Hydrogen as an energy storage technology

Jorgo Chatzimarkakis, Secretary General

Wind Europe, Annual Conference 2016

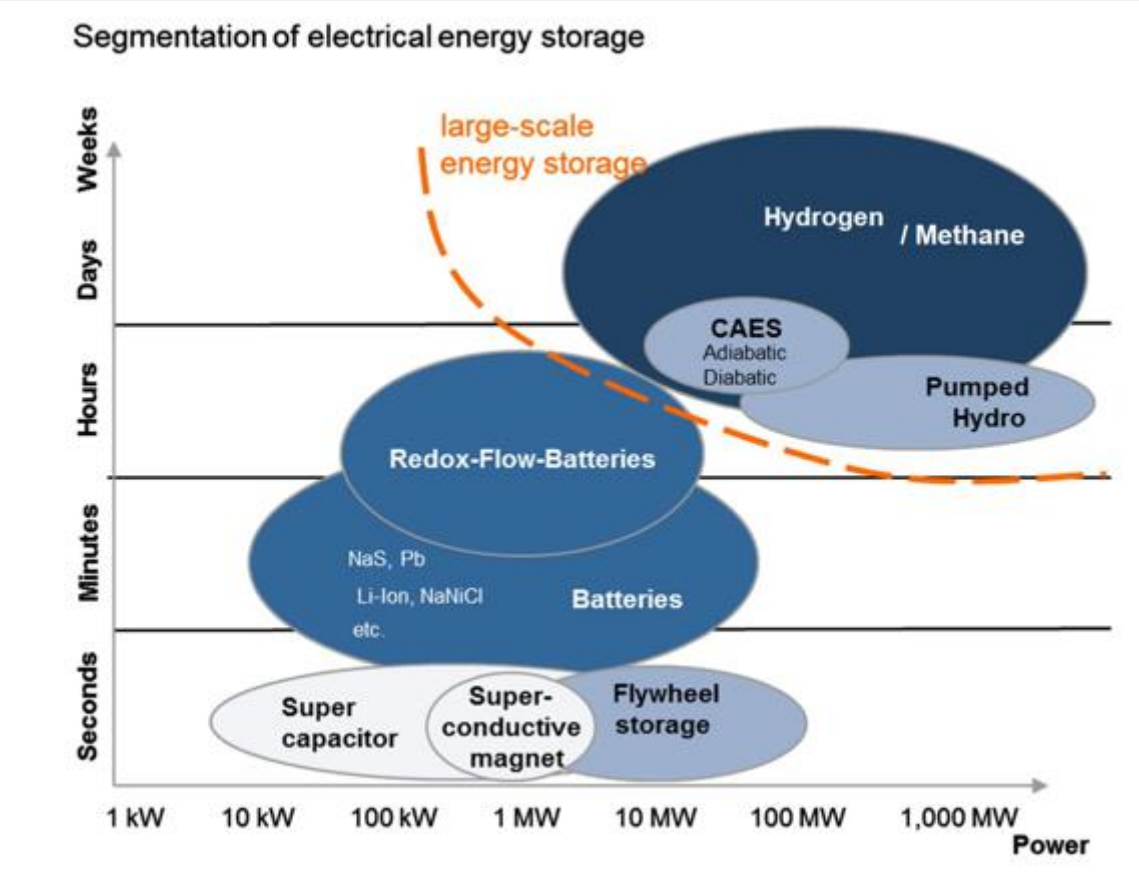
Our membership:
100 companies from 16 countries

Hydrogen Europe

Hydrogen is a flexible energy vector

- *„Water will be the coal of the future. Energy of tomorrow will be water that was split by electricity“*
  (Jules Verne, 1874)

