Energy storage technologies

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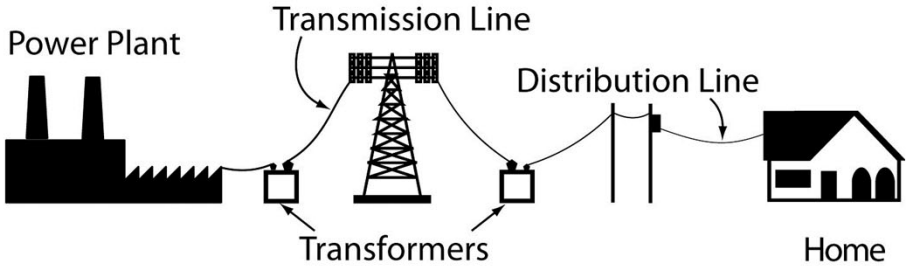
Outline

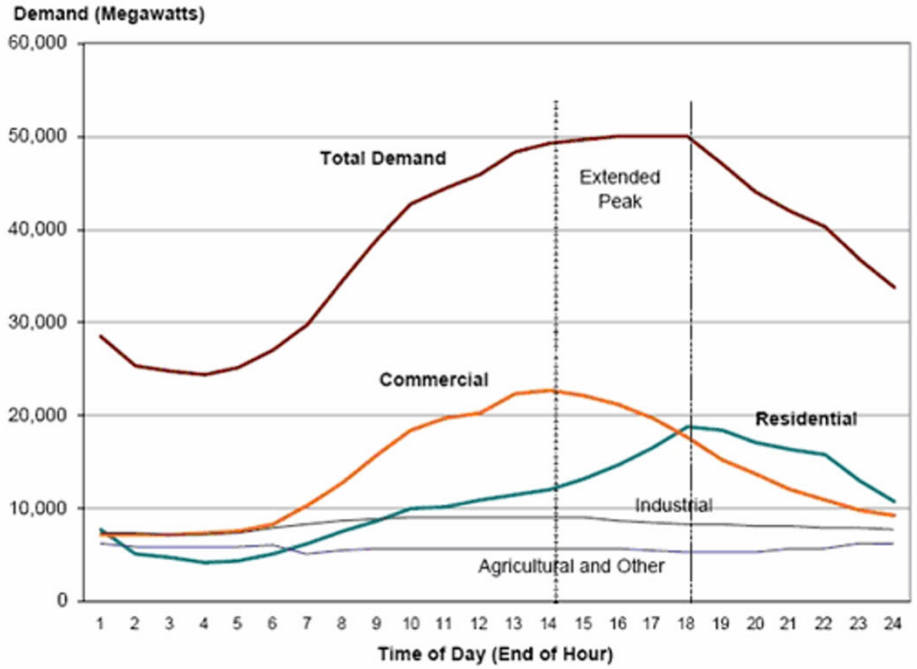
- Why has electricity storage become necessary?
- Technologies and applications
- History of electricity storage development
- Data collection issues

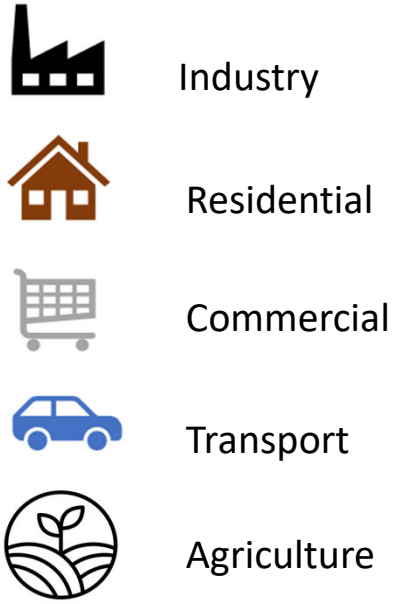
How is electricity generated and consumed

Typical Power System

- Electricity is generated at the same time as it is consumed.
- Generation should follow demand and provide peak load with a certain level of reserve margin.

