



Hydrogen and Wind – A Winning Formula

**Wind Finland 2022**

A company in the

**Bertel  Steen**  
Group

**2.3 BEUR revenue**

2700 employees  
founded in 1901

# Bertel Steen

Power Solutions



A Rolls-Royce  
solution

Distributor since 1969

**53**  
years

Marine Propulsion



Power Generation



Service & Value Care



Svolvær



Örnsköldsvik,



Molde



Bergen (HQ)



Rubbestadneset



Stockholm



Helsinki



Copenhagen

**65 MEUR revenue (2022b)\***

190 employees

8 locations

6 workshops

45 technicians

*mtu* training centre

\* exclusive Servogear

Development of sustainable power solutions as a  
System Integrator for the Marine and Power  
Generation segments



[bospower.com](https://bospower.com)

# Harald Norvik – Chairman Bertel O. Steen Power Solutions

“

Challenges of energy transition are the new normal. Therefore, we need to look for new solutions in fuel production, such as hydrogen technology, on the way towards a sustainable energy future.

”



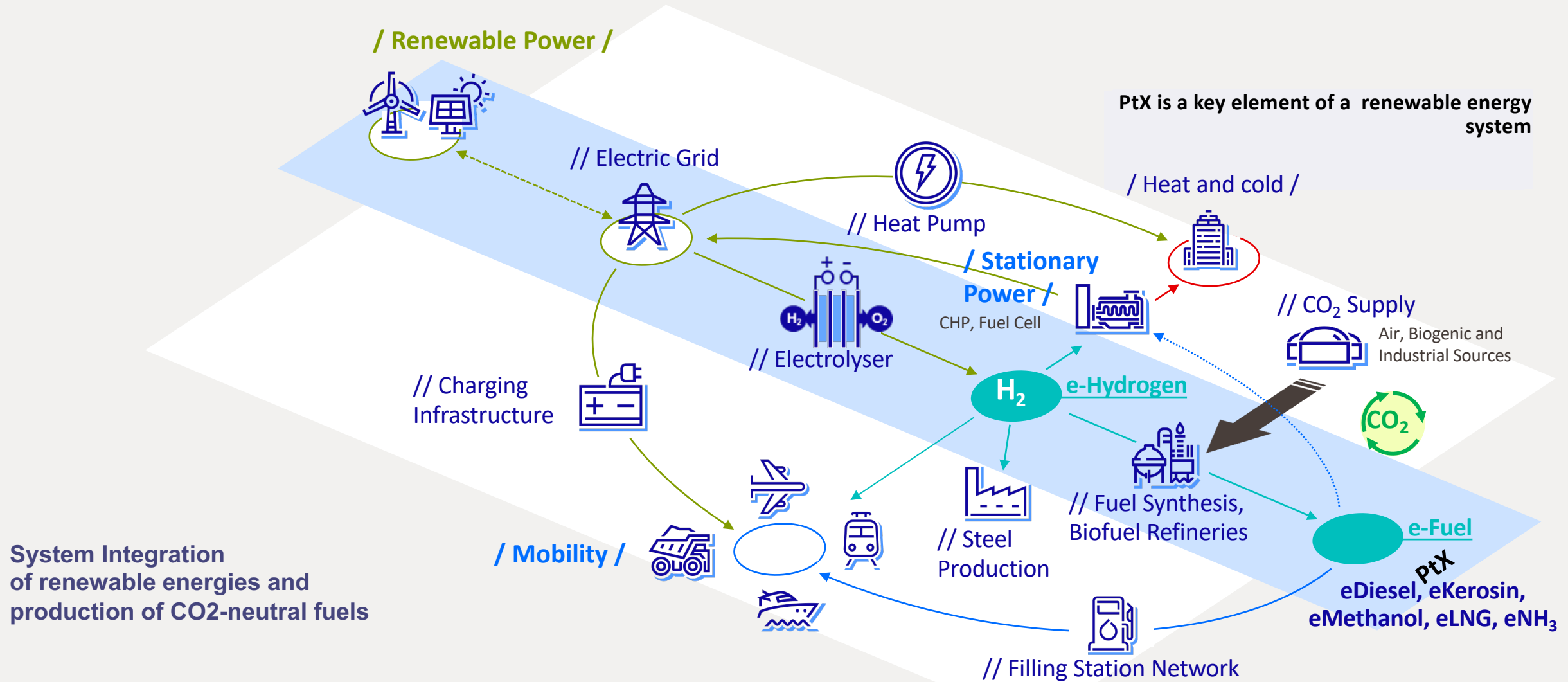
**Harald Norvik**

Chairman Bertel O. Steen Power Solutions

Former CEO Statoil, chairman of Telenor and director of ConocoPhillips



# The Power-to-X (PtX) ecosystem as a key element of energy transition



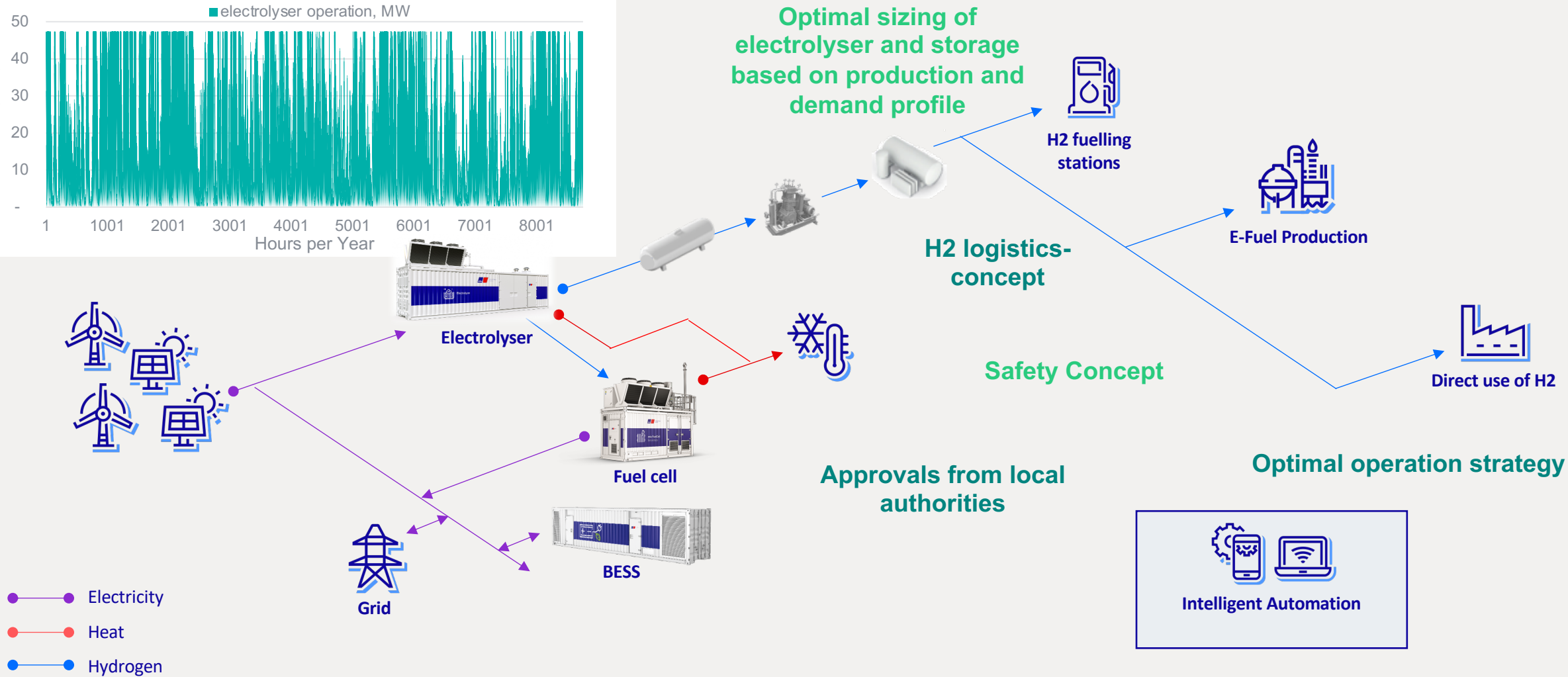
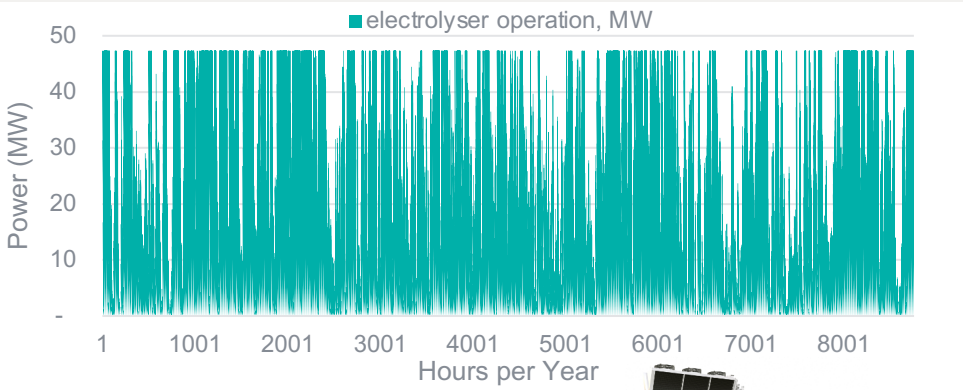