Hydrogen compared to other technologies

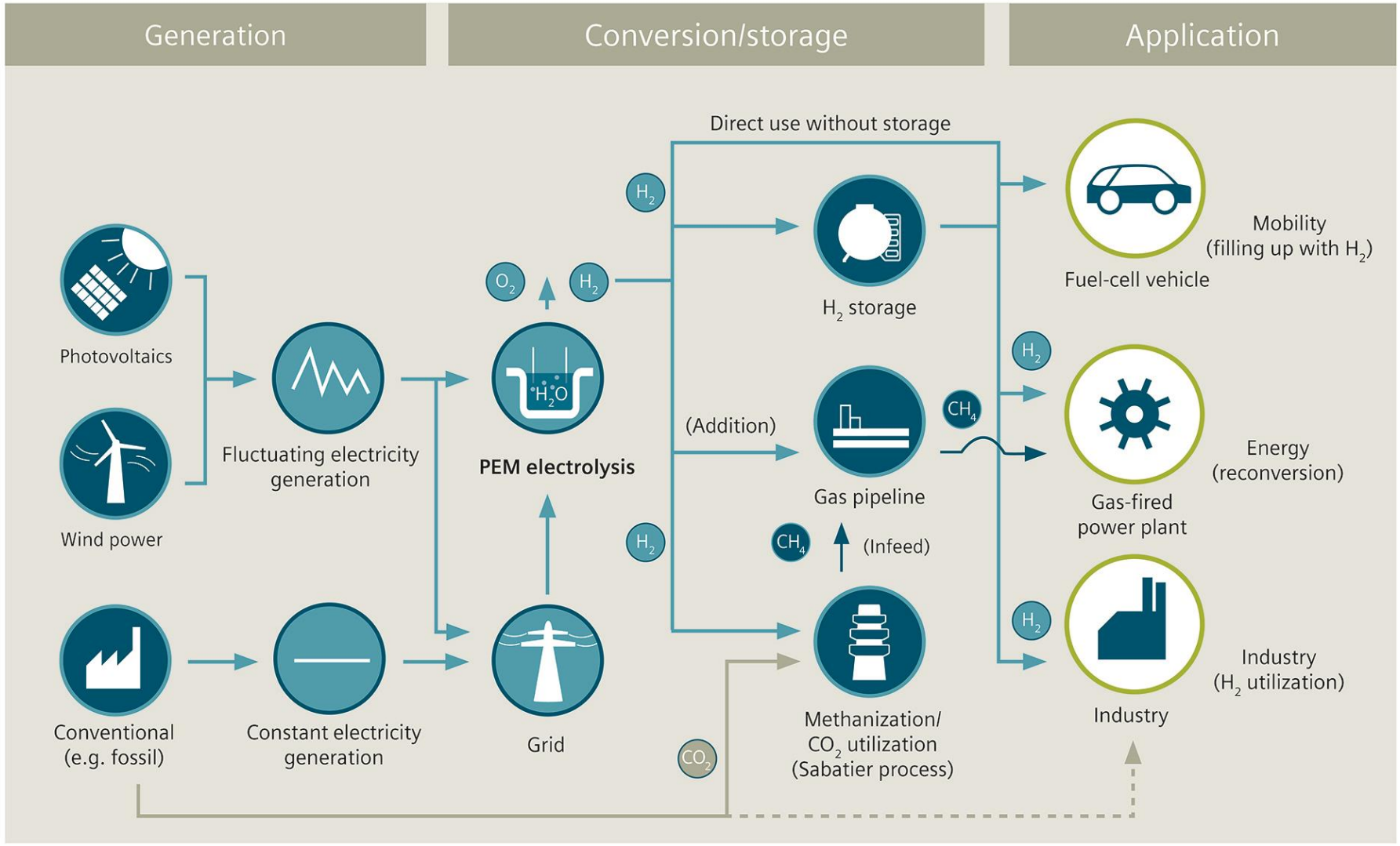


- **No universal solution for electrical storage**
- **Large scale storage only via:**
  - **Pumped Hydro,**
  - **Compressed Air (CAES)**
  - **chemical storage media (H2 / Methane)**
- **Potential to extend pumped hydro capacities limited**
- **CAES: limitations in operational flexibility and capacity**