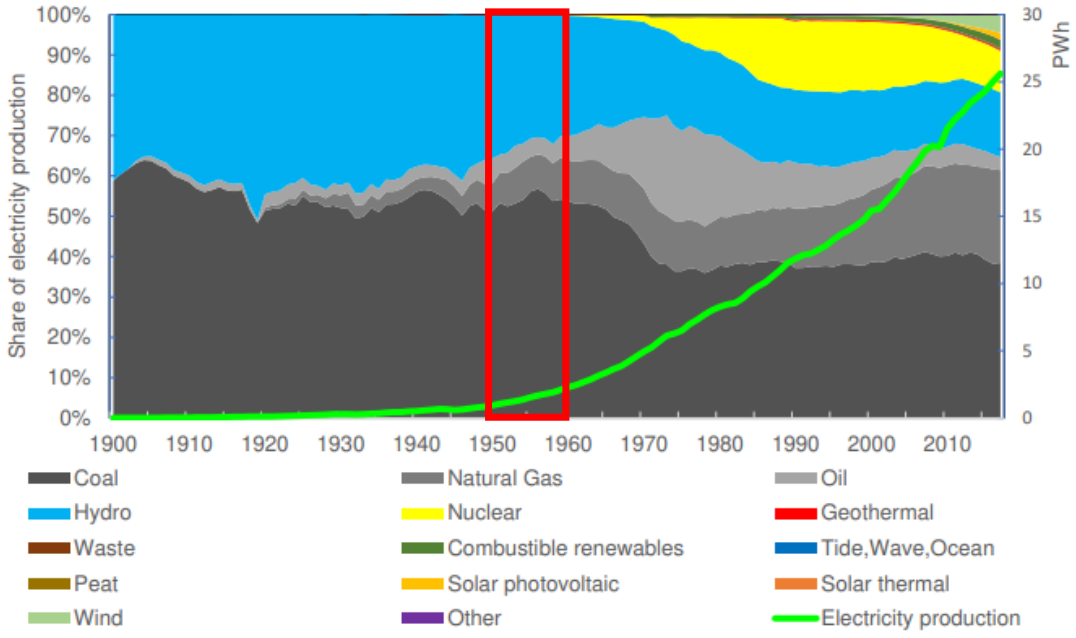




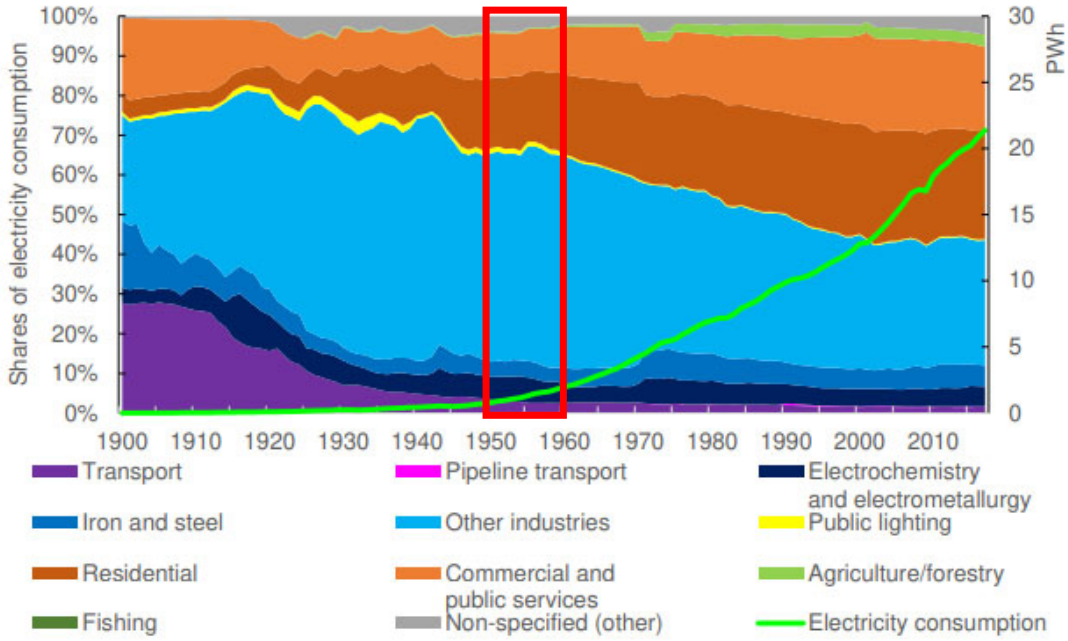


World electricity production and consumption

Production



Consumption



Source. The rise and stall of world electricity efficiency:1900-2017, results and implication for the renewables transitions MPRA_paper_112530.pdf (uni-muenchen.de)

