

ETES Electric Thermal Energy Storage

Strommarkttreffen Mai 2019 - Maximilian Schumacher

Executive Summary

Electricity system challenges & solutions

Increased RE penetration causes **challenges to electricity systems**.

Most challenges (e.g. increasing flexibility of conv. Power plants, RE curtailment, security of supply) require **high power** and **high capacity** storage solutions.

ETES is the **most cost-competitive** and **efficient** GWh-scale storage **solution to solve the majority of challenges**.

Applications & technology

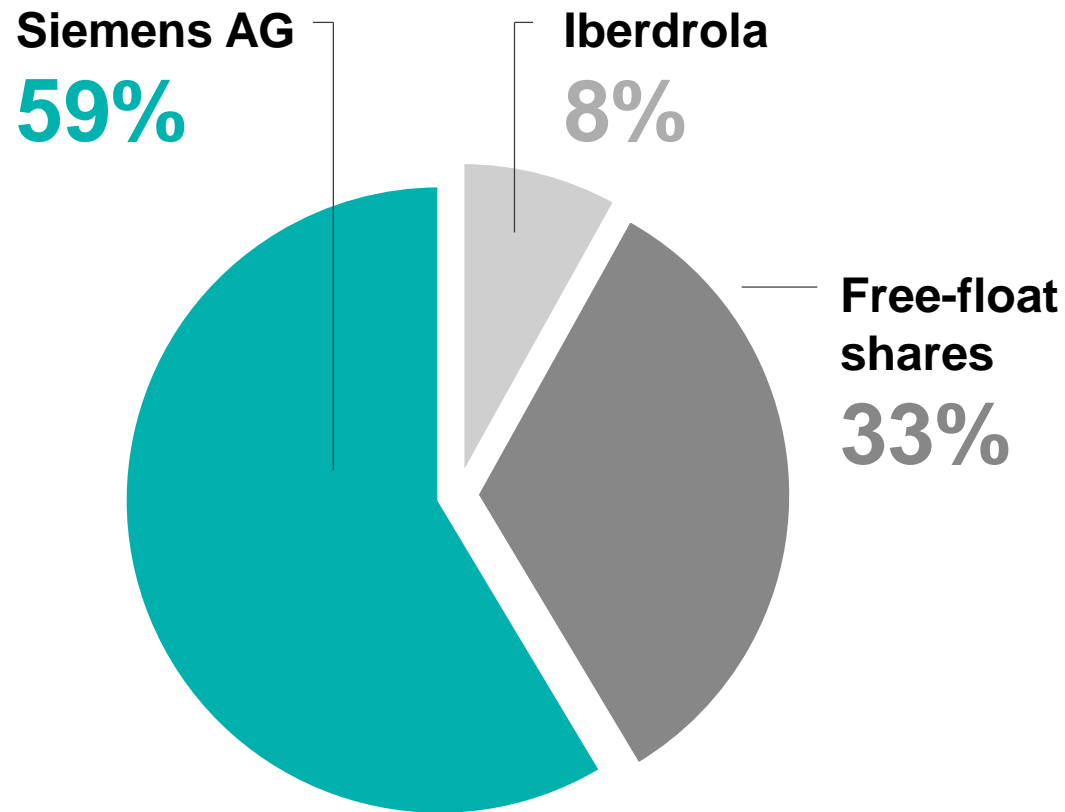
- Main application **options for ETES**:
 - **ETES base**: **Utility-scale storage** solution with **80% off the shelf components** to make renewables **baseload capable**.
 - **ETES add**: **Upgrade** fossil fuel power plant to **hybrid power plant** with additional revenue streams.
 - **ETES switch**: **Conversion** of fossil fuel power plant to **storage plant** to provide **second-life** for **power plant infrastructure**.
- Proven technology:
 - **Test Site**: Storage technology extensively **tested since 2014** → results outperformed expectations
 - **Demonstrator**: With **8.9 mio€ biggest German publicly funded storage R&D project** → currently under construction.

