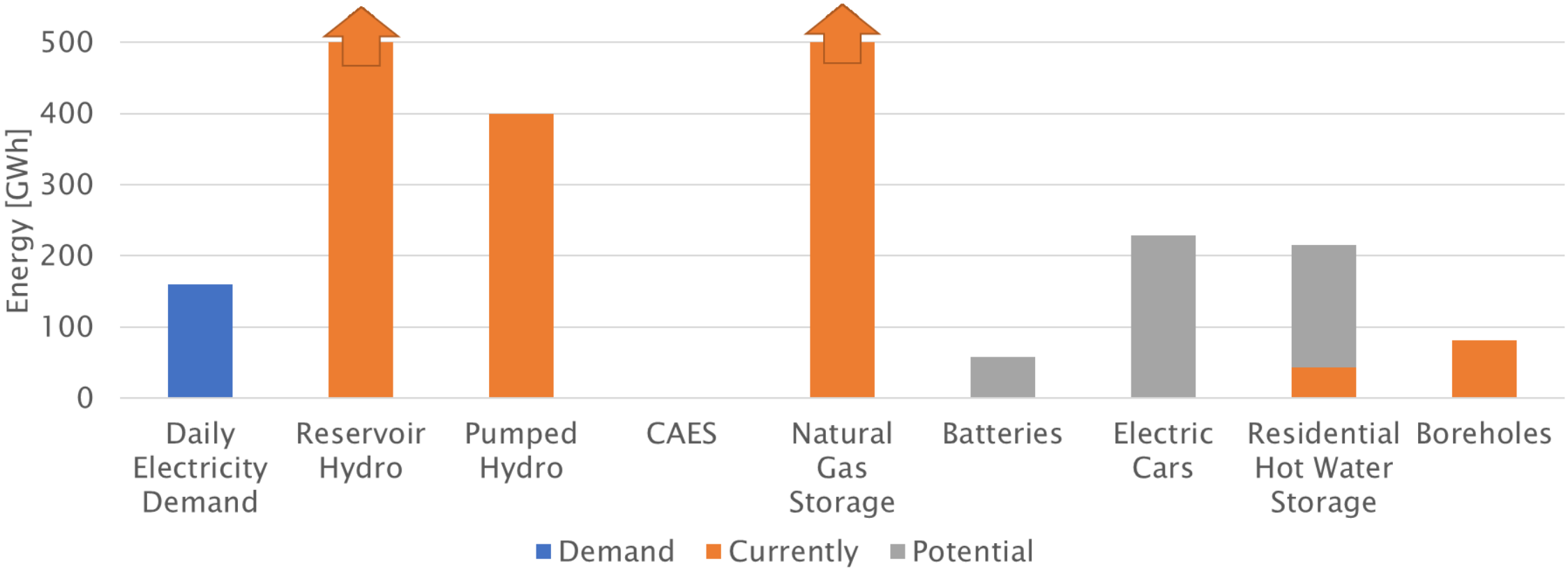
Borehole Heat Storage

- Boreholes offer a large potential for true seasonal energy storage.
- High investment costs, limited density and geographical limitations make it not universally suited.
- Some areas for example in Zürich are already reaching saturation.
- Maximum usable potential is unclear.



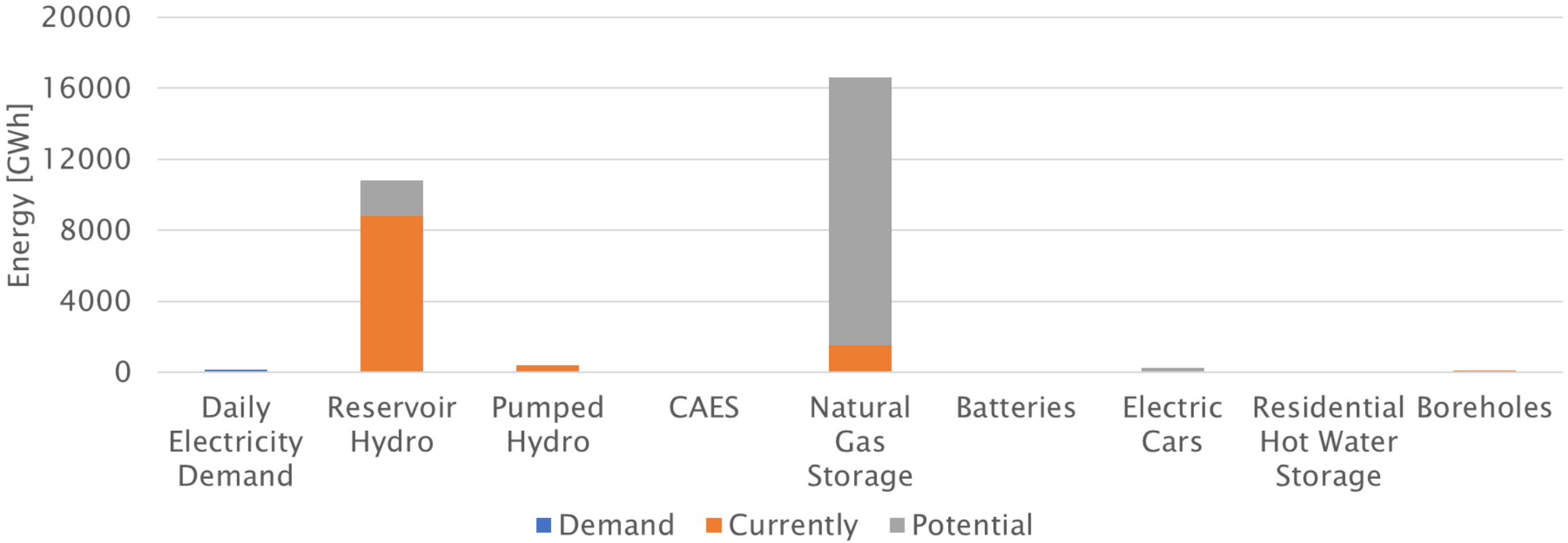
Summary (I)