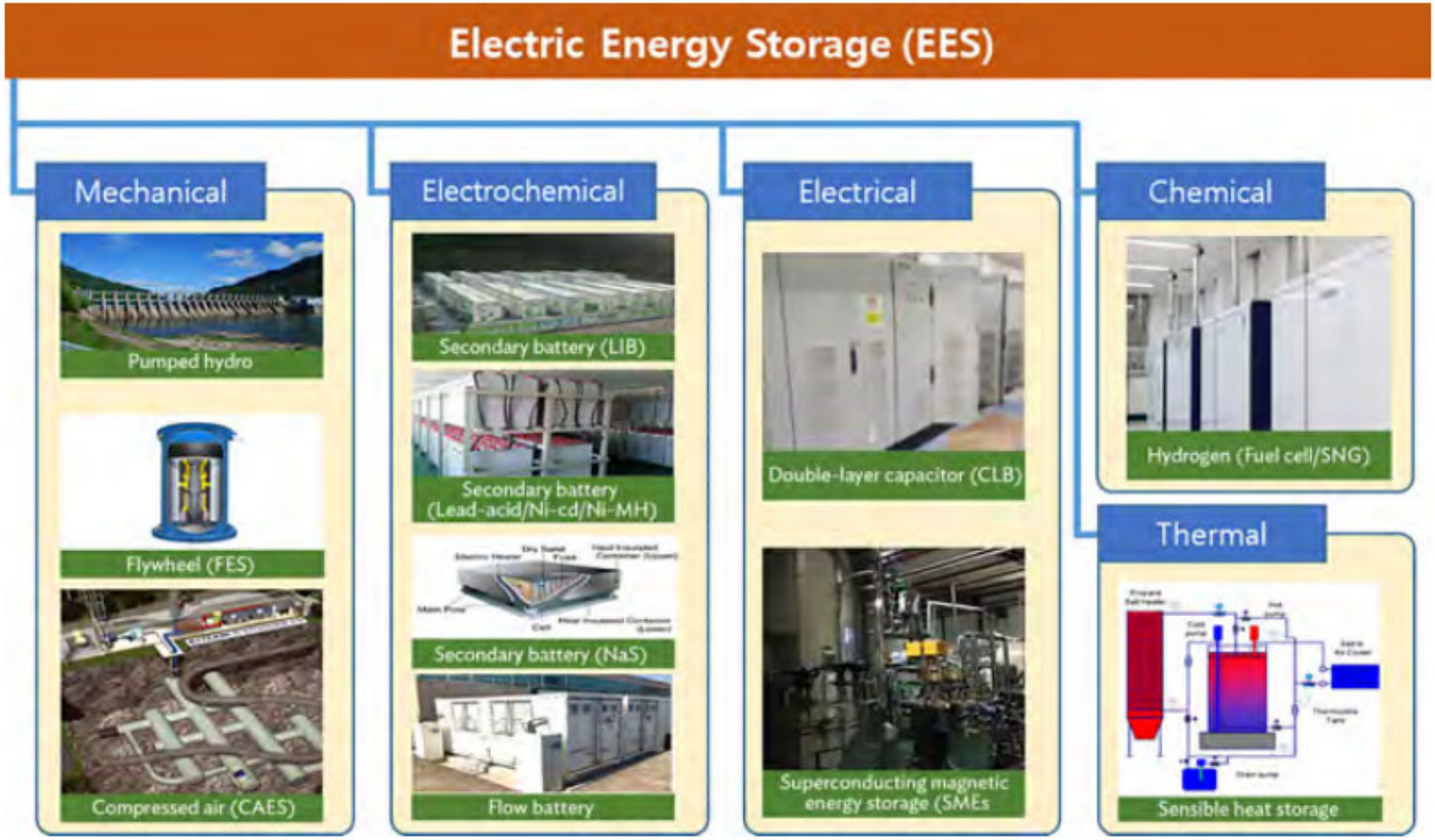
- 1950-1960 turning point: the share of variable demand started to grow with the rapid growth of consumption
- Main goal: to support thermal power plan to operate in optimal or near optimal mode and reduce the capacity