Cost & commercial roll-out

- **Low CAPEX** makes ETES **most cost-competitive** universal **storage solution**.
- **CAPEX of ETES** up to **10-times lower** than CAPEX of **Batteries**.
- **Technical feasibility is proven** and extensively tested → **GWh-scale Prototype** scheduled for **CY2020**

SIEMENS Gamesa

RENEWABLE ENERGY



23,000
Employees

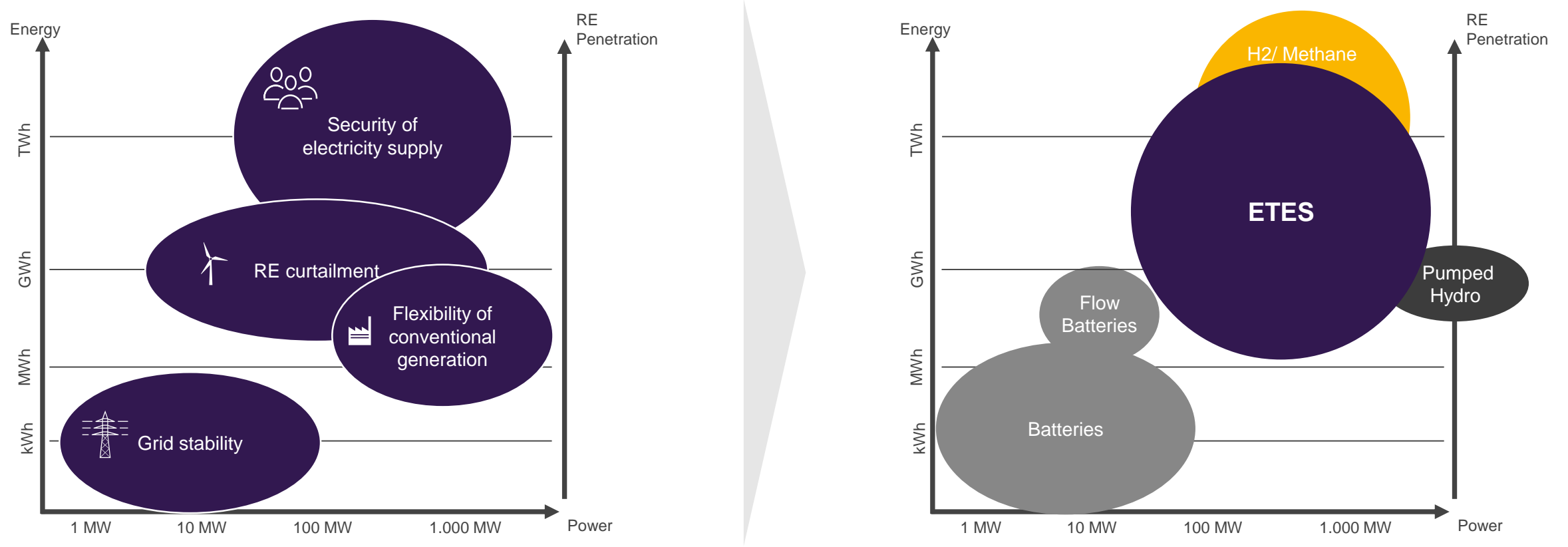


90.6 GW