H2 via Power2Gas only viable approach to store energy >10 GWh

Source: Siemens

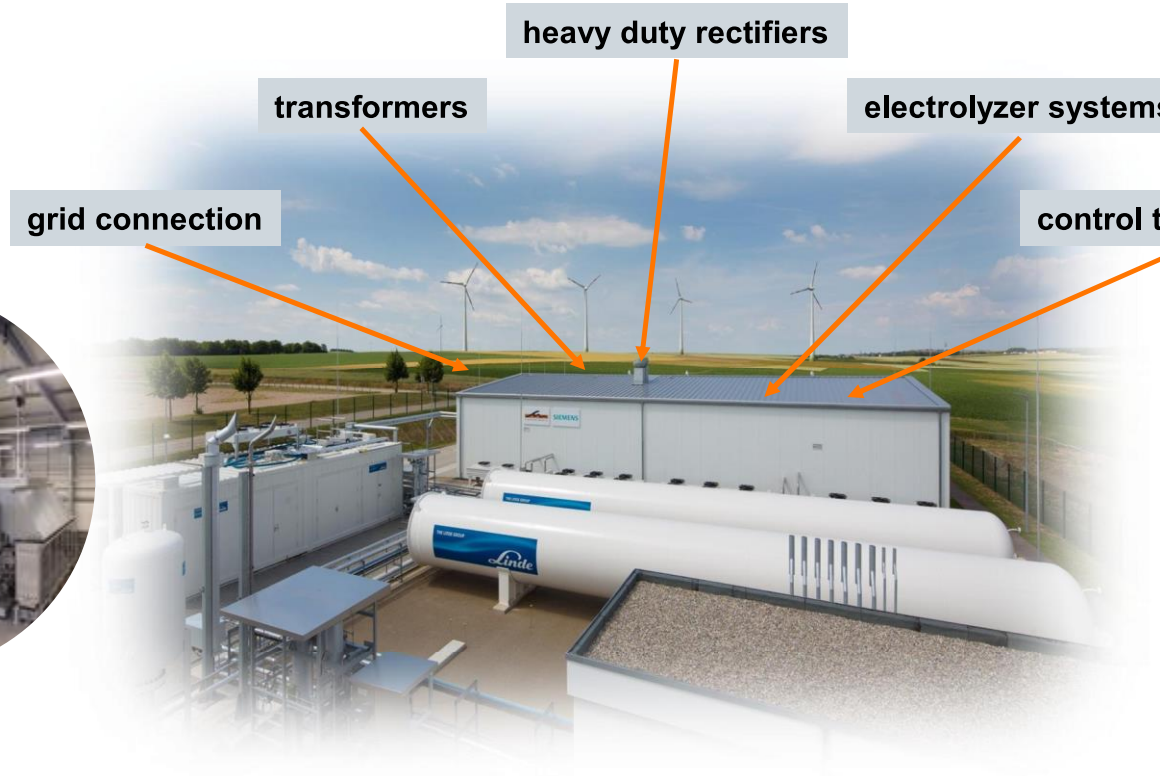
How does it work?



Applications and examples of use of hydrogen electrolysis

How does it interact with the energy system?

ENERGIE PARK MAINZ



Source: Siemens

How much does it cost?

- Need definition on EU level of storage
- Need incentives (e.g. renumeration for grid flexibility)
- Need to stop paying for inefficiency (Curtailment)
- Barriers: Storage = treated as end consumer (fees, tariffs, taxes)

European Union has to create an appropriate mechanism: RED / EMD

How much does it cost?