Most current energy storage technologies have the potential to store energy equivalent to about 1-3 days of the electricity use in Switzerland.



Summary

Natural Gas seems to have the largest potential for seasonal storage, but would require large investments.



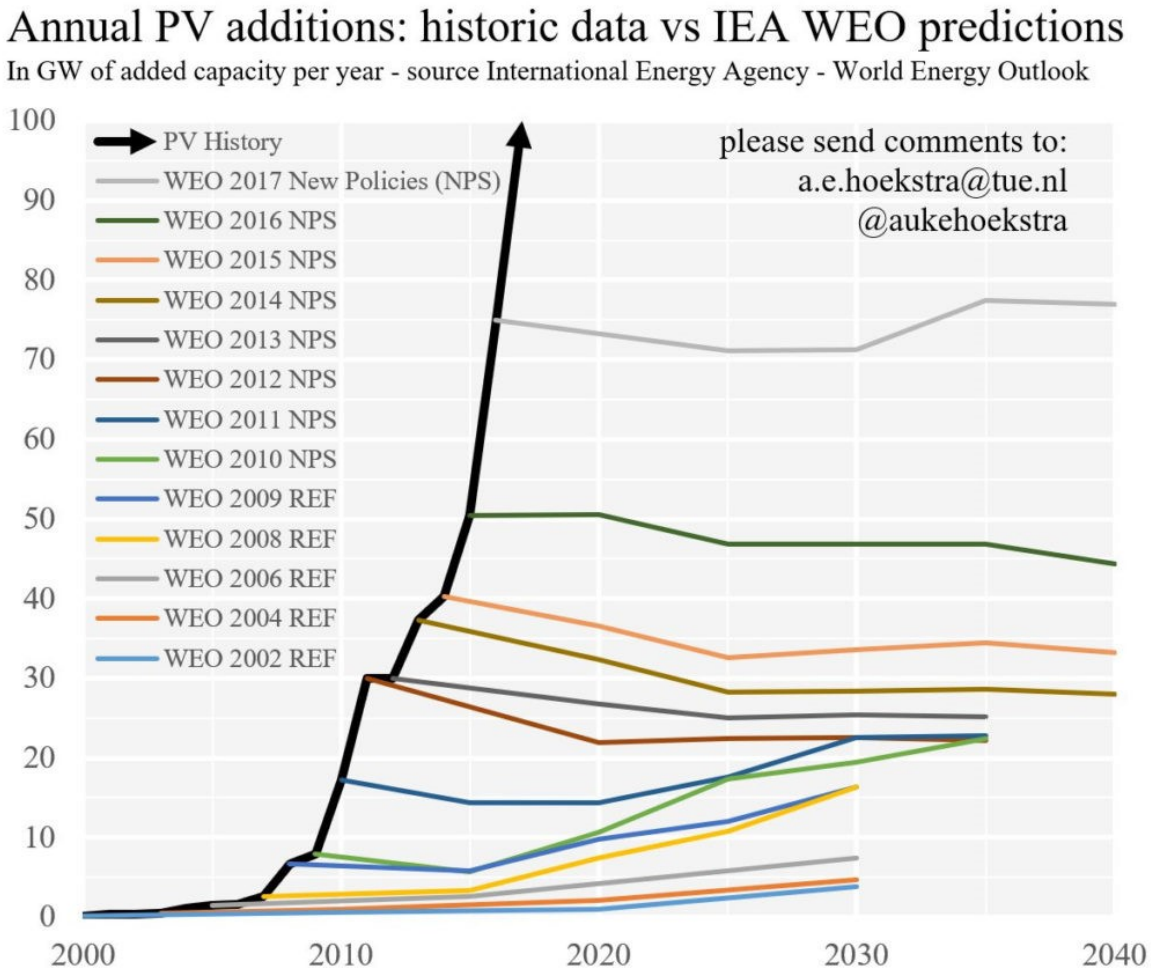
Website

- We continue to collect information about
  - Pilot Projects
  - Commercially offered battery systems
  - Research projects related to energy storage
  - Everything else related to energy storage.
- We are grateful for all input.
- The goal is to provide an full overview of the energy storage situation in Switzerland.
- Future funding is unclear though.

Predictions

«Predictions are difficult, especially about the future.»

– supposedly Mark Twain



Thank you for your attention!

www.energystorageoverview.ch