



elestor

electricity  
storage

# electricity storage at an unrivalled cost level

The enabling technology for a 100% decarbonized electricity supply

# Launching a technology

- For large scale, stationary electricity storage
- Applications:
  - Combined with large PV and Wind
  - Substitute for peaking power plants
  - Connection with hydrogen infrastructures
- Fully modular, up to GW/GWh range
- Based on:
  - Flow battery technology
  - Active materials: Hydrogen & Bromine
- Patented worldwide



ELESTOR'S MISSION:

Targeting the lowest possible storage costs per MWh

# Targeting the lowest storage costs per MWh

$$\text{Levelised Cost of Storage (LCoS)} = \frac{\text{Total costs during the system's lifetime (€)} \quad \text{€} \text{ icon}}{\text{Total delivered energy during the system's lifetime (MWh)} \quad \text{⚡ icon}}$$

(Investment + Maintenance)

(Lifetime (cycles), Capacity (MWh), Roundtrip Efficiency (%))

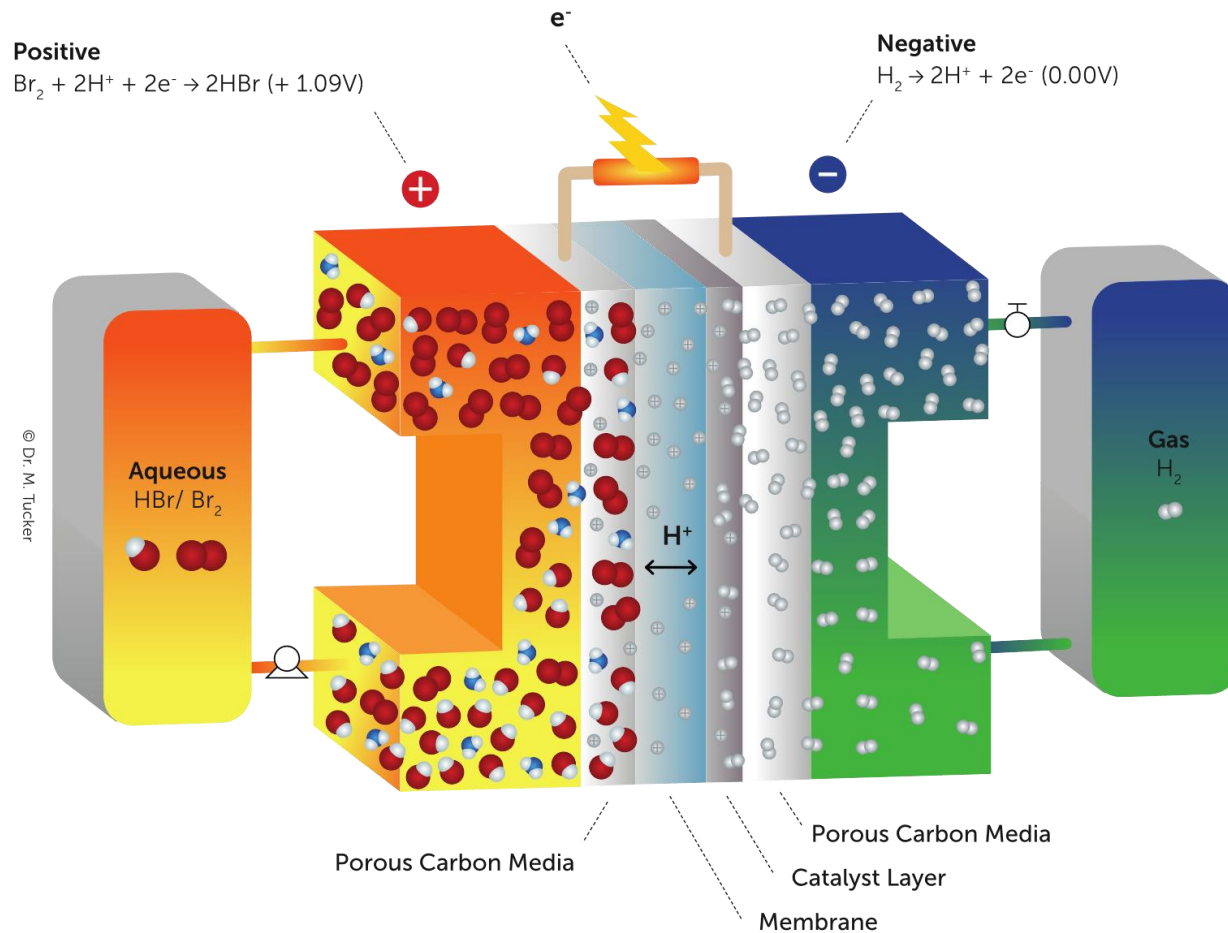
The Levelised Cost of Storage (LCoS) defines what the actual costs are to store 1 MWh of electrical energy