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Hydrogen generation cost according to DVGW/NOW study:

Application	Single use 20 €/MWh$_{el}$ 2,000 h/a	Multiple use 20 €/MWh$_{el}$ 2,000 h/a	Multiple use 20 €/MWh$_{el}$ 4,000 h/a	Multiple use 20 €/MWh$_{el}$ 4,000 h/a Improvements efficiency & cost	Reference price w/o tax and apportionment
Industry	7.54 €/kg	7.47 €/kg	4.49 €/kg	3.30 €/kg	**2.13 €/kg** *260 ¥/kg*
Mobility	11.65 €/kg	7.47 €/kg	4.49 €/kg	3.30 €/kg	**5.96 €/kg** *750 ¥/kg*
Gas Grid	21 Ct/kWh	19 Ct/kWh	11 Ct/kWh	8 Ct/kWh	**3-4 Ct/kWh** **(9 Ct/kWh biogas)** *4-11 ¥/kg*

Conclusion: Mobility and Industry are the first markets for green H2!

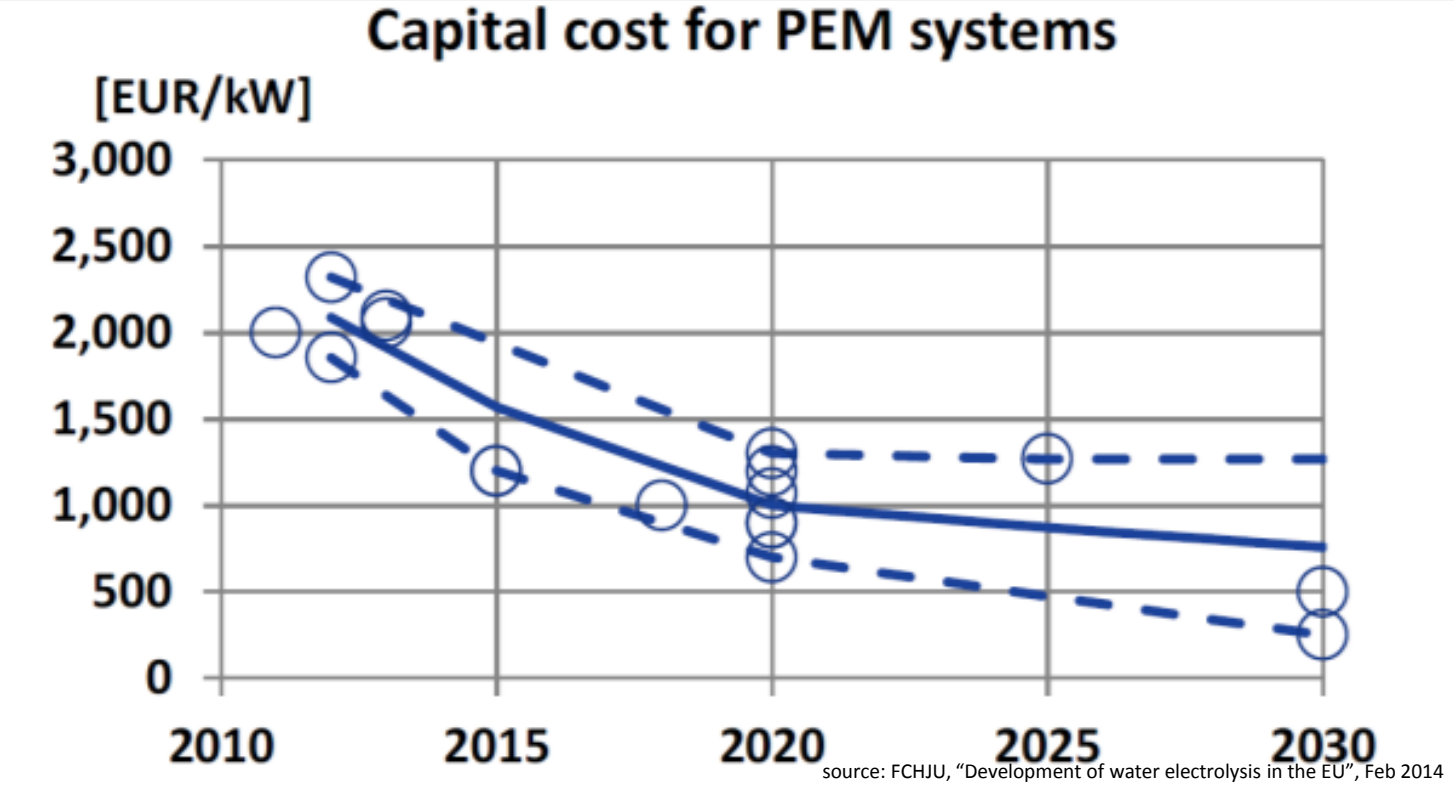
How much does it cost?