Globally Installed

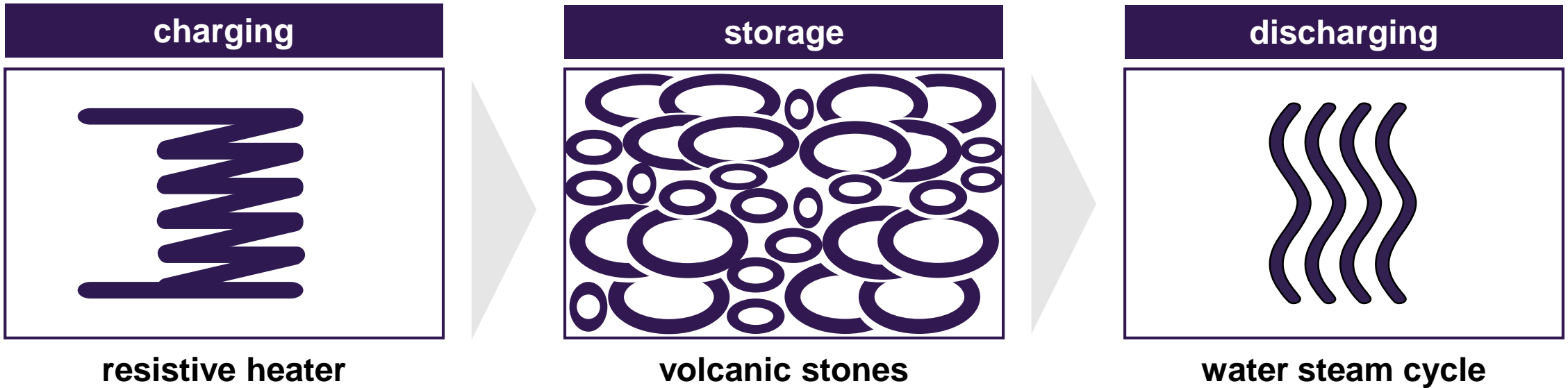


€9.1 B
Annual Revenue

GWh-scale storage solutions needed to solve majority of challenges ETES doesn't compete with MWh-scale batteries

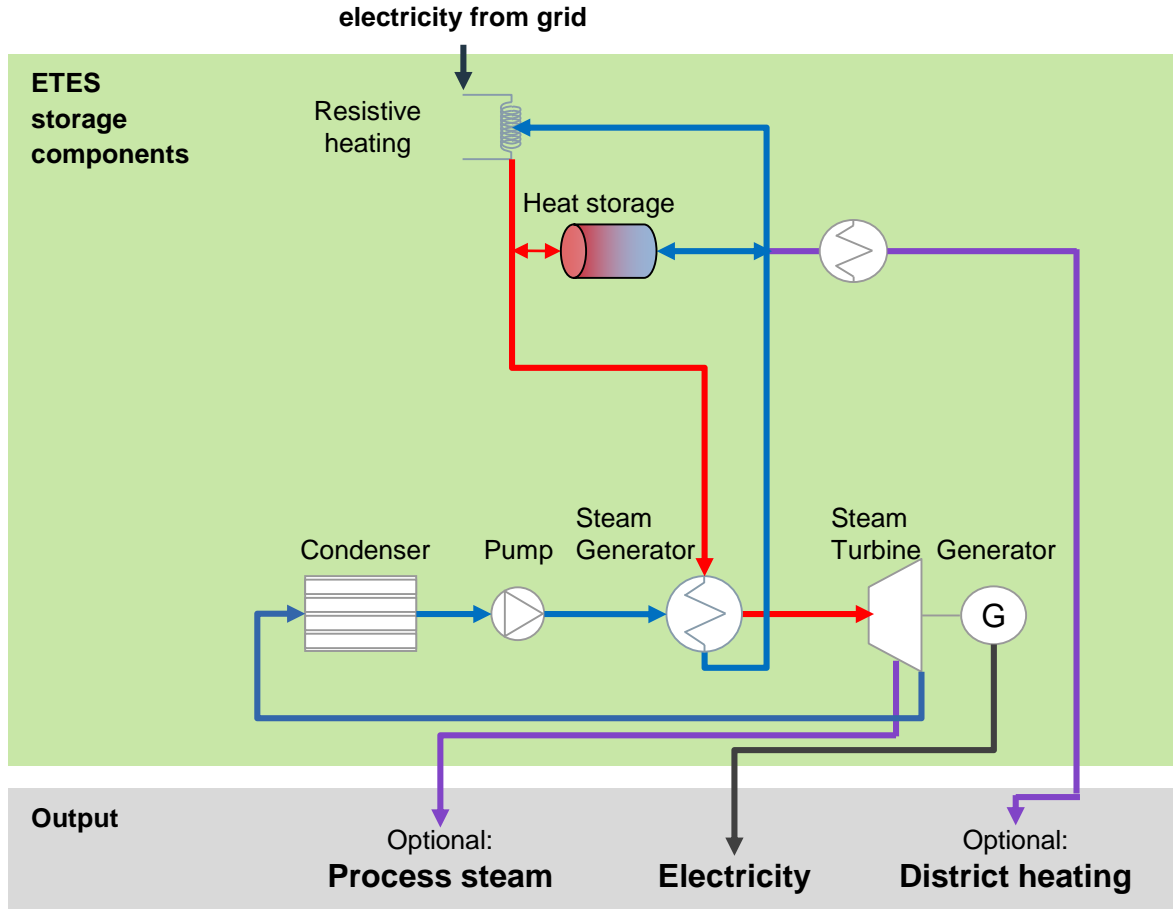


ETES base: make renewables base-load capable with 80% off the shelf components



Charging power, storage capacity and discharging power are independently scalable.