- Enables objective comparison of different storage technologies
- Determines storage business case viability

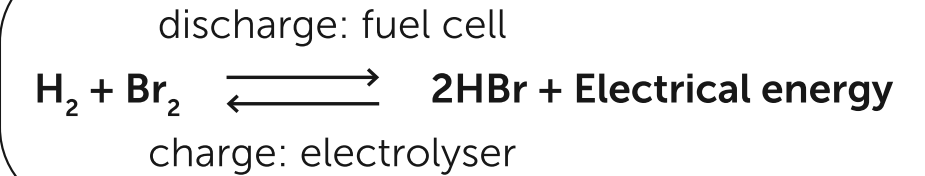
FACT:

The LCoS is decisive for the impact of storage on the energy transition

# Technology: Combined Electrolyser and Fuel Cell



© Dr. M. Tucker



Power and Capacity are not coupled

- Membrane surface area → Power [MW]
  - Active material volumes → Capacity [MWh]
- Virtually every thinkable combination is possible*

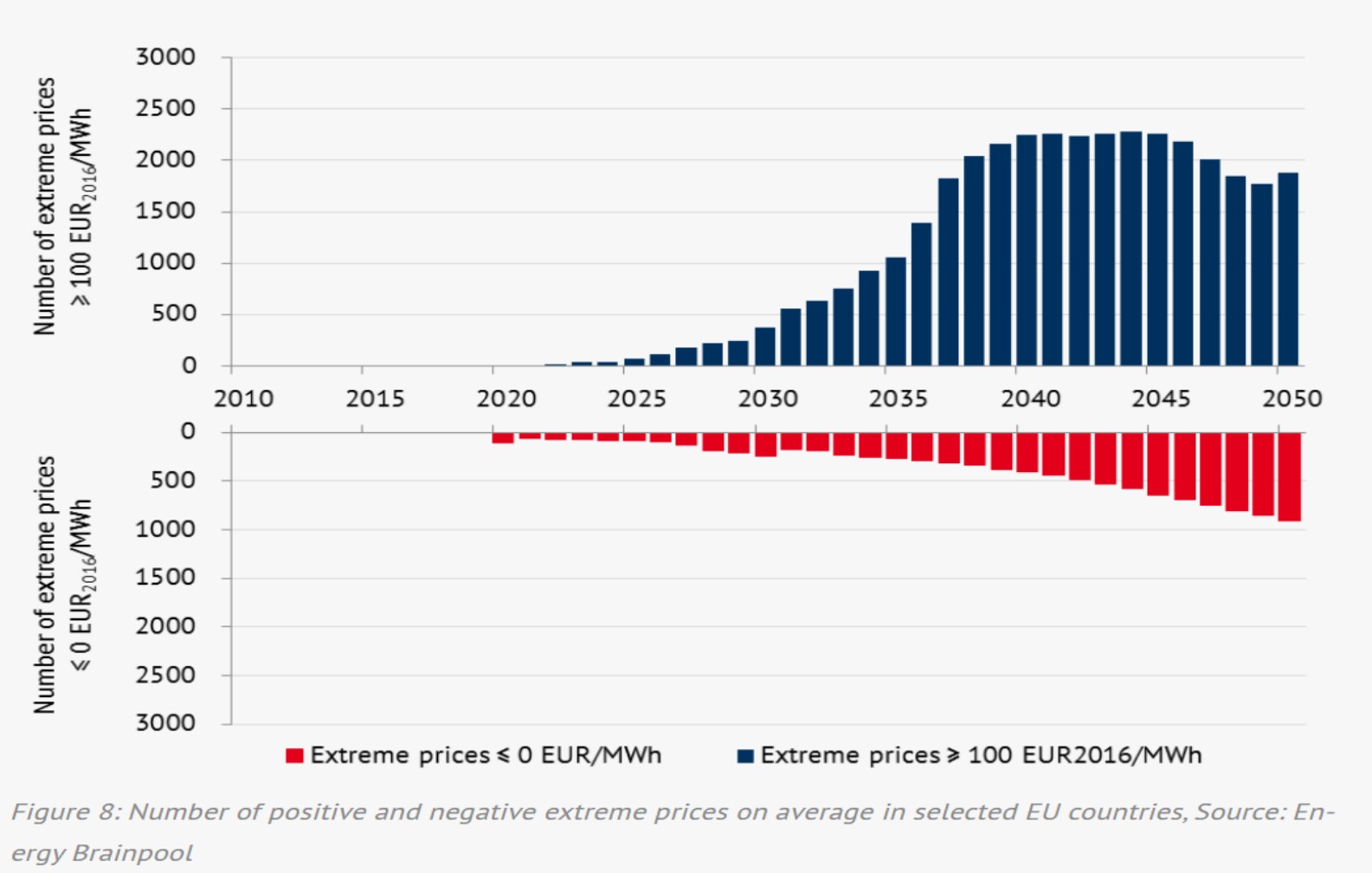
100% reversible chemical reaction

- Chemicals are used, not consumed
- No refill during lifetime necessary
- Negligible loss of capacity during lifetime

FACT:

**Reduces the LCoS to  
< € 50 / MWh**

# Implications of the transition to intermittent sources



Source: <https://blog.energybrainpool.com/en/update-trends-in-electricity-price-development-eu-energy-outlook-2050/>

# Elestor's technology perfectly matched the world's changing needs ...

- With more electricity from intermittent sources, longer periods of time need to be bridged to secure availability of electricity

→ **Growing need for storage with a large Energy [MWh] versus Power [MW]**

- With conventional batteries, Power scales linearly with Energy

→ **Elestor's system allows configuration of *any desired* combination of Power and Energy**

- Product strategy:



2023  
Next generation  
system version I



2026  
Next generation  
system version II



Storage  
duration of  
**10 hours**

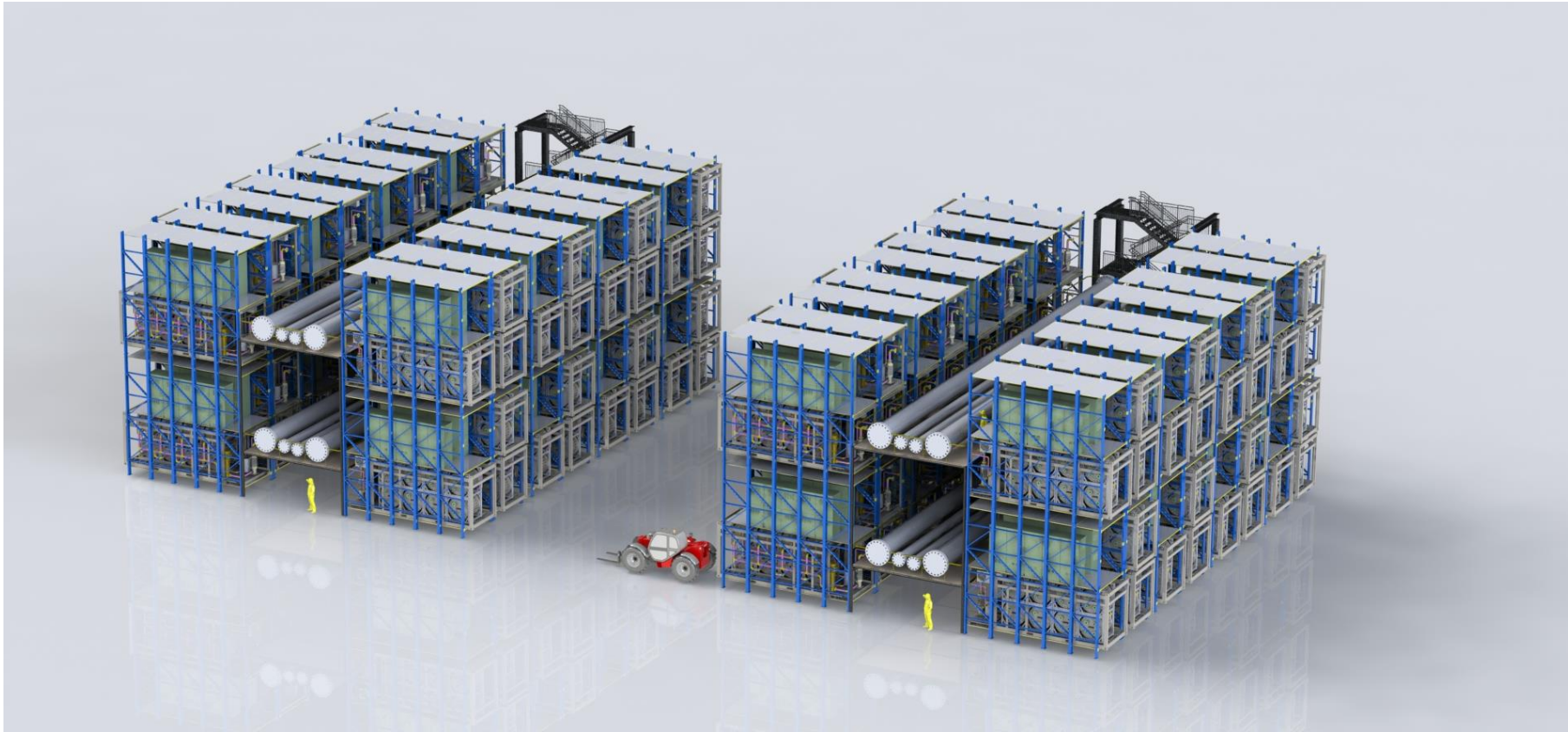


Storage duration  
between **20 to 50 hours**  
targeting solar and wind  
co-locations








(next slide)

... up to HBr flow batteries serving as Bi-Directional Power Plants  
replacing current gas peaker power plants



An in-depth analysis shows that, with the optimal combination of Sun+Wind+Storage, Elestor's technology offers the optimal economic solution for a reliable and fully decarbonized electricity supply, with 100+ hr storage duration

# Global bromine reserves are virtually unlimited, thus low cost

Material 	Global reserves (Kilotons) 	Usage (kg/MWh) 	Sufficient for ...% of required capacity 	Supply & cost constraints 
$\text{Li}^3$ Lithium Li-ion batteries	16.000 <sup>2</sup>	0,9 <sup>3</sup>	4%	<ul style="list-style-type: none"> <li>- &gt;90% of global reserves in 4 countries: Chile, China, Argentina, Australia.</li> <li>- Oligopoly, no price pressure</li> <li>- Mining creates large scale depletion and pollution of groundwater</li> </ul>
$\text{Co}^{27}$ Cobalt Li-ion batteries	7.100 <sup>4</sup>	0,2 <sup>5</sup>	7%	<ul style="list-style-type: none"> <li>- Approx. 60% of global reserves in 1 country: Congo, extreme geographic dependency</li> <li>- Mined under torturous labour conditions</li> </ul>
$\text{V}^{23}$ Vanadium Vanadium Redox Flow	20.000 <sup>7</sup>	4,4 <sup>8</sup>	1%	<ul style="list-style-type: none"> <li>- 85% of the global supply comes from China, Russia, South Africa</li> <li>- Cost increased &gt;400% from US\$ 13.50/kg in 12-2015 to US\$ 68/kg in 5-2018</li> <li>- 90% of the Vanadium supply is used for hardening steel</li> </ul>
$\text{Br}^{35}$ Bromine Hydrogen Bromine Flow batteries	<b>100.000.000.000</b>	<b>3,2</b>	<b>100%</b>	<ul style="list-style-type: none"> <li>+ Only 0,0016% of the global bromine reserves are sufficient for a 100% decarbonized electricity supply</li> </ul>