APERC

Electricity storage: technologies and applications

APERC
Asia Pacific Energy Research Centre

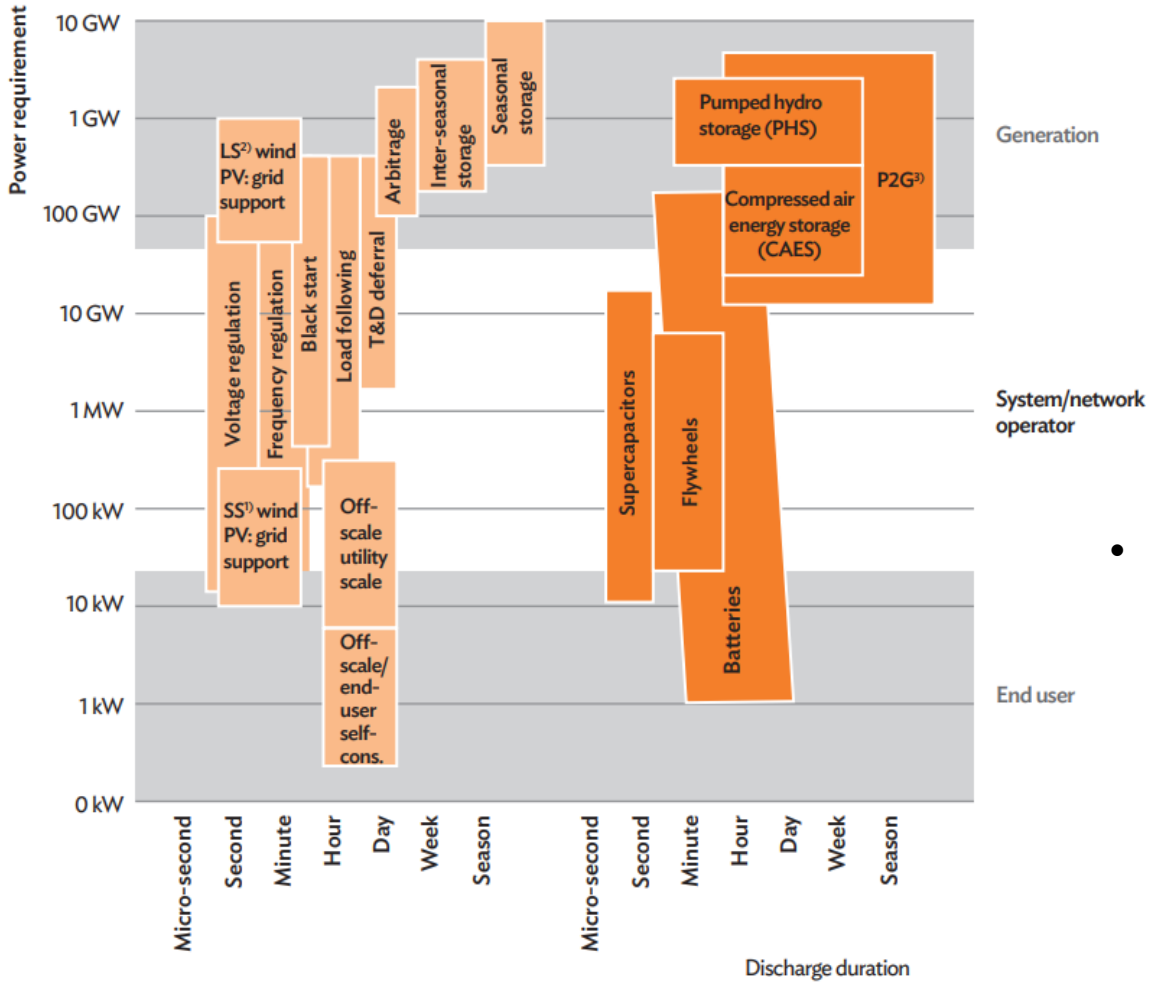
Electric energy storage technologies

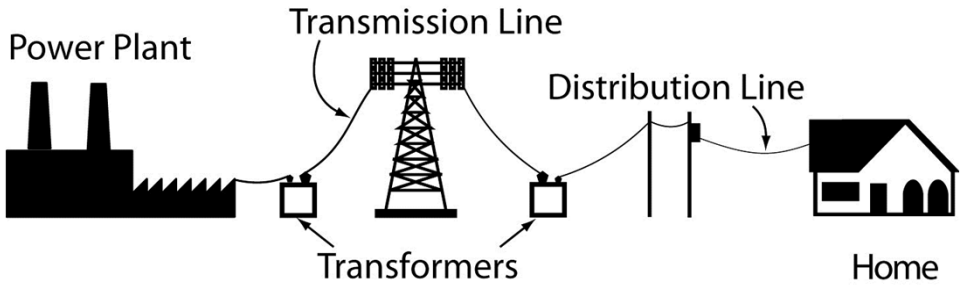


Energy storage applications

Service	Application	Duration
Bulk Energy Services	Electric Energy Time Shift (Arbitrage)	Day - Season
	Renewable Energy Time Shift	Day - Season
	Renewable Energy Time Shift (Firming)	Day - Season
Ancillary Services	Voltage Support	Second
	Frequency Regulation	Minute
	Operating Reserve (Spinning)	Minute
	Black Start	Minute
	Operating Reserve (Supplementary)	Hour
	Ramp Support	Minute – Hour
	Operating Reserve (Non-Spinning)	Hour
Transmission Services	Transmission Congestion Relief	Hour
	Stability Damping Control	Hour
	Transmission Upgrade Deferral	Hour
Distribution Services	Reliability	Hour
	Distribution Upgrade Deferral	Hour