Electrolyser costs are falling:

- Business cases (e.g. refinery)
- Rewarding grid flexibility
- Avoiding curtailment
- „Greening“ gas

Sector Coupling

How much does it cost?



source: FCHJU, "Development of water electrolysis in the EU", Feb 2014

2016: 1200 € / KW

2018: 700 € / KW

Once installed, how dispatchable is it?

- **Electrolysers = excellently dispatchable**
- **respond up or down (0-100% in <1s, 100-0% in <1s)**
- **provide grid services at all timescales**
- **primary, secondary, tertiary control power**
- **low-carbon grid balancing (unlike conventional methods)**

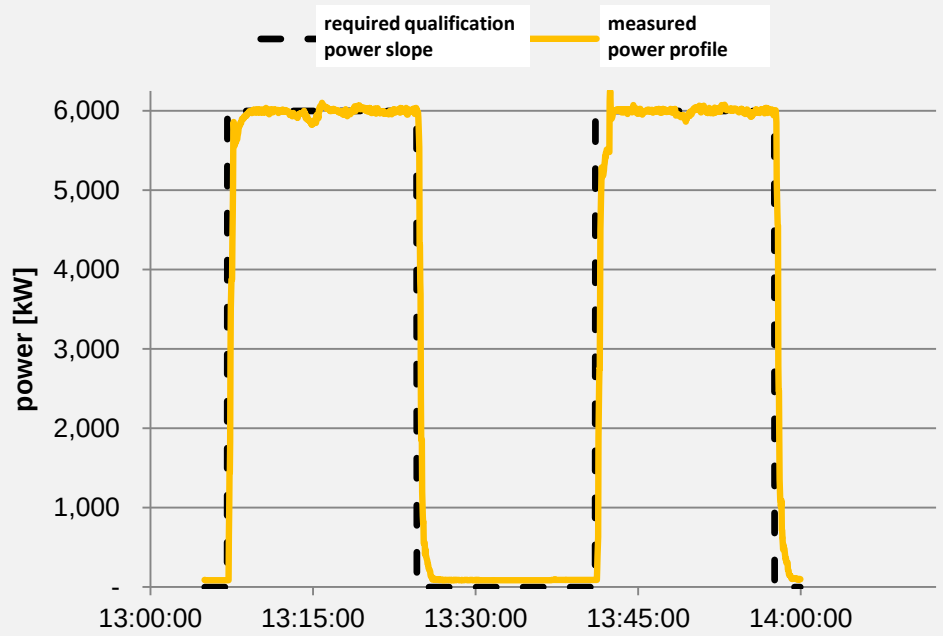
Source: ITM Power

Once installed, how dispatchable is it?