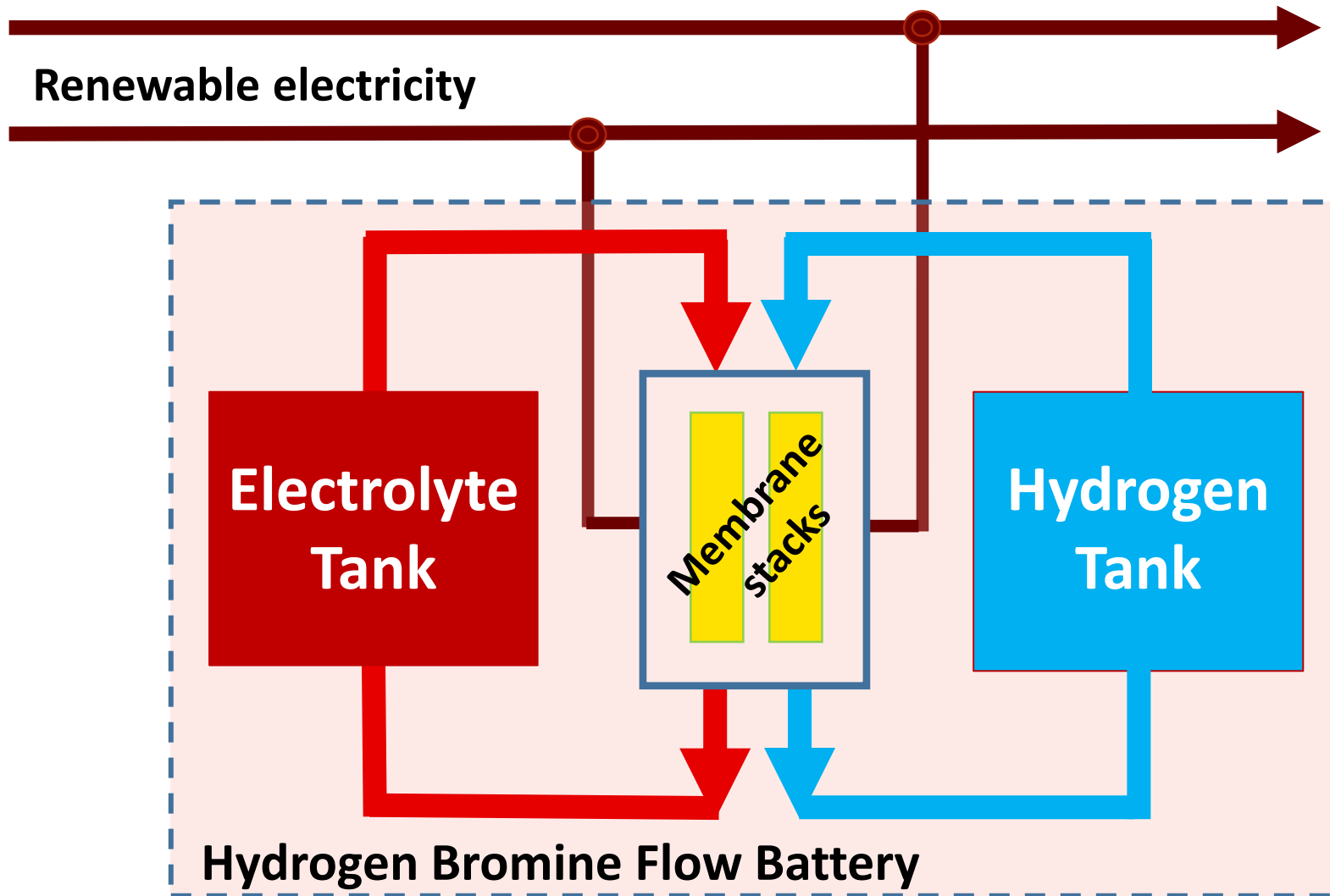
# The Hydrogen Bromine Flow Battery connects