- Electricity
- Heat
- Hydrogen



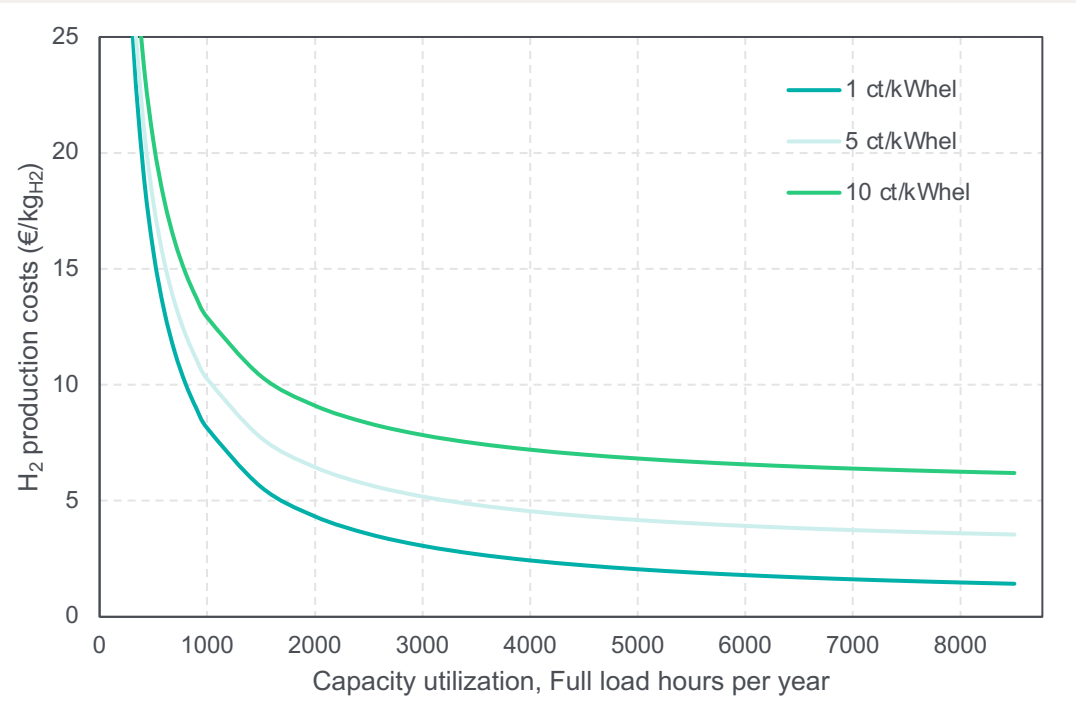
# Challenges of direct coupling of PtH2 with volatile renewable energies