ETES base: make renewables base-load capable with 80% off the shelf components



Power-to-heat-to-power technology

- Charging cycle: non-pressurized **air-cycle** with
 - **Resistive heater** to convert electricity into heat
 - **Blower** to move the air through the storage
- **Heat storage:** pebble bed heat storage
 - Volcanic stones store heat
 - Insulated containment
- Discharging cycle: conventional water-steam-cycle
 - **Heat recovery steam generator** generates steam from hot air
 - **Steam turbo generator** to generate electricity
 - Auxiliary equipment (condenser, pumps etc.)

— Electric energy — Medium temperature — High temperature — Low temperature

ETES switch: Converting a conventional power plant into an emission-free storage facility



ETES switch

- Second-life option for conventional power plants
- Replacing boiler by steam generator
- Utilization of existing steam cycle and infrastructure
- Well known O&M processes
- Mitigation of negative effects from closing power plants
- CAPEX up to 10 times lower compared to batteries

ETES: Proven and reliable technology with 80% off-the-shelf components

Test Site



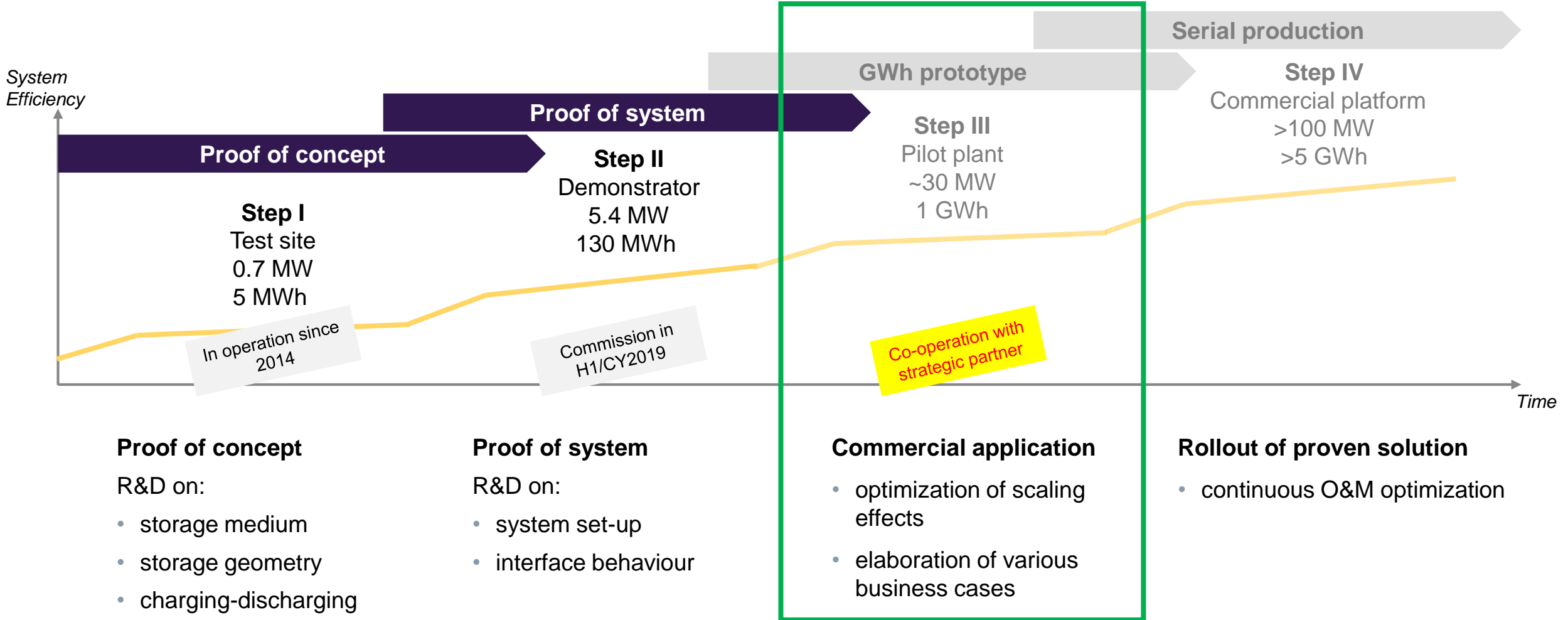
Dis-/Charging Power: **0.7 MW**
Storage Capacity: **5 MWh**
In operation since: **2014**