Energiepark Mainz

Qualification for grid services

participation control power market started in Q2 / 2016

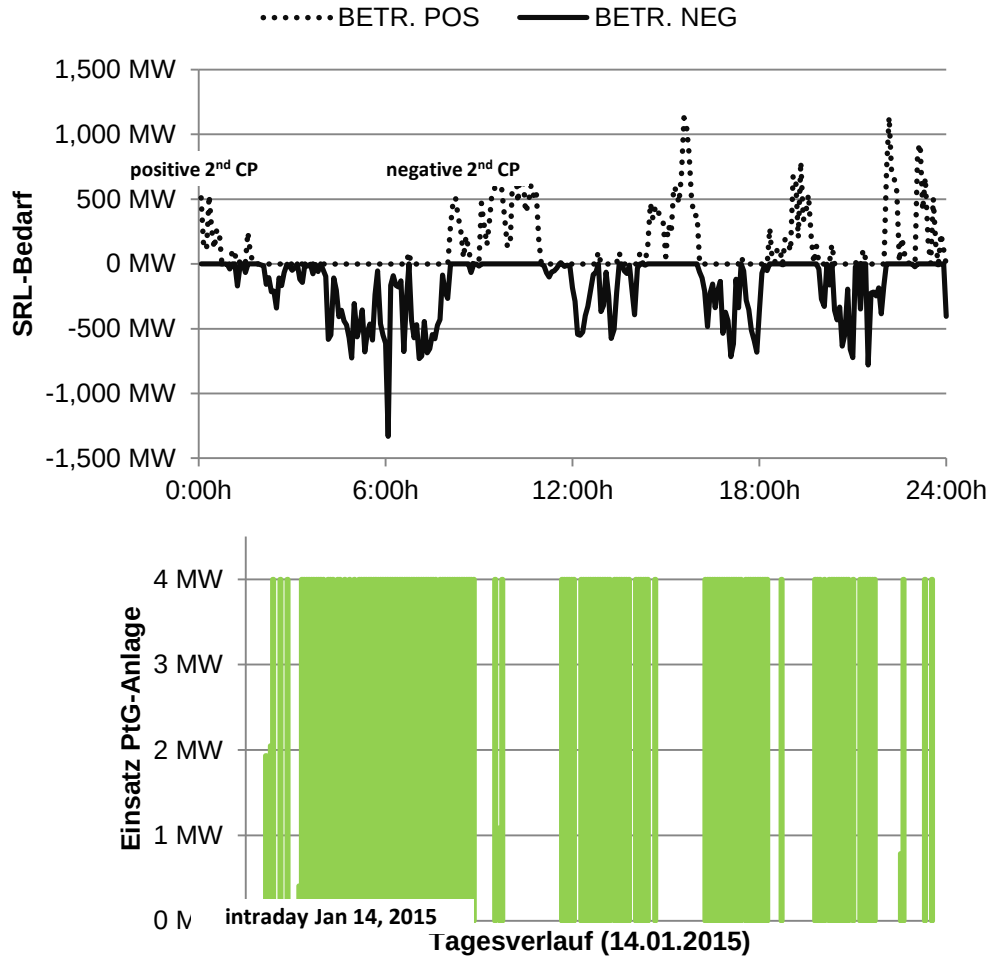


source: own measurements Energy Park Mainz

demand in 2nd control power

operation of PtG plant

Demand in secondary control power (2nd CP) and conceivable use of a PtG plant



How ready is it for large scale deployment?