Electricity Storage



Hydrogen Infrastructures





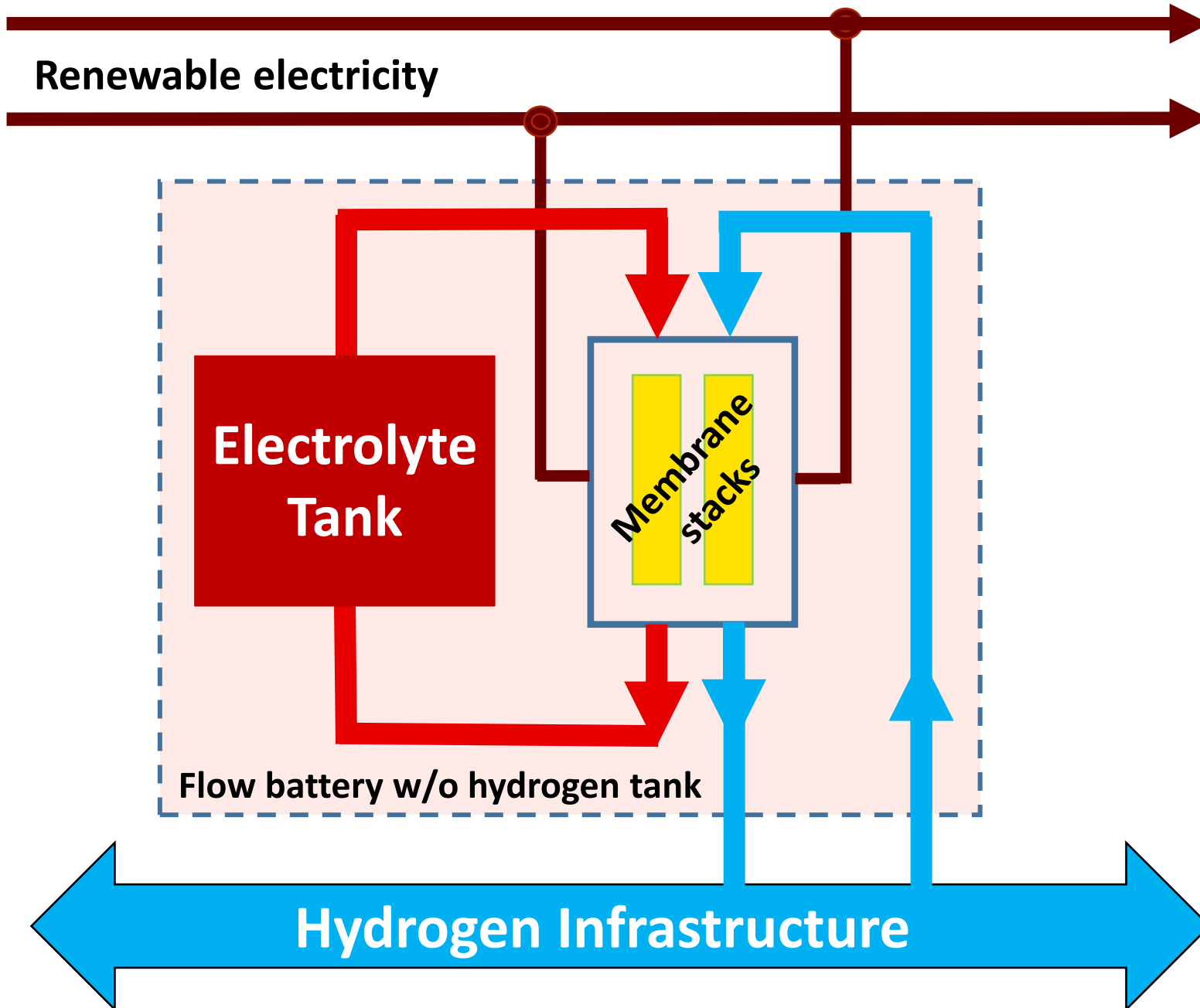
✓ Electricity storage based on Hydrogen Bromine Flow Battery technology