Right technology for different application





- Each technology can serve a specific application

HANDBOOK ON BATTERY ENERGY STORAGE SYSTEM, 2018

Electricity storage history

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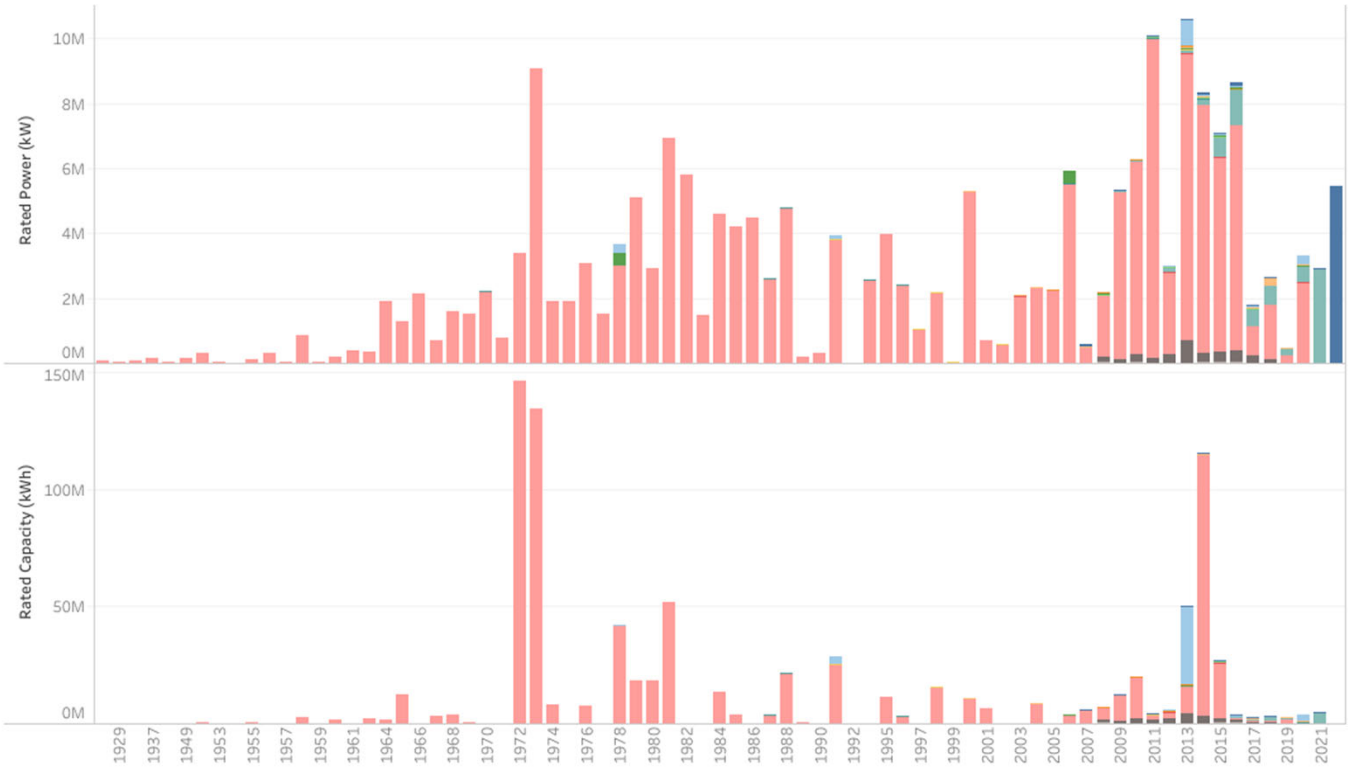
Energy Storage Installations by Year