Electrolyzer technology changing due to new requirements

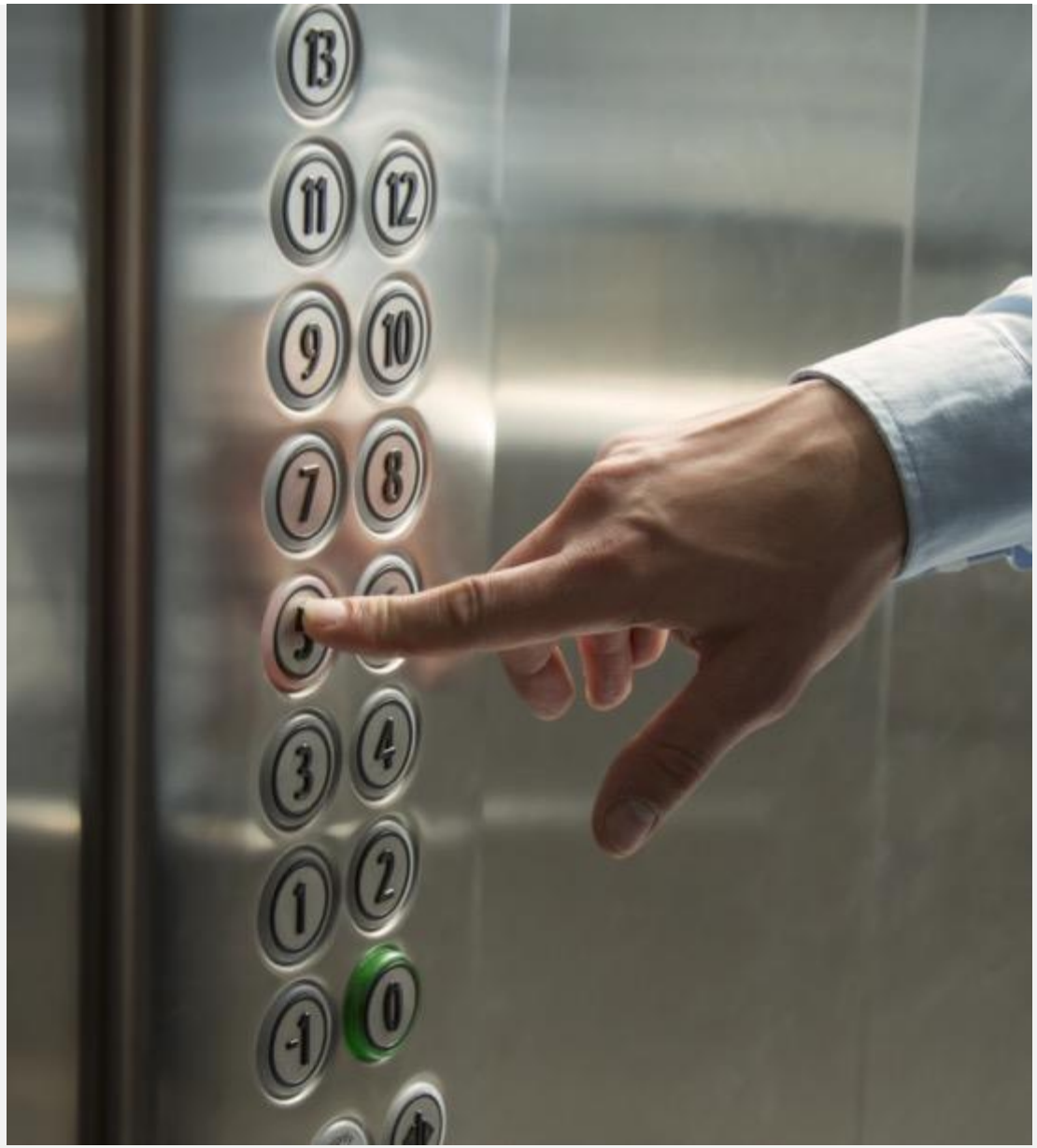
grid

Yesterday	Today	Tomorrow
• demand driven	• Flexiblity for RE	• smart grid

electrolysis

- **Industry can address volume/cost requirements for future.**
- **Capacity for a large scale deployment given!**

Elevator pitch



- CO_2-reduction targets clearly linked with RE.
- Require storage capacities in the TWh-range.
- H2 via Power2Gas = only viable approach to store energy >10 GWh.
- H2 = multifunctional: it can be re-electrified, but also shifted to the industry or mobility sector ("sector coupling").
- Power2Gas - via electrolyzer - increases the flexibility of the electric grid.
- Sector coupling will be essential to reach CO_2 reduction targets.

Hydrogen: The time has come!

- *„Nothing is more powerful than an idea whose time has come.“*
  (Victor Hugo, 1870)