## Extremely dynamic operation of the electrolyser required



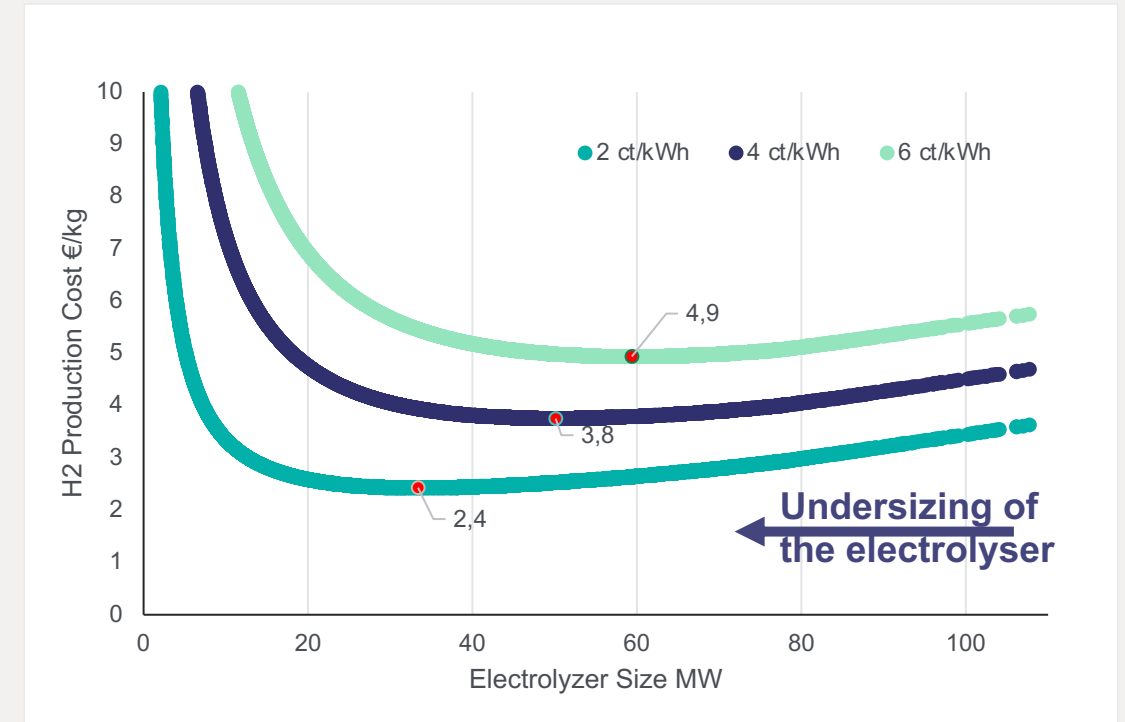
# System sizing based on detailed simulation is required

- **H<sub>2</sub>-Production costs (LCOH) decrease with higher capacity utilization**



*Generic dependency of LCOH from electricity costs and capacity utilization not taking profile of energy source into account*

- **Optimal sizing of the PtH<sub>2</sub>-system minimizes LCOH by undersizing of the electrolyser and increasing of yearly capacity utilization**

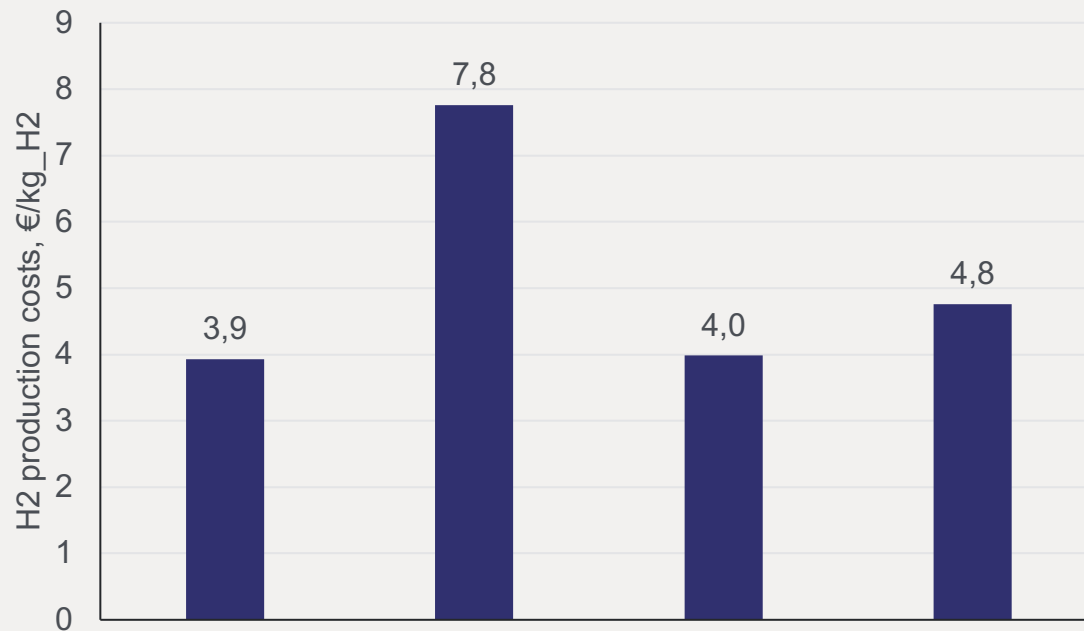


*Optimization of the electrolyser capacity for direct coupling with a hybrid Wind (75 MW) +PV (35 MW) electricity supply in Finland based on yearly profiles from the year 2021. Assumption: Surplus electricity can be fed into the grid @ 1ct/kWh.*