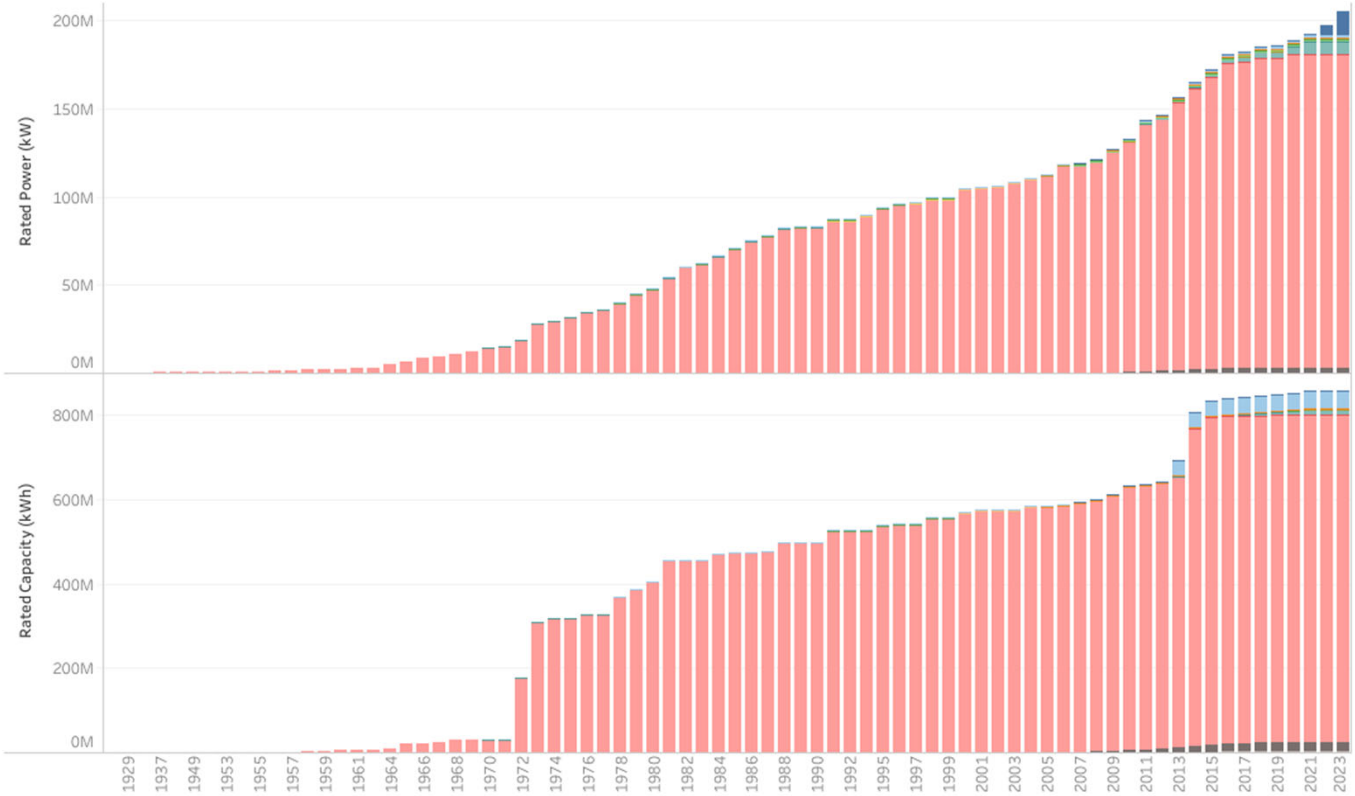


Notes:
1. If the project commisioning date is not available in the database, the year represents either the constructed date or announced date. The projects for which the constructed/comissioned/announced date were not available have been omitted from the visualization.
2. The discharge duration of a few projects are missing in the database and thus are not included in these visualizations. Please download the full database from the Projects page for more accurate information.
3. Details on energy storage technology categorization can be found at U.S. Department of Energy's Energy Storage Handbook (https://www.sandia.gov/ess/publications/doe-oe-resources/eshb)

Source. DOE Global Energy Storage Database

- The use of storage facilities was part of the electric power industry
- Historically, the first method was pumped-hydro storage
- Pumped-hydro storage remained dominant in terms of new capacity additions