✓ Consists of

- Electrolyte tank
- Hydrogen tank
- Membrane stacks

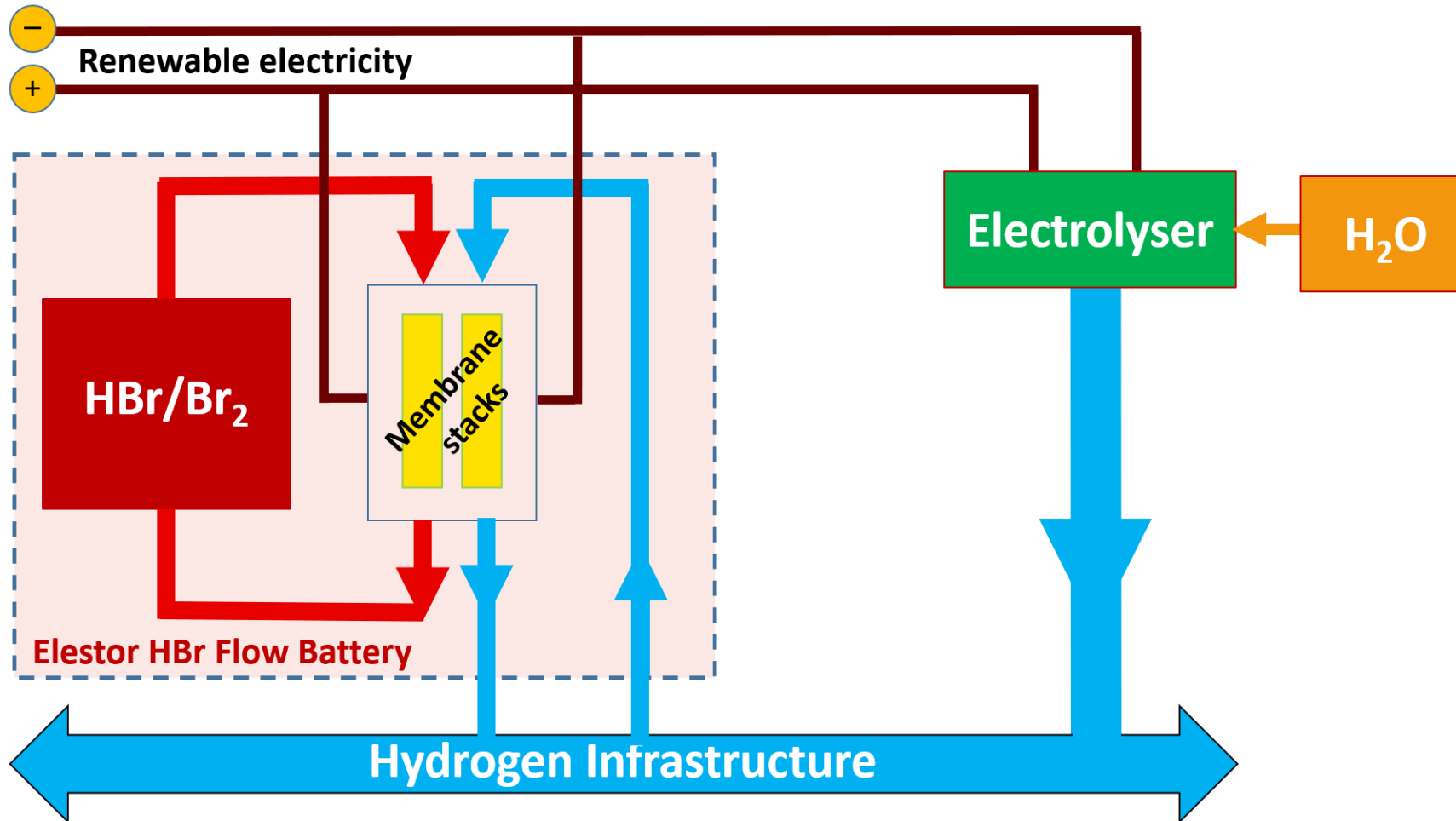
✓ Enables

electricity storage at very low cost (LCoS)



- ✓ Connects  
electricity storage with hydrogen infrastructures
- ✓ Hydrogen infrastructure  
serves as 'hydrogen tank' (with zero effect on infrastructure)
- ✓ Reduces
  - 1) Battery capex
  - 2) Storage costs
  - 3) System size
- ✓ Introduces  
new optimization options

# Integration with electrolysers



- ✓ **Integrates** electricity storage & hydrogen production
- ✓ **Maximizes** electrolyser utilization
- ✓ **Reduces**
  - Capex flow battery
  - Hydrogen production costs
- ✓ **Reduces** storage costs per kWh (LCoS) *further*

# About Elestor



# Management



**Guido Dalessi (60)**  
CEO

- Graduated in Physics
- Demonstrated history in developing companies from startup to established global players
- Former CEO of Singulus Mastering BV, subsidiary of Singulus Technologies AG, Germany
- Early investor in Elestor BV



**Wiebrand Kout (44)**  
Founder & CTO

- High level of expertise of 3 hydrogen electrochemical systems:
  - PEM Fuel cells
  - Electrochemical hydrogen compressors
  - HBr flow batteries
- Head of Mechanical Design at Nedstack
- COO and Lead Designer at HyET



**Hylke van Bennekom (38)**  
COO

- Industrial Business Administration
- Background in PV and semicon
- Experience in high volume manufacturing of advanced technologies
- Broad international experience in strategic sourcing, establishing production locations in Europe & Asia
- Joined per April 12, 2021 (MBI)

# Team



## The Team

- International team (26 FTEs) of Scientists & Engineers, combined with broad Business Development experience
- 1 PhD candidate graduated in 2020 at Technical University Eindhoven, Dept of Membrane Materials and Processes (MMP),
- Prof. Dr. Kitty Nijmeijer.
- A second PhD candidate to promote in 2022
- 8 different nationalities
- Member of the European 'FlowCamp' consortium, led by Fraunhofer Institute, Germany
- Deep tech know-how on: Catalysts, Electrodes, Membranes, Electrolytes, Cell stacks, Control & power electronics, System architecture, Compliancy
- > 100,000 R&D hours since June 2014