# Case study: Combination of Wind+Solar electricity supply can be advantageous

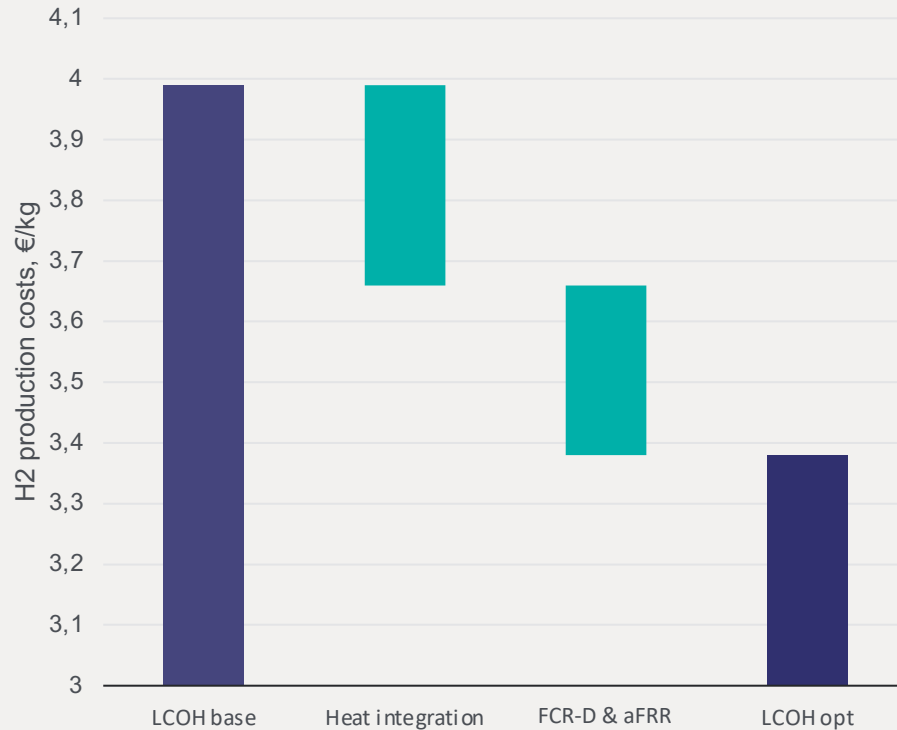
## ○ H2-Production costs (LCOH) for 4 use cases



		Wind	Solar	Wind+Solar	Grid
LCOE	ct/kWh	3,5	6	3,8	7,2
Electrolyser	h/a	4674	2001	4922	8322

- Wind is more attractive than solar in Finland (LCOE)
- Hybrid supply by Wind+Solar achieves higher capacity utilisation
- Taking the H2-demand profile into account can change the results significantly due to storage demand → More detailed analysis

# Additional revenue streams of a highly dynamic PEM electrolyser



*FCR-D+aFRR revenues are taken from: Business Finland: National Hydrogen Roadmap for Finland, November 2020.*

Possible additional value streams:

- Heat utilisation of low grade heat
- Reserve markets
- Utilisation of by-product oxygen

Arbitrage trading and reserve markets as well as highly dynamic operation can be optionally supported by battery energy storage systems

# Conclusions

- Power-to-X (PtX) is a key element of energy transition towards a zero emission future
- Direct coupling of H<sub>2</sub>-electrolysis with volatile renewable energies like wind and solar requires highly flexible PEM electrolysis technology
- PtX business cases are strongly dependent on the quality of the renewable energy source (LCOE+capacity utilisation)
- For PtX-systems a complex sizing based on detailed simulation is required to optimize the business case, taking volatile RE supply, H<sub>2</sub> demand profiles, spotmarket grid prices and revenue opportunities like arbitrage trading, frequency control and heat integration into account
- Finnish wind energy offers great chances for competitive renewable H<sub>2</sub> production



# Thank you for listening!