Cumulative Sum of Energy Storage Installations by Year



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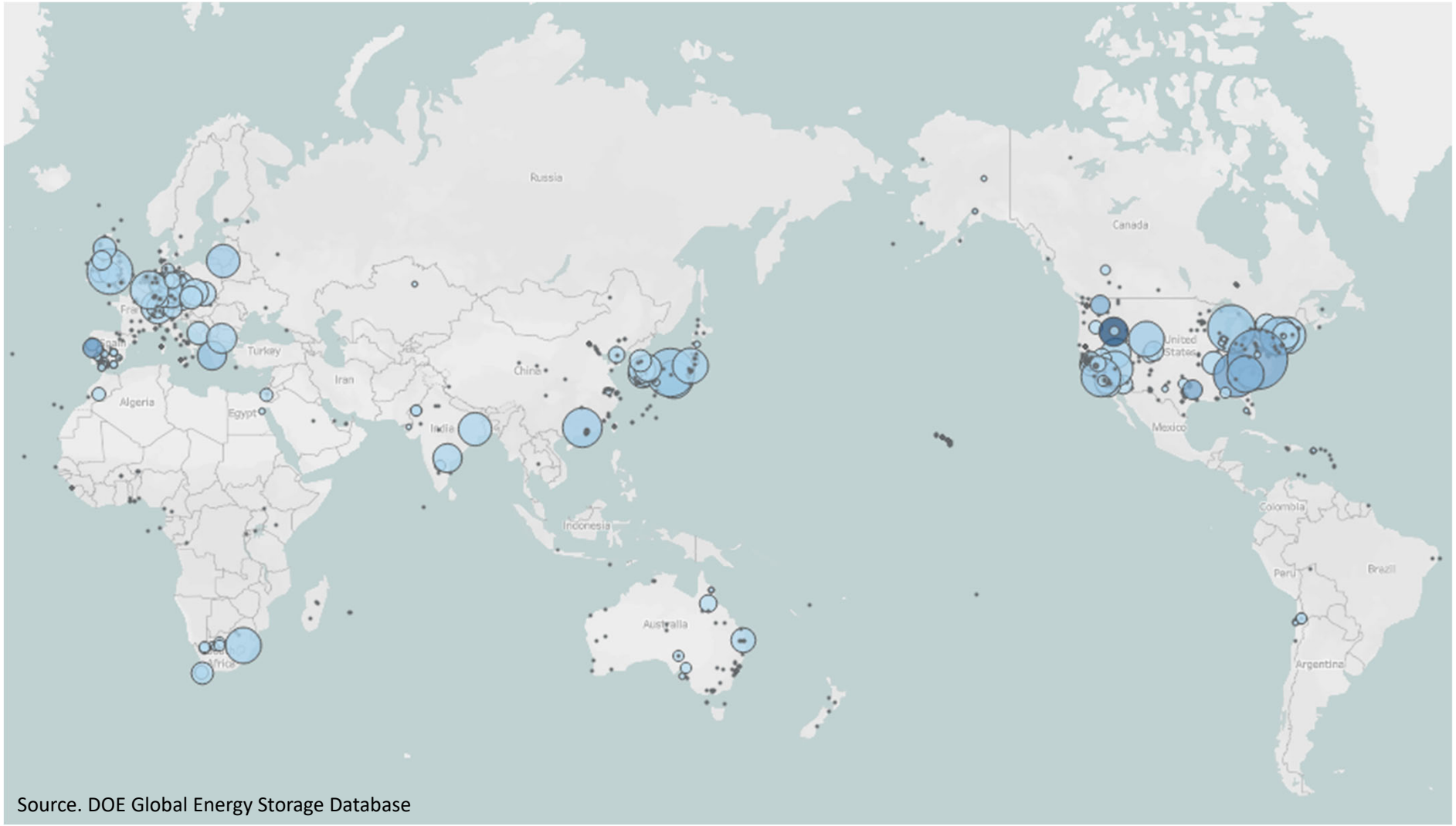
- Unknown Technology Mid-Type
- Compressed air energy storage
- Electro-chemical capacitor
- Flow battery
- Flywheel
- Heat thermal storage
- Hydrogen storage
- Latent heat
- Lead-acid battery
- Lithium-ion battery
- Nickel-based battery
- Pumped hydro storage
- Sensible heat
- Sodium-based battery
- Zinc-based battery

Source. DOE Global Energy Storage Database

- **Pumped-storage hydropower** is still the most widely deployed grid-scale storage technology today.
- Total installed capacity stood at around 160 GW in 2021.
- Global pumped-storage capacity was around **8 500 GWh** in 2020, accounting for over 90% of total global electricity storage.
- Global storage capacity of **Li-ion batteries** was around **4 GWh**