# Ecosystem

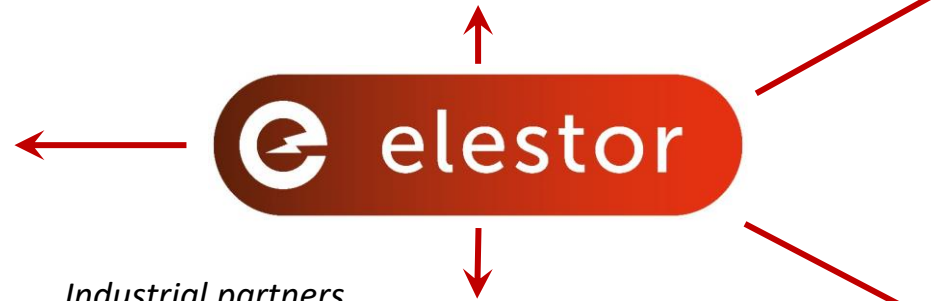
## Research partners



## Investors



## Financial partners



## Industrial partners



## Key Suppliers





# Elestor was granted several (inter)national awards

2015 **Challenge Cup for Best Pitch** InnoEnergy Benelux

2016 **Jan Terlouw Ambition Award 2016** Kiemt Congress

**Audience Award 2016** Kiemt Congress

**Sustainable Energy Startup Award** SWECO

2017 **Best Technical Development within Energy Storage** IDTechEx Europe  
(juried by Fraunhofer Institute, Technical University Berlin, Toyota Motors Europe)

2019 **Pearl of the Region** The Economic Board

2020 **Best Poster Award** German Society for Membrane Technology

**Verbund X-Accelerator, Austria**, 1 of 6 winners out of 300+ participants

2021 **Innovation 2020 Audience Award** Chamber of Commerce

**Best Energy Storage Solutions Provider 2021** Benelux Enterprise Award

**TOP10 Dutch Innovation Award** Amsterdam Centre for business Innovation (University of Amsterdam)



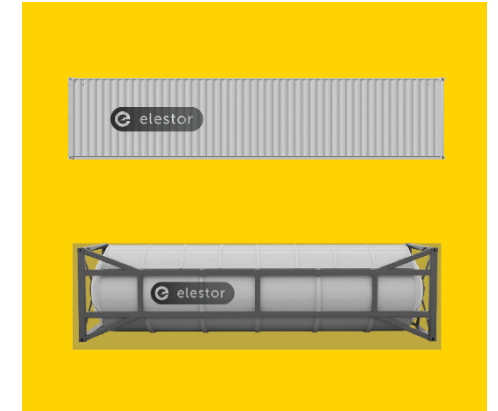
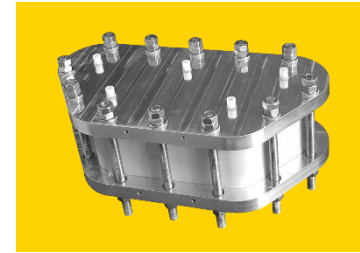
# Commercial projects

- Royal Vopak is the world's leading independent tank storage company on sea port terminals
  - Agreement signed in April 2021
  - Part of Vopak's "New Energy strategy"
  - Initially 500kW/3MWh → 25MW/250MWh scale
- A 2<sup>nd</sup> agreement with a European corporate in sight for integration with electrolysers
- Elestor preferred supplier SunCable tender, Australia, 1GWh delivery between 2024-2030
- Discussing various projects in Europe, Asia and USA



# Roadmap and perspective

- 2020-21      Deploy pre-production system (Norway)
- 50kW/250kWh
  - In-house production of stacks
  - Outsource system assembly
- 2021-22      1<sup>st</sup> and 2<sup>nd</sup> commercial deals: Vopak (+2 in pipeline)
- 500kW/3MWh, to be scaled to 25MW/250MWh
  - Automated stack production
  - Max outsource system assembly
- 2022-24      Construct and operate pilot plant for large scale automated stack production
- 2025-          Construction first 'Giga-factory' equivalent for stack production, system assembly at local markets





elestor

“We will make electricity so cheap  
that only the rich will burn candles”

Thomas A. Edison