Demonstrator



Dis-/Charging Power: **5.4 MW**
Storage Capacity: **130 MWh**
Commissioning: **2019**

Four steps towards commercialization of ETES technology





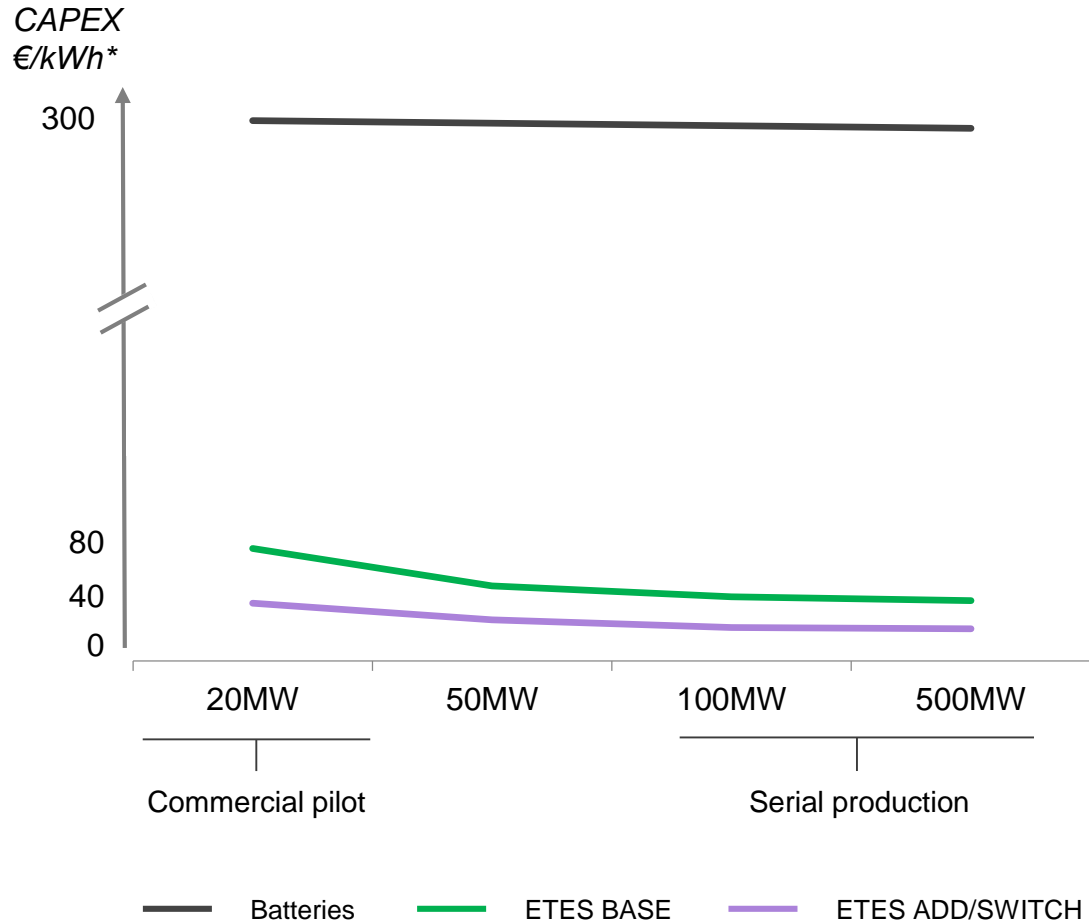
Cost-efficient

GWh-scale

Modular

Adaptable

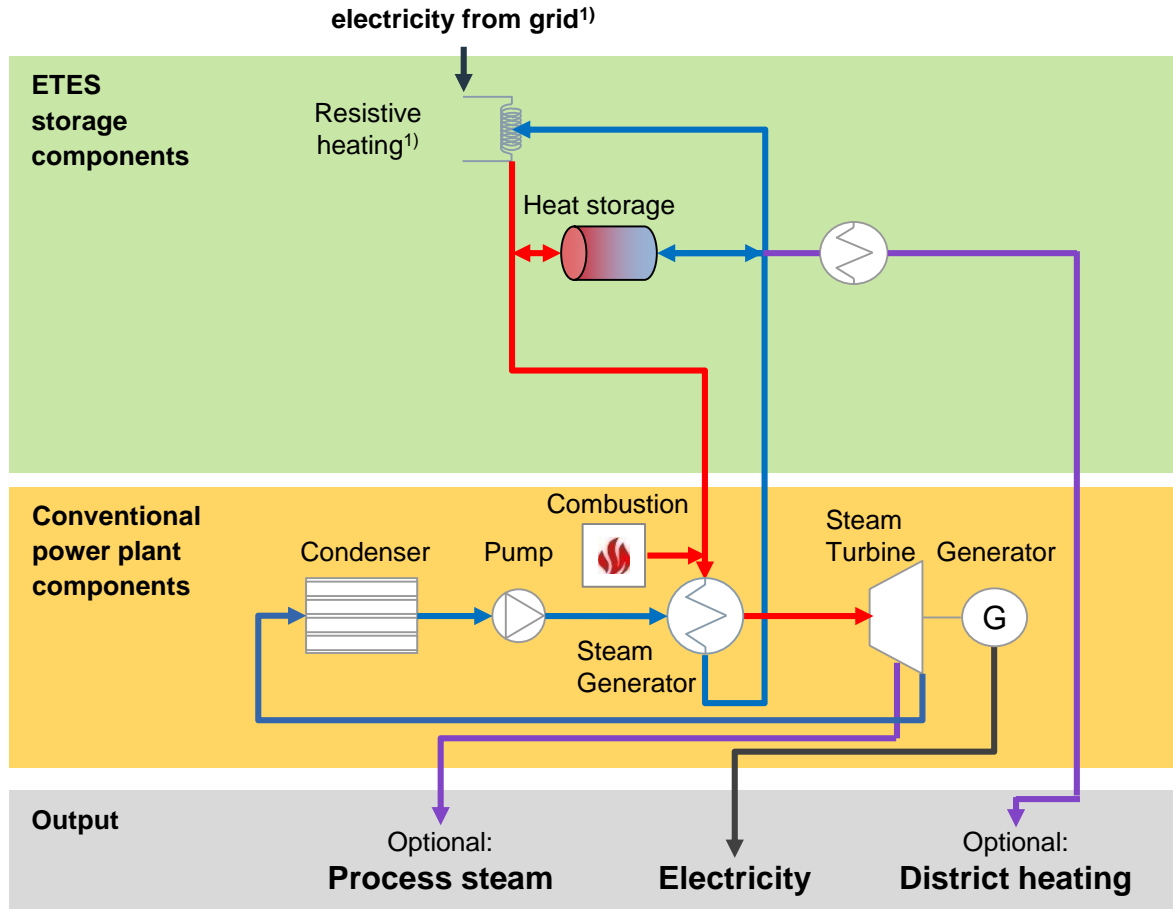
ETES benefiting from economies of scale and retrofit advantage



ETES Cost

- ETES cost **significantly lower** than classic storage solutions
- Already **commercial pilot** would be **cost-competitive** compared to **batteries**
- **Economies of scale** lead to substantial reduction in CAPEX with increasing storage rating
- Reduction of CAPEX by ~50% additionally possible with **switch concept**