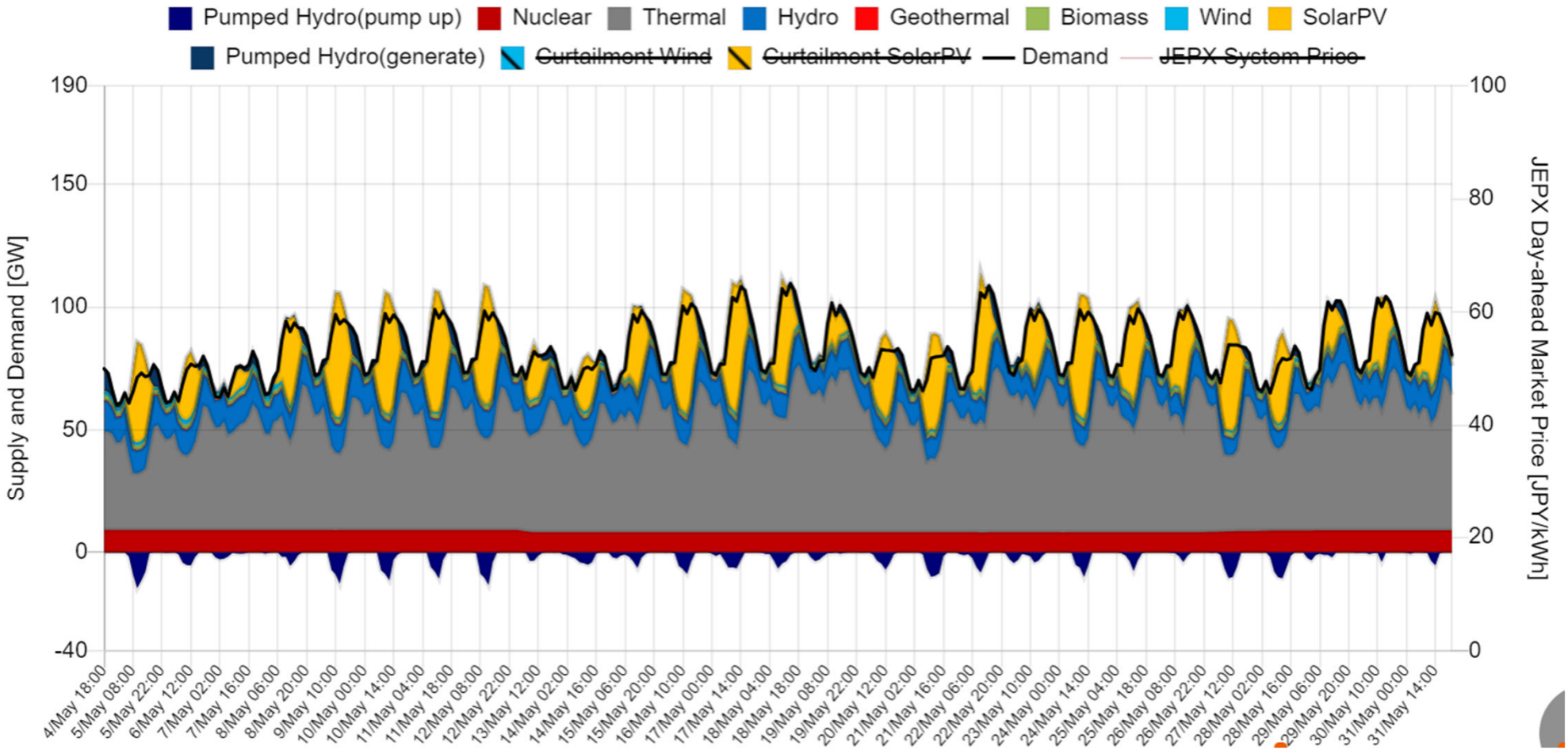
Global Map of Energy Storage Installations



Source. DOE Global Energy Storage Database

Electricity storage: data collection issues

Generation mix in Japan



https://www.renewable-ei.org/en/statistics/electricity/#demand

Some observations

Usually, new, especially battery storage, reports two “nameplate” capacity numbers:

1. Storage Capacity (in MWh),
2. Output power (in MW),

These numbers are related to installed capacity statistics.
Good to collect these numbers by technology: pump-hydro, batteries, flying wheels, etc.

For performance data: analysts need annual data on the inputs, own use, and outputs (all in MWh). The indicators are the same as for generation technologies, except for the energy carrier for the inputs.

In the case of storage, the input energy carrier is electricity.

In the energy balance tables, pumped hydro is usually “hidden” in Hydro. Therefore, the data on hydropower plants are not correct.

Thank you.

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