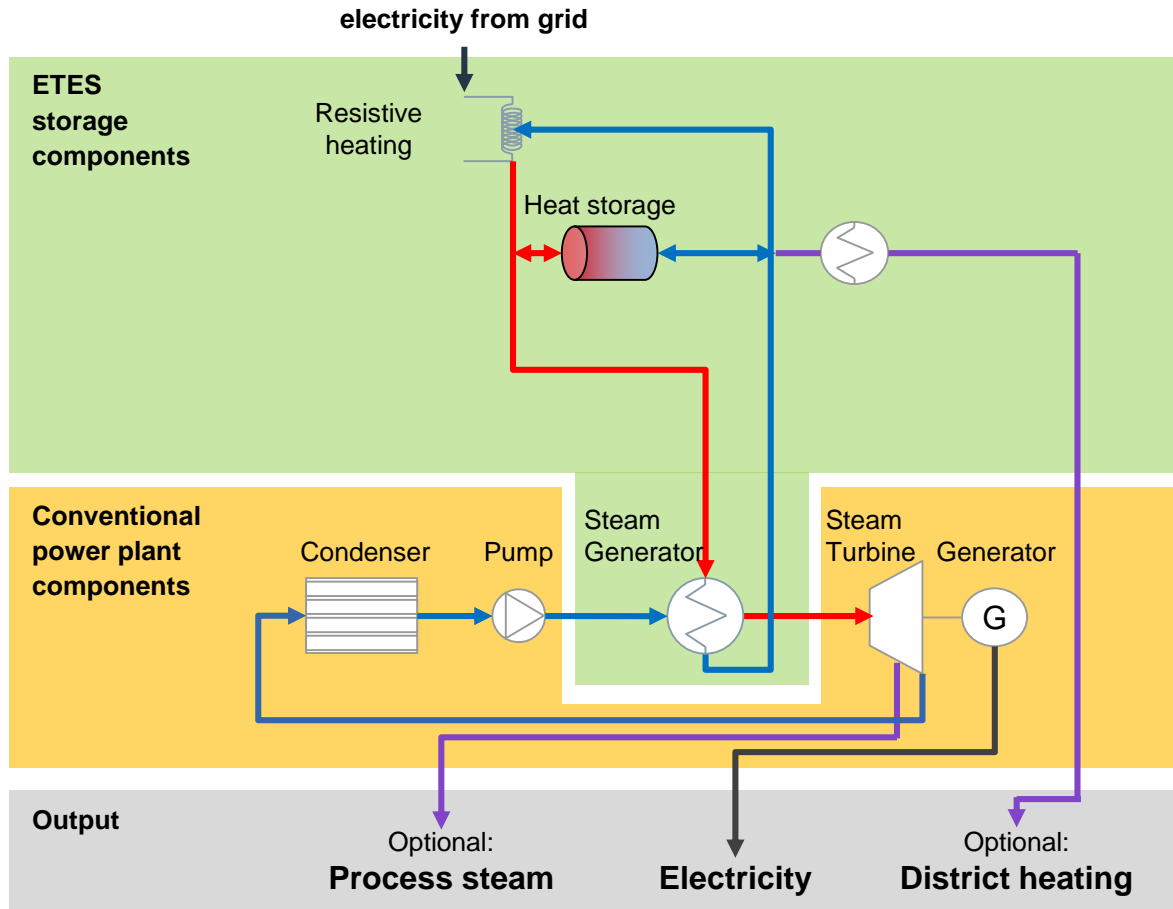
ETES add: Flexibilize power-heat coupling



Adding storage capacity to power-heat processes

- Stored heat added to existing heat cycle
- Reuse 100% of existing conventional components
- Increasing heat cycle efficiency
- Ability to control electricity and heat output independent of fuel input
- Additional revenue streams:
 - district heating
 - heat storage
 - ancillary services
 - electricity arbitrage

ETES switch: Conversion of power plant to storage plant



Transform conventional power plant infrastructure

- Second-life for power plant infrastructure
- Replacing combustion chamber by steam generator
- Utilization of existing steam cycle and O&M processes
- Mitigation of negative effects from closing